ROUTE 15 SAFETY AND OPERATIONS STUDY

ATCS®

US-15

JAMES MONROE HIGHWAY

STUMPTOWN ROAD

QUADRANT ROADWAY

LUCKETTS ROAD

QUADRANT ROADWAY

LUCKETTS ROAD

SCALE
0 100' 200'

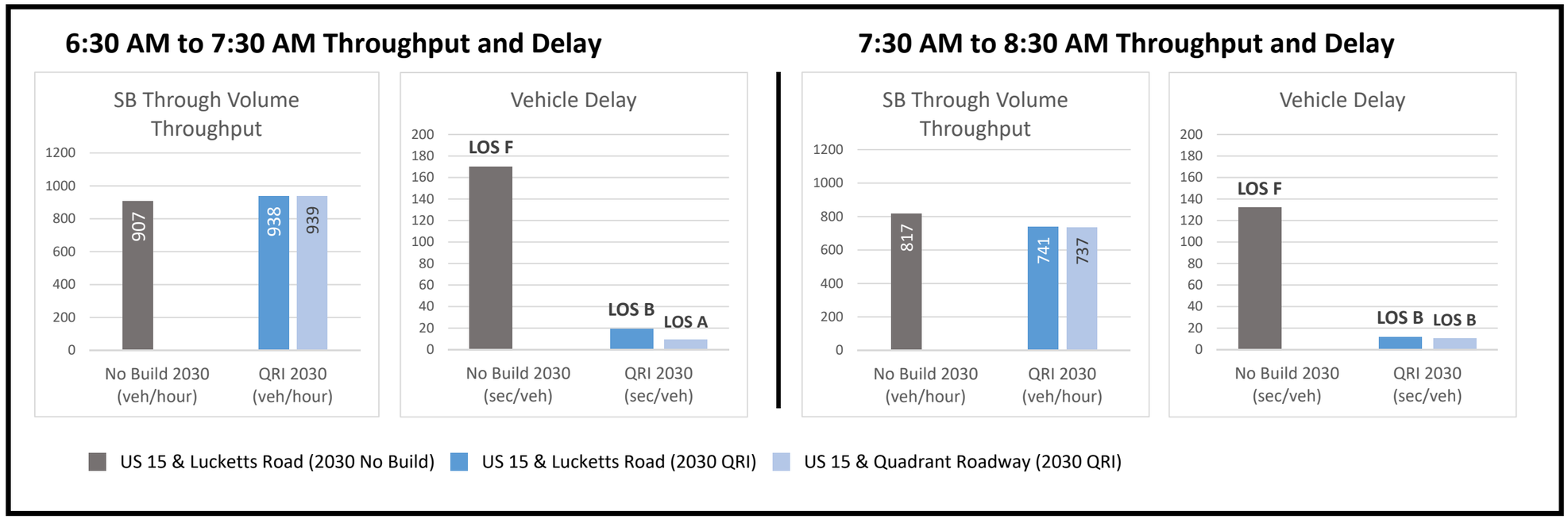
LEGEND

- NEW PAVEMENT (OPTION 1)
- NEW PAVEMENT (OPTION 2)
- CONCRETE PAVEMENT / PROPOSED SIDEWALK
- PROPOSED FIRE STATION
- PROPOSED PARKING LOT
- PROPOSED POND
- PROPOSED POND ACCESS ROAD
- PROPOSED BUILDING
- PROPOSED WASTEWATER TREATMENT PLANT
- GREEN SPACE
- EXISTING POND
- PROPOSED LOD
- WETLAND
- PROPERTY LINE
- DOUBLE YELLOW PAVEMENT MARKING
- PROPOSED PARKING SPACES

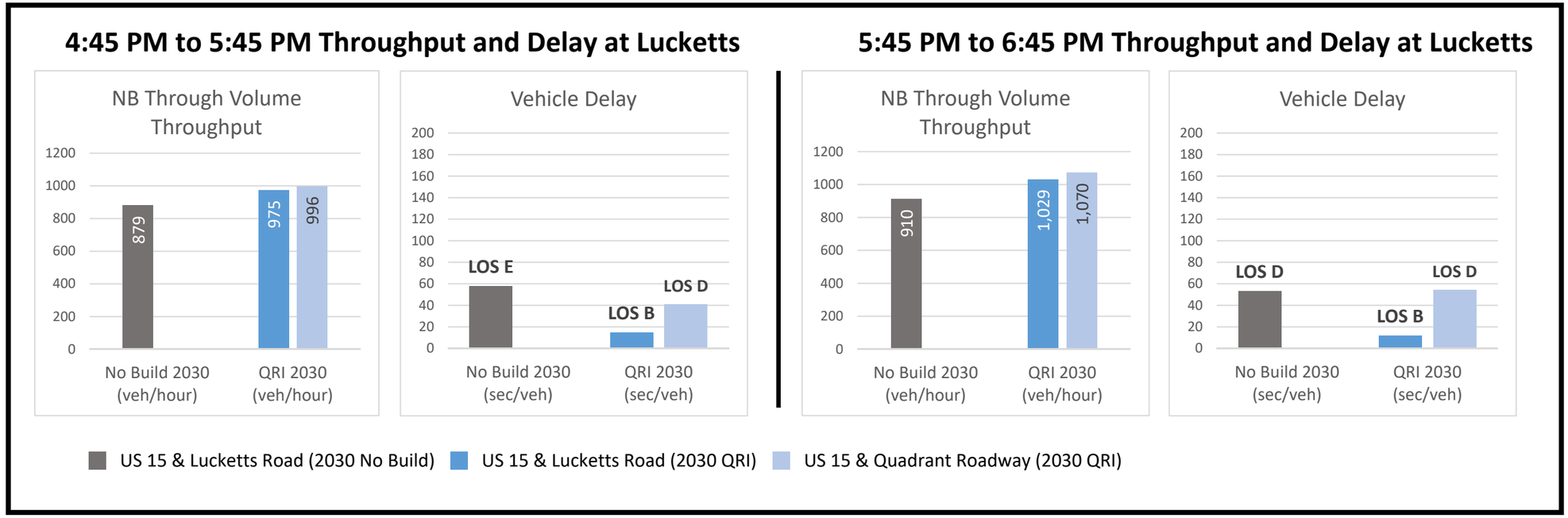
US 15 QRI: Intersection Operations Comparison Between 2030 AM and PM No Build and the 2030 AM and PM QRI Concept

5/14/2020

AM Operations through Lucketts



PM Operations through Lucketts



The evaluation shown above is an average of 10 VISSIM simulation runs

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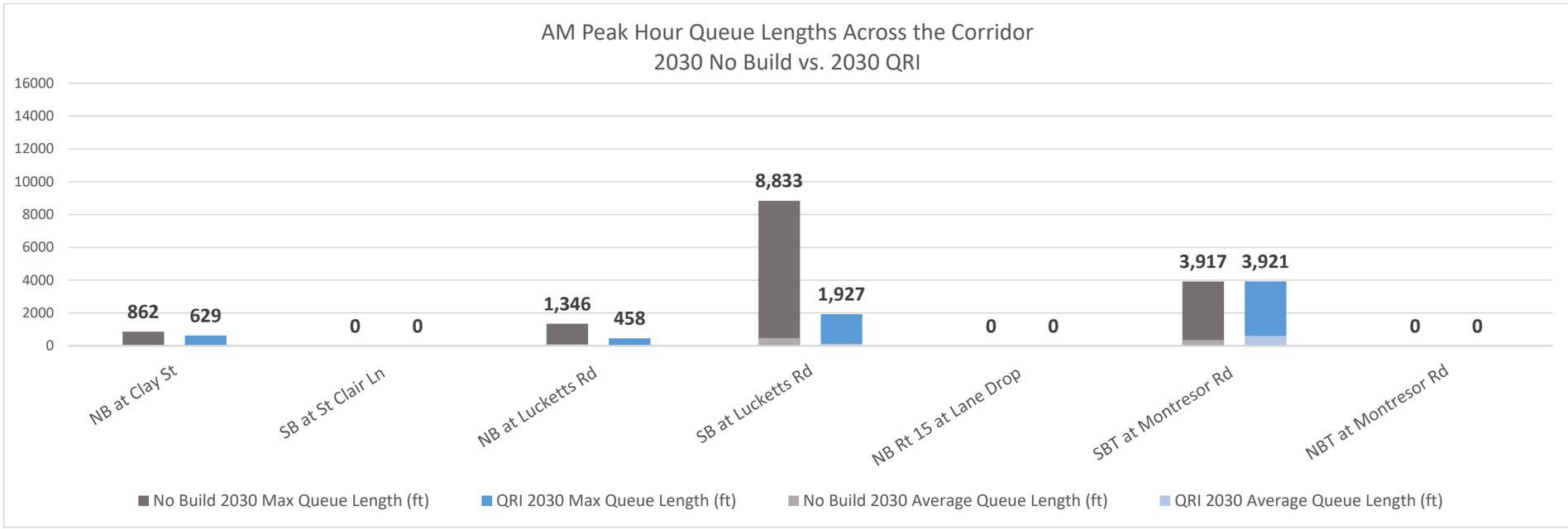
US 15 QRI: VISSIM Queue Length Comparison Between 2030 AM and PM No Build and the 2030 AM and PM QRI Concept

5/14/2020



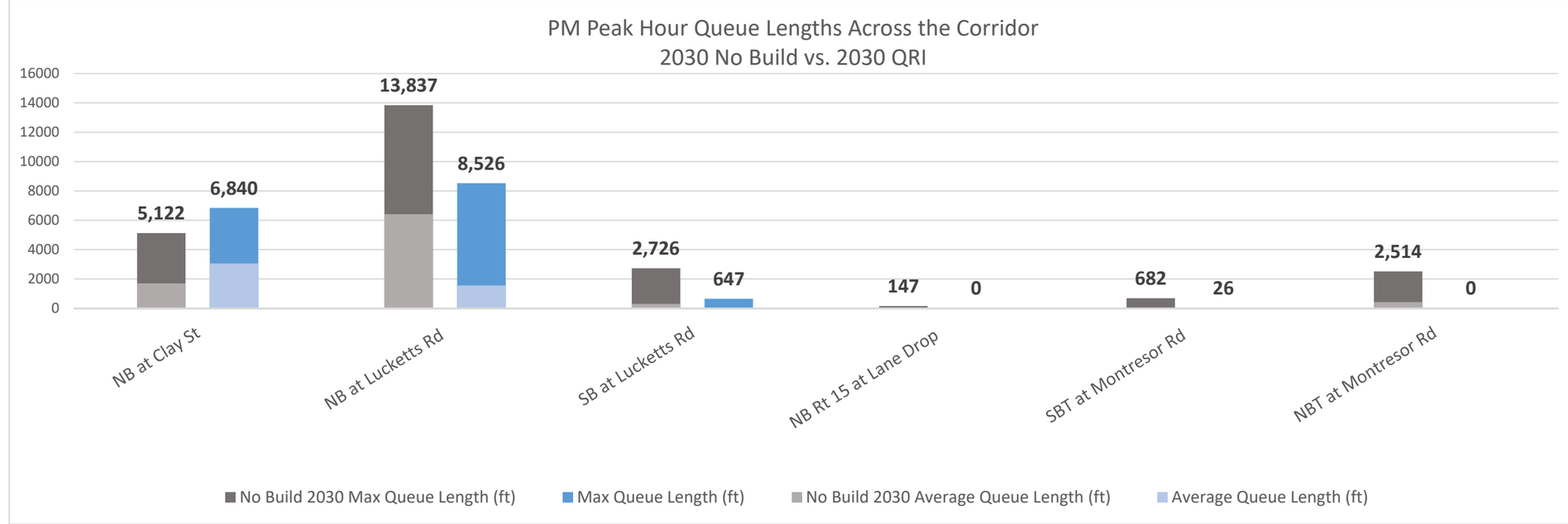
Decrease in average AM queues

21%

Decrease in maximum AM queues

54%

Comparing 2030 No Build to the 2030 QRI concept



Decrease in average AM queues

48%

Decrease in maximum AM queues

36%

Comparing 2030 No Build to the 2030 QRI concept

The evaluation shown above is an average of 10 VISSIM simulation runs

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Technical Memo

DATE: May 26, 2020

TO: Chad Tucker, Program Manager
Jonathan Robbins, PE, Sr. Engineer
Office of Intermodal Planning and Investment

FROM: Nathan Umberger, PE, PTOE
John Albonetti
ATCS, PLC - Traffic Engineering

SUBJECT: US 15 and Loudoun County
Performance Based Planning Pilot

Introduction

This memo summarizes the potential improvement alternatives considered for the intersection of US 15 (James Monroe Highway) and Route 662 (Lucketts Road/Stumptown Road) in Lucketts, Virginia. An aerial image of the study area can be seen in **Figure 1**.

Figure 1: Study Area

Several roadway improvements on US 15 in the vicinity of Lucketts are proposed to existing facilities considered insufficient, including:

- Widening US 15 from Battlefield Parkway to Montressor Road
- Realigning New valley Church to the intersection of US 15 and Spinks Ferry Road and subsequent installation of a roundabout at the new intersection

As part of the Route 15 Safety and Operations Study prepared by Kimley-Horn & Associates, dated April 2019, a bypass around Lucketts is currently under consideration to reduce delay and improve safety on the US 15 corridor. Concepts for this bypass developed by Kimley-Horn & Associates are shown below in **Figure 2** and **Figure 3**.

Figure 2: Kimley-Horn & Associates Western Bypass Concept

Figure 3: Kimley-Horn & Associates Eastern Bypass Concept

It is noted that these bypass options may require signalization at connection points with existing roads.

The existing at US 15 and Lucketts Road/Stumptown Road intersection has a single lane on each approach with the exception of the northbound approach on US 15, which has a dedicated right turn lane. An aerial image of the existing lane geometry at the intersection is shown in **Figure 4**.

Figure 4: Existing Lane Geometry

This technical memo was developed to explore additional alternatives that may provide a similar benefit to the intersection and overall corridor at a reduced cost.

Existing Safety Analysis

For safety analysis, the VDOT Crash Database Tableau Tool was utilized to determine the crash history in the study area. Crash data was collected and analyzed for a five-year period spanning from 2014 to 2019. A map of the reported crashes over the study period is shown in **Figure 5**. A summary of the crash types and severities are shown in **Figure 6** and **Figure 7**, respectively.

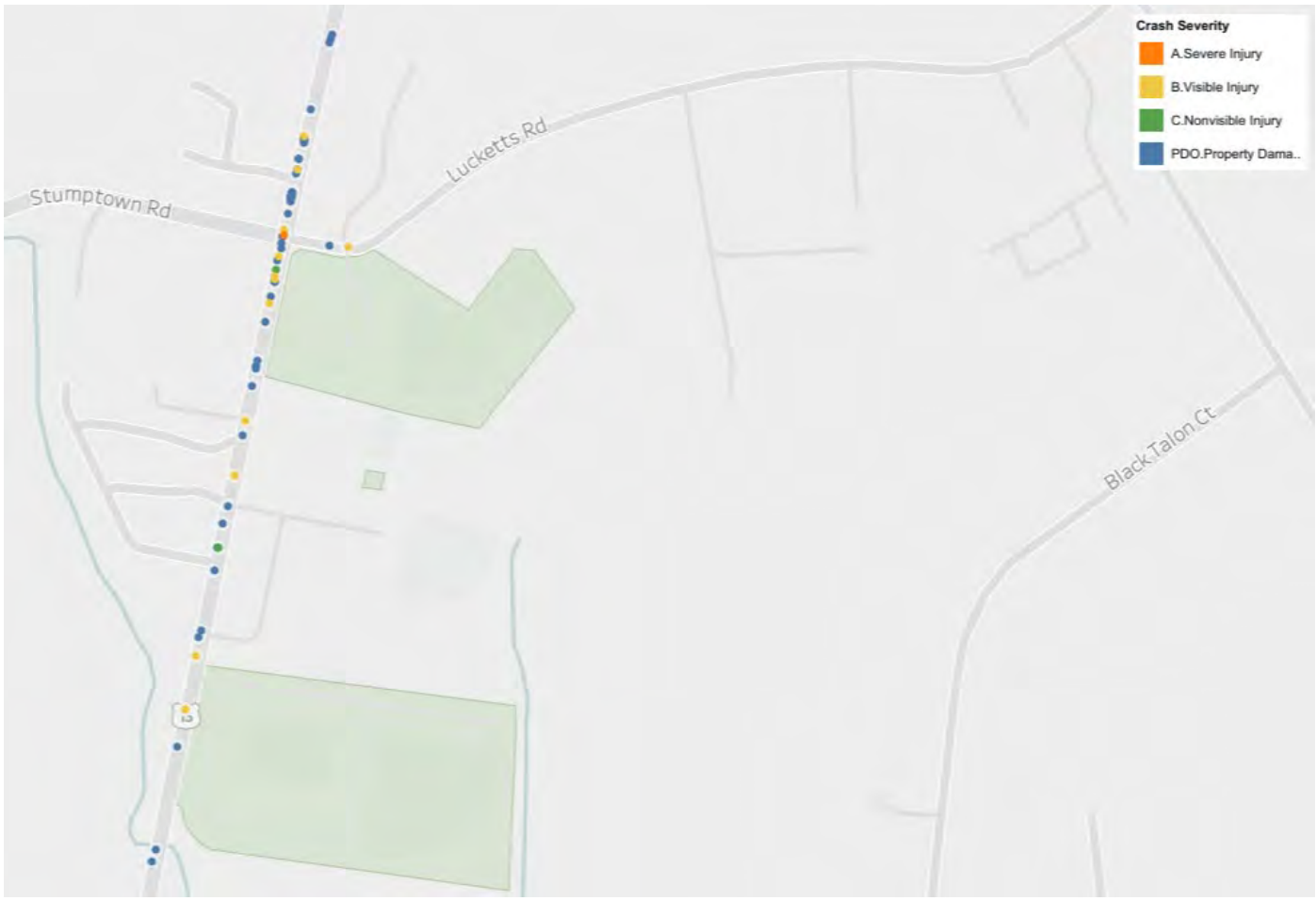

Figure 5: Study Area Crash Map

Crash Type	Number of Reported Crashes
Rear End	45
Angle	9
Head On	1
Sideswipe - Opposite Direction	2
Non-Collision	2
Fixed Object - Off Road	2
Total	61

Figure 6: Crashes Summarized by Type

Crash Severity	Number of Reported Crashes
A. Severe Injury	1
B. Visible Injury	12
C. Nonvisible Injury	2
PDO - Property Damage Only	46
Total	61

Figure 7: Crashes Summarized by Severity

The majority of reported within the study area occurred on the US 15 approaches to and within the functional area of the signal. 45 of the 61 reported crashes were recorded as rear end crashes and an additional 9 were recorded as angle crashes.

Approximately 25% of the crashes were recorded as coinciding with an injury. Year over year crash trends were generally consistent, with between 10 to 14 crashes occurring per year over the five-year crash history study period.

Analysis Scenarios

Volumes used as part of this analysis are 2019 existing volumes that were collected for the 2019 Kimley-Horn study. The AM and PM peak hours are noted as 7:00-8:00 AM and 4:45-5:45 PM, respectively. Peak hour and heavy vehicle factors were provided as part of that study and incorporated into the models. Counts from the study are dated as collected on Wednesday, September 13, 2017. The AM peak hour volumes are shown below in **Figure 8** and the PM peak hour volumes are shown in **Figure 9**.

Figure 8: 2019 Existing AM Volumes

Figure 9: 2019 Existing PM Volumes

VJUST analysis was performed to screen potential alternatives. Due to the high mainline and low side street volumes, more detailed modeling was required as no alternatives separated from the others from a screening standpoint. The alternatives deemed most feasible and potentially effect based on the existing traffic patterns were considered for further analysis. The

alternatives tested as part of this memo involve removing and redirecting left turns at the intersection of US 15 and Lucketts Road/Stumptown Road to better improve flow through the corridor and reduce the effects of existing safety deficiencies.

The scenarios tested as part of this analysis are as follows:

- Existing
- Alternative 1: Quadrant Roadway
- Alternative 2: Quadrant Roadway with a Roundabout on Lucketts Road
- Alternative 3: Median U-Turn
- Alternative 4: Bowtie

Each alternative is explained in more detail in the following sections.

Alternative 1
This alternative consists of the addition of a quadrant roadway in the southeast quadrant of the intersection with signalized quadrant intersections on US 15 and Lucketts Road. A design concept of this alternative is shown in **Figure 10**.

Figure 10: Alternative 1 Design Concept

Alternative 2

Due to the low traffic volume on Lucketts Road, a roundabout was considered in lieu of signalization at the quadrant roadway intersection to allow for better coordination of the signals on US 15 to further improve mobility through the corridor. To best accommodate the turning movements to and from US 15, signalization is still recommended at the quadrant intersection connection on US 15. A design concept for this alternative is shown in **Figure 11**.

Figure 11: Alternative 2 Design Concept

With both quadrant roadway alternatives, there are potential benefits for traffic related to the adjacent Lucketts Elementary School. Platooning of vehicles on US 15 and potential for direct connectivity to the quadrant roadway will provide for additional safety and operational benefits for school traffic.

Alternative 3

This alternative proposes the implementation of two median U-turn intersections on Stumptown Road and Lucketts Road to act as a replacement for left turns at the intersection at US 15. Figure 12

Figure 12: Alternative 3 Design Concept

Alternative 4

In this scenario, the traffic signal at the intersection of US 15 and Lucketts Road/Stumptown Road has been removed. The signal has been replaced with two-way stop control on the Lucketts Road and Stumptown Road approaches. Additionally, those approaches have been restricted to right-in/right-out movements. All US 15 left turn volumes and side street through and left turn volumes have been redirected through the appropriate U-turn movement at new roundabouts on US 15 arranged in a Bowtie configuration. A map of the study area with the approximate locations used for the analysis of the Bowtie roundabouts is shown below in **Figure 13**.

Figure 13: Study Area Map with Approximate Roundabout Locations

The base roundabout configuration consists of a single approach lane in each direction, with the U-turn for the approach downstream from the main intersection at Lucketts Road sharing a lane with the through movement. SIDRA representations of the roundabout configurations are shown in **Figure 14** for the northern roundabout and **Figure 15** for the southern roundabout.

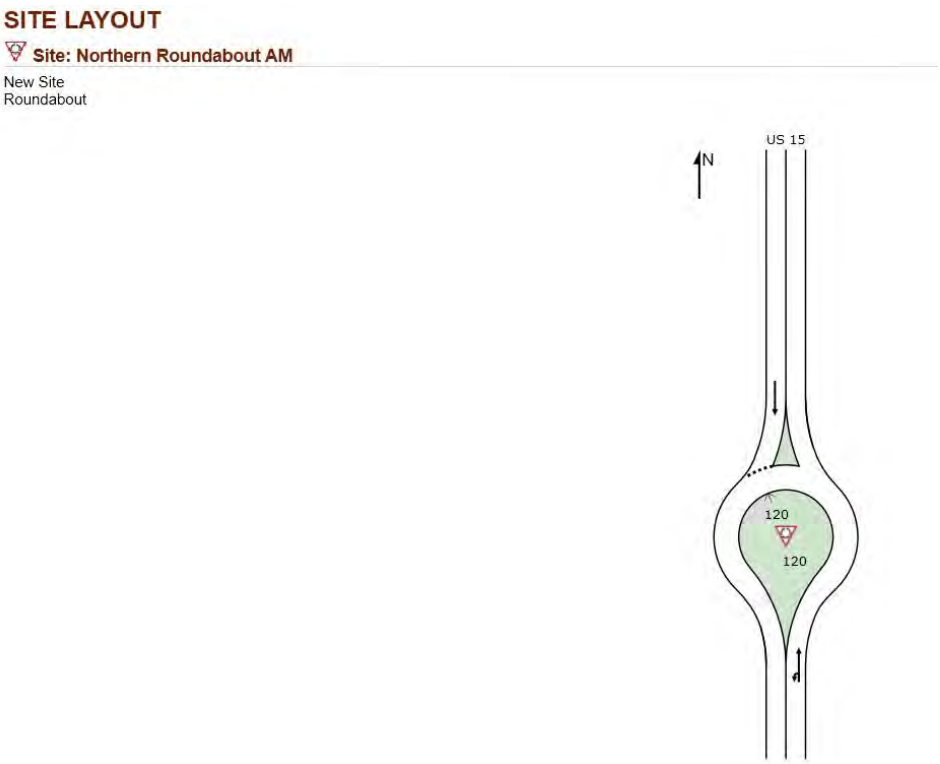

Figure 14: Geometric Configuration for the Roundabout North of Lucketts Road

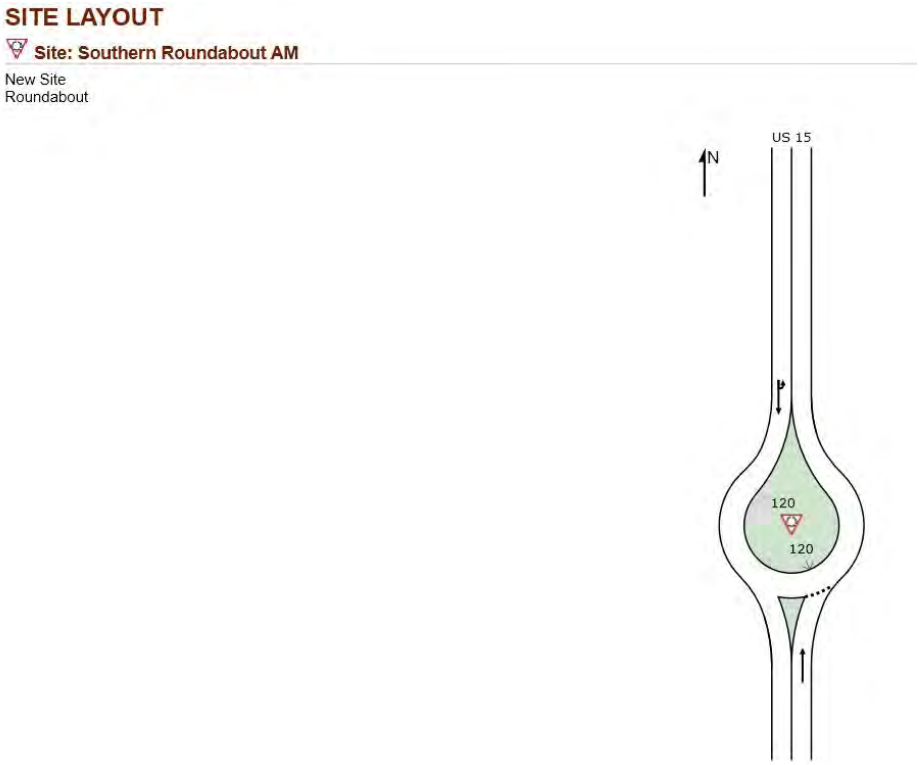

Figure 15: Geometric Configuration for the Roundabout South of Lucketts Road

An additional location was tested for the southern roundabout at the intersection of the Lucketts Elementary School northern driveway and the residential property to the west of US 15. For this scenario, each approach to the roundabout

at that location was analyzed as a single lane, full movement approach. A SIDRA representation of the geometry for the roundabout is shown below in **Figure 16**.

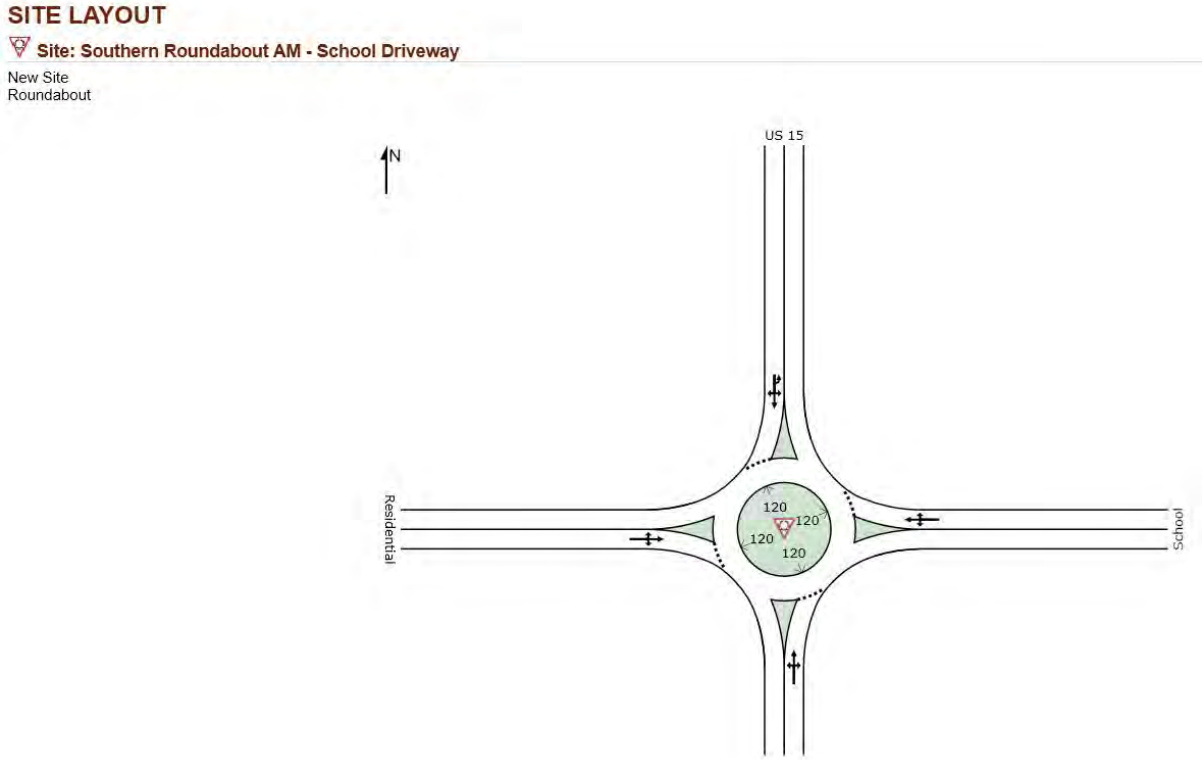

Figure 16: Geometric Configuration for the Roundabout at Lucketts Elementary Driveway

It is noted that the geometric location and design of all alternatives is for initial testing purposes only and does not represent ultimate conditions.

Analysis Results

For the purposes of this analysis, the existing traffic signal at US 15 and Lucketts Road/Stumptown Road was left in place as a two-phase signal for Alternatives 1, 2, and 3. This signal was coordinated with the quadrant roadway signals in Alternatives 1 and 2. Removal of signalization at the intersection was tested and performed poorly, as the free-flowing mainline did not allow for gaps for vehicles on the side streets. Due to the presence of historical properties in the vicinity of the intersection, construction of a roundabout is not feasible at that location.

AM and PM peak hour scenarios were analyzed using SimTraffic 10. Signal timings for the No-Build scenario were imported from the existing Synchro files provided by The Virginia Department of Transportation (VDOT). Signal timings for alternatives were optimized within Synchro. The roundabouts in Alternative 4 were analyzed in SIDRA 6 using HCM 2010 sign control methodologies, while analysis results for the two-way stop-controlled intersection at US 15 and Lucketts Road/Stumptown Road were produced with SimTraffic 10.

Delay is reported as seconds of delay/vehicle. Queue is reported as maximum queue for SimTraffic results and 95th percentile queue for the roundabouts in Alternative 4.

Alternatives 1, 2, and 3 were directly compared through SimTraffic results. The results of the AM peak hour analysis for the main intersection at US 15 and Lucketts Road/Stumptown Road is shown below in **Table 1** and the PM peak hour in **Table 2**.

Table 1: AM SimTraffic Results for US 15 and Lucketts Road/Stumptown Road

Model	Existing AM			Alternative 1 AM			Alternative 2 AM			Alternative 3 AM		
Total Network Delay (Hrs)	8.0			6.9			6.9			7.2		
Total Network Travel Time (Hrs)	32.9			33.2			33.3			34.2		
US 15 and Lucketts Road Movements	Delay/Veh (Sec)	LOS	Max Queue (Ft)	Delay/Veh (Sec)	LOS	Max Queue (Ft)	Delay/Veh (Sec)	LOS	Max Queue (Ft)	Delay/Veh (Sec)	LOS	Max Queue (Ft)
Stumptown Road EBL	32.8	C	86	N/A			N/A			N/A		
Stumptown Road EBT	27.5	C		24.4	C	116	25.1	C	94	20.5	C	136
Stumptown Road EBR	15.4	B		8.9	A		9.2	A		11.5	B	
Lucketts Road WBL	32.0	C	199	N/A			N/A			N/A		
Lucketts Road WBT	36.0	D		20.2	C	89	23.7	C	89	21.7	C	218
Lucketts Road WBR	18.2	B		1.0	A		9.7	A		10.8	B	
US 15 NBL	24.8	C	424	N/A			N/A			N/A		
US 15 NBT	12.7	B		5.0	A	157	5.8	A	180	7.5	A	203
US 15 NBR	1.5	A	31	1.9	A	46	1.3	A	52	1.5	A	64
US 15 SBL	9.4	A	364	N/A			N/A			N/A		
US 15 SBT	10.9	B		7.9	A	262	7.6	A	238	10.7	B	315
US 15 SBR	7.6	A		5.0	A		7.4	A		10.0	A	
Total	14.3	B		7.8	A		8.4	A		10.8	B	

Table 2: PM SimTraffic Results for US 15 and Lucketts Road/Stumptown Road

Model	Existing PM			Alternative 1 PM			Alternative 2 PM			Alternative 3 PM		
Total Network Delay (Hrs)	9.1			9.7			8.6			9.6		
Total Network Travel Time (Hrs)	38.2			41.5			39.4			42.4		
US 15 and Lucketts Road Movements	Delay/Veh (Sec)	LOS	Max Queue (Ft)	Delay/Veh (Sec)	LOS	Max Queue (Ft)	Delay/Veh (Sec)	LOS	Max Queue (Ft)	Delay/Veh (Sec)	LOS	Max Queue (Ft)
Stumptown Road EBL	33.6	C	126	N/A			N/A			N/A		
Stumptown Road EBT	35.8	D		41.1	D	115	42.7	D	159	30.4	C	261
Stumptown Road EBR	19.0	B		24.2	C		29.5	C		19.3	B	
Lucketts Road WBL	35.9	D	189	N/A			N/A			N/A		
Lucketts Road WBT	33.5	C		45.5	D	50	31.6	C	69	20.8	C	116
Lucketts Road WBR	28.9	C		20.9	C		12.5	B		15.9	B	
US 15 NBL	20.3	C	336	N/A			N/A			N/A		
US 15 NBT	11.0	B		7.3	A	271	6.3	A	257	11.0	B	299
US 15 NBR	1.6	A	53	1.6	A	30	2.3	A	70	2.2	A	68
US 15 SBL	37.0	D	423	N/A			N/A			N/A		
US 15 SBT	10.8	B		4.3	A	167	5.1	A	226	8.4	A	296
US 15 SBR	10.2	B		3.1	A		2.8	A		6.2	A	
Total	13.2	B		8.0	A		8.2	A		11.6	B	

All alternatives show a reduction in intersection and overall network delay as compared to the No-Build scenario in the AM peak hour while also showing an increase in network travel time. In the PM peak hour, only Alternative 2 shows a reduction in overall network delay. All alternatives show an increase in network travel time as compared to the No-Build option in the PM peak hour. The likely reason for the increase in travel time is due to the increased travel distance for the diverted left turns. Through vehicles on the corridor will generally experience a strong reduction in travel time.

A comparison of the maximum queue reduction for each alternative is shown below in **Table 3**.

Table 3: % Change in Maximum Queue Compared to Existing Conditions Compared for Each Alternative

Maximum Queue Change Compared to Existing Conditions							
Approach to US 15 and Lucketts Road/Stumptown Road	Existing	Alternative 1		Alternative 2		Alternative 3	
	Queue	Queue	Change	Queue	Change	Queue	Change
AM							
Eastbound Approach	86	116	34.9%	94	9.3%	136	58.1%
Westbound Approach	199	89	-55.3%	89	-55.3%	218	9.5%
Northbound Approach (Through/Left)	424	157	-63.0%	180	-57.5%	203	-52.1%
Northbound Approach (Right)	31	46	48.4%	52	67.7%	64	106.5%
Southbound Approach	364	262	-28.0%	238	-34.6%	315	-13.5%
PM							
Eastbound Approach	126	115	-8.7%	159	26.2%	261	107.1%
Westbound Approach	189	50	-73.5%	69	-63.5%	116	-38.6%
Northbound Approach (Through/Left)	336	271	-19.3%	257	-23.5%	299	-11.0%
Northbound Approach (Right)	53	30	-43.4%	70	32.1%	68	28.3%
Southbound Approach	423	167	-60.5%	226	-46.6%	296	-30.0%

The majority of approach lanes are expected to experience a reduction in queueing for each alternative compared to existing. The approaches that do see an increase in queue are generally short queues in existing conditions and thus do not increase by a significant amount.

Results for the alternative intersections added as part of each alternative are shown below for Alternatives 1 and 2 in **Table 4** and Alternative 3 in **Table 5.**

Table 4: AM SimTraffic Results for Alternatives 1 and 2 Alternative Intersections

Model	Alternative 1 AM			Alternative 2 AM			Alternative 1 PM			Alternative 2 PM		
Lucketts Road Quadrant Movements	Delay/Veh (Sec)	LOS	Max Queue (Ft)	Delay/Veh (Sec)	LOS	Max Queue (Ft)	Delay/Veh (Sec)	LOS	Max Queue (Ft)	Delay/Veh (Sec)	LOS	Max Queue (Ft)
Lucketts Road EBT	3.4	A	52	3.3	A	32	2.4	A	55	3.9	A	57
Lucketts Road EBR	1.3	A	31	2.6	A	32	0.6	A	31	2.9	A	0
Lucketts Road WBL	3.4	A	75	3.0	A	74	3.3	A	54	2.6	A	0
Lucketts Road WBT	1.3	A	32	3.8	A	74	0.9	A	0	3.1	A	0
Quadrant Roadway NBL	11.8	B	50	2.1	A	0	10.7	B	29	2.1	A	0
Quadrant Roadway NBR	4.3	A	26	2.3	A	0	4.4	A	50	2.1	A	0
Total	3.5	A		3.1	A		2.4	A		3.2	A	
US 15 Quadrant Movements	Delay/Veh (Sec)	LOS	Max Queue (Ft)	Delay/Veh (Sec)	LOS	Max Queue (Ft)	Delay/Veh (Sec)	LOS	Max Queue (Ft)	Delay/Veh (Sec)	LOS	Max Queue (Ft)
Quadrant Roadway WBL	19.8	B	114	24.2	C	116	38.6	D	115	33.5	C	129
Quadrant Roadway WBR	4.2	A	52	3.9	A	30	4.5	A	53	4.4	A	73
US 15 NBT	3.6	A	206	3.1	A	114	5.9	A	375	3.9	A	189
US 15 NBR	1.3	A	29	1.1	A	31	2.5	A	0	0.6	A	0
US 15 SBL	9.2	A	31	6.3	A	31	18.0	B	31	22.6	C	31
US 15 SBT	5.4	A	179	4.6	A	160	5.6	A	180	5.5	A	209
Total	5.7	A		5.4	A		7.3	A		6.1	A	

Table 5: PM SimTraffic Results for Alternative 3 Alternative Intersections

Model	Alternative 3 AM			Alternative 3 PM		
Eastern MUT	**Delay/Veh (Sec)**	**LOS**	**Max Queue (Ft)**	**Delay/Veh (Sec)**	**LOS**	**Max Queue (Ft)**
Lucketts Road EBU	2.8	A	53	2.2	A	38
Lucketts Road EBT	1.1	A	0	1.5	A	0
Lucketts Road WBT	0.1	A	0	0.1	A	0
Total	0.8	A		1.2	A	
Western MUT	**Delay/Veh (Sec)**	**LOS**	**Max Queue (Ft)**	**Delay/Veh (Sec)**	**LOS**	**Max Queue (Ft)**
Stumptown Road EBT	0.6	A	0	0.5	A	0
Stumptown Road WBU	2.9	A	57	3.2	A	55
Stumptown Road WBT	2.3	A	0	1.9	A	0
Total	2.1	A		1.8	A	

All alternative intersections are expected to operate at LOS A.

Analysis results for the base roundabout locations are shown below in **Table 6**. Analysis results for the right-in/right-out configuration at the intersection of US 15 and Lucketts Road/Stumptown Road are shown in **Table 7**.

Table 6: Baseline Roundabout Location Analysis Results

Roundabout Location	AM			PM		
North of Lucketts Road	**Delay/Veh (Sec)**	**LOS**	**95th % Queue (Ft)**	**Delay/Veh (Sec)**	**LOS**	**95th % Queue (Ft)**
US 15 NBTU	19.3	C	0.0	101.3	F	1,270.3
US 15 SBT	51.1	F	626.5	23.7	C	256.1
South of Lucketts Road	**Delay/Veh (Sec)**	**LOS**	**95th % Queue (Ft)**	**Delay/Veh (Sec)**	**LOS**	**95th % Queue (Ft)**
US 15 NBT	14.3	B	118.8	119.2	F	2,401.1
US 15 SBTU	42.4	E	0.0	32.6	D	0.0

Table 7: Right-In/Right-Out Restriction Analysis Results

Model	AM			PM		
US 15 and Lucketts Road Movements	**Delay/Veh (Sec)**	**LOS**	**Max Queue (Ft)**	**Delay/Veh (Sec)**	**LOS**	**Max Queue (Ft)**
Stumptown Road EBR	12.0	B	100	10.9	B	96
Lucketts Road WBR	6.8	A	72	49.9	D	301
US 15 NBT	1.1	A	0	3.4	A	91
US 15 NBR	0.9	A	0	2.4	A	91
US 15 SBT	3.2	A	0	1.4	A	0
US 15 SBR	2.0	A	0	0.5	A	0
Total	3.1	A		5.3	A	

The roundabouts show significant amounts of delay and queueing in the upstream approaches towards the signal at Lucketts Road due to conflicts with the free-flowing U-turns. Additionally, the northbound approach at the northern roundabout shows substantial queueing and delay in the PM peak hour due to the approach volumes reaching overcapacity.

While the removal of the signal at the main intersection generally shows acceptable levels of delay, the westbound right-turn movement shows heightened delay compared to the rest of the movements due to lack of gaps in the northbound through traffic.

Analysis results for the roundabout location at the Lucketts Elementary driveway are shown below in **Table 8**.

Table 8: Lucketts Elementary Driveway Roundabout Analysis Results

Roundabout Location	AM			PM		
At Lucketts Elementary	Delay/Veh (Sec)	LOS	95th % Queue (Ft)	Delay/Veh (Sec)	LOS	95th % Queue (Ft)
NB Approach	16.0	C	126.8	124.5	F	2,507.9
WB Approach	6.5	C	0.6	9.2	A	1.3
SB Approach	51.1	F	23,418.6	34.5	D	704.6
EB Approach	9.3	E	1.5	8.5	A	0.6

Analysis results show that the increased conflicts within the roundabout will lead to substantial delay for the through movements on US 15.

Full SimTraffic standards from The Traffic Operations and Safety Analysis Manual (TOSAM) were not implemented for the purposes of this initial analysis, as only each model was only run once for each peak hour. Additional calibration would potentially further increase the benefits as queues in the field are generally reported to be up to twice as long as those seen in the models.

Recommendations

The implementation of a quadrant intersection is recommended for further analysis into the effects on mobility and safety on US 15. In particular, Alternative 2 is recommended for investigation due to the likely lack of necessity for a signal on Lucketts Road. Further, a Quadrant Roadway allows flexibility for conversion to a bypass in future years if traffic volumes rise to the level of need.

Concept/Estimating

To further provide detail to the potential alternatives, concept sketches and planning level estimates were developed for the QRI with potential roundabout.

GIS and databases were used to define Right of Way and potential wetland impacts and to then minimize disturbances and major property takes through alignment. **Figure 10** shows an early, planning level sketch and **Table 6** displays planning level cost estimates.

Figure 10: Develop Design Sketch with Roundabout Option (Alt 2)

	Quadrant Roadway
	Planning Level Cost Estimate
Preliminary Engineering	$1,500,000
Right of Way/Utilities	TBD - Early estimate $2,000,000 - $2,500,000
Roadway Construction	$4,000,000-$5,000,000
Intersection Construction	$3,500,000-$4,000,000
TOTAL	$11,000,000 - $13,000,000

Table 6: Planning Level Cost Estimate Ranges