

Charlotte Highway (SC 49) Corridor Study

York County
South Carolina

Prepared for



York County
South Carolina

Prepared by



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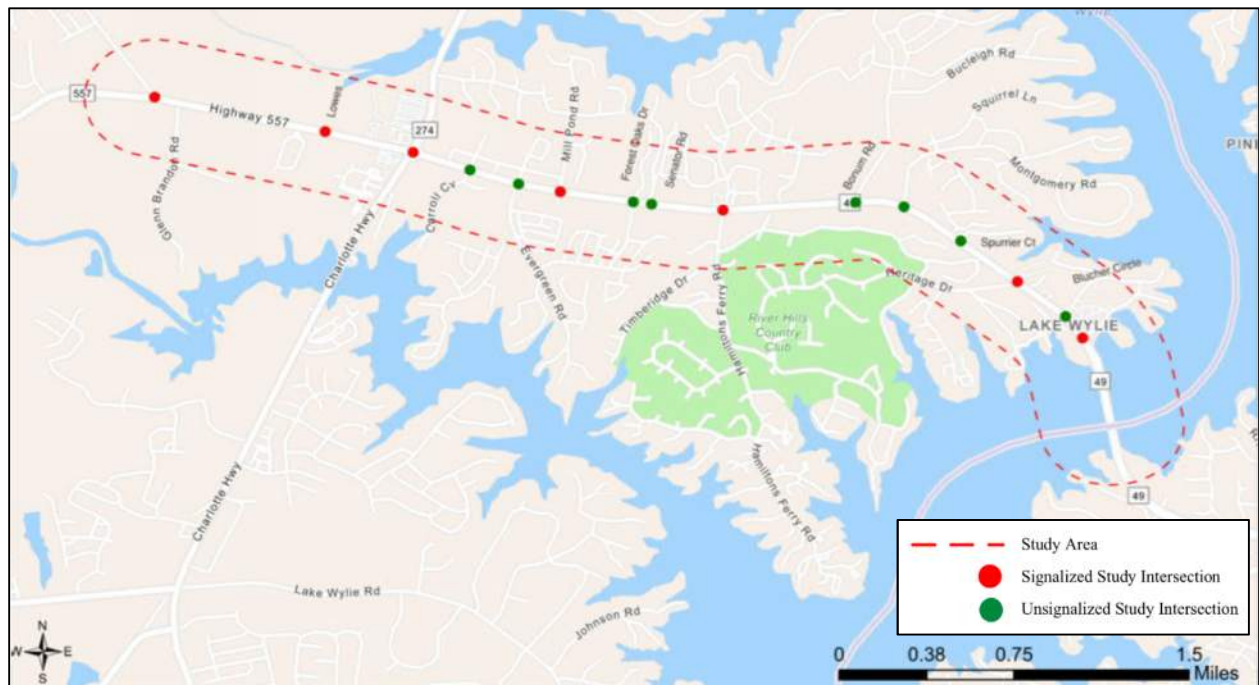
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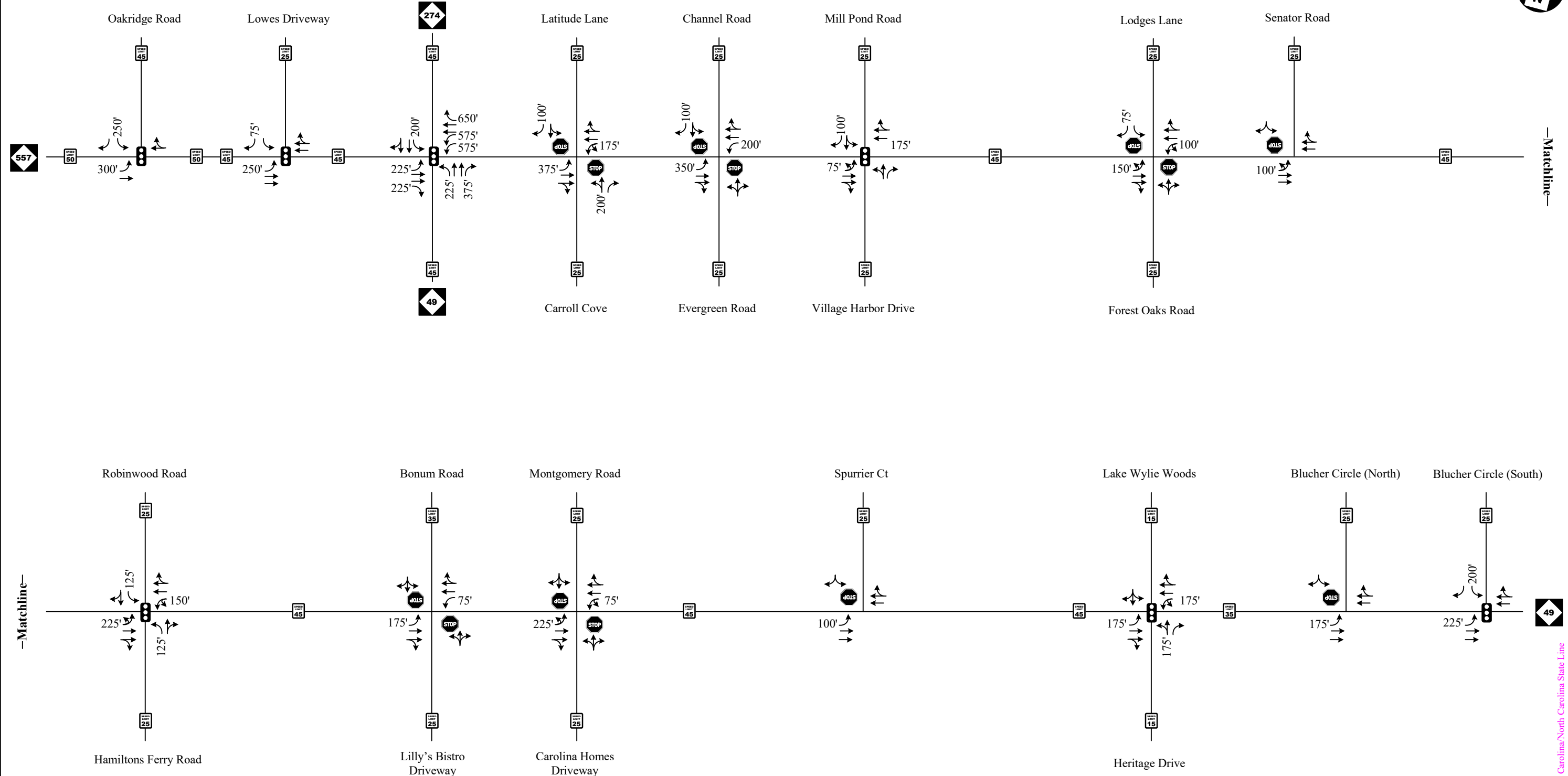
EXECUTIVE SUMMARY

The Rock Hill-Fort Mill Area Transportation Study (RFATS) is seeking a traffic operations and safety evaluation study for the SC 49 corridor from the North Carolina state line in Lake Wylie to the intersection of SC 557 and Oakridge Road. SC 49 serves as a major carrier of the heavy commuter traffic between Lake Wylie area of York County and the Greater Charlotte Region. The study corridor was identified to be experiencing recurring congestion due to heavy commuter traffic as well as non-recurring congestion due to incidents and seasonal traffic. With the anticipated growth projected in the Lake Wylie area and western York County, the local and commuter traffic (motorized and non-motorized) accessing the corridor is expected to increase in the future. This could have significant impacts to the safety conditions and operations along the already congested corridor. The purpose of this study is to identify feasible and cost-effective solutions to improve safety, mobility, and operations within the corridor constraints.

SC 49, in the RFATS study area is an east-west five-lane minor arterial roadway with a two-way-left-turn-lane (TWLTL) median type. SC 557, in the RFATS study area transitions from a 2-lane undivided (west of Bailey Lane) to a 5-lane undivided roadway (east of Harper Green Drive). This study included a total of 15 intersections. **Figure ES-1** shows the study corridor limits as well as the study intersections. **Figure ES-2** shows the existing lane configuration, posted speed limits, and traffic control at the study intersections. The base and future years for this study are 2020 and 2023 respectively.

Figure ES 1 - SC 49 Corridor Study Area





Not to scale



LEGEND

- Existing Roadway
- Existing Laneage
- ###' Storage Length
- ⓧ Posted Speed Limit
- ⓧ Existing Stop Control
- ⓧ Existing Signal Control

SC 49 Corridor Study
City of Rock Hill, South Carolina

2020 Existing Configuration

Data used in this study includes traffic data – intersection/corridor traffic, historic crashes, field observations; background projects – planned roadway projects/developments, and planning data – future transportation/land use/small area plans, Metrolina Regional Model (MRM), etc.; An assessment of the existing conditions using the MRM planning data showed that the traffic volume in the study corridor exceeds the capacity. Review of the historic crash data showed that 939 crashes occurred along the corridor between 2015 and 2019. That represents 2.71% of the 34,704 crashes that occurred within York County during the same time frame. The percentage of injury crashes occurring in the study area (20.87%) between 2015 and 2019 is lower than that occurred within York County (36.05%).

Additionally, between 2015 and 2019, the yearly injury crashes increased by 10.26% in the study area compared to 20.65% increase within York County.

Potential safety issues in the study corridor are identified as:

- Heavy congestion and stop-go conditions
- Queue spillbacks to adjacent intersections
- Inadequate gap times and gaps for the two-way stop controlled traffic, especially left turns
- Inefficient permissive left turn phases at signalized intersections

Using the historic traffic data and MRM, the annual growth rate in the study area was identified to be 3%. Comparison of the 2020 existing traffic data with the historic counts showed a 4% drop in corridor ADT (Average Daily Traffic), 29% and 21% drop in AM and PM peak hour traffic, respectively. This drop in the 2020 traffic was attributed primarily to the impact of the COVID-19 pandemic, most notably the impacts to commuter traffic during peak hours. The 2020 existing volumes were then adjusted to account for the impact of the COVID-19 pandemic using the data from historic counts, and 2020 traffic projections from previous studies. This provided volume data for 2020 under normal circumstances which projected volumes for 2023 could be based. 2023 future year volumes were estimated by applying the identified area-wide growth rate to the adjusted 2020 existing volumes. Any associated redistribution of traffic due to the background and proposed build projects was applied to develop the volumes for the 2023 future year no-build and build scenarios.

Capacity Analysis of No-Build Conditions

Capacity analysis of the no-build conditions include both 2020 base year and 2023 future year scenarios. A summary of the results is shown in **Table ES-1**, in page ix.

Capacity analysis results for the 2020 base year no-build conditions showed that all the study unsignalized intersections along the SC 49 corridor operate under LOS “E” or worse, and all the study signalized intersections operate under acceptable LOS (LOS “D” or better). Of the 15 study intersections, mainline turn lane queues (on SC 49) spillback to the adjacent lanes at four signalized intersections. These include the SC 49 intersections at Heritage Drive, Hamiltons Ferry Rd/Robinwood Road, Mill Pond Road/Village Harbor Road, and SC 274/SC 557.

For the 2023 future year no-build scenario, the study corridor included the improvements made from York County Pennies for Progress. Capacity analysis results for this scenario showed that all the study unsignalized intersections on SC 49 are projected to operate under LOS “E” or worse. All study signalized intersections on SC 49 are projected to operate under acceptable LOS except the SC 49 intersections at Mill Pond Road/Village Harbor Drive and SC 274/SC 557. At Montgomery Road, Bonum Road, and Evergreen Road/Channel Road, the projected delay is beyond the computation limits of the Highway Capacity Manual’s (HCM) delay equation. This implies that significant delays are projected for the yielding traffic (mainline left turns from SC 49 and side street traffic) at these locations. Of the 15 study intersections, mainline turn lane queues on SC 49 are projected to spillback to the adjacent lanes at all the study intersections except at Oakridge Road, Lowes Entrance, and Spurrier Court.

Mainline turn lane spillbacks on SC 49 at the signalized intersections are primarily due to the inadequate gaps for the left turning traffic during the permissive phase (where left turning traffic yields to the

opposing traffic) and inadequate green time during the protected phase. Mainline turn lane spillbacks at the unsignalized intersections of SC 49 are primarily due to the inadequate gaps for the left turning traffic.

Toolbox of Potential Improvements

Based on a review of the historical crash data, field observations, and projected future year no-build operations, the project team prepared a toolbox with the potential improvements that could enhance safety, increase mobility, and improve the operations along the study corridor. The toolbox was prepared in accordance to the SCDOT policies and guidelines as well as the state-of-the-art practices.

Improvements in the toolbox are broadly classified into three categories:

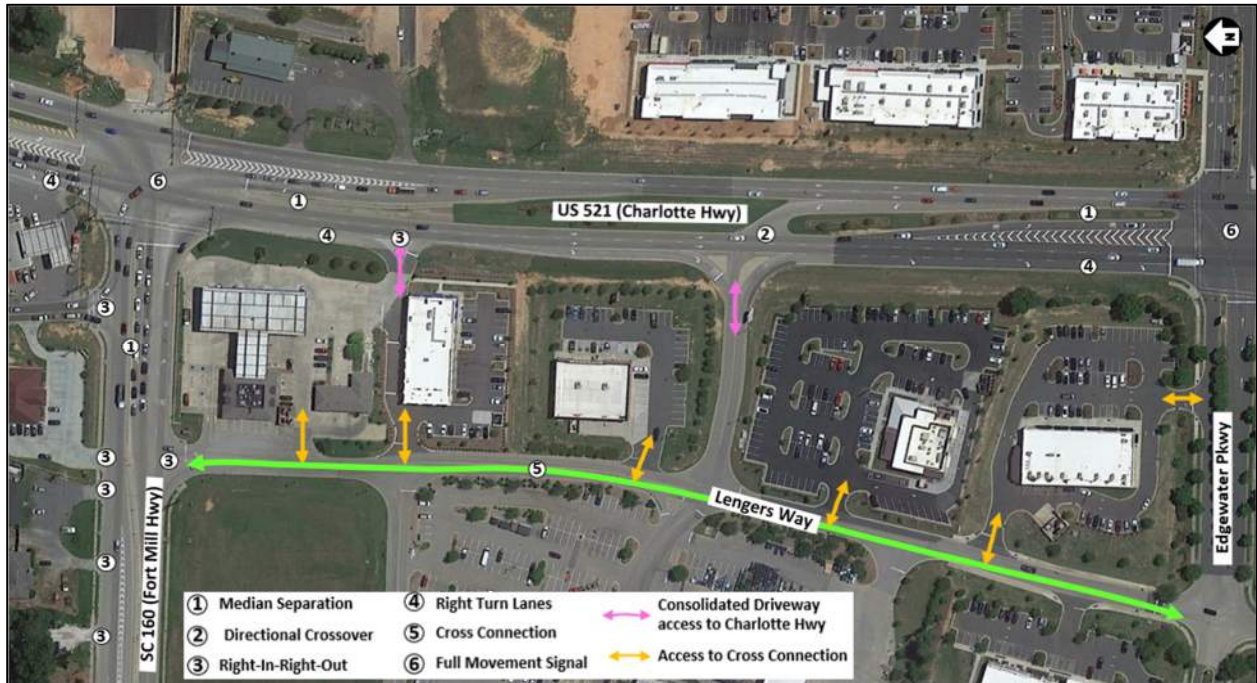
- Access management strategies
 - Raised median implementation
 - Access restriction to right-in/right-out (RIRO)
 - Directional median opening
 - Driveway consolidation
- Spot (intersection) improvements
 - Turn lane addition
 - Signalization
 - Signal timing/phasing improvements
- Adaptive signal control technology



Adaptive Traffic Signal

Some of these practices were implemented locally in Lancaster County, SC within the vicinity of US 521 and SC 160 intersection and are shown in **Figure ES-3**.

Figure ES 3 - Access Management Example – Lancaster County, SC



Signal Warrant Analysis

A Signal Warrant Analysis examines the need, or warrant, for installation of traffic signals. A warrant is a condition that an intersection must meet to justify signal installation. Based on available data, this study performed the following five signal warrants:

- Peak Hour (Warrant 3)
- Pedestrian Volume (Warrant 4)
- Coordinated Signal System (Warrant 6)
- Crash Experience (Warrant 7)
- Roadway Network (Warrant 8)

Results show that all the unsignalized intersections along SC 49 meet the Roadway Network warrant, and six of the eight intersections meet at least one of the other four signal warrants (Warrants 3, 4, 6, and 7). However, only three locations meet the SCDOT signal spacing requirements of maintaining at least 1,320 feet distance between adjacent signalized intersections. These include SC 49 intersections at Forest Oaks Drive/Lodges Lane, Bonum Road, and Montgomery Road. Between the SC 49 intersections at Bonum Road and Montgomery Road, the latter is identified more appropriate for signal installation due to existing sight distance issues.

Proposed Build Improvements

Using the existing/historic data, projected growth/future year operations, and a review of the potential improvements listed in the toolbox, the project team recommends the following improvements for the study corridor. These recommendations are also presented in **Figure ES-4**.

High-Level Cost Estimate of Improvements

The following high-level cost estimate ranges of improvements presented in **Table ES 1** were developed based on a review of similar local project costs, high-level order-of-magnitude estimates from other agencies, and coordination with project stakeholders. The high-level cost estimate ranges do not consider

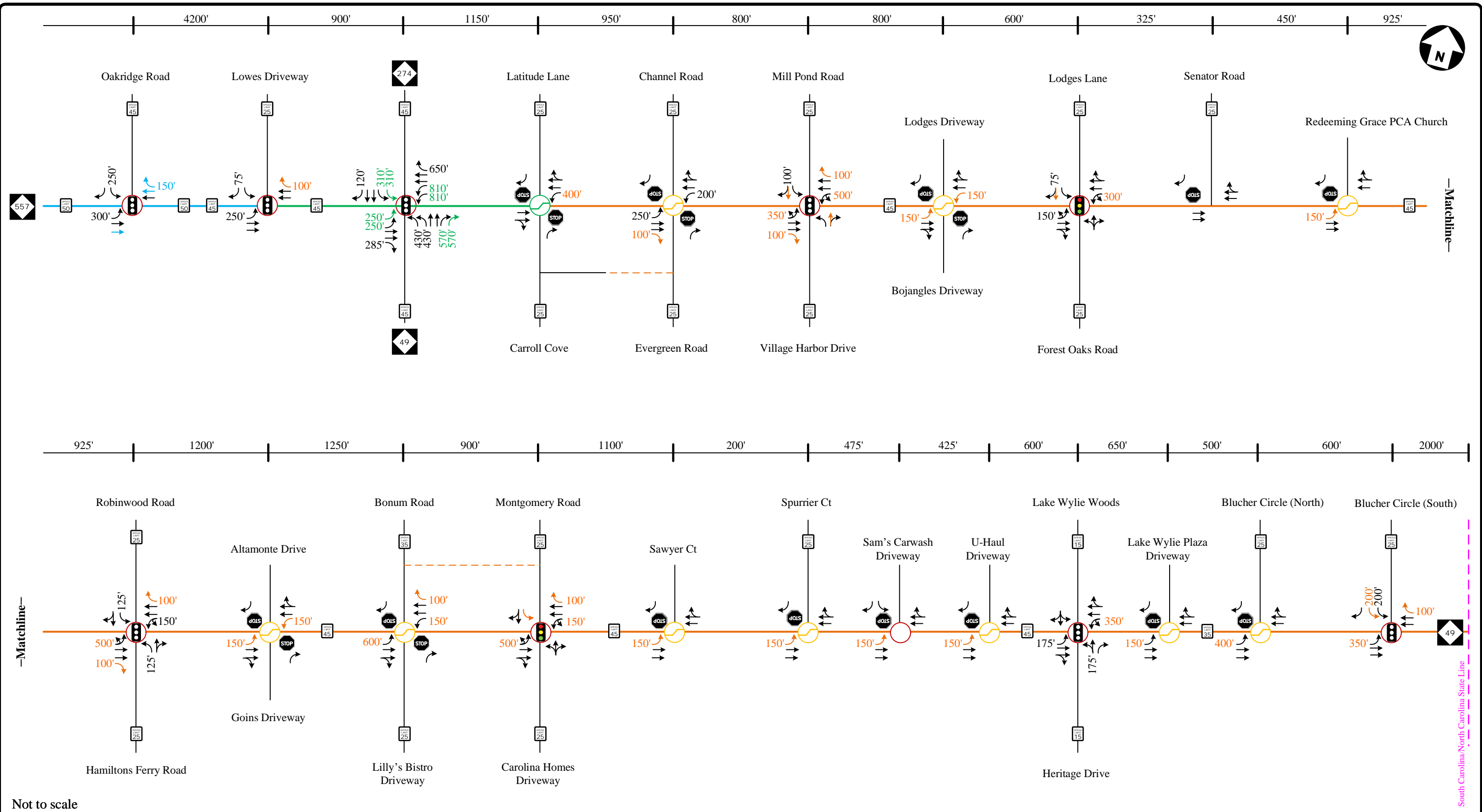
contingencies, right-of-way, utility relocations, and engineering costs. Additional evaluation and design will need to be conducted to develop a more refined cost of improvements.

Table ES 1 High-Level Cost Estimate of Improvements

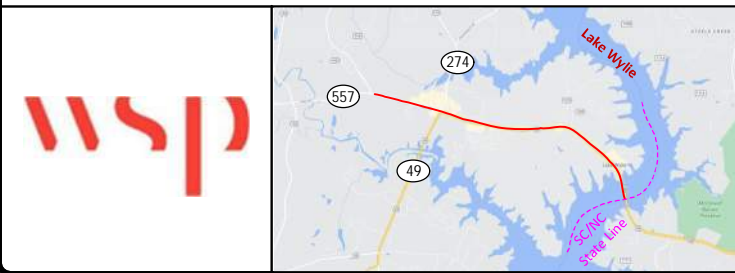
Item	Cost Estimate Range (\$)
Signal Enhancements	\$1,000,000 to \$1,500,000
Intersection Improvements	\$250,000 to \$3,000,000
New Roadway Connections	\$500,000 to \$1,500,000
Access Management	\$8,000,000 to \$10,000,000
Total	\$9,750,000 to \$16,000,000

Each cost estimate item is assumed to include the following improvements:

- Signal Enhancements include new signal installations, corridor coordination, and adaptive signal control.
- Intersection Improvements include right turn lanes, restriping, signal updates, increased turn lane storage, new turn lanes, etc.
- New Roadway Connections include connections from Vesla Lane to Evergreen Road and Bonum Road to Montgomery Road.
- Access Management includes conversion of existing roadway of 4-lane with TWLTL to proposed cross-section of 4-lane divided with raised median with curb & gutter and sidewalks estimated at \$3.3M per mile.



Not to scale



LEGEND		
Existing Roadway	Existing Signal Control	Intersection Spacing
Existing Laneage	Proposed Signal Control	SC 49/SR 274/SC 557 Intersection Project
Storage Length	Median Crossover	Proposed Median Separation
Posted Speed Limit	Median Opening	Proposed Connection
Existing Stop Control	Proposed Laneage	SC 557 Widening Project

Corridor-wide Improvements

Access Management Strategies

- Convert the existing SC 49 5-lane undivided roadway with TWLTL median to a 4-lane divided roadway with a raised median from SC 557 to the Buster Boyd Bridge
- Provide full access median openings on SC 49 at the following three locations:
 - Forest Oaks Road/Lodges Lane
 - Montgomery Road
 - Driveway at Sam's Carwash
- Provide median crossovers on SC 49 at the following 10 locations:
 - Evergreen Road/Channel Road
 - Lodges Driveway/Bojangles Driveway (west of Forest Oaks Road)
 - Church Driveway (east of Senator Road)
 - Altamonte Drive/Goins Driveway
 - Bonum Road/Lily's Bistro Driveway
 - Sawyer Court
 - Spurrier Court
 - U-Haul Driveway (west of Heritage Drive)
 - Lake Wylie Plaza Driveway
 - Blucher Circle North

Per the SCDOT design manual guidelines, all median crossover locations should be provided with an exclusive left turn lane and a minimum storage of 150 feet. In considering the proposed recommendations, some of the items that require further evaluation for design feasibility include:

- Total width of the median
- Width of the raised median
- U-turn accommodations at full-movement and median crossover locations
- Emergency access in the corridor

Traffic Control and Operational Improvements

- Conduct a full warrant study to evaluate the need for traffic signal, marked crosswalks, and associated pedestrian phases at SC 49 and Forest Oaks Road/Lodges Lane intersection. The traffic volumes used in the warrant study needs to consider the traffic redistribution if the corridor characteristics change. This study analyzed this intersection as a signal in the build scenario.
- Conduct a full warrant study to evaluate the need for traffic signal, marked crosswalks, and associated pedestrian phases at SC 49 and Montgomery Road intersection. The traffic volumes used in the warrant study needs to consider the traffic redistribution if the corridor characteristics change. This study analyzed this intersection as a signal in the build scenario.
- Conduct a full evaluation for the application of adaptive signal control technologies along the corridor. Due to the limitation of Synchro/SimTraffic software, this study did not analyze the impact of this improvement in the build scenario.
- Implement infrastructure improvements for a corridor-wide coordinated signal system.
 - These improvements will be necessary if or when an adaptive signal system is implemented along the corridor.

Spot Improvements

- At the existing signalized intersection of SC 49 and Lowes Entrance, provide exclusive westbound right turn lane.
- At the existing signalized intersection of SC 49 and Mill Pond Road/Village Harbor Drive, provide exclusive eastbound and westbound right turn lanes, extend the existing eastbound and westbound left turn storages. Additionally, provide a protected phase for the westbound left turns.

- At the existing signalized intersection of SC 49 and Forest Oaks Road/Lodges Lane, extend the existing westbound left turn storage. Additionally, re-stripe both the side street lane markings to provide exclusive left turn lane and a shared through/right turn lane.
- At the existing signalized intersection of SC 49 and Hamiltons Ferry Road/Robinwood Road, provide exclusive eastbound and westbound right turn lanes, extend the eastbound left turn storage.
- At the existing signalized intersection of SC 49 and Heritage Drive, extend the westbound left turn storage.
- At the existing signalized intersection of SC 49 and Blucher Circle South, provide exclusive westbound right turn lane, extend the eastbound storage at this intersection. Additionally, provide a protected phase for the eastbound left turns.
- At the proposed median crossover intersection of SC 49 and Evergreen Road/Channel Road, provide an exclusive eastbound right turn lane.
- At the proposed median crossover intersection of SC 49 and Bonum Road, provide an exclusive westbound right turn lane.
- At the future median crossover intersection of SC 49 and Carroll Cove/Latitude Lane, extend the westbound left turn lane.
- At the proposed signalized intersection of SC 49 and Montgomery Road, provide an exclusive westbound right turn lane.

The right turn lanes that are recommended in this study are primarily located at signalized locations where a left turn from the side streets would be protected by a signal phase. In the locations where these are recommended for unsignalized locations, this should be done only if left turns from side streets are controlled or restricted by access management.

Cross Connections

- Provide a roadway connection between Carroll Cove and Evergreen Road south of SC 49.
- Provide a roadway connection between Bonum Road and Montgomery Road north of SC 49.

Figure ES-3 shows the recommended lane configuration, storage lengths, and proposed roadway connections for the proposed build conditions.

Capacity Analysis of Proposed Build Conditions

For the 2023 future year proposed build scenario, the study corridor included the proposed improvements as well as the improvements made from York County Pennies for Progress. Capacity analysis results for this scenario showed significant improvements from the no-build conditions. Based on the results, all the study unsignalized intersections are projected to operate under LOS “E” or worse, and all study signalized intersections are projected to operate under acceptable LOS except the SC 49 intersection at SC 274/SC 557. Of the 15 study intersections along SC 49, mainline turn lane queues are projected to continue spillbacks to the adjacent lanes at Hamiltons Ferry Road/Robinwood Road and SC 274/SC 557. The improved operations in the proposed build conditions are primarily due to the following improvements:

- Implementation of raised median treatments reducing vehicular conflict points and redirecting minor street movements
- Increased intersection capacity due to the proposed right-turn lanes
- Improved progression due to the proposed signalization and existing signal optimization

Additionally, the average speed along the SC 49 corridor is projected to improve by 30% and 94% along the westbound and eastbound directions during the AM and PM peaks respectively. This is mainly due to the reduced through lane blocks associated to the mainline turn lane queue spillbacks. A slight drop in the average speed is noted along the peak flow direction (eastbound in AM and westbound in PM) due to the proposed signals which result in additional stops. However, the overall network delay and travel time are projected to improve with recommendations made from this study compared to the no-build conditions.

Table ES 2, ES 3, and ES 4 summarize the performance measures for the study intersections, overall network, and SC 49 arterial respectively. The arterial performance measures included in **Table ES 4** corresponds to the SC 49 corridor from SC 274/SC 557 to Blucher Circle South.

Table ES 2 No-Build Capacity Analysis Results

Intersection	Level of Service		
	2020 No-Build AM (PM)	2023 No-Build AM (PM)	2023 Build AM (PM)
SC 49 & Blucher Circle South	A (A)	A (C)	B (D)
SC 49 & Blucher Circle North	B (E)	C (F)	B (F)
SC 49 & Heritage Drive/Lake Wylie Woods	A (B)	C (C)	C (C)
SC 49 & Spurrier Court	C (E)	D (F)	B (F)
SC 49 & Montgomery Road	F (F)	F (F)	B (D)
SC 49 & Bonum Road	F (F)	F (F)	D (F)
SC 49 & Hamiltons Ferry Road/Robinwood Road	B (C)	C (D)	D (D)
SC 49 & Senator Road	C (E)	D (F)	C (F)
SC 49 & Forest Oaks Drive/Lodges Lane	F (F)	F (F)	B (D)
SC 49 & Village Harbor Drive/Mill Pond Road	A (C)	C (F)	C (D)
SC 49 & Evergreen Road/Channel Road	F (F)	F (F)	F (F)
SC 49 & Carroll Cove/Latitude Lane	F (F)	F (F)	F (F)
SC 49 & SC 274 & SC 557	D (D)	E (E)	E (D)
SC 557 & Lowes Driveway	A (A)	A (A)	A (A)
SC 557 & Oakridge Road	D (D)	C (B)	C (B)

Table ES 3 - Peak Hour (PM) Network Performance

Measure of Effectiveness	2020 No Build	2023 No Build	2023 Proposed Build	% Difference (2023 No-Build to 2023 Build)
Total Delay (hours)	191	733	574	-22%
Stop Delay/Vehicle (seconds)	60	212	124	-42%
Total Stops	9157	21,177	25,229	+19%
Travel Distance (miles)	11,352	13,946	15,194	+9%
Travel Time (hours)	475	1,222	999	-18%
Average Speed (mph)	24	13	16	+23%

Table ES 4 - Peak Hour (PM) Arterial Performance

Measure of Effectiveness	Direction	2020 No Build	2023 No Build	2023 Proposed Build	% Difference (2023 No-Build to 2023 Build)
Delay (seconds/vehicle)	Eastbound	44	381	90	-76%
	Westbound	126	415	460	+11%
Travel Time (seconds)	Eastbound	260	594	305	-49%
	Westbound	362	670	746	+11%
Arterial Speed (mph)	Eastbound	36	16	31	+94%
	Westbound	28	16	15	-6%

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Appendix B	2020 Traffic Counts
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INTRODUCTION

RFATS has selected WSP USA to assist RFATS staff in the provision of MPO Project Management Services on an on-call, project specific basis. For contract modification #6, RFATS is seeking a traffic operations and safety evaluation study for the SC 49 corridor from the North Carolina state line in Lake Wylie to the intersection of SC 557 and Oakridge Road. SC 49 serves as a major carrier of the heavy commuter traffic between Lake Wylie area of York County and the Greater Charlotte Region. The study corridor was identified to be experiencing recurring congestion due to the heavy commuter traffic as well as non-recurring congestion due to incidents and seasonal traffic. With the anticipated growth projected in the Lake Wylie area and western York County, the local and commuter traffic (motorized and non-motorized) accessing the corridor is expected to increase in the future. This could have significant impacts to the safety conditions and operations along the already congested corridor. The purpose of this study is to identify feasible, and cost-effective solutions to improve safety, mobility, and operations within the corridor constraints. The base and future years for this study are 2020 and 2023 respectively. This report discusses the following:

- Study area
- Data collection
- Existing conditions assessment
- Crash and safety analysis
- Volume development
- Capacity analysis methodology
- No-build operations analysis
- Proposed build improvements
- Proposed build operations analysis
- Conclusions

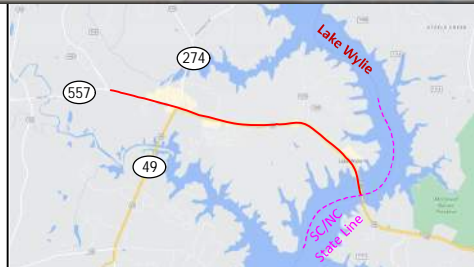
1.0 STUDY AREA

The study area for this project is along the SC 49 corridor from the North Carolina state line (Buster Boyd Bridge) in Lake Wylie to the intersection of SC 557 and Oakridge Road. The study intersections include 7 signalized intersections and 8 two-way stop-controlled intersections (TWSC) as listed below:

1. SC 49 at Blucher Circle South - 3-legged, signal control
2. SC 49 at Blucher Circle North - 3-legged, TWSC
3. SC 49 at Heritage Dr/ Lake Wylie Woods - 4-legged, signal control
4. SC 49 at Spurrier Ct - 3-legged, TWSC
5. SC 49 at Montgomery Road - 4-legged, TWSC
6. SC 49 at Bonum Road - 4-legged, TWSC
7. SC 49 at Robinwood Road/Hamilton Ferry Road - 4-legged, signal control
8. SC 49 at Senator Road - 3-legged, TWSC
9. SC 49 at Forest Oaks Drive/Lodges Lane - 4-legged, TWSC
10. SC 49 at Mill Pond Road/Village Harbor Drive - 4-legged, signal control
11. SC 49 at Channel Road/Evergreen Road - 4-legged, TWSC
12. SC 49 at Carroll Cove/ Latitude Lane - 4-legged, TWSC
13. SC 49 at SC 274 & 557 - 4-legged, signal control
14. SC 557 at Lowes Driveway - 3-legged, signal control
15. SC 557 at Oakridge Road - 3-legged, signal control

Figure 1 shows the study corridor limits and study intersections. The existing lane configuration at the study intersections, traffic control, and posted speed limits are shown in **Figure 2**.

SC 49, in the RFATS study area is an east-west five-lane undivided roadway with a two-way-left-turn-lane (TWLTL) median type. SC 557, in the RFATS study area transitions from a 2-lane undivided (west of Bailey Lane) to a 5-lane undivided roadway (east of Harper Green Drive). The posted speed limit in this area changes from 50 mph on the western limits to 45 mph near Lowes entrance and to 35 mph near Heritage Drive and back to 45 mph near Blucher Circle North. The area is identified to be transitioning from a rural type on the west to a suburban type towards the east with a mixed land use including several residential, retail, and commercial stores. Oakridge Middle School and Oakridge Elementary School are located off Oakridge road, just north of SC 557. Several recreational destinations are located on the eastern end of the SC 49 including YMCA Camp Thunderbird, River Hills Country Club, and Lake Wylie Marina. The study corridor has a driveway density of approximately 20 driveways per mile.

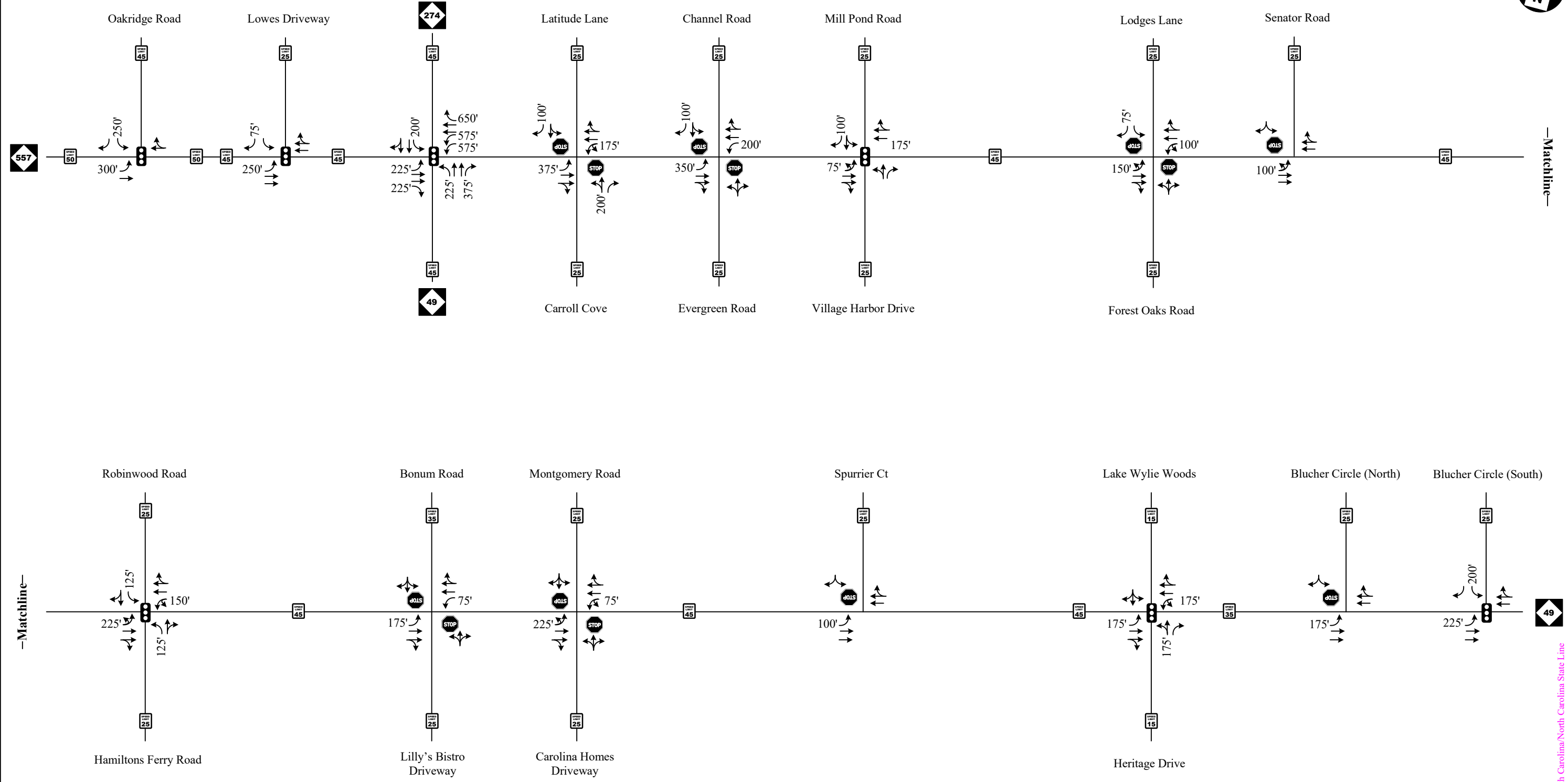


LEGEND

- - - Study Area
- Signalized Study Intersection
- Unsignalized Study Intersection

SC 49 Corridor Study
City of Rock Hill, South Carolina

Study Area



Not to scale



LEGEND

- Existing Roadway
- Existing Laneage
- ###' Storage Length
- ⓧ Posted Speed Limit
- ⓧ Existing Stop Control
- ⓧ Existing Signal Control

SC 49 Corridor Study
City of Rock Hill, South Carolina

2020 Existing Configuration

2.0 DATA COLLECTION

As a part of this corridor study, WSP gathered the following information for review and evaluation to assist in developing improvement recommendations:

- Historic Annual Average Daily Traffic (AADT)
- Existing Traffic Counts
 - 2020 AM and PM peak hour turning movement counts
 - 2020 mainline 48-hour vehicle/speed/classification counts
- Traffic signal plans and timing plans
- Background roadway projects and developments
- Previous studies in the study area
- Planning data
 - Existing and future transportation plans, land use plans, small area plans,
 - Metrolina Regional Model (MRM)
- Field visit
 - September 30, 2020

2.1 Historic AADT

Using the SCDOT traffic counts data portal, historic AADT in the study area was collected to review the growth trend in traffic and identify a suitable growth rate for the area. **Table 1** summarizes the historic AADT collected in this study.

Table 1 Historic AADT

Station ID	Location Description	AADT										
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
216	SC 49 west of Heritage Road	25,600	25,700	25,700	26,500	28,800	27,100	34,700	35,300	32,500	33,800	35,500
214	SC 49 south of SC 274/SC 557	19,500	18,700	19,600	20,400	21,300	21,700	25,100	26,400	27,200	28,300	29,800
213	SC 274 north of SC 49/SC 557	11,400	11,200	11,800	12,500	13,300	13,500	16,200	17,500	19,100	20,600	20,100

2.2 Historic Turning Movement Counts

SCDOT provided the 2019 peak hour turning movement counts (TMC) at 9 of the study intersections and 2018 peak hour TMC for 2 study intersections. These counts are included in **Appendix A**.

2.3 2020 Traffic counts

Peak Hour Turning Movement Counts

WSP collected the AM (7-9 AM) and PM (4-6 PM) peak period TMC on a typical weekday at the 15 study intersections on September 17, 2020. The peak hour counts included all the vehicles as well as the pedestrians crossing at the study intersections. **Figure 4** shows the 2020 Base Year existing volumes for the AM and PM peak hours. The 4-hour raw counts are provided in **Appendix B**.

48-hour Classification Counts

WSP collected the 48-hour counts at 6 locations on the study corridor during typical weekdays in September 2020. These counts included vehicle classification and speed. A summary of this data is shown in **Table 2**. The 48-hour counts are included in **Appendix C**.

Table 2 ADT and Speed Data Summary

ID	Location Description	Posted Speed Limit	2020 ADT (vpd)	85 th Percentile Speed (Direction 1)	85 th Percentile Speed (Direction 2)
1	SC 49 east of Blucher Circle South	45 mph	35,191	Day 1: 49 mph Day 2: 49 mph	Day 1: 54 mph Day 2: 53 mph
2	SC 49 east of Hamiltons Ferry Road	45 mph	36,318	Day 1: 54 mph Day 2: 54 mph	Day 1: 55 mph Day 2: 54 mph
3	SC 49 east of SC 274/SC 557	45 mph	39,034	Day 1: 48 mph Day 2: 47 mph	Day 1: 50 mph Day 2: 50 mph
4	SC 557 east of Oakridge Road	50 mph	20,336	Day 1: 53 mph Day 2: 52 mph	Day 1: 51 mph Day 2: 50 mph
5	SC 274 north of SC 49/SC 557	45 mph	12,800	Day 1: 48 mph Day 2: 47 mph	Day 1: 46 mph Day 2: 45 mph
6	SC 49 south of SC 274/SC 557	45 mph	29,501	Day 1: 55 mph Day 2: 55 mph	Day 1: 55 mph Day 2: 55 mph

Note: For location IDs 1 through 4, Direction 1 is westbound, and Direction 2 is eastbound;
For locations IDs 5 and 6, Direction 1 is northbound, and Direction 2 is southbound

Comparing the 2019 AADT and 2020 ADT, the 2020 daily traffic on SC 49 and SC 274 shows an approximate reduction of 4% and 38% respectively. This reduction in daily traffic on SC 49 and SC 274 is anticipated to be a combination of the COVID pandemic and the ongoing construction of the Pennies for Progress Widening Project on Pole Branch Road which have both resulted in changes to traffic patterns.

2.4 Traffic Signal and Timing Plans

SCDOT provided the latest traffic signal and timing plans for all the 7 signalized intersections in the study area. These plans are included in **Appendix C**.

2.5 Background Roadway Projects and Developments

The background projects include any funded roadway projects and approved developments in the study influence area. RFATS provided this information including the design plans and site plans as available.

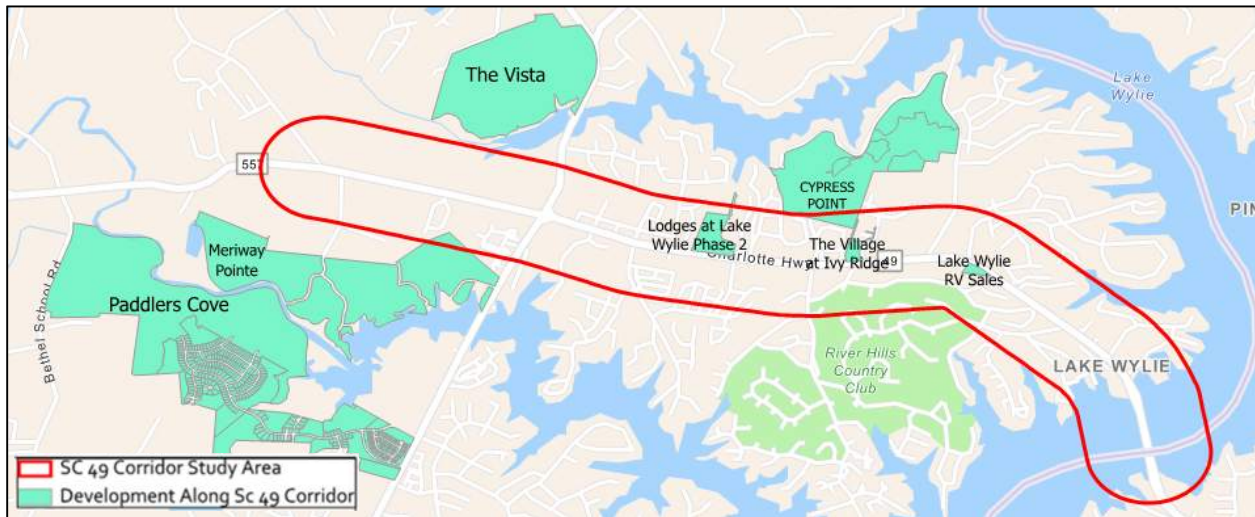
The planned roadway projects funded by the York County Pennies for Progress One Cent Sales Tax Program are listed below:

- SC 49/SC 274/SC 557 intersection improvements project
 - Improvements include providing dual left turn lanes on all intersection approaches
 - Addition of a southbound exclusive right turn lane on SC 274
 - Extending median on SC 49 (east leg) past Latitude Lane/Carroll Cove and convert this intersection to a right-in/right-out (RIRO) with westbound left-in.
 - RFATS provided the design plans for this project and are included in **Appendix D**.
- SC 557 widening west of SC 49/SC 274
 - Widen SC 557 to 5-lane undivided roadway with a TWLTL median type

The planned developments are shown in **Figure 3** and include the following:

- Cypress Point
 - Located north of SC 49 between Robinwood Road and Bonum Road
 - 358 single family homes
 - This is currently under construction with approximately 100 homes remaining
- Meriway Pointe
 - Located south of SC 557 between SC 49 and Bethel School Road
 - 449 single family homes
 - This is in the preliminary plan stage estimated to begin construction in 3 years
- The Village at Ivy Ridge
 - Located north of SC 49 just east of Altamonte Drive
 - Townhomes
 - This is currently under construction with approximately 86 homes remaining
- Lodges at Lake Wylie Phase 2
 - Located north of SC 49 between Mill Pond Road and Senator Road
 - 114 multifamily homes
 - The site plan is currently under review
- Lake Wylie RV Sales
 - Located south of SC 49 at Montgomery Road
 - Recreational vehicle sales and service
 - This is in the early stages of the review process. No site plan is available

Figure 3 – Proposed Developments



Potential projects being studied in North Carolina in close proximity to the SC 49 Corridor were also considered by the project team. RFATS staff continue to monitor the potential impacts of the Catawba Crossings project in Gaston County, as well as the widening of S New Hope Road (NC 274). These projects are not yet funded and therefore fall outside of the future years utilized during this particular study of SC 49. However, the MPO recognizes these projects could have significant impact on traffic related to SC 49 and will continue to gather information regarding these projects as they develop.

2.6 Previous Studies

In order to compare the 2020 count data collected for this study, the project team reviewed the previous studies completed within the project limits to identify any available 2020 volume projections at the study intersections. RFATS provided the following studies:

- Bonum Road Traffic Impact Analysis (TIA) Study
 - This TIA was done in 2014 for the Mattamy Homes residential development located on Bonum Road north of SC 49. At the time of the study, the site was expected to fully develop by 2019.
 - This study includes the 2020 volume projections at:
 - SC 49 and Bonum Road intersection
 - SC 49 and Robinwood Road intersection
 - SC 49 and Heritage Drive intersection
- Cypress Point TIA Study
 - This TIA was done in 2017 for the three sites – Brentwood/Cypress Point, The Meadows/Ivy Ridge, and Freeze. At the time of the study, the three sites were expected to fully develop by 2020.
 - This study includes the 2021 volume projections at:
 - SC 49 and Bonum Road intersection
 - SC 49 and Hamiltons Ferry Road/Robinwood Road intersection

2.7 Planning data

RFATS provided the future transportation plans, land use plans, small area plans, and regional planning model – Metrolina Regional Model (MRM). Among this information was the Lake Wylie Small Area Plan which was completed by York County in 2020. All of the plans and data were reviewed by the project team to assess the existing and future conditions of the study corridor.

2.8 Field Visit

WSP project team conducted a field visit on a September 30, 2020 and observed the AM (7:00am-9:00am), noon (12:00pm-2:00pm), and PM (3:30pm-6:30pm) peak hour operations along the corridor. Travel time runs were also performed along the corridor during the peak and off-peak periods. Some of the key observations are listed below:

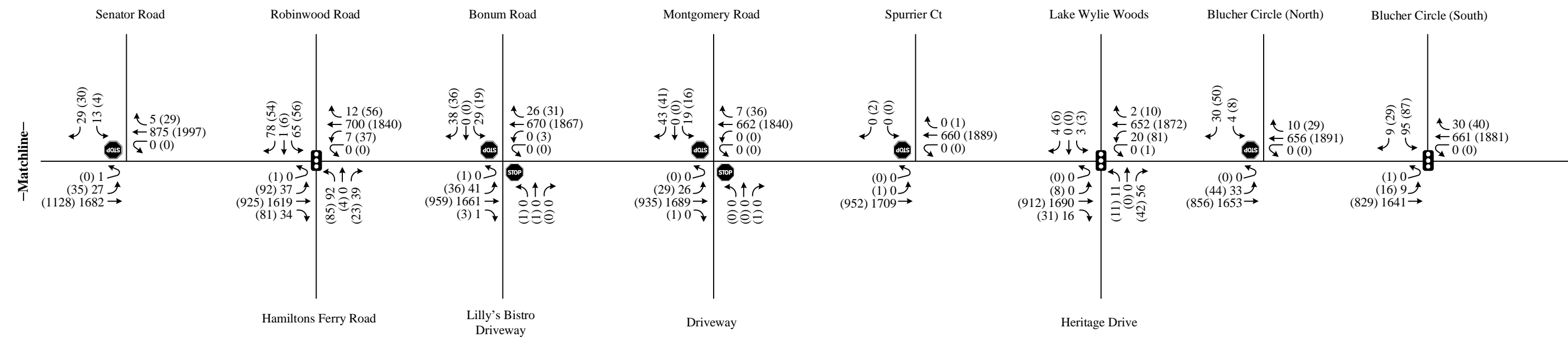
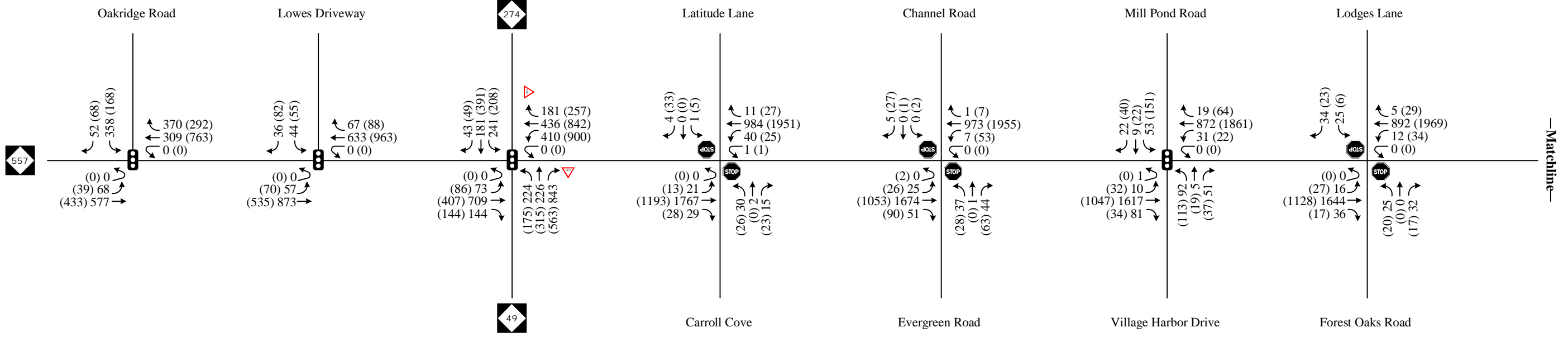
- AM and PM peak periods experienced significant congestion with PM peak more congested than the AM peak.
- During the AM peak, eastbound traffic experienced notable queueing and delays at the following signalized intersections:
 - SC 49 at Lowe’s Entrance
 - SC 49 at SC 274/SC 557
 - SC 49 at Hamiltons Ferry Road
 - Queues extended up to Mill Pond Road/Village Harbor Drive
 - SC 49 at Mill Pond Road/Village Harbor Drive
- During the AM peak, traffic making westbound left turns on SC 49, and left turns from the side streets appeared to have inadequate gaps in the heavy eastbound traffic.
- During the PM peak, westbound traffic experienced notable queueing and delays at the following signalized intersections:
 - SC 49 at Blucher Circle South
 - Queues extended beyond the Buster Boyd Bridge
 - SC 49 at Heritage Drive
 - Queues extended past Blucher Circle North
 - SC 49 at Hamiltons Ferry Road
 - Queues extended slightly past Spurrier Court
 - SC 49 at Mill Pond Road/Village Harbor Drive
 - Queues extended slightly past Senator Road
- During the PM peak, traffic making eastbound left turns on SC 49 and left turns from the side streets appeared to have inadequate gaps in the heavy westbound traffic.

- Traffic exiting Montgomery Road appeared to have sight distance issues.
- During the mid-day peak, SC 49 traffic appeared to travel at high speeds making it difficult for the side street traffic to find adequate gaps

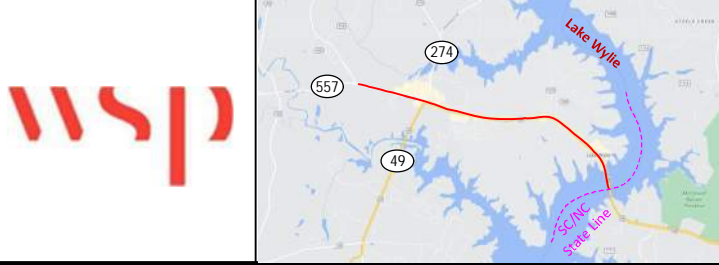
Since the field visit was performed during the COVID pandemic period, the observations made do not represent pre-pandemic typical weekday traffic operations. **Table 3** shows the summary of the travel time runs performed along the SC 49 corridor between Oakridge Road and Blucher Circle South intersections.

Table 3 Travel Time Runs Summary

Direction	Distance (miles)	Off-peak Travel Time (minutes)	Peak	Number of Runs	Average Travel Time (minutes)	Maximum Travel Time (minutes)
Eastbound	3.6	5.0	AM	1	10.0	10.0
			PM	4	6.5	7.0
Westbound		5.0	AM	2	6.0	6.0
			PM	3	12.0	13.5



Not to scale



LEGEND

- Existing Roadway
- Turning Movement
- XX (XX) AM (PM) Volumes
- ▽ Yield Control
- STOP Existing Stop Control
- Ⓜ Existing Signal Control

SC 49 Corridor Study City of Rock Hill, South Carolina

2020 Existing Peak Hour Traffic Volumes

South Carolina/North Carolina State Line

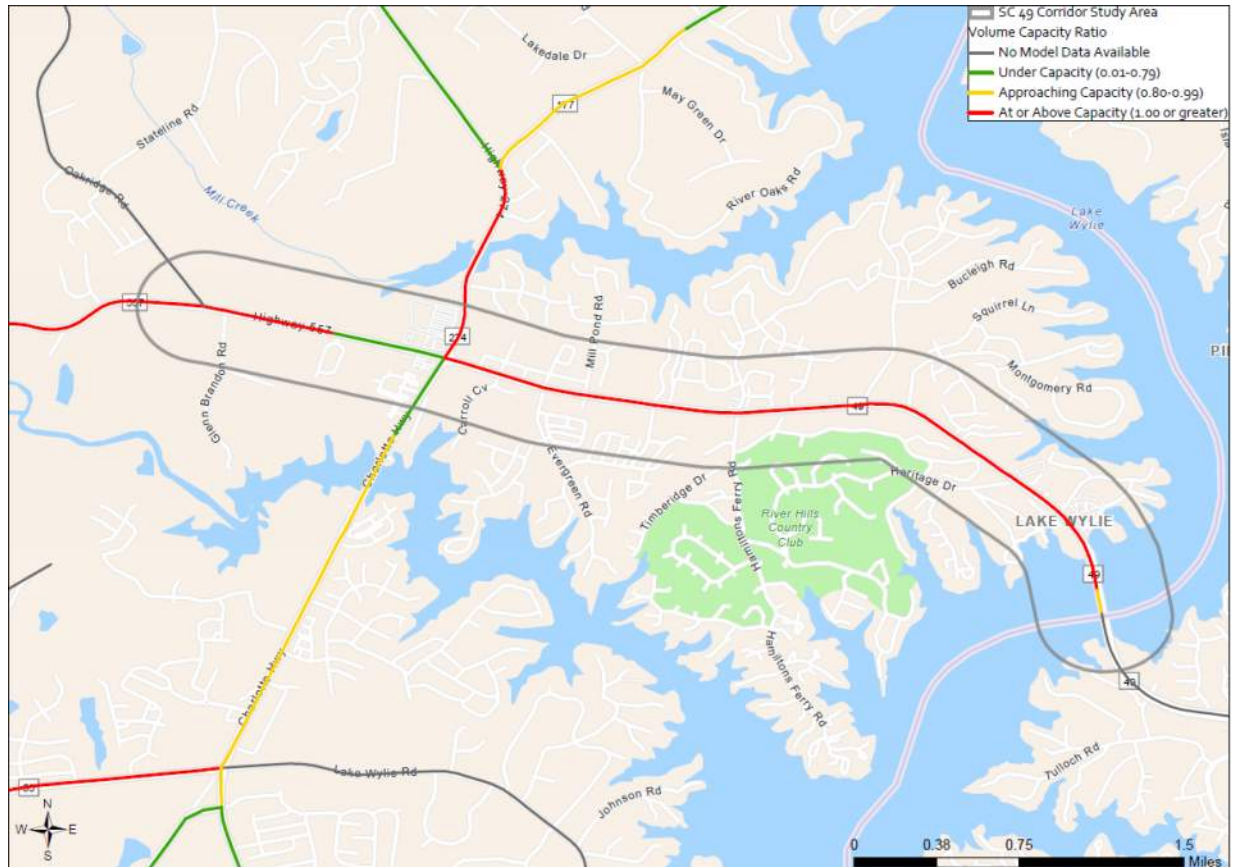
3.0 EXISTING CONDITIONS ASSESSMENT

The existing conditions assessment is essential to understand the nature and extent of traffic congestion (i.e., its intensity, duration, and recurring / non-recurring causes, etc.) along the corridor. This study evaluated the basic physical layout of this area by looking at the existing land use as well as the socio-economic growth that has occurred in the past 10 and 20-year periods. The study utilized the MRM to outline the volume-to-capacity ratios and AADT projections along the corridor. This MRM analysis informs the transportation analysis relative to capacity and network design including areas of potential land use change. The study also reviewed the current York County Comprehensive Plan and development plans along the corridor for evaluating growth and potential new connections (intersections and driveways) along SC 49. The following study area assessment figures/maps were prepared:

- Corridor AADTs
- Adjacent Developments
- 2018 Employment per TAZ
- 2018 Population per TAZ
- Existing Land Use Map (from Small Area Plan)
- Future Land Use Map (from Small Area Plan)
- Daily traffic projections from MRM
- Corridor Volume to Capacity Ratio from MRM – Shown in **Figure 5**
- Peak Hour Corridor Volumes
- Transportation Improvement Projects (Pennies for Progress Projects & RFATS Collector Street Plan)

These illustrations summarizing the existing conditions assessment are provided in **Appendix E**.

Figure 5 – SC 49 Corridor Volume to Capacity Ratio



4.0 CRASH AND SAFETY ANALYSIS

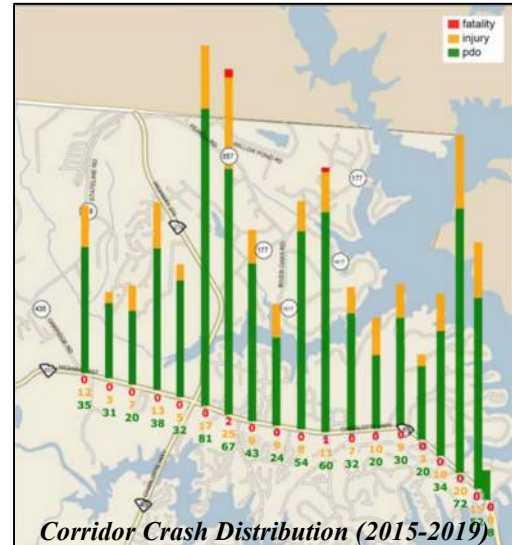
SCDOT provided the most current 5-year (2015-2019) crash data within the study area. This data was reviewed, geo-processed, and analyzed to identify the crash patterns and potential safety issues within the study area. Intersection crash summaries were developed using the “Base Street Name” attribute that identifies the nearest cross street for every crash.

Additionally, SCDOT provided the collision diagrams for the following study intersections:

- SC 49 at Blucher Circle South
- SC 49 at Heritage Drive
- SC 49 at Bonum Road
- SC 49 at Hamiltons Ferry Road/Robinhood Road
- SC 49 at Forest Oaks Drive/Lodges Lane
- SC 49 at Millpond Road/Village Harbor Drive
- SC 49 at Evergreen Road/Channel Road

The crash summaries and collision diagrams are provided in **Appendix F**. Key observations from crash analysis include:

- A total of 939 crashes occurred in the study area during the review period
 - This represents 2.71% of the 34,704 crashes that occurred across York County during this same time period
- The crash frequency increased (42%) from 65 crashes in 2015 to 92 crashes in 2019
 - The crash frequency for York County increased 18.54% from 6,139 crashes in 2015 to 7,277 crashes in 2019
- 59% of the crashes occurred near an unsignalized intersection
- 86% of crashes occurred during weekdays - of which 13% occurred during the AM peak (6-8 AM), 25% during PM peak (5-7 PM). Additionally, 23% of crashes occurred between 1-5 PM
 - 79.89% of crashes in York County occurred during weekdays – of which 12.63% occurred during the AM peak (6-8 AM), 18.46% during PM peak (5-7 PM). Additionally, 29.51% of crashes occurred between 1-5 PM.
- Rear end and angle crashes include 55% and 28% respectively. Majority of the rear end and angle crashes occurred at unsignalized intersections
 - Rear end crashes across York County represented 41.13%, while angle crashes represented 26.62% of all crashes.
- 9% of the angle crashes occurred at signalized intersections, while 19% occurred at unsignalized intersections
- “Driving too fast for conditions” (48%) and “Failure to yield right-of-way” (22%) were reported as the major possible causes
 - “Driving too fast for conditions” represented 28.26% of the major possible cause of all crashes across York County, while “Failure to yield right-of-way” represented 18.47% of the major possible cause of all crashes.



Based on the crash analysis and review of the collision diagrams, the project team identifies the following as the potential safety issues in the study corridor:

- Driver Behavior Characteristics
- Heavy congestion and stop-go conditions
- Queue spillbacks to adjacent intersections
- Inadequate gap times and gaps for the TWSC traffic, especially left turns
- Inefficient permissive left turn phases at signalized intersections

5.0 VOLUME DEVELOPMENT

The COVID-19 pandemic has impacted businesses, schools, offices, transit, and other aspects of typical life across the country, state and within the corridor study area. These impacts have changed typical traffic volumes, travel patterns, commuter volumes, and overall traffic operations. Due to these impacts to existing conditions, additional assumptions and engineering judgment are necessary to grow 2020 Base Year existing volumes to 2023 Future Year volumes to reasonably evaluate future corridor operations and recommended improvements.

This section discusses the methodology used to develop AM and PM peak hour traffic volumes for existing conditions (2020) and future year (2023) analysis to be evaluated in the study. In general, 2023 volumes were developed by adjusting 2020 existing volumes to reflect historical intersection volumes and then growing volumes to 2023 based on an annual growth rate.

5.1 Area-wide Annual Traffic Growth Rate

An annual growth rate of 3.0% was calculated and applied to grow 2020 AM and PM peak hour volumes in the study area to 2023. The annual traffic growth rate in the study area was estimated using the available historic Annual Average Daily Trip Data from SCDOT and the Metrolina Regional Travel Demand Model (MRM). The annual growth in AADT per the latest 10-year and 5-year periods as well as the growth rate in daily traffic per the 2015 and 2025 MRM models was considered. The area-wide annual growth rate was determined using a weighted average of the growth rates from the historic AADT (2009-2019) and the MRM (2015-2025). **Table 4** shows the summary of the growth rate calculations.

Table 4 Growth Rates

Location Description	Annual Growth Rates (AGR)				
	2009-2019 (a)	2015-2019 (b)	MRM (c)	Corridor AGR [=Avg(a,c)]	Applied Area- wide AGR
SC 49 west of Heritage Road	3.3%	0.6%	1.2%	2.5%	3%
SC 49 south of SC 274/SC 557	4.3%	4.4%	1.2%	3.0%	
SC 274 north of SC 49/SC 557	5.8%	5.5%	1.3%	3.5%	

5.2 2020 Base Year Projected

2020 Base Year Projected volumes were developed by growing historic TMC data provided by SCDOT at the study intersections from 2018 and 2019 to 2020 based on the area-wide annual growth rate. These volumes were developed to provide a baseline comparison to 2020 Base Year volumes to help quantify impacts to existing volumes. 2020 Base Year AM and PM volumes were calculated to be 29.0% and 21.0% lower corridor-wide than 2020 Base Year Projected, respectively.

5.3 2020 Base Year Adjusted

2020 Base Year Adjusted volumes were developed by increasing 2020 Base Year AM and PM volumes corridor-wide by 29.0% and 21.0%, respectively. These adjusted volumes provide a reasonable estimate of 2020 volumes that account for impacts due to COVID-19.

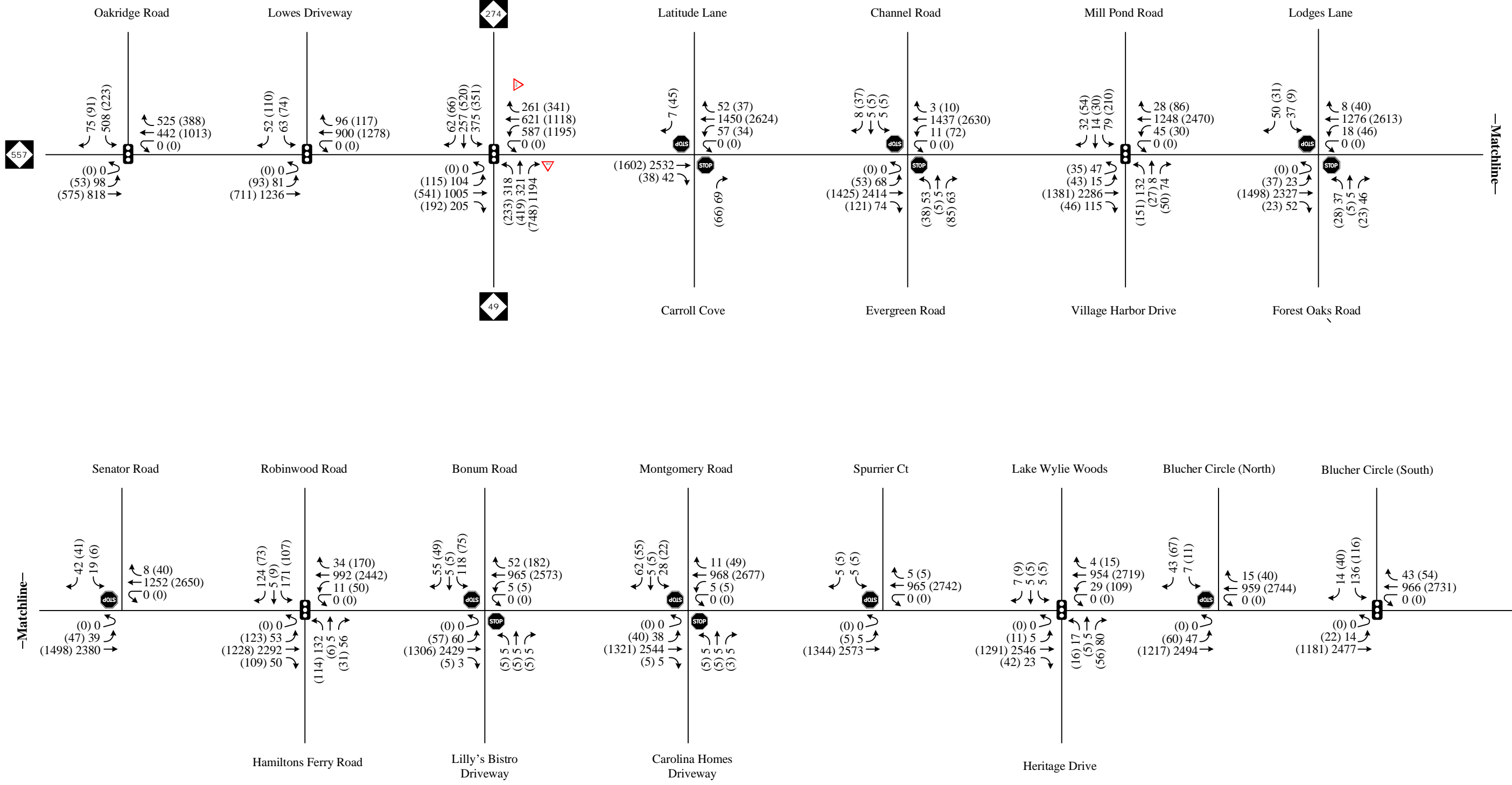
5.4 2023 Future Year

2023 Future Year AM and PM peak hour volumes were developed by applying the area-wide annual growth rate of 3.0% to the 2020 Base Year Adjusted volumes. For *2023 Future Year* no-build conditions, volumes are redistributed as necessary to account for planned geometric or access management changes. The *2023 Future Year* projected volumes including the volume development methodology was submitted to RFATS for review on November 3rd, 2020. Upon review and discussions with SCDOT, RFATS and SCDOT suggested to use the Bonum TIA and Cypress Point TIA volume projections for the SC 49 intersections at Bonum Road and Robinwood Road/Hamiltons Ferry Road.

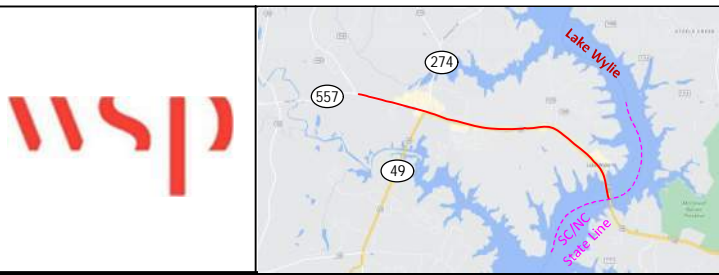
The *2023 Future Year* no-build conditions included the following traffic redistribution:

- Left turn and through traffic exiting Latitude Lane was redirected to Village Harbor Drive/Mill Pond Road signal via Nautical Drive
- Left turn traffic exiting the Publix driveway was redirected to SC 274/SC 557 intersection via Nautical Drive. This traffic is calculated using the eastbound traffic volume imbalance between the adjacent study intersections.

The 2023 Future Year no-build volumes are shown in **Figure 6**.



Not to scale



LEGEND

- Existing Roadway
- Turning Movement
- XX (XX) AM (PM) Volumes
- ▽ Yield Control
- STOP Existing Stop Control
- Ⓜ Existing Signal Control

SC 49 Corridor Study City of Rock Hill, South Carolina

2023 No Build Peak Hour Traffic Volumes

6.0 CAPACITY ANALYSIS METHODOLOGY

6.1 Level of Service Concept

The performance of an intersection is measured by the level of service (LOS) that it provides, as described in the Highway Capacity Manual (HCM), 6th Edition. LOS is a measure that is used to describe the operating conditions of an intersection based on characteristics such as speed, traffic volumes, geometric/lane configuration, and delays. LOS ranges from “A” to “F”, with “A” describing smooth, free flow conditions where queues easily clear through each cycle length, and “F” describing heavily congested, over-saturated conditions, where queues are often forced to wait through potentially multiple cycle lengths prior to clearing an intersection, resulting in heavy delays.

Signalized intersection level of service (LOS) is defined in terms of a weighted average control delay for the entire intersection. Control delay quantifies the increase in travel time that a vehicle experiences due to the traffic signal control as well as provides a surrogate measure for driver discomfort and fuel consumption. Two-way stop-controlled intersection LOS is defined in terms of the highest control delay between the minor-street movements and major-street left-turns. This is because major street through vehicles are assumed to experience zero delay, a weighted average of all movements results in very low overall average delay, and this calculated low delay could mask efficiencies of minor movements. It is not uncommon that Two-way stop-controlled intersections operate at LOS E or F and hence don’t require capacity improvements except when the stop-controlled approaches experience excessive queuing.

For this study, acceptable LOS is considered as LOS “D” or better. **Table 5** provides the LOS and delay criteria for signalized and unsignalized intersections provided in the HCM.

Table 5 Level of Service Criteria

LOS	Delay per Vehicle (in seconds)	
	Signalized Intersection	Unsignalized Approach
A	≤10	≤10
B	>10 and ≤20	>10 and ≤15
C	>20 and ≤35	>15 and ≤25
D	>35 and ≤55	>25 and ≤35
E	>55 and ≤80	>35 and ≤50
F	>80	>50

6.2 Capacity Analysis

The capacity analysis for the study corridor including the signalized and stop-controlled intersections in the study area was performed using Synchro 10 and SimTraffic. The existing roadway network was modeled in Synchro with the existing lane configuration and traffic control. Existing signal plans and timing plans provided by RFATS/SCDOT were used to code the timing, phasing, and detector settings for the signalized intersections in the study. Additionally, SCDOT standards for Synchro v10 were adopted in the analysis.

Some of the key details and assumptions in the Synchro modeling are summarized below:

- A minimum of 4 vehicles per hour were assumed in the analysis at the movements that are allowed.
- Speed limit of 25 mph was used for all the driveways where posted speed limit is not available

- At signalized intersections with over-sized pedestrian phases (where pedestrian clearance time exceeds minimum green of the concurrent phase), the minimum splits associated to the minimum green of the concurrent phases was used in Synchro.
 - Justification: Traffic counts at the study signalized intersections indicated no pedestrians crossing during the peak hours. Hence, no pedestrian calls will be detected.
- Sequence (lead-lag) optimization was not applied for the no-build conditions.

HCM 6 reports were extracted from Synchro for the unsignalized intersections and the Intersection Lane, Volumes, Timings reports were extracted for the signalized intersections. Queuing, network performance, and arterial level-of-service measures were extracted from the SimTraffic simulations. All the Synchro and SimTraffic outputs for the analyses performed are included in **Appendix G**.

7.0 NO-BUILD OPERATIONS ANALYSIS

7.1 2020 Base Year

This scenario includes the 2020 existing lane configuration and *2020 Base Year* volumes collected as a part of this study. Capacity analysis results for this scenario are discussed below and are summarized in **Table 6**.

Signalized Intersections

Based on the Synchro results, all the study signalized intersections operate under acceptable overall LOS. However, 5 of the 7 signalized intersections have one or more approaches operating at LOS “E” or worse during at least one of the peak hours. Based on the SimTraffic results mainline turn lane queues on SC 49 spillback to the adjacent lanes at the following intersection approaches:

- SC 49 at Heritage Drive
 - Eastbound, Westbound
- SC 49 at Hamiltons Ferry Road/Robinwood Road
 - Westbound
- SC 49 at Mill Pond Road/Village Harbor Drive
 - Both approaches
- SC 49 at SC 274/SC 557
 - Eastbound

Unsignalized Intersections

Based on the Synchro results, all the study unsignalized intersections operate under LOS “E” or worse during at least one of the peak hours. Based on SimTraffic results no queue spillbacks from mainline turn lanes on SC 49 are reported..

Table 6: 2020 Base Year Capacity Analysis Results

Node	Intersection	Traffic Control	LOS		Delay (sec/veh)		Approach	LOS		Delay (sec/veh)		Lane Group	LOS		Delay (sec/veh)		Synchro 95th Percentile Queue (ft)		SimTraffic Maximum Queue (ft)	
			AM	PM	AM	PM		AM	PM	AM	PM		AM	PM	AM	PM	AM	PM	AM	PM
1	SC 49 & Blucher Circle South	Signalized	A	A	7.6	9.3	Eastbound	A	A	6	6	L	A	B	4	18	m3	m26	40	-
							Westbound	A	A	4	8	T-R	A	A	4	8	102	515	103	217
							Southbound	E	D	59	48	L	E	E	65	64	134	125	153	142
2	SC 49 & Blucher Circle North	Unsignalized	-	-	-	-	Eastbound	-	-	0	1	L	A	C	10	22	2.5	17.5	64	84
							Westbound	-	-	-	-	T-R	-	-	-	-	-	-	6	15
							Southbound	B	E	14	44	L-R	B	E	14	44	7.5	45	80	98
3	Heritage Drive/Lake Wylie Woods & SC 49	Signalized	A	B	8.7	11.2	Eastbound	A	B	10	10	L	D	D	53	54	15	24	25	37
							Westbound	A	B	5	11	T-R	A	A	10	10	599	263	309	231
							Northbound	B	B	14	16	L	E	E	56	63	45	m96	58	-
							Southbound	D	D	44	40	T-R	A	A	4	9	132	403	119	373
4	SC 49 & Spurrier Court	Unsignalized	-	-	-	-	Eastbound	-	-	-	0	L	A	F	9	60	0	5	22	51
							Westbound	-	-	-	-	T-R	-	-	-	-	-	-	-	2
							Southbound	C	E	17	48	L-R	C	E	17	48	2.5	7.5	32	57
5	Driveway/Montgomery Road & SC 49	Unsignalized	-	-	-	-	Eastbound	-	-	0	1	L	A	C	10	21	2.5	10	40	61
							Westbound	-	-	0	-	T-R	-	-	-	-	-	-	1	-
							Northbound	F	F	244	485	L-T-R	F	F	244	485	40	52.5	38	38
							Southbound	F	F	123	1571	L-T-R	F	F	123	1571	105	222.5	92	156
6	Driveway/Bonum Road & SC 49	Unsignalized	-	-	-	-	Eastbound	-	-	0	1	L	A	C	10	23	5	15	32	-
							Westbound	-	-	0	-	T-R	-	-	-	-	-	-	-	20
							Northbound	F	F	244	718	L-T-R	F	F	244	718	40	57.5	45	53
							Southbound	F	F	305	2905	L-T-R	F	F	305	2905	100	235	58	114
7	Hamiltons Ferry Road/Robinwood Road & SC 49	Signalized	B	C	19.6	32.1	Eastbound	B	B	17	15	L	A	C	4	22	m8	m83	47	-
							Westbound	B	D	15	40	T-R	B	B	17	14	963	450	253	241
							Northbound	E	E	62	66	L	F	E	82	80	148	140	159	167
							Southbound	D	D	37	40	T-R	B	C	19	23	41	34	100	94
8	SC 49 & Senator Road	Unsignalized	-	-	-	-	Eastbound	-	-	0	1	L	B	C	11	24	2.5	15	-	65
							Westbound	-	-	-	-	T-R	-	-	-	-	-	-	-	14
							Southbound	C	E	18	38	L-R	C	E	18	38	12.5	25	67	75
9	Forest Oaks Drive/Lodges Lane & SC 49	Unsignalized	-	-	-	-	Eastbound	-	-	0	1	L	B	C	10	22	2.5	10	30	64
							Westbound	-	-	0	0	T-R	-	-	-	-	-	-	4	8
							Northbound	F	F	819	1565	L-T-R	F	F	819	1565	195	165	142	123
							Southbound	F	-	207	-	L	F	-	472	-	87.5	-	66	50
10	Village Harbor Drive/Mill Pond Road & SC 49	Signalized	A	C	9.8	20.6	Eastbound	A	A	6	5	L	A	B	2	18	m2	m24	-	71
							Westbound	A	B	6	20	T-R	A	A	6	5	699	149	217	158
							Northbound	E	E	56	64	L	B	A	14	5	46	m4	58	88
							Southbound	D	E	50	73	T-R	A	C	6	20	346	m#1283	106	336
11	Evergreen Road/Channel Road & SC 49	Unsignalized	-	-	-	-	Eastbound	-	-	0	1	L	B	D	11	27	2.5	15	33	-
							Westbound	-	-	0	0	T-R	-	-	-	-	-	-	-	2
							Northbound	F	-	2064	-	L-T-R	F	-	2064	-	305	-	214	227
							Southbound	F	F	319	1077	L-T	F	F	511	4630	40	57.5	46	44
12	Carroll Cove/Latitude Lane & SC 49	Unsignalized	-	-	-	-	Eastbound	-	-	0	0	L	B	C	11	21	2.5	5	37	39
							Westbound	-	-	1	0	T-R	-	-	-	-	-	-	10	2
							Northbound	F	-	3025	-	L	C	B	21	13	15	5	-	-
							Southbound	F	-	553	-	T-R	-	-	-	-	-	-	1	7
13	SC 49 & SC 274 & SC 557	Signalized	D	D	37.2	40.4	Eastbound	C	D	35	46	L	E	E	73	72	107	138	151	-
							Westbound	D	C	35	29	T	D	D	36	53	416	273	302	222
							Northbound	C	C	29	34	L	E	D	61	42	242	m435	272	534
							Southbound	E	F	71	81	T	C	C	26	24	240	m493	244	365
14	SC 557 & Lowes Driveway	Signalized	A	A	6.9	6.1	Eastbound	A	A	3	3	L	A	A	2	3	17	22	64	94
							Westbound	A	A	8	3	T-R	A	A	8	3	150	45	120	144
							Southbound	D	D	47	43	L	E	E	74	75	86	101	118	107
15	SC 557 & Oakridge Road	Signalized	D	D	35.1	36.4	Eastbound	B	A	14	5	L	B	A	10	5	34	14	91	73
							Westbound	D	D	46	44	T-R	D	D	46	44	#631	#1133	536	683
							Southbound	D	E	50	63	L	E	F	56	85	#396	#266	255	206

'+' indicates Computation Not Defined.

'm' indicates volume for 95th percentile queue is metered by upstream signal.

'#' indicates 95th percentile volume exceeds capacity, queue may be longer.

BOLD indicates failing LOS (E or F)

7.2 2023 Future Year

This scenario includes the 2020 existing network along with the background roadway projects which are both funded by York County Pennies for Progress. These include the intersection improvements at SC 49/SC 557/SC 274 and the 5-lane widening of SC 557. The 2023 Future Year lane configuration is provided in **Figure 7. 2023 Future Year** volumes discussed in the volume development section were used for this scenario. Capacity analysis results for this scenario are discussed below and are summarized in **Table 7.**

Signalized Intersections

Based on the Synchro results, all the study signalized intersections are projected to operate under acceptable overall LOS except the following:

- SC 49 at Mill Pond Road/Village Harbor Drive
 - Possible reasons include reduced intersection capacity due to the shared through-left turn lanes on the side street
- SC 49 at SC 274/SC 557
 - Possible reasons include inadequate intersection capacity for the future year projected demand

Six of the 7 signalized intersections have one or more approaches that are projected to operate at LOS “E” or worse. Additionally, based on SimTraffic results mainline turn lane queues are projected to spillback to the adjacent lanes at the following five (5) intersection approaches:

- SC 49 at Blucher Circle South
 - Eastbound
- SC 49 at Heritage Drive
 - Eastbound, Westbound
- SC 49 at Hamiltons Ferry Road/Robinwood Road
 - Eastbound, Westbound
- SC 49 at Mill Pond Road/Village Harbor Drive
 - Eastbound, Westbound
- SC 49 at SC 274/SC 557
 - Eastbound, Westbound

Mainline turn lane spillbacks at signalized intersections on SC 49 is primarily due to the inadequate gaps for the left turning traffic during the permissive phase (where left turning traffic yields to the opposing traffic) and inadequate green time during the protected phase.

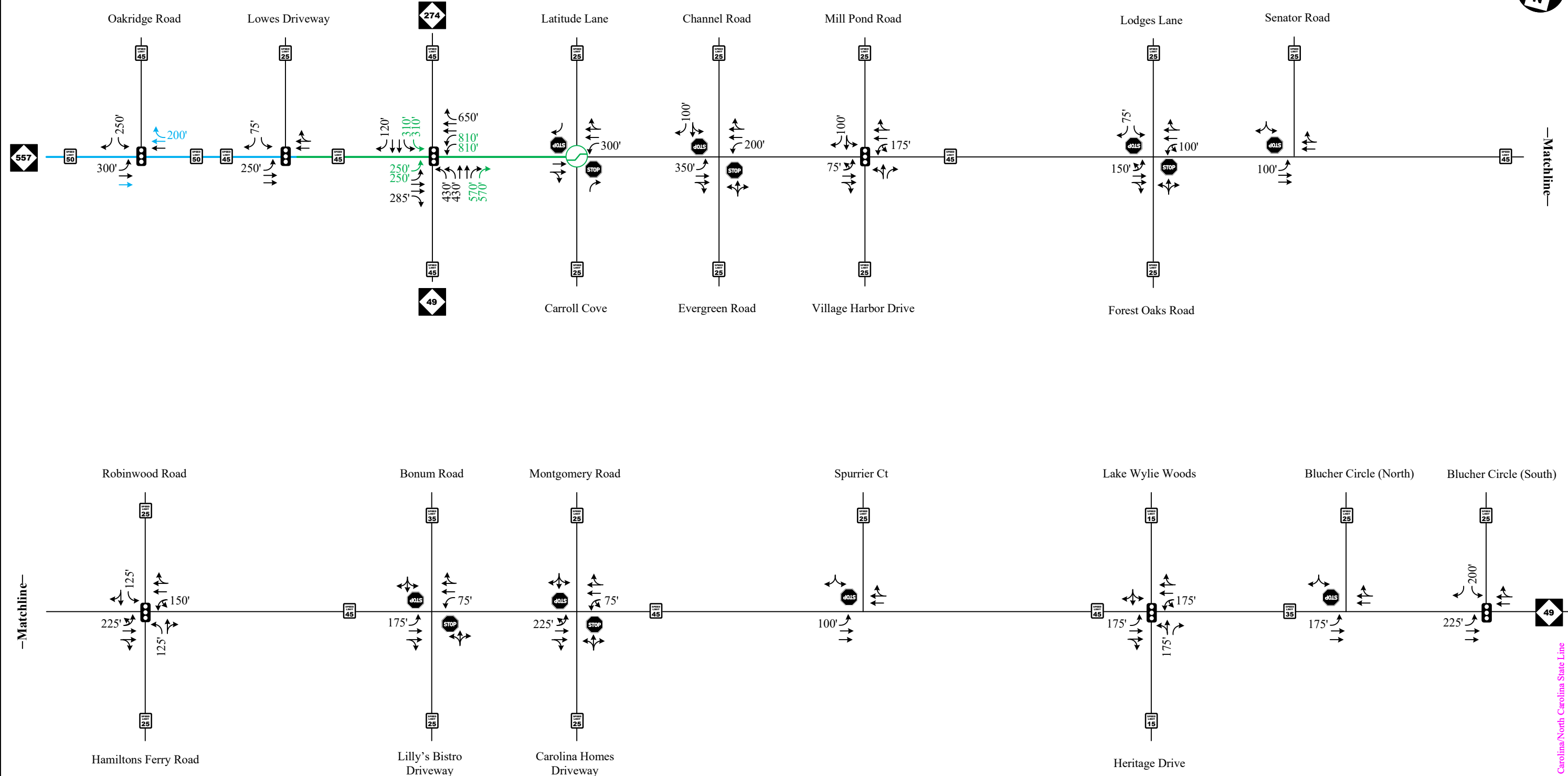
Unsignalized Intersections

Based on the Synchro results, all the study unsignalized intersections are projected to operate under LOS “E” or worse during at least one of the peak hours. At Montgomery Road, Bonum Road, and Evergreen Road/Channel Road, the projected delay is beyond the computation limits of the HCM delay equation. This implies that significant delays are projected for the yielding traffic (mainline left turns from SC 49 and side street traffic) at these locations. Based on SimTraffic results mainline turn lane queues are projected to spillback to the adjacent lanes at the following intersection approaches.

- SC 49 at Blucher Circle North
 - Eastbound
- SC 49 at Montgomery Road
 - Eastbound
- SC 49 at Bonum Road
 - Eastbound
- SC 49 at Senator Road
 - Eastbound
- SC 49 at Forest Oaks Drive/Lodges Lane
 - Eastbound, Westbound

- SC 49 at Evergreen Road/Channel Road
 - Eastbound
- SC 49 at Carroll Cove/Latitude Lane
 - Westbound

Mainline turn lane spillbacks at unsignalized intersections is primarily due to the inadequate gaps for the left turning traffic.



Not to scale



LEGEND

- Existing Roadway
- Existing Laneage
- Storage Length
- Posted Speed Limit
- Existing Stop Control
- Existing Signal Control
- SC 49/SR 274/SC 557 Intersection Project
- SC 557 Widening Project

SC 49 Corridor Study
City of Rock Hill, South Carolina

2023 No-Build Configuration

Table 7: 2023 Future Year Capacity Analysis Results

Node	Intersection	Traffic Control	LOS		Delay (sec/veh)		Approach	LOS		Delay (sec/veh)		Lane Group	LOS		Delay (sec/veh)		Synchro 95th Percentile Queue (ft)		SimTraffic Maximum Queue (ft)						
			AM	PM	AM	PM		AM	PM	AM	PM		AM	PM	AM	PM	AM	PM	AM	PM					
1	SC 49 & Blucher Circle South	Signalized	A	C	8.6	29.7	Eastbound	A	A	5	5	L	A	D	0	51	m0	m30	79	92					
							Westbound	A	D	4	37	T	A	A	5	4	m33	240	386	185					
							Southbound	F	F	105	94	L	F	F	116	126	#295	#271	264	231					
2	SC 49 & Blucher Circle North	Unsignalized	-	-	-	-	Eastbound	-	-	0	4	L	B	F	12	81	7.5	75	62	163					
							Westbound	-	-	-	-	T	-	-	-	-	-	-	103	131					
							Southbound	C	F	22	782	L-R	C	F	22	782	20	235	186	598					
3	Heritage Drive/Lake Wylie Woods & SC 49	Signalized	C	C	29.6	20.5	Eastbound	D	B	37	12	L	F	E	85	74	26	m23	48	37					
							Westbound	A	C	6	24	T-R	D	B	37	12	#1988	330	463	244					
							Northbound	E	C	60	27	L	F	F	97	85	80	m121	95	271					
							Southbound	E	D	65	54	T-R	A	C	3	22	199	m#1854	200	709					
4	SC 49 & Spurrier Court	Unsignalized	-	-	-	-	Eastbound	-	-	-	1	L	B	F	11	260	0	20	25	47					
							Westbound	-	-	-	-	T	-	-	-	-	-	-	-	9	148				
							Southbound	D	F	26	263	L-R	D	F	26	263	5	35	36	72					
5	Driveway/Montgomery Road & SC 49	Unsignalized	-	-	-	-	Eastbound	-	-	0	2	L	B	F	11	60	5	42.5	46	161					
							Westbound	-	-	0	-	T-R	-	-	-	-	-	-	1						
							Northbound	F	F	+	+	L	D	B	32	13	2.5	0	28	25					
							Southbound	F	F	+	+	T-R	-	-	-	-	-	-	3	167					
6	Driveway/Bonum Road & SC 49	Unsignalized	-	-	-	-	Eastbound	-	-	0	3	L	B	F	12	74	10	67.5	56	275					
							Westbound	-	-	-	-	T	-	-	-	-	-	-	2316						
							Northbound	F	F	+	3099	L	A	B	0	13	0	0	-	61					
							Southbound	F	F	+	35336	T-R	-	-	-	-	-	-	12	609					
7	Hamiltons Ferry Road/Robinwood Road & SC 49	Signalized	C	D	30.4	52.3	Eastbound	C	B	22	18	L	A	F	1	99	m3	m#221	118	282					
							Westbound	B	E	12	63	T-R	C	B	23	11	m#1301	m363	392	1070					
							Northbound	F	F	136	161	L	A	A	5	2	6	m3	85	249					
							Southbound	F	F	90	82	T-R	B	E	13	64	280	m#1752	592	2339					
8	SC 49 & Senator Road	Unsignalized	-	-	-	-	Eastbound	-	-	0	2	L	B	F	13	57	7.5	47.5	50	161					
							Westbound	-	-	-	-	T	-	-	-	-	-	-	12	307					
							Southbound	D	F	34	212	L-R	D	F	34	212	37.5	102.5	278	368					
9	Forest Oaks Drive/Lodges Lane & SC 49	Unsignalized	-	-	-	-	Eastbound	-	-	0	1	L	B	E	13	48	5	32.5	40	177					
							Westbound	-	-	0	0	T-R	-	-	-	-	-	-	21	629					
							Northbound	F	F	12322	17012	L	D	C	30	16	10	12.5	98	199					
							Southbound	F	F	+	+	T-R	-	-	-	-	-	-	125	414					
10	Village Harbor Drive/Mill Pond Road & SC 49	Signalized	C	F	22.8	118.4	Eastbound	B	C	18	22	L	A	D	4	38	m11	m77	-	-					
							Westbound	B	F	17	159	T-R	B	C	19	21	m884	m726	474	521					
							Northbound	E	F	79	201	L	F	B	92	11	m#104	m8	211	232					
							Southbound	E	F	72	196	T-R	B	F	15	160	m452	m#1717	813	1343					
11	Evergreen Road/Channel Road & SC 49	Unsignalized	-	-	-	-	Eastbound	-	-	0	2	L	C	F	16	57	17.5	52.5	201	226					
							Westbound	-	-	0	1	T-R	-	-	-	-	-	-	266	324					
							Northbound	F	F	+	23250	L	D	C	32	17	7.5	20	118	80					
							Southbound	F	F	+	+	T-R	-	-	-	-	-	-	446	4					
12	Carroll Cove/Latitude Lane & SC 49	Unsignalized	-	-	-	-	Eastbound	-	-	-	-	L	F	C	55	17	55	10	381	60					
							Westbound	-	-	2	0	T-R	-	-	-	-	-	-	610	7					
							Northbound	F	C	70	22	R	F	C	70	22	77.5	25	269	129					
							Southbound	C	F	16	57	R	C	F	16	57	2.5	35	107	106					
13	SC 49 & SC 274 & SC 557	Signalized	E	E	67.1	59.3	Eastbound	E	E	61	61	L	E	E	64	83	76	106	303	265					
							Westbound	E	D	60	48	T	E	E	72	73	#625	398	551	421					
							Northbound	E	E	70	61	R	A	B	4	16	29	113	384	277					
							Southbound	F	F	87	86	L	F	E	120	67	m#410	m584	653	480					
14	SC 557 & Lowes Driveway	Signalized	A	A	5.4	9.5	Eastbound	A	A	4	4	L	A	A	4	6	26	31	88	97					
							Westbound	A	A	3	7	T	A	A	4	3	216	111	154	182					
							Southbound	D	E	40	56	L	E	F	64	90	99	142	125	154					
15	SC 557 & Oakridge Road	Signalized	C	B	21.1	16.3	Eastbound	B	A	20	8	L	B	A	17	8	68	26	126	76					
							Westbound	B	B	17	17	T	C	A	20	8	261	107	240	118					
							Southbound	C	C	30	28	R	A	A	7	4	90	51	259	111					

'+' indicates Computation Not Defined.
 'm' indicates volume for 95th percentile queue is metered by upstream signal.
 '#' indicates 95th percentile volume exceeds capacity, queue may be longer.
 BOLD indicates failing LOS (E or F)

8.0 DEVELOPMENT OF IMPROVEMENTS

Based on a review of the historical crash data, field observations, and projected future year no-build operations, the project team prepared a toolbox with the potential improvements that could enhance safety, increase mobility, and improve the operations along the study corridor. The toolbox was prepared in accordance to the SCDOT policies and guidelines as well as the state-of-the-art practices. This section discusses the toolbox, qualitative and quantitative evaluation of the improvements as well as the recommendations for the study corridor.

8.1 Toolbox of Potential Improvements

Access Management

FHWA defines access management as a process of managing and planning the spacing and design of driveways, median openings, traffic signals, and interchanges. Access management is achieved through the application of the planning, regulatory, and design strategies. Based on the FHWA's Crash Modification Factor (CMF) Clearing House, many access management strategies are identified as safety enhancements. A 2018 study (FHWA-SC-18-08) conducted jointly by Clemson University and the University of South Carolina also identified that some of the access management strategies effectively improve the safety and mobility along the subject corridors.

This SC 49 corridor study considered the following access management strategies:

- Raised median implementation
 - Converting TWLTL to a raised median is estimated to have a 61% reduction in the crashes/driveway, 23% reduction in angle crashes, and 21% reduction in injury crashes.
 - Based on the FHWA-SC-18-08, converting TWLTL to a raised median does not have a negative impact on the businesses.
- Access restriction to RIRO
 - Converting full access driveways to RIRO is estimated to have a 56% reduction in crashes/driveway.
 - Driveways with right only access are expected to have shorter queues and delays, especially when the mainline traffic is heavy.
- Directional median opening
 - Converting a full access median opening to a directional median opening is estimated to have a 24% reduction in the injury crashes. However, the property damage only (PDO) crashes are estimated to increase by 13%.
 - Driveways with right only access are expected to have shorter queues and delays, especially when the mainline traffic is heavy.
 - Per the SCDOT design manual guidelines, minimum median crossover spacing is 500' for an urban area.
- Driveway consolidation
 - Estimated to improve mainline traffic flow and reduce travel time.
 - Providing a parallel access for the driveway traffic helps in consolidating the driveways.

Spot (Intersection) Improvements

The intersection improvements considered in the study are listed below:

- Signalization
 - Converting a TWSC intersection to a signal is estimated to have a 67% reduction in angle crashes and 23% reduction in injury crashes. However, there is potential for increase in rear end crashes.
 - Signal installation has the potential to improve the platooning along the corridor.
 - Per MUTCD guidelines, a full warrant study is required to install a signal.
 - Per the SCDOT design manual guidelines, minimum signal spacing is 1,320'.

- Add Right Turn Lane
 - Addition of a right-turn lane is estimated to have a 9% reduction in injury crashes at the intersection.
 - With the additional intersection capacity, queues and delays are expected to reduce.
 - SCDOT design manual (Figure 9.5-B) provides guidance for adding right turn lanes.
- Signal Timing/Phasing Improvements
 - Signal timing optimization, sequence optimization is expected to reduce the number of stops at the intersection which in turn reduces the potential rear end crashes.

Adaptive Signal Control Technology

Adaptive signal control technology (ASCT) differs from traffic responsive signal control technology, which selects a signal-timing plan most similar to the “observed” current traffic conditions from a set of timing plans developed for specific time periods of the day. Instead, ASCT specifically optimizes each component of the traffic signal timing, typically splits, offsets, and/or cycle lengths based on the current detected traffic conditions. Additionally, some systems use predictive algorithms that supplement the current traffic data with historical traffic data, such as average link speed, that the ASCT system has observed during similar times of day. Two types of adaptive systems have been used in South Carolina – Synchro Green and In-Synch. There are currently two adaptive systems that have been installed in the RFATS Study Area along Carowinds Boulevard and SC 160. These are both Synchro Green systems that were installed in 2020.

Adaptive signal control technologies are best suited for arterials that experience highly variable or unpredictable traffic demand for which multiple signal timing solutions are necessary during a typical time-of-day period. Corridors with longer than ideal signal spacing combined with multiple access points could induce variability in traffic arrivals at signals and also disturb the traffic platooning. Some of the qualitative and quantitative considerations to the agencies when considering ASCT are:

- Corridor length, density of signals, and character of the arterial
 - Based on an evaluation of existing adaptive systems nationwide, the minimum number of signals typically included in an ASCT system is three signals. In addition, spacing should be approximately $\frac{3}{4}$ mile or less to facilitate coordination.
- Non-recurring congestion
 - ASCT is most beneficial in areas with non-recurring congestion, with a buffer time index (BI) of 0.3 or greater, long shoulder periods, or the proximity of land uses that create variable traffic flow, such as events and sporting venues, large shopping centers, etc.
- Operations, management, and maintenance
 - Per NCHRP Synthesis 403, yearly operations and maintenance costs can vary per intersection for a number of reasons and may require weekly maintenance.

Adaptive signal control is estimated to improve travel time, control delay, emissions, and fuel consumption by more than 10 percent, depending on operating conditions along the corridor. Improvement might not be significant in areas where traffic demand is predictable during typical time-of-day periods, or if performance is regularly monitored, and/or if signal timing is well maintained. It is worth noting that during peak-periods adaptive signal control helps to extract further efficiency from the network. However, a higher degree of improvement can be realized if a corridor also experiences fluctuations of demand during off-peak periods which can often be the result of seasonal trends in traffic or special events.

8.2 Signal Warrants

In identifying the spot improvements as well as improving the platooning along the corridor, the project team performed signal warrant analysis using the available data for all the study unsignalized intersections. Due to the limited data, the following warrants were only performed:

- Peak hour warrant (Warrant 3)
 - Peak hour vehicular volumes at the intersections were used.
 - One of the conditions to meet this Warrant include - minor-street volume should be at least 75 vehicles in the peak hour for a major street volume exceeding 1,300 vehicles (both approaches combined).
- Pedestrian volume (Warrant 4)
 - Peak hour pedestrian volumes at the intersections were used.
 - One of the conditions to meet this Warrant include - the number of pedestrians crossing the major street in the peak hour be at least 93.
- Coordinated signal system (Warrant 6)
 - One of the conditions to meet this Warrant include - study showing improved platooning of vehicles along a coordinated system.
 - A qualitative evaluation was done which is supported by the corridor simulation results with the proposed signals.
- Crash experience (Warrant 7)
 - Historic crash data was used to identify the crashes correctable by a signal installation.
 - One of the conditions to meet this Warrant include - five or more reported crashes, of types susceptible to corrective by a traffic signal should have occurred within a 12-month period.
- Roadway network (Warrant 8)
 - Peak hour vehicular volumes at the intersections were used.
 - As one of the minimum conditions for this Warrant, the major route should be part of a street or highway system that serves as the principal roadway network for through traffic flow.

8.3 Recommendations

Using the existing/historic data, projected growth/future year operations, and a review of the potential improvements listed in the toolbox, the project team recommends the following improvements for the study corridor. These recommendations are also presented in **Figure 8**

Corridor-wide Improvements

Access Management Strategies

- Convert the existing SC 49 5-lane undivided roadway with TWLTL median to a 4-lane divided roadway with a raised median from SC 557 to Lake Wylie
- Provide full access median openings on SC 49 at the following three locations:
 - Forest Oaks Road/Lodges Lane
 - Montgomery Road
 - Driveway at Sam's Carwash
- Provide median crossovers on SC 49 at the following 10 locations:
 - Evergreen Road/Channel Road
 - Lodges Driveway/Bojangles Driveway (west of Forest Oaks Road)
 - Redeeming Grace PCA Church
 - Altamonte Drive/Goins Driveway
 - Bonum Road/Lily's Bistro Driveway
 - Sawyer Court
 - Spurrier Court
 - U-Haul Driveway (west of Heritage Drive)
 - Lake Wylie Plaza Driveway
 - Blucher Circle North

Per the SCDOT design manual guidelines, all median crossover locations should be provided with an exclusive left turn lane and a minimum storage of 150 feet. In considering the proposed recommendations, some of the items that require further evaluation for design feasibility include:

- Total width of the median
- Width of the raised median
- U-turn accommodations and need for bulb-outs at full-movement and median crossover locations
- Emergency access in the corridor

Traffic Control and Operational Improvements

- Conduct a full warrant study to evaluate traffic signal needs at SC 49 and Forest Oaks Road/Lodges Lane intersection. The traffic volumes used in the warrant study needs to consider the traffic redistribution if the corridor characteristics change. This study analyzed this intersection as a signal in the build scenario.
- Conduct a full warrant study to evaluate traffic signal needs at SC 49 and Montgomery Road intersection. The traffic volumes used in the warrant study needs to consider the traffic redistribution if the corridor characteristics change. This study analyzed this intersection as a signal in the build scenario.
- Conduct a full evaluation for the application of adaptive signal control technologies along the corridor. All the study signalized intersections are spaced adequately (under both no-build and proposed build conditions) for facilitating coordination. Due to the limitation of Synchro/SimTraffic software, this study did not analyze the impact of this improvement in the build scenario.
- Implement infrastructure improvements for a corridor-wide coordinated signal system.
 - These improvements will be necessary if or when an adaptive signal system is implemented along the corridor.

Spot Improvements

- At the existing signalized intersection of SC 49 and Lowes Entrance, provide exclusive westbound right turn lane.
- At the existing signalized intersection of SC 49 and Mill Pond Road/Village Harbor Drive, provide exclusive eastbound and westbound right turn lanes, extend the existing eastbound and westbound left turn storages. Additionally, provide a protected phase for the westbound left turns.
- At the existing signalized intersection of SC 49 and Forest Oaks Road/Lodges Lane, extend the existing westbound left turn storage. Additionally, re-stripe both the side street lane markings to provide exclusive left turn lane and a shared through/right turn lane.
- At the existing signalized intersection of SC 49 and Hamiltons Ferry Road/Robinwood Road, provide exclusive eastbound and westbound right turn lanes, extend the eastbound left turn storage.
- At the existing signalized intersection of SC 49 and Heritage Drive, extend the westbound left turn storage.
- At the existing signalized intersection of SC 49 and Blucher Circle South, provide exclusive westbound right turn lane, extend the eastbound storage at this intersection. Additionally, provide a protected phase for the eastbound left turns.
- At the proposed median crossover intersection of SC 49 and Evergreen Road/Channel Road, provide an exclusive eastbound right turn lane.
- At the proposed median crossover intersection of SC 49 and Bonum Road, provide an exclusive westbound right turn lane.
- At the future median crossover intersection of SC 49 and Carroll Cove/Latitude Lane, extend the westbound left turn lane.
- At the proposed signalized intersection of SC 49 and Montgomery Road, provide an exclusive westbound right turn lane.

The right turn lanes that are recommended in this study are primarily located at signalized locations where a left turn from the side streets would be protected by a signal phase. In the locations where these are recommended for unsignalized locations, this should be done only if left turns from side streets are controlled or restricted by access management.

Cross Connections

- Provide a roadway connection between Carroll Cove and Evergreen Road south of SC 49.
- Provide a roadway connection between Bonum Road and Montgomery Road north of SC 49.
- When possible, plan for additional collector streets like those referenced in the RFATS Collector Street Plan as future development and redevelopment occurs.

Figure 8 shows the recommended lane configuration, storage lengths, and proposed roadway connections for the proposed build conditions.

8.4 High-Level Cost Estimate of Improvements

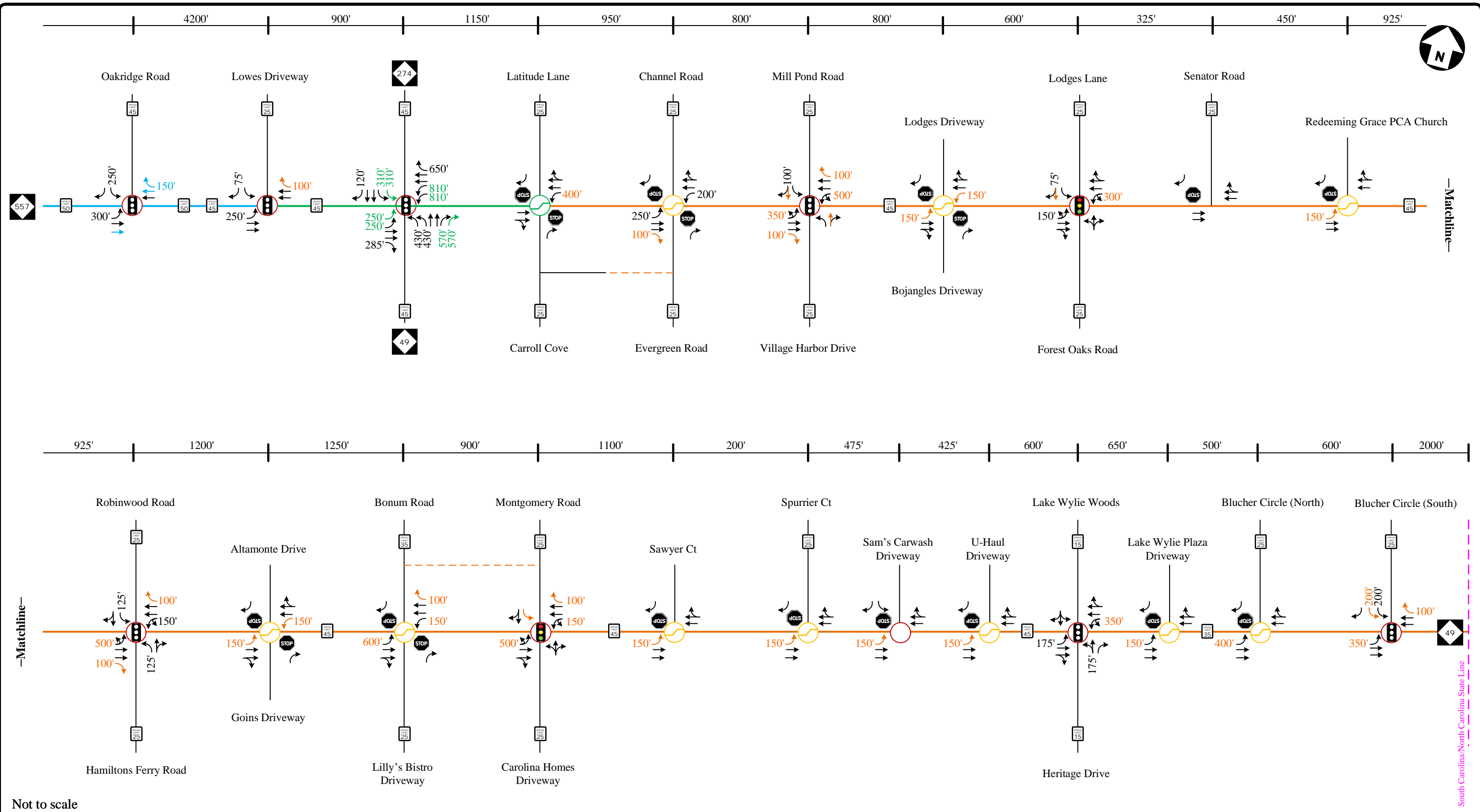
The following high-level cost estimate ranges of improvements presented in **Table ES 1** were developed based on a review of similar local project costs, high-level order-of-magnitude estimates from other agencies, and coordination with project stakeholders. The high-level cost estimate ranges do not consider contingencies, right-of-way, utility relocations, and engineering costs. Additional evaluation and design will need to be conducted to develop a more refined cost of improvements.

Table 8 High-Level Cost Estimate of Improvements

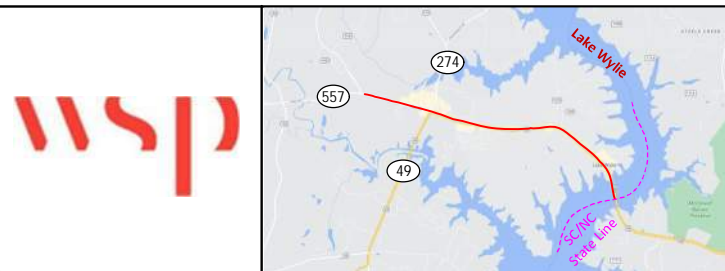
Item	Cost Estimate Range (\$)
Signal Enhancements	\$1,000,000 to \$1,500,000
Intersection Improvements	\$250,000 to \$3,000,000
New Roadway Connections	\$500,000 to \$1,500,000
Access Management	\$8,000,000 to \$10,000,000
Total	\$9,750,000 to \$16,000,000

Each cost estimate item is assumed to include the following improvements:

- Signal Enhancements include new signal installations, corridor coordination, and adaptive signal control.
- Intersection Improvements include right turn lanes, restriping, signal updates, increased turn lane storage, new turn lanes, etc.
- New Roadway Connections include connections from Vesla Lane to Evergreen Road and Bonum Road to Montgomery Road.
- Access Management includes conversion of existing roadway of 4-lane with TWLTL to proposed cross-section of 4-lane divided with raised median with curb & gutter and sidewalks estimated at \$3.3M per mile.



Not to scale



LEGEND

- | | | | | | |
|-----|-----------------------|---|-------------------------|-------|--|
| — | Existing Roadway | ⊗ | Existing Signal Control | ### | Intersection Spacing |
| → | Existing Laneage | ⊗ | Proposed Signal Control | — | SC 49/SR 274/SC 557 Intersection Project |
| ### | Storage Length | ⊗ | Median Crossover | — | Proposed Median Separation |
| ⊗ | Posted Speed Limit | ⊗ | Median Opening | - - - | Proposed Connection |
| ⊗ | Existing Stop Control | → | Proposed Laneage | — | SC 557 Widening Project |

SC 49 Corridor Study City of Rock Hill, South Carolina

2023 Proposed Build Configuration & Improvements

9.0 BUILD OPERATIONS ANALYSIS

9.1 Signal Warrant Analysis

Signal warrant analysis examines the need, or warrant, for installation of traffic signals. A warrant is a condition that an intersection must meet to justify signal installation. This study performed the following five signal warrants:

- Peak Hour (Warrant 3)
- Pedestrian Volume (Warrant 4)
- Coordinated Signal System (Warrant 6)
- Crash Experience (Warrant 7)
- Roadway Network (Warrant 8)

Results show that all the unsignalized intersections along SC 49 meet the Roadway Network warrant, and six of the eight intersections meet at least one of the other four signal warrants (Warrants 3, 4, 6, and 7). However, only three locations meet the SCDOT signal spacing requirement of maintaining at least 1,320 feet distance between adjacent signalized intersections. Between the SC 49 intersections at Bonum Road and Montgomery Road, the latter is identified more appropriate for signal installation due to existing sight distance issues. A summary of the analysis performed is shown in **Table 9**.

Table 9 Signal Warrant Summary

Intersection	Distance to nearest signal	Peak Hour Volume (Major Rd both Approaches)	Peak Hour Volume (Highest Volume Minor Rd)	Angle Crash Frequency (per year)	Warrants Met
SC 49 at Carroll Cove Rd/Latitude Ln	1,150'	4,335	66	6	Warrants 7, 8
SC 49 at Channel Rd/Evergreen Rd	800'	4,311	123	6	Warrant 3, 7, 8
SC 49 at Forest Oaks Drive/Lodges Ln	1,400'	3,704	87	4	Warrants 3, 8
SC 49 at Senator Rd	1,375'	3,679	61	2	Warrant 8
SC 49 at Bonum Rd	2,450'	3,509	173	3	Warrant 3, 6, 8
SC 49 at Montgomery Rd	2,800'	3,561	90	1	Warrants 3, 6, 8
SC 49 at Spurrier Ct	1,500'	4,092	4	0	Warrant 8
SC 49 at Blucher Circle N	600'	4,061	78	3	Warrant 3, 8

9.2 2023 Future Year Build Volumes

The *2023 Future Year* no-build volumes discussed in the volume development were re-distributed for the proposed access modifications along the study corridor. The traffic re-distribution included the following:

- At the proposed median closure and median crossover locations, traffic currently turning left from the side streets is redirected to make a right turn followed by a downstream U-turn unless a parallel route exists or is proposed.
- At the proposed median closure locations, left turn from SC 49 is continued to make a U-turn at the downstream intersection followed by a right turn unless a shorter path exists (or is proposed).

To reasonably estimate the U-turns, this study considered traffic to/from all the driveways affected along the study corridor with the proposed median separation. The traffic at these driveways was estimated using the volume imbalance between the study intersections. A minimum of 5 vehicles per turn were assumed (in the peak hours) at all the minor driveways where traffic counts were not available. The traffic was then redistributed and balanced along the corridor. This study conservatively assumed that all the redistributed U-turns were made at signalized intersections even though some of these U-turns could be made at the nearest unsignalized median crossover locations. The balanced corridor volumes including all the driveways are provided in **Appendix H**. The *2023 Future Year Build* peak hour volumes at the study intersections are shown in **Figure 9**.

9.3 2023 Future Year Build Operations Analysis

This scenario includes the 2023 future year proposed network along with the background roadway projects funded by York County Pennies for Progress and the *2023 Future Year Build* peak hour volumes.

Capacity analysis results for this scenario are discussed below and are summarized in **Table 10**.

Signalized Intersections

Based on the Synchro results, all the study signalized intersections are projected to operate under acceptable LOS except the following:

- SC 49 at SC 274/SC 557
 - Possible reasons include inadequate intersection capacity for the future year projected demand

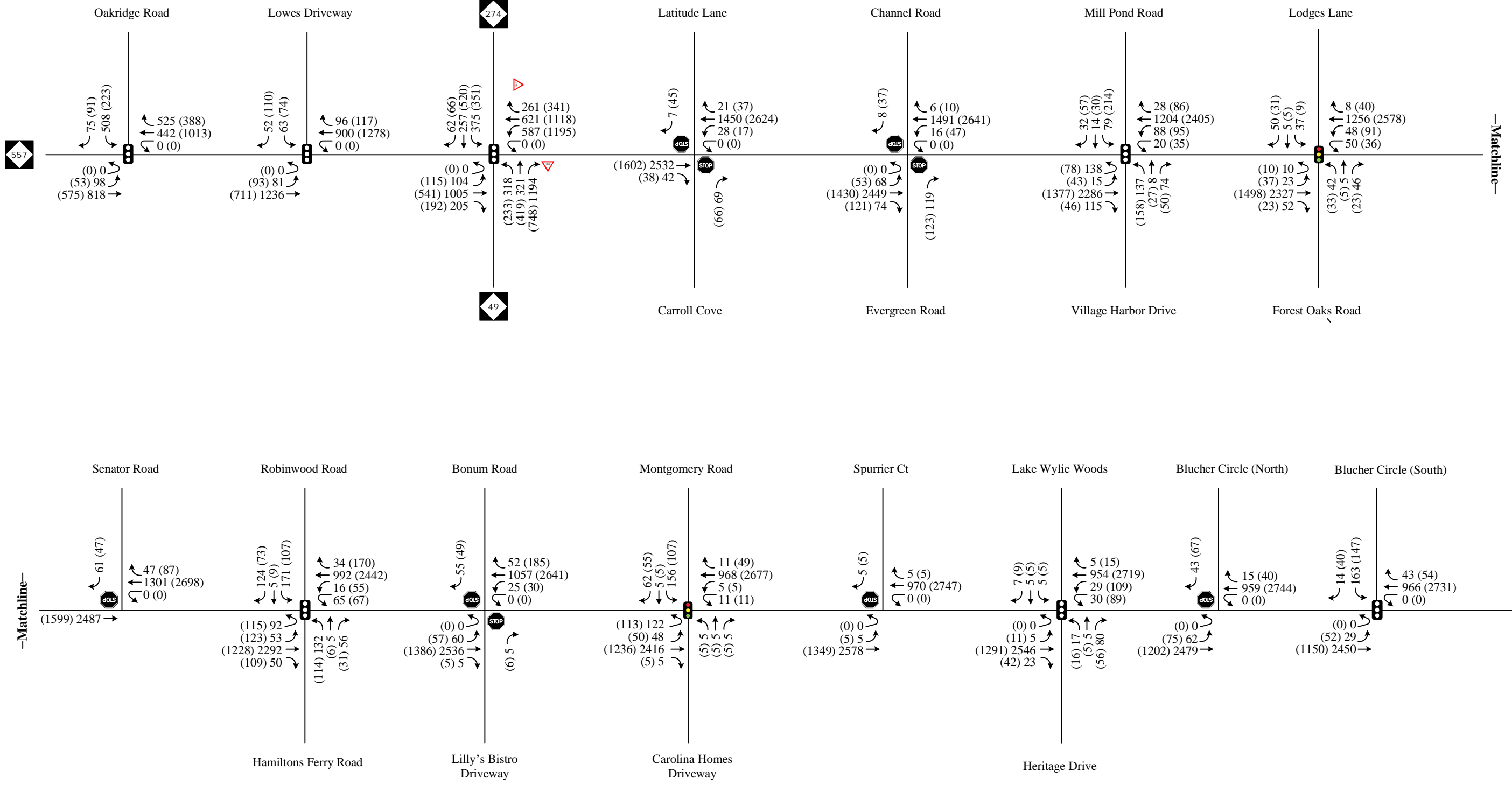
Seven of the nine signalized intersections have one or more approaches that are projected to operate at LOS “E” or worse. Additionally, based on SimTraffic results mainline turn lane queues on SC 49 are projected to spillback to the adjacent lanes at the following intersection approaches:

- SC 49 at Hamiltons Ferry Road/Robinwood Road
 - Eastbound
- SC 49 at SC 274/SC 557
 - Westbound

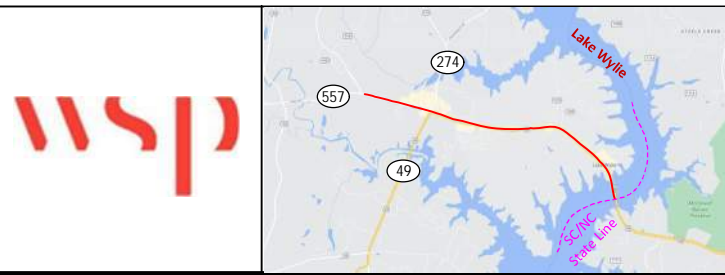
The spillback at the Hamiltons Ferry Road/Robinwood Road intersection is primarily due to the added U-turn traffic. As mentioned earlier, this study assumed all the U-turns were made at the signalized intersections and hence the queues at such locations could potentially be contained within the available/proposed storage if some of the U-turns were made at the nearest median crossover locations. Similar to the 2023 no-build conditions, the spillbacks at the SC 274/SC 557 intersection is primarily due to the inadequate capacity resulting in oversaturated conditions at this intersection.

Unsignalized Intersections

Based on the Synchro results, all the study unsignalized intersections are projected to operate under LOS “E” or worse during at least one of the peak hours. Based on SimTraffic results no spillbacks are projected from the mainline turn lane.



Not to scale



LEGEND

- Existing Roadway
- Turning Movement
- XX (XX) AM (PM) Volumes
- ▽ Yield Control
- STOP Existing Stop Control
- Existing Signal Control
- Proposed Signal Control

SC 49 Corridor Study
City of Rock Hill, South Carolina

2023 Build Peak Hour Traffic Volumes

South Carolina/North Carolina State Line

Table 10: 2023 Future Year Build Capacity Analysis Results

Node	Intersection	Traffic Control	LOS		Delay (sec/veh)		Approach	LOS		Delay (sec/veh)		Lane Group	LOS		Delay (sec/veh)		Synchro 95th Percentile Queue (ft)		SimTraffic Maximum Queue (ft)		
			AM	PM	AM	PM		AM	PM	AM	PM		AM	PM	AM	PM	AM	PM	AM	PM	
1	SC 49 & Blucher Circle South	Signalized	B	D	10.3	44.4	Eastbound	A	A	6	3	L	A	C	1	22	m1	m40	56	111	
							Westbound	A	E	6	60	T	A	A	6	2	m36	64	286	144	
							Southbound	F	E	95	77	R	A	A	2	3	12	20	49	200	
2	SC 49 & Blucher Circle North	Unsignalized	-	-	-	-	Eastbound	-	-	0	6	L	B	F	12	106	10	107.5	86	256	
							Westbound	-	-	-	-	T-R	-	-	-	-	-	-	-	7	343
							Southbound	B	F	15	101	R	B	F	15	101	10	95	83	313	
3	Heritage Drive/Lake Wylie Woods & SC 49	Signalized	C	C	23.5	22.3	Eastbound	C	B	28	11	L	F	E	100	64	m7	m24	22	37	
							Westbound	B	C	10	28	T-R	C	B	28	10	#1984	m256	476	441	
							Northbound	D	C	39	25	L	F	E	131	59	#174	m211	-	-	
							Southbound	E	D	65	50	T-R	A	C	3	25	195	m#1618	200	1094	
4	SC 49 & Spurrier Court	Unsignalized	-	-	-	-	Eastbound	-	-	-	1	L	B	F	11	277	0	22.5	25	76	
							Westbound	-	-	-	-	T-R	-	-	-	-	-	-	-	1380	
							Southbound	B	F	12	64	R	B	F	12	64	0	7.5	31	140	
5	Driveway/Montgomery Road & SC 49	Signalized	B	D	11.9	50.6	Eastbound	A	C	6	21	L	A	F	2	153	m15	m#312	-	-	
							Westbound	A	E	9	57	T-R	A	A	6	4	m160	m234	333	164	
							Northbound	D	D	52	54	L	D	A	51	1	#56	m0	-	-	
							Southbound	F	F	95	191	T	A	E	9	58	321	m#1638	260	1229	
6	Driveway/Bonum Road & SC 49	Unsignalized	-	-	-	-	Eastbound	-	-	0	3	R	A	A	1	0	m3	m0	41	200	
							Westbound	-	-	1	0	L-T-R	D	D	52	54	40	39	57	54	
							Northbound	D	C	34	16	L	F	F	128	260	#365	#287	317	625	
							Southbound	B	F	14	61	T-R	B	E	19	69	60	104	102	117	
7	Hamiltons Ferry Raod/Robinwood Road & SC 49	Signalized	D	D	51.0	48.6	Eastbound	E	D	55	44	L	B	F	13	232	88	#477	-	-	
							Westbound	B	D	18	40	T	E	B	59	11	#1814	348	734	964	
							Northbound	F	F	142	181	R	A	A	1	3	12	30	184	155	
							Southbound	E	F	79	105	L	F	A	80	3	#152	m10	-	-	
8	SC 49 & Senator Road	Unsignalized	-	-	-	-	Eastbound	-	-	-	-	T	-	-	-	-	-	-	3	66	
							Westbound	-	-	-	-	T-R	-	-	-	-	-	-	-	12	223
							Southbound	C	F	18	69	R	C	F	18	69	17.5	55	70	196	
9	Forest Oaks Drive/Lodges Lane & SC 49	Signalized	B	D	17.3	51.8	Eastbound	B	B	12	15	L	D	F	54	83	m37	m81	-	-	
							Westbound	B	E	16	72	T-R	B	B	11	13	m83	m421	290	286	
							Northbound	F	F	124	97	L	F	F	130	91	#232	221	-	-	
							Southbound	E	D	65	42	T-R	A	E	7	71	302	#1889	289	380	
10	Village Harbor Drive/Mill Pond Road & SC 49	Signalized	C	D	31.5	52.2	Eastbound	C	B	34	19	L	A	F	8	93	m39	m#177	-	-	
							Westbound	B	E	11	59	T	D	B	38	13	m827	m340	466	364	
							Northbound	F	F	103	85	R	A	A	2	2	m11	m4	200	184	
							Southbound	E	F	67	143	L	E	B	72	17	m#169	m17	-	-	
11	Evergreen Road/Channel Road & SC 49	Unsignalized	-	-	-	-	Eastbound	-	-	0	2	T	A	E	6	63	m177	m#1507	215	578	
							Westbound	-	-	0	0	R	A	A	0	1	m0	m4	37	200	
							Northbound	F	C	128	23	L	F	F	150	112	#311	#337	309	326	
12	Carroll Cove/Latitude Lane & SC 49	Unsignalized	-	-	-	-	Eastbound	-	-	-	-	T-R	C	C	24	30	74	88	147	153	
							Westbound	-	-	1	0	L	F	F	89	181	#167	#482	147	788	
							Southbound	C	F	16	57	T-R	C	D	29	47	58	126	94	200	
13	SC 49 & SC 274 & SC 557	Signalized	E	D	72.1	45.7	Eastbound	E	E	60	57	L	C	F	16	59	17.5	55	76	124	
							Westbound	E	C	57	22	T	-	-	-	-	-	-	-	23	11
							Northbound	F	E	88	57	R	-	-	-	-	-	-	-	2	3
							Southbound	F	F	88	86	T-R	-	-	-	-	-	-	-	509	110
14	SC 557 & Lowes Driveway	Signalized	A	A	5.1	8.6	Eastbound	A	A	4	3	R	C	F	17	51	2.5	35	35	88	
							Westbound	A	A	2	6	L	E	C	40	16	22.5	5	374	48	
							Southbound	D	D	51	55	T-R	-	-	-	-	-	-	-	190	-
15	SC 557 & Oakridge Road	Signalized	C	B	21.3	15.8	Eastbound	B	A	20	8	R	F	C	70	22	77.5	25	297	82	
							Westbound	B	B	17	17	L	F	F	16	57	2.5	45	37	91	
							Northbound	C	C	32	26	L	F	F	88	82	94	105	350	271	
							Southbound	C	C	32	26	T	E	E	67	67	#711	323	608	331	

*' indicates Computation Not Defined.
 'm' indicates volume for 95th percentile queue is metered by upstream signal.
 '#' indicates 95th percentile volume exceeds capacity, queue may be longer.
 BOLD indicates failing LOS (E or F)

10.0 CONCLUSIONS

The SC 49 corridor within the study limits has higher than average crash rates compared to similar arterial roadways. It also experiences significant congestion during the AM and PM peak periods due to the high commuter traffic. With the expected future growth in the study area vicinity, the safety and operations are projected to cause more challenges under no-build conditions including high delays for the driveway traffic. Additionally, mainline left turning traffic at multiple intersections along SC 49 are projected to have queues spillback to the mainline which could adversely affect the safety, mobility and operations of the corridor. This study identifies the SC 49 corridor as a suitable candidate for access management changes that include median separation, driveway consolidation, and access restriction. The study also identifies potential intersections improvements that include signal installation, signal timing/phasing, auxiliary turn lanes, and adaptive signal control.

With regard to access management techniques and driveway consolidation (where appropriate), there are examples along the SC 49 Corridor to learn from as additional development or re-development occurs in the future. For example, Nautical Drive was developed as a parallel collector roadway to decrease the amount of access points off of SC 49 itself. The limited nature of the collector road system in this area has made incorporating the demand level along the corridor more challenging. Not only does this add further pressure in additional traffic volume on SC 49, but also fosters the need for all access points to occur directly on the corridor. For example, between Altamonte Drive and Montgomery Road there are 24 access points in just under 2,200 feet of the corridor. This high number of access points and the required turning movements can quickly degrade traffic flow, especially during peak-hour conditions. As future re-development occurs along this corridor it is quite important to emphasize two key factors. The first is a need to improve east-west connectivity in this area (where possible), utilizing Nautical Drive as a model for access off of the mainline. The second is a need to consolidate driveways when possible, in order to decrease the amount of turning movements made along the corridor.

Results from the capacity analysis show that the proposed build conditions reflected in this report are projected to improve the network performance within the study area. Peak hour delays and mainline turn lane spillbacks are projected to reduce at most of the study intersections. Additionally, the average speed along the corridor is projected to improve along the westbound and eastbound directions during the AM and PM peaks respectively. This is mainly due to the reduced through lane blocks associated to the mainline turn lane queue spillbacks. A slight drop in the average speed is noted along the peak flow direction due to the proposed signals which result in additional stops. However, the overall network delay and travel time are projected to improve by 25% in the AM and 18% in the PM respectively. **Table 11** shows a comparison of the traffic operations for no-build and proposed build PM peak hour conditions.

It is worth noting that recent access management treatments on similar corridors in the RFATS region have shown positive impact on safety conditions. For example, access management treatments completed on a 1/3rd mile section of Carowinds Boulevard in 2017 showed approximately 40% reduction in crashes from 2015 to 2019. These results are encouraging and further supplements the recommendations provided in the current study. Analysis of the crash data indicate that the two most frequent causes of accidents along the corridor are “driving too fast for conditions” or “failure to yield right-of-way”. While access management treatments can be helpful, additional law enforcement in this area will certainly play an important role as well.

Based on this evaluation, a combination of access management and intersection improvements do have the ability to provide feasible, cost-effective solutions to improve safety, mobility, and operations for managing recurring congestion, commuter traffic, and accommodating future growth.

Table 11: Comparison of 2023 Future Year No-Build and Build Peak Hour (PM) Operations

Intersection	Proposed Improvements	Scenario	Control Type	Peak Hour Delay (s/veh)	Mainline Turn Lane Spillbacks	Peak Hour Arterial Performance - Eastbound		Peak Hour Arterial Performance - Westbound		Peak Hour Network Performance	
						Delay (s/veh)	Arterial Speed (mph)	Delay (s/veh)	Arterial Speed (mph)	Total Delay (s/veh)	Travel Time (hr)
SC 49 & Blucher Circle South	Signal improvements, exclusive turn lanes, existing turn lane storage extension	No Build [Build]	Signal, Full Access [Signal, Full Access]	30 [44]	Yes [No]	381 [90]	16 [31]	415 [460]	16 [15]	299 [223]	1222 [999]
SC 49 & Blucher Circle North	Median Crossover		TWSC, Full Access [TWSC, Median Crossover]	782 [101]	No [No]						
SC 49 & Heritage Drive/Lake Wylie Woods	Signal improvements, existing turn lane storage extension		Signal, Full Access [Signal, Full Access]	21 [22]	Yes [No]						
SC 49 & Spurrier Court	Median Crossover		TWSC, Full Access [TWSC, Median Crossover]	263 [64]	No [No]						
SC 49 & Montgomery Road	Signalization, exclusive turn lanes, existing turn lane storage extension		TWSC, Full Access [Signal, Full Access]	+ [51]	Yes [No]						
SC 49 & Bonum Road	Median crossover, exclusive turn lanes, existing turn lane storage extension		TWSC, Full Access [TWSC, Median Crossover]	+ [61]	Yes [No]						
SC 49 & Hamiltons Ferry Road/Robinwood Road	Signal improvements, exclusive turn lanes, existing turn lane storage extension		Signal, Full Access [Signal, Full Access]	52 [49]	Yes [Yes]						
SC 49 & Senator Road	Median closure		TWSC, Full Access [TWSC, Median Closure]	212 [69]	Yes [No]						
SC 49 & Forest Oaks Drive/Lodges Lane	Signalization, existing turn lane storage extension		TWSC, Full Access [Signal, Full Access]	+ [52]	Yes [No]						
SC 49 & Village Harbor Drive/Mill Pond Road	Signal improvements, side street lane restripe, existing turn lane storage extension		TWSC, Full Access [TWSC, Median Crossover]	118 [52]	Yes [No]						
SC 49 & Evergreen Road/Channel Road	Median crossover, existing turn lane storage extension		TWSC, Full Access [TWSC, Median Crossover]	+ [51]	Yes [No]						
SC 49 & Carroll Cove/Latitude Lane	Existing turn lane storage extension		TWSC, Full Access [TWSC, Median Crossover]	57 [57]	Yes [No]						
SC 49 & SC 274 & SC 557	Signal improvements		Signal, Full Access [Signal, Full Access]	59 [46]	Yes [Yes]						
SC 557 & Lowes Driveway	Signal improvements, exclusive turn lanes		Signal, Full Access [Signal, Full Access]	10 [9]	No [No]	82 [72]	25 [28]	22 [20]	37 [38]		
SC 557 & Oakridge Road	None. Improvements per planned SC 557 widening project.	Signal, Full Access [Signal, Full Access]	16 [16]	No [No]							

Note: + indicates HCM 6 computation undefined; **Bold** highlights represent improvement from no-build conditions