Exit 32 Safety and Capacity Improvements Study

Prepared for:

Maine Turnpike Authority

Prepared by:

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1 BACKGROUND

The City of Biddeford is the sixth largest City in the state of Maine, with more than 21,000 residents. It is the principal commercial center of York County, Maine, located 30 miles north of the New Hampshire border and 15 miles south of the City of Portland. In addition to being a key connection to communities to the west, it is home to growing commercial and retail centers along with health care and higher education institutions[1]. Three transportation routes, the Maine Turnpike (Turnpike), Route 1, and Route 111, provide access to this community.

The mainline of the Turnpike through Biddeford services an average of 70,000 vehicles per day[2]. More than a third of that volume uses the interchange at Exit 32 as an access point, making it one of the busiest interchanges on the Turnpike[3]. These vehicles are destined for Route 111, a vital 14-mile state highway connecting Alfred to Biddeford and for the Biddeford Connector, connecting vehicles to coastal routes. Traffic volumes double from its beginning in Alfred as it moves east towards its busiest section at Exit 32, servicing an average of nearly 30,000 vehicles per day at the interchange.

Regularly, the southbound off-ramp backs up to the mainline during weekday peak afternoon periods creating congestion and safety concerns.

> *The primary purpose of the Exit 32 Safety and Capacity Improvements Study (Study) is to evaluate the effectiveness of short and long-term alternatives based on their ability to address the frequent traffic congestion observed at the Exit 32 southbound off-ramp on the Maine Turnpike (Turnpike) in Biddeford. The Study also aims to improve safety at high crash locations and general mobility within the Study Area.*

To accomplish this a Study Area, as shown in **Figure 1** (page 6), was established. The Study Area encompasses Route 111 from the intersection with Andrews Road to the intersection with Irving/Shaws (including the five signalized intersections labeled 2-6 on the map), the I-95 Exit 32 Ramps (labeled as 1 on the map), and any new roads or connections as part of alternatives evaluation. Any future analysis will likely include Barra Road (labeled with an asterisk) as it has recently become part of the Route 111 interconnected signal system and potentially the Route 111 intersection with the Five Points Shopping Center. The intersections are labeled as follows:

1. Exit 32 Ramps (unsignalized)
2. Exit 32 and Route 111
3. Irving/Shaws and Route 111
4. Exit 32 Park and Ride/Walmart and Route 111
5. Biddeford Gateway Center/New Life and Route 111
6. Mariner Way and Route 111 (Target/Market Basket)

* Barra Road and Route 111

[1] https://www.biddefordmaine.org/2363/In-About-Biddeford

[2] https://www.maine.gov/mdot/mapviewer/index.html?hide=FFC&show=CSL%20Safety%20Data%20Public

[3] https://maineturnpike.com/About-MTA/Traffic-Statistics/Traffic-by-Interchange.aspx


South Street
Maine Water Company
Tank & Detention Pond
Dirt Access Road
95
Utility Corridor
Andrews Road
Exit 32
Barra Road
Biddeford
Connector
Route 111
Existing Signals
Intersection
Number - See Table 3-X
Exit 32 Safety and Capacity
Figure 1: Study Area
Existing Toll Plaza
National Wetlands Inventory
Railroad
0 0.13 0.25 0.5
Miles
N

1.1 STUDY AREA HISTORY AND NEED

In 1947, the Turnpike, including the Exit 32 interchange, opened to relieve congestion on Route 1. The original configuration remained until 1994 when the Route 111 Bridge over the Turnpike was replaced with a longer, wider structure that was designed to accommodate four lanes over the Turnpike, providing future relief for growth to the west. Construction of a third lane on the Turnpike was completed in 2004 and included interchange improvements to the area. Additional improvements south of the interchange followed in 2007 and included upgrades to the toll plaza, utility buildings, park and ride, and the Exit 32 Approach to Route 111.

Following the completion of MTA upgrades to this area, in September 2010, the Maine Department of Transportation (MaineDOT) began work on the Central York County Connections Study[4] (CYCCS) "to identify a series of recommendations designed to preserve or enhance transportation connections between central York County and US Route 1 and the Maine Turnpike." This study discusses a South Street link to Route 111 as well as additional connections to Exit 32 and potential new interchange locations. It also recommends improvements on Route 111 including traffic signal upgrades and lane choice sign improvements.

Field observations and Google Maps confirm anecdotal reports of backups on the mainline originating from the southbound off-ramp during the PM Peak. These backups have a variety of causations:

- I-95 Southbound Off Ramp geometry;
- High volumes at the intersection of Exit 32 and Route 111; and
- Heavy weaving movements between northbound and southbound off-ramps.

On August 13, 2019, an on-site survey was conducted to confirm weaving movements. The result of this survey is located in **Appendix A: Turning Movement Counts** and shows that more than half of all off-ramp vehicles are making a weaving movement.

Using the Google Maps departure and arrival feature – which uses a variety of vehicular speed (both posted speed limits and historic data) as well as travel times from previous travelers – delays and queues were able to be graphically confirmed. **Figure 2** (page 8) reflects the Google Maps estimate of queue buildup during the PM Peak for a typical summer day (July 18, 2019) in 15-minute increments[5]. The combination of field observations and this peak hour map confirm that queues build at the intersection of Exit 32 and Route 111 and along the radius of the ramp – meeting and forming a long chain that causes queues that spill onto the mainline.

Stopped and rolling queues on the mainline that cause unexpected speed changes to high speed mainline users are both a degradation to customer service and a serious safety concern. Because of this, upon completion of the CYCCS study in 2016, the Turnpike commissioned this Exit 32 Conceptual Connections

[4] https://www.maine.gov/mdot/planning/docs/cycc/CYCCSfinalstudyfulldoc.pdf

[5] On the Google Maps image, yellow indicates queues and delays, while blue indicates free-flowing traffic.

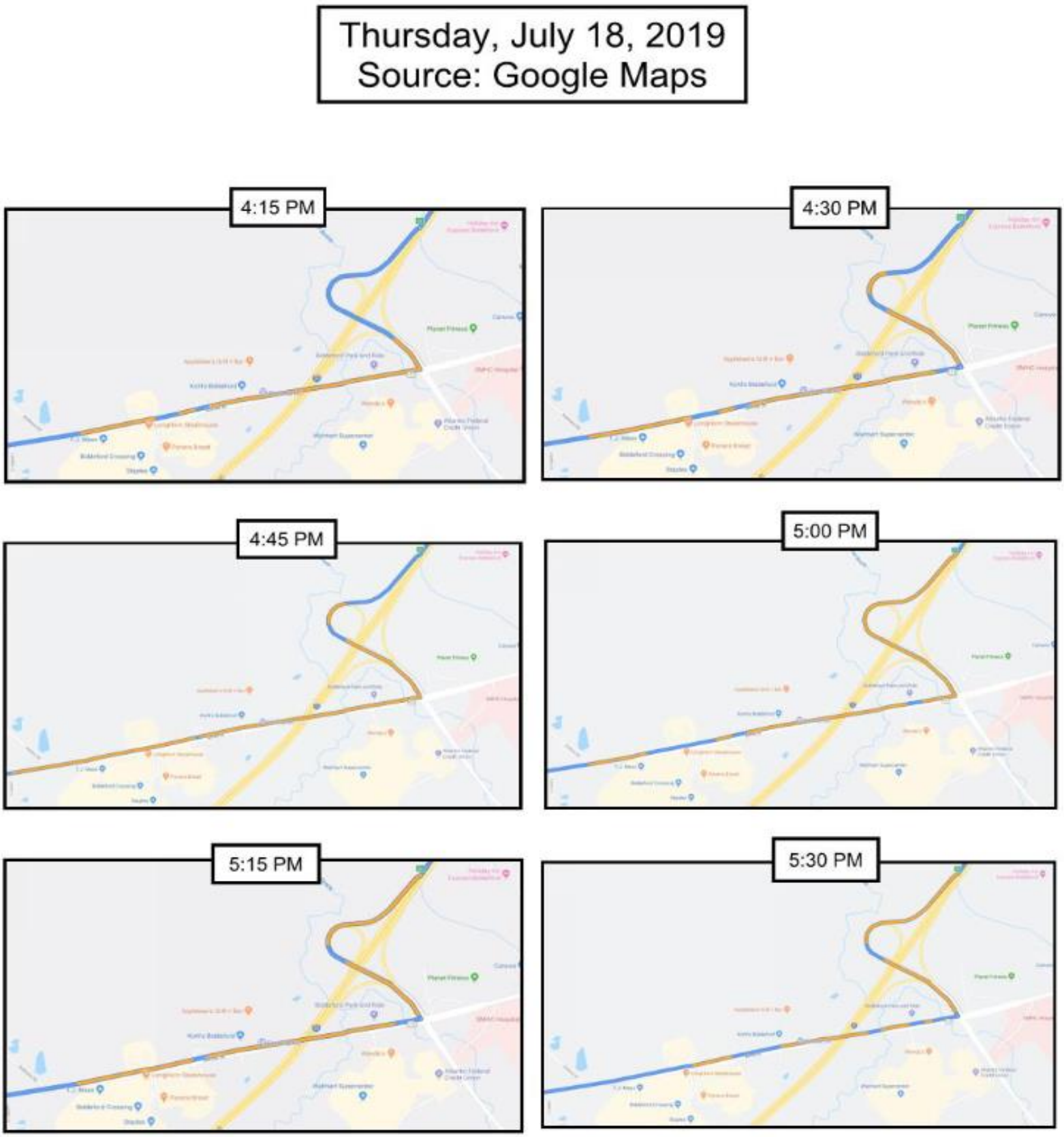


Figure 2: Google Estimated Queue Development at Exit 32

Study to look at short and long-term alternatives, including many of the improvements discussed in the MaineDOT study, as a means to help alleviate congestion at Exit 32 Southbound Off Ramp. These improvements include new connections to Route 111, a connection with South Street and new interchange configurations.

1.2 Study Area Safety

MaineDOT classifies any intersection or segment as a high crash location (HCL) when there are 8 or more crashes in a 3-year period and when the Critical Rate Factor (CRF) is greater than 1 – indicating a crash rate per hundred million vehicle miles greater than similar intersections in the state.

While there are no reported fatalities in the Study Area during the safety analysis period from 2016-2018, there are three high crash locations: one intersection and two segments[6][7]:

- **The intersection of Route 111 and Exit 32** had 84 reported crashes with a CRF of 1.51 and an injury rate of 21.4%.
- **The segment from the Exit 32 Southbound Off Ramp at Exit 32 to just west of the toll plaza** had 8 reported crashes with a CRF of 1.06 and an injury rate of 12.5%.
- **The segment just east of the toll plaza at Exit 32 to the intersection of Route 111 and Exit 32** had 14 reported crashes with a CRF of 2.15 and an injury rate of 14.3%.

In the segments from the Exit 32 Southbound Off-Ramp to the Exit 32/Route 111 Intersection, the most reported type of crash was rear end/sideswipe followed closely by vehicles that went off the road. At the intersection itself, more than 80% of the crashes were identified as rear-end, followed by intersection movements and vehicles that went off the road. A collision diagram of the Route 111 and Exit 32 Intersection follows in **Figure 3** (page 10).

It should be noted that the toll plaza in this area was undergoing upgrades from October 14, 2015 through substantial completion December 1, 2017. The number of crashes does not appear to have any correlation to the construction activities as shown in the table that follows:

Table 1: Number of Crashes at High Crash Locations by Year

	Number of Crashes			
Location	2016	2017	2018	2019
Intersection of Route 111/32	23	26	35	27
Segment Between the Off Ramps and Exit 32 (SB Approach)	5	3	6	8
Segment Between Boulder and Exit 32 (EB Approach)	2	3	3	2

[6] https://mdotapps.maine.gov/MaineCrashPublic/

[7] https://www.maine.gov/mdot/mapviewer/

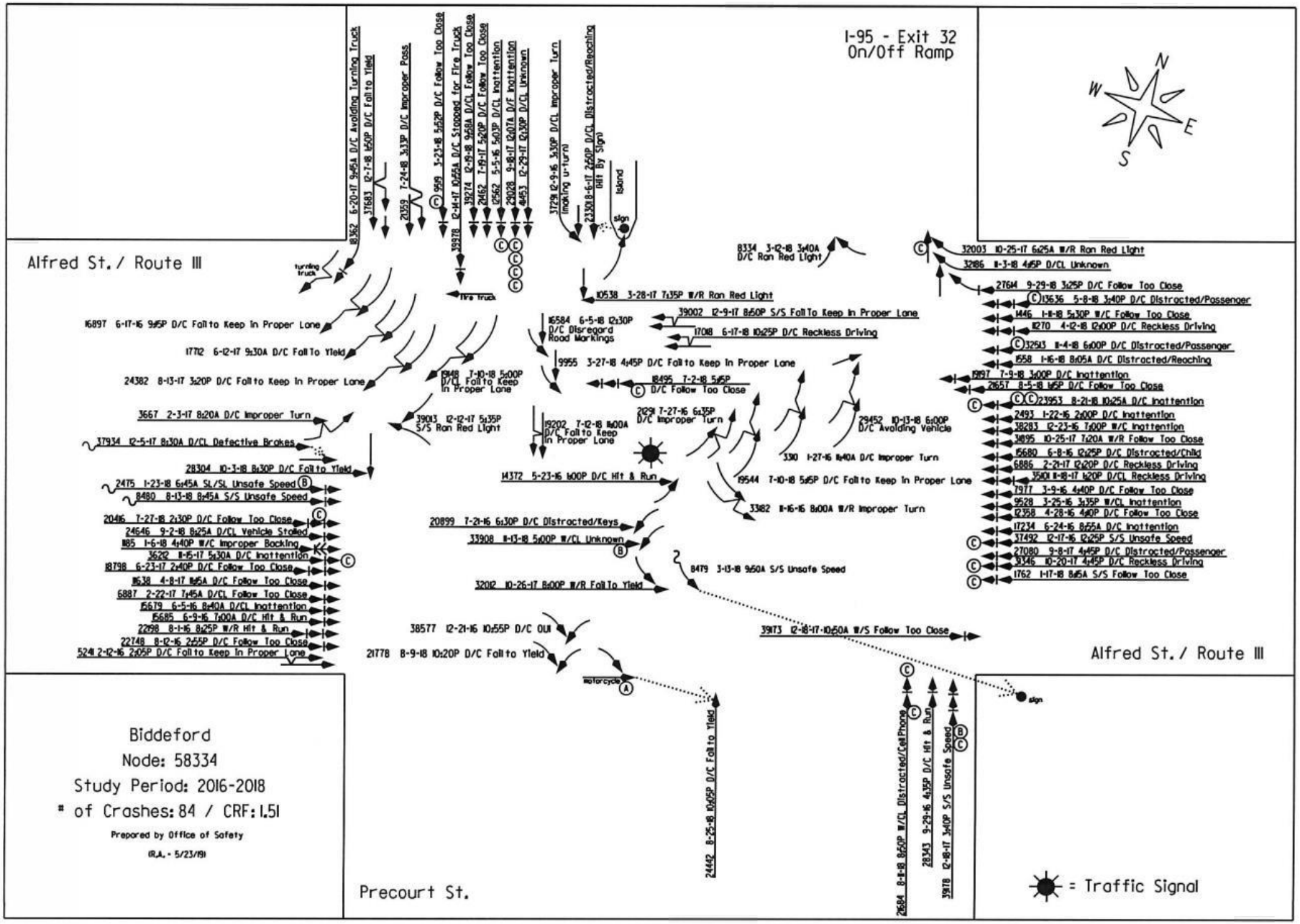


Figure 3: Exit 32/Route 111 Crash Map

1.3 VOLUME DEVELOPMENT

Turning movement counts (TMCs) used for analysis include data obtained from previous traffic impact studies in the area, hourly counts from MaineDOT, and data from MTA count stations and toll lanes. The TMCs were adjusted seasonally and balanced to correspond with the Exit 32 Southbound Off Ramp peak volumes to form a base 2016 summer weekday PM Peak model. Future volumes were developed by increasing base model volumes at a rate of 1.5% compounded annually and were then assigned using a combination of the Maine Statewide Model and proportional distributions based on existing volumes. Turning Movement Diagrams used for analysis are located in **Appendix A**.

Because this study has evolved over several years, short-term alternatives are evaluated against 2016 volumes and long-term alternatives against 2036 volumes. While there would be some change to delays and queues if they were to be updated to 2020 and 2040 volumes, the order of magnitude remains the same, and therefore was not updated for this alternative analysis.

1.4 STUDY ANALYSIS METHODOLOGY

Traffic operations were analyzed with VISSIM, a microscopic, time-step and behavior-based traffic simulation model. This industry standard tool assesses complex traffic flows that involve extensive merging, diverging, and weaving. Its microsimulation capabilities enable VISSIM to assess the extent to which changes at one location will affect adjacent locations. In the summary tables that follow, evaluations are compared using three measures of effectiveness: delay (seconds of delay per vehicle), Level of Service (LOS) and 95th percentile queue (feet of queue).

In an effort to evaluate critical periods of congestion, these models were calibrated based on the summer PM peak-hour observations of the key sections of the network as opposed to the peak traffic times of each individual roadway link and ramp. This method ensures the models represent a summer weekday afternoon, when traffic is heaviest for Exit 32 and the adjacent Route 111.

- Delays: Delays reported are those experienced by the average vehicle at each approach and are measured in seconds per vehicle. Vehicle density measurements for the merge and diverge areas of the ramps were used to calculate delay.

- Level of Service: LOS describes the operating conditions using a scale of A-F, with LOS A being a free-flow open condition and LOS F being a heavily congested condition with frequent slowing or stops on a highway or excessive intersection delays in an urban setting. Roadways are typically designed to operate at LOS C or D under 20-year projections. LOS tables from the Highway Capacity Manual[8] were used to assign these letter-grade measures.

[8] Transportation Research Board. *Highway Capacity Manual*. Washington, D.C.: 2010.

- Queues: Queues reported in this study are reported to the 95th percentile indicating a length of queue that is not exceeded 95% of the time. Intersection queues were measured from the stop bar at the study-area intersections. Ramp queues are measured from the point of diverge (the painted gore) at the ramps. In a well-functioning off-ramp, no queues would develop at the point of diverge. The presence of a traffic queue at this point indicates that exiting vehicles are experiencing congestion and back up from the ramp onto the mainline.

The longevity of an alternative is estimated to be when the queue at the gore is estimated to be greater than zero. This is calculated in five-year increments and provides useful information regarding improvement effectiveness and potential improvement phasing opportunities.

A planning level cost estimate was developed for each alternative. This estimate was calculated in 2019 dollars[9] and is comprised of the following categories:

- New roadways and existing roadway improvements
- Bridge widening, replacement, and new structures
- Toll structures and equipment
- NEPA and permitting
- Wetland mitigation
- Engineering and design services
- Construction services

A 25% contingency added to the roadway, bridge and tolling portion of the estimate. Right of way costs are not included in the estimate of alternatives – however right of way lines are included on each map for informational purposes and every effort is made to minimize right of way impact. Similarly, utility work is not included in this estimate.

[9] If the estimate is increased beyond 2020, inflation factors will need to be applied for programming purposes. The estimate year was used for comparative purposes only.

2 SHORT-TERM ALTERNATIVES ANALYSIS

This section compares the effects of two readily implementable short-term solutions against the existing (no-build) corridor conditions to determine their effectiveness at reducing Exit 32 Southbound Off Ramp congestion using existing volumes.

In addition to the short-term alternatives that are being considered in the text that follows, ongoing efforts to improve the general mobility of the corridor are being made. These efforts include optimizing the signal timing of the Route 111 corridor, maintaining pre-emption and detection devices, performing clearing/vegetative maintenance on the ramp, and including Barra Road in the coordinated signal system. An examination of the geometry at the Route 111 and Exit 32 intersection will also be conducted to see if lane reconfigurations will allow for additional vehicular processing efficiencies.

As shown in **Figure 4** (page 14), additional potential short-term solutions are as follows:

Short-Term Alterative 1 (ST1): Queue Detection

This alternative utilizes the existing queue detector (not currently in operation) at the southbound (Turnpike departing) approach of the intersection of Exit 32 and Route 111 to allow the southbound (departing) queues to clear the intersection. The queue detector is functional and test runs are expected to see when the queue detector would be utilized to assess its effect on corridor operations. At a minimum implementation requires ongoing improvements to the overall Route 111 flow to prevent severe back-ups on Route 111 that would likely occur during existing conditions if the queue detector was activated.

Short-Term Alternative 2 (ST2): Ramp Deceleration Lane Extension

This alternative extends the southbound off ramp deceleration lane 750 ft to provide additional queue storage. This length provides the maximum additional storage and deceleration length available without impact to the existing culvert crossing.

2.1 SHORT-TERM ALTERNATIVES ANALYSIS

To determine the effectiveness of potential improvements, **Table 1** (page 15) examines delay, level of service and queue under existing conditions at the Exit 32 Interchange Ramps (with queues measured at the gore area) and at the intersection of the Exit 32 Ramps and Route 111 (with queues measured from the stop bar). As previously stated, delays are measured in seconds per vehicle and queues are determined for the 95th percentile, measured in feet.

Exit 32 Safety and Capacity

Figure 3: Short-Term Alternatives

Table 2: Short-Term Improvement Analysis Results				
Location	Approach	No Build		
		Delay	LOS	Queue
1. I-95 Ramps	Exit 32 SB Off	23.1	C	115[10]
	Exit 32 SB On	8.8	A	-
	Exit 32 NB Off	15.6	B	-
	Exit 32 NB On	16.8	B	-
2. Exit 32 Ramps and Rte 111	Exit 32 SB Approach	64.8	E	1650*
	Route 111 EB Approach	58.7	E	785
	Route 111 WB Approach	27.9	C	271
	Biddeford Connector NB Approach	32.2	C	148
	Overall Level of Service	49.9	D	-

* Queues exceed default threshold.

2.1.1 Short-Term Alternative 1: Queue Detection

It has been determined that queues on the mainline build up based on a combination of high volumes, ramp geometry, and poor levels of service at the intersection of Route 111 and the I-95 Ramps. With improved operations along Route 111 and geometric improvement to the intersection of Route 111 and the I-95 Ramps, queue detection will provide an additional tool to flush southbound movements at that intersection, reduce its effect on the mainline, and reduce congestion at an existing high crash location.

2.1.2 Short-Term Alternative 2: Ramp Deceleration Lane Extension

Because motorists traveling on the Turnpike Mainline do not expect slowed or stopped conditions, queues (estimated to be approximately 115 ft during the 95th percentile condition)[10] are the source of significant safety concern. Providing additional storage space will allow those queues to be removed from the gore area, improving the overall flow on the mainline under peak conditions. Providing 750 ft of storage will maximize the amount of storage while minimizing impact on the existing infrastructure as a short-term alternative.

2.2 Short-Term Analysis Findings

Both queue detection and an increased deceleration length at the Exit 32 Southbound Off Ramp provide a different approach to improve mainline queues on the Exit 32 Southbound Off Ramp.

- Queue detection will reduce the effects of the intersection of Route 111 and the Exit 32 Ramps, relieving congestion at a high crash location, but should not be implemented without signal efficiency improvements to the Route 111 corridor.
- Additional storage for departing vehicles will remove queues from the mainline, improving corridor safety and mobility.

[10] The Exit 32 Southbound Off Ramp queue is measured from the gore.

These alternatives, combined with ongoing signal and potential geometric improvements on the Route 111 corridor and performing vegetative maintenance on the ramp shoulders, will provide safety and operational improvement until more substantial solutions can be implemented. Continued coordination with the City of Biddeford will be required.

Recommendation: Continue existing Route 111 Corridor signal improvements and implement both short-term solutions as soon as possible.

The queue detector is already in place, has been tested, and is in working order. Therefore, costs to implement this short-term improvement are minimal and are not calculated separately. The additional Exit 32 Southbound Off Ramp length provides 750 ft of storage in a parallel ramp, ending prior to the existing culvert. This length encompasses the existing 95th percentile queue and provides the largest benefit without incurring large structural costs for a short-term solution. It should be noted that long-term (2036) 95th percentile queues are estimated to be 1000 ft and this alternative would not provide enough storage for the estimated long-term scenario:

Short Term Improvement Costs are estimated to be $674,000

Estimated costs for short term improvements include roadway work, stormwater mitigation, permitting, wetland mitigation, and design and construction services. It is assumed that there will not be any structural or tolling implications required as a result of this improvement. While not estimated, right of way costs are expected to be minimal, if any. Design should be conducted with the long-term solution in mind to avoid any unnecessary rework/impact to mainline traffic.

3 LONG-TERM ALTERNATIVES ANALYSIS

The Short-term solutions discussed do not eliminate the need for more substantial improvements to maintain the safety and capacity of this area in the long-term. This section provides information about the effectiveness of six alternatives at improving safety and reducing congestion related to the Exit 32 Southbound Off Ramp and other significant intersections in the Study Area.

3.1 DEVELOPMENT OF LONG-TERM ALTERNATIVES

Alternatives were developed using a combination of recommendations from the CYCCS and discussions with MTA. These alternatives:

- Aim to increase the capacity of southbound movements by widening the southbound off-ramp to add an additional off-ramp lane that would continue through to the intersection of Exit 32 and Route 111;
- Seek to redistribute volumes from the Intersection of Exit 32 and Route 111 by adding new connections to Route 111 west of the Turnpike, possibly extend to South Street (by others);
- Look to improve interchange operations by reconfiguring the Exit 32 interchange; and
- Evaluate any other ideas developed during the design process.

Based on the goals outlined above, the following six long-term alternatives were developed and analyzed in the 2036 study year:

- Alternative 1: Addition of a second Exit 32 Southbound Off Ramp lane;
- Alternative 2: Addition of a new connection from the Exit 32 Southbound Off Ramp to Route 111 west of the Maine Turnpike;
- Alternative 3: Utilization of a collector-distributor to push movements away from the mainline and remove westbound traffic from the Exit 32 and Route 111 Intersection;
- Alternative 4: Addition of a new one-way connection from the Southbound Off Ramp to Route 111 and South Street;
- Alternative 5: Addition of a new connection from the Southbound Off Ramp to Route 111 and South Street with a flyover to the NB On Ramp; and
- Alternative 6: Addition of a new connection from the Southbound Off Ramp to Route 111 and South Street with a diamond interchange (both conventional and folded diamond configurations)

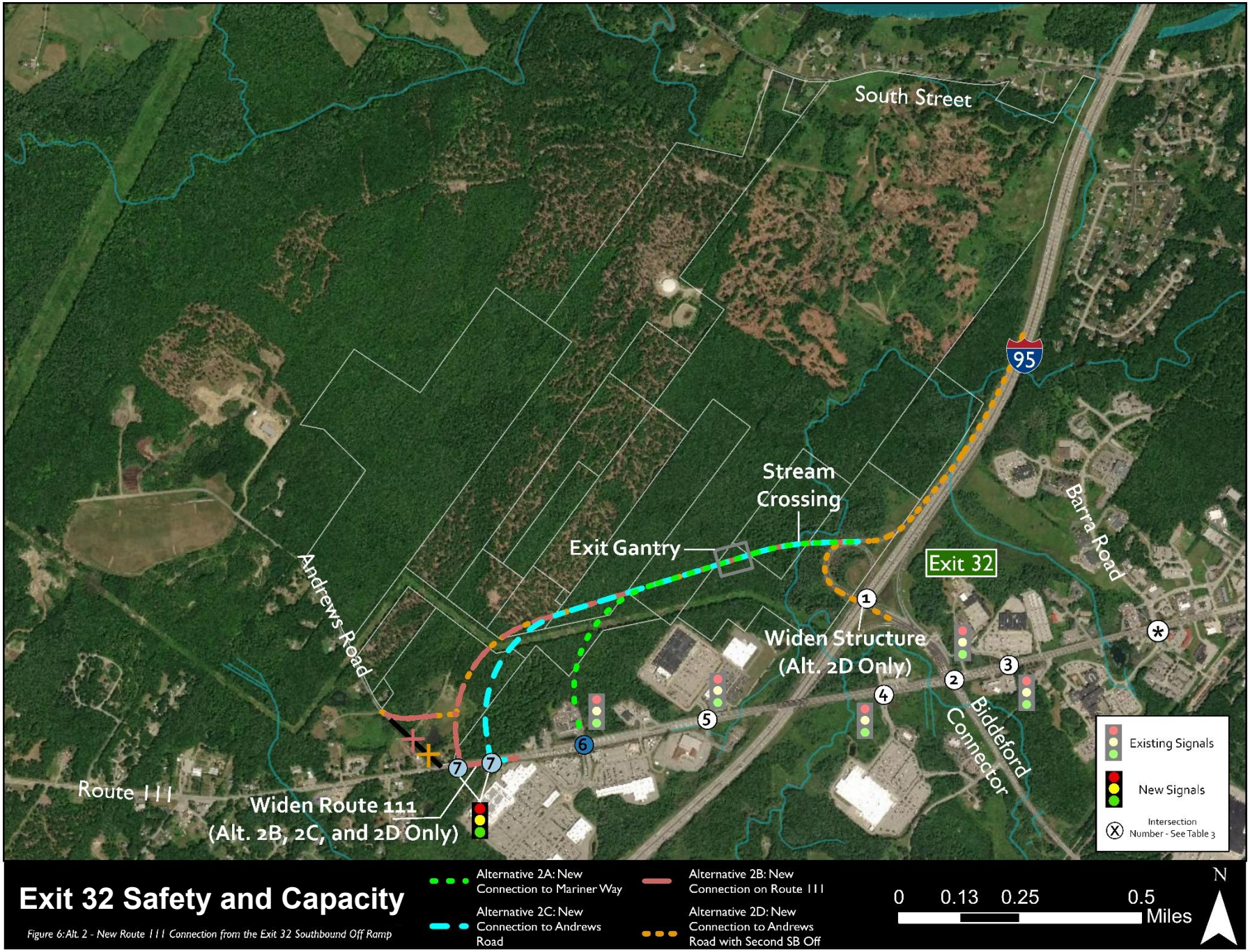
Table 3 summarizes each alternative and the variations evaluated:

Table 3: Long-Term Alternatives Analyzed						
		SB Off Ramp Lanes	New Route 111 Connection		South Street Connection	Interchange Configuration
No Build		1	N/A	N/A	N/A	Existing
Alt 1		2	N/A	N/A	N/A	Existing
Alt 2	A	1	Mariner Way	1-way	N/A	Existing
	B	1	Andrews Rd	1-way	N/A	Existing
	C	1	New intersection	1-way	N/A	Existing
	D	2	Andrews Rd	1-way	N/A	Existing
Alt 3		1	Channelized Right WB	N/A	N/A	Existing
Alt 4	A	1	Andrews Rd	1-way ramp	2-way	Existing
	B	1	Mariner Way	1-way ramp	2-way	Existing
Alt 5		1	Andrews Rd	2-way	2-way	Flyover
Alt 6	A	1	Mariner Way	2-way	2-way	Conventional Diamond
	B	2	Andrews Rd	2-way	2-way	Conventional Diamond
	C	2	Mariner Way	2-way	2-way	Conventional Diamond
	D	2	Andrews Rd	2-way	2-way	Folded Diamond

Each alternative is summarized graphically in **Figures 5-10** (pages 19-24). Intersection numbers appear in each figure and are summarized in **Table 4**. These numbers are also used in summary tables to correlate operations analysis results with locations. Intersection 1 summarizes each of the Exit 32 ramps at their respective gore area, intersections 2-6 are existing signalized intersections , and intersections 7-12 would be created as part of new connections. As previously noted, the intersection of Barra Road and Route 111 is not included in this analysis. Analysis results for the full study area is located in **Appendix B**.

Table 4: Intersection Analysis List	
1	I-95 Exit 32 Ramps
2	Exit 32 and Route 111
3	Irving/Planet Fitness and Route 111
4	Exit 32 Park and Ride/Walmart and Route 111
5	Biddeford Gateway Center/New Life and Route 111
6	Mariner Way and Route 111
7	Potential New Intersection/Route 111
8	Andrews Road and Route 111
9	Route 111 Connector and South Street Connector
10	South Street and the South Street Connector
11	Northerly Signalized Diamond Intersection
12	Southerly Signalized Diamond Intersection
*	Barra Road and Route 111

Figure 5: Alt. 1 - Additional Southbound Off Ramp Lane


South Street
95
Stream Crossing
Exit Gantry
Exit 32
Barra Road
Andrews Road
Widen Structure (Alt. 2D Only)
Biddeford Connector
Route 111
Widen Route 111 (Alt. 2B, 2C, and 2D Only)
Existing Signals
New Signals
Intersection Number - See Table 3
Exit 32 Safety and Capacity
Figure 6: Alt. 2 - New Route 111 Connection from the Exit 32 Southbound Off Ramp
Alternative 2A: New Connection to Mariner Way
Alternative 2B: New Connection on Route 111
Alternative 2C: New Connection to Andrews Road
Alternative 2D: New Connection to Andrews Road with Second SB Off
0 0.13 0.25 0.5 Miles
N

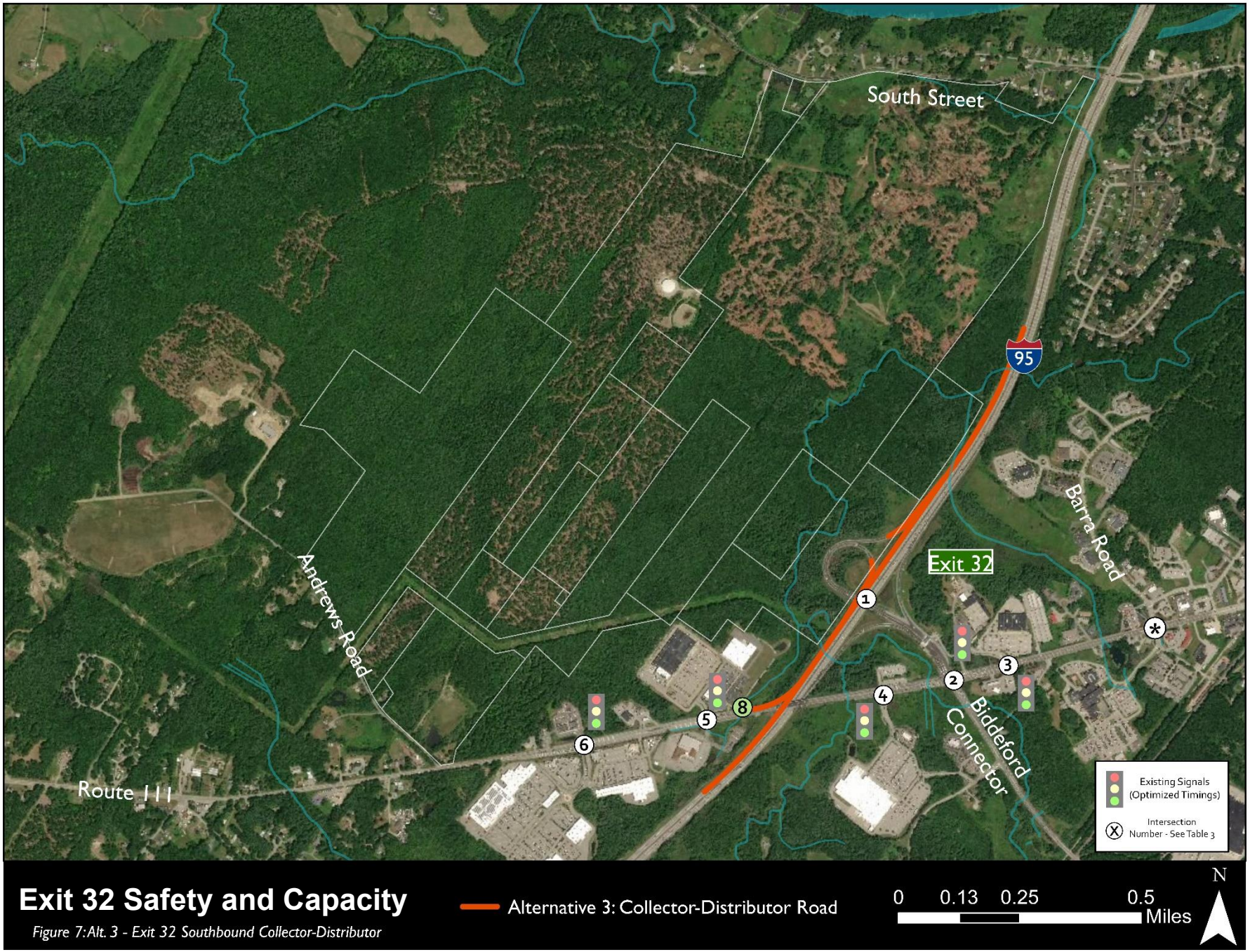


Figure 7: Alt. 3 - Exit 32 Southbound Collector-Distributor

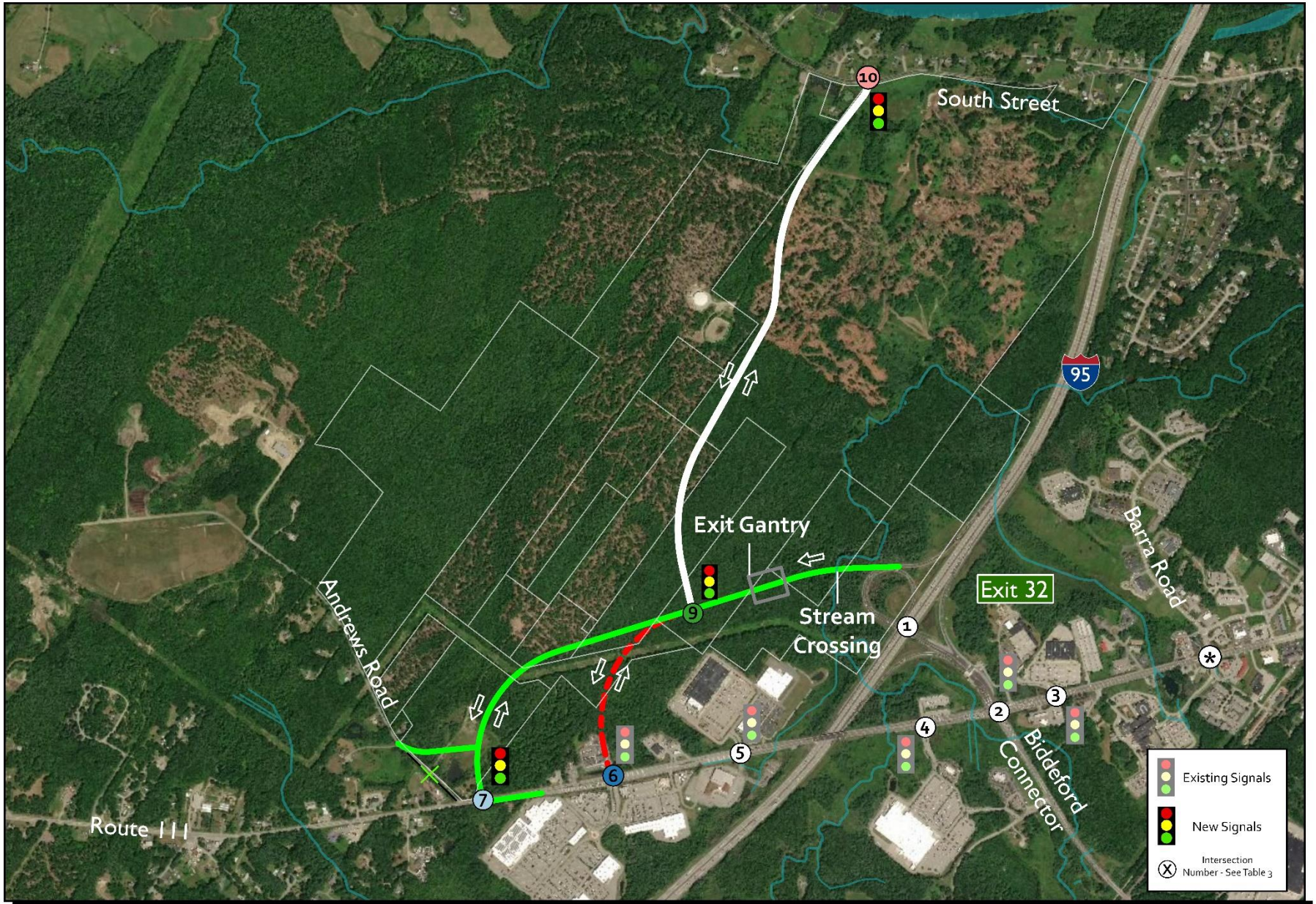
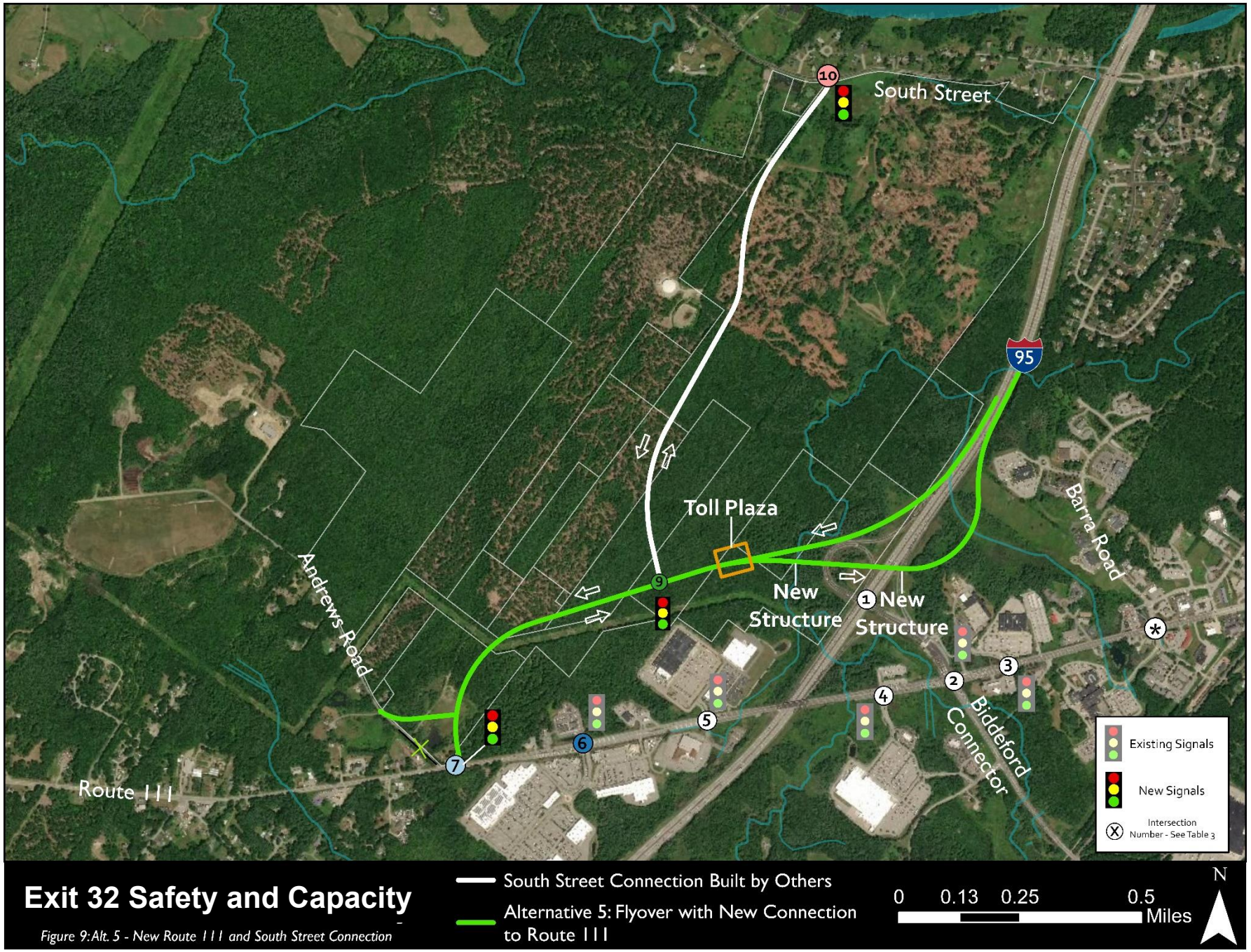
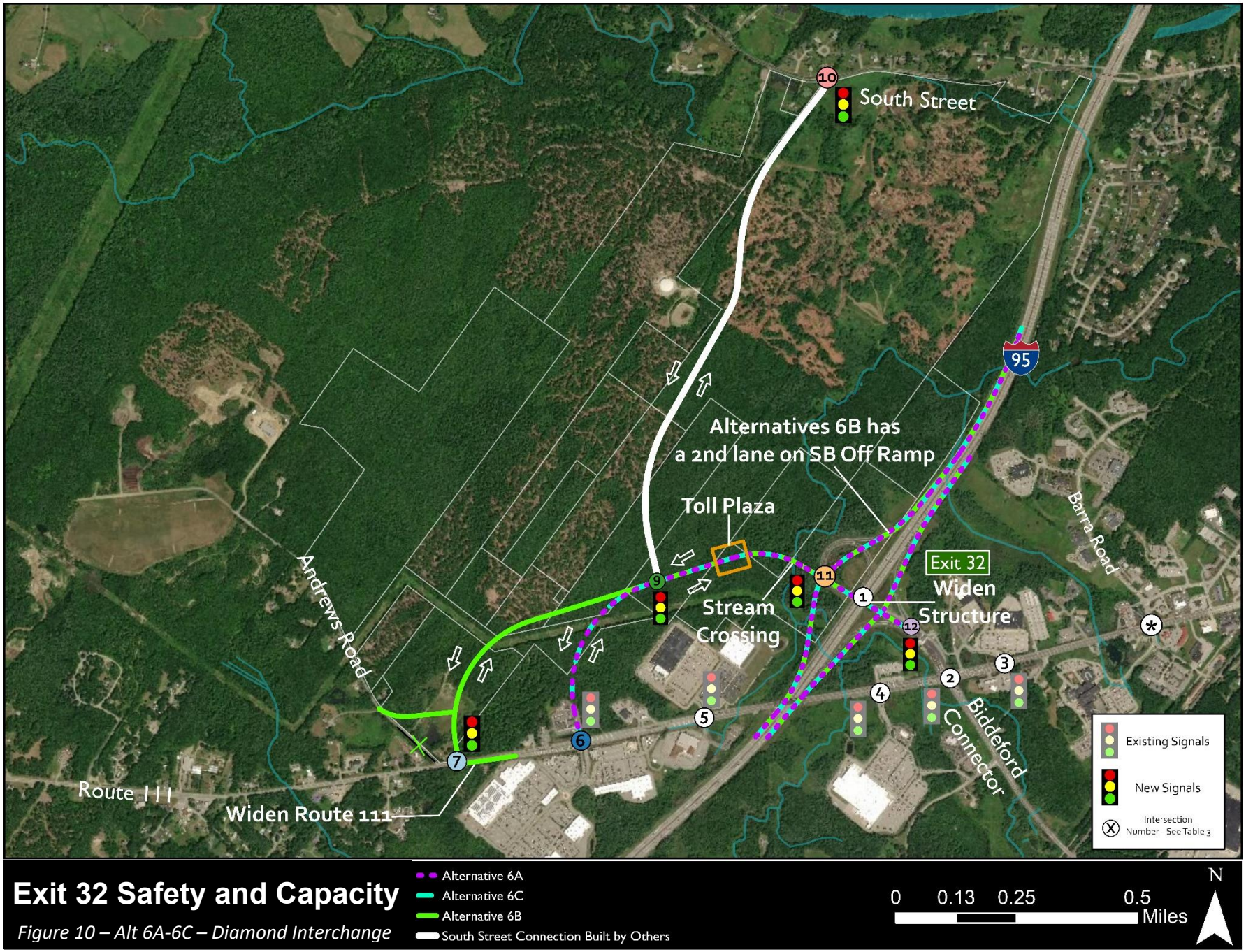


Figure 8: Alt. 4 - New Route 111 and South Street Connections from Exit 32 Southbound Off


South Street
10
95
Toll Plaza
Andrews Road
Barra Road
New Structure
1 New Structure
9
Route 111
6
7
5
4
2
3
Biddeford Connector
*
Existing Signals
New Signals
Intersection Number - See Table 3
Exit 32 Safety and Capacity
Figure 9: Alt. 5 - New Route 111 and South Street Connection
South Street Connection Built by Others
Alternative 5: Flyover with New Connection to Route 111
0 0.13 0.25 0.5 Miles
N


South Street
10
95
Alternatives 6B has
a 2nd lane on SB Off Ramp
Toll Plaza
Andrews Road
Barra Road
Exit 32
Widen
Structure
Stream
Crossing
9
11
1
12
2
3
4
5
6
7
Biddeford
Connector
Route 111
Widen Route 111
Existing Signals
New Signals
Intersection
Number - See Table 3
Exit 32 Safety and Capacity
Figure 10 – Alt 6A-6C – Diamond Interchange
Alternative 6A
Alternative 6C
Alternative 6B
South Street Connection Built by Others
0 0.13 0.25 0.5
Miles
N

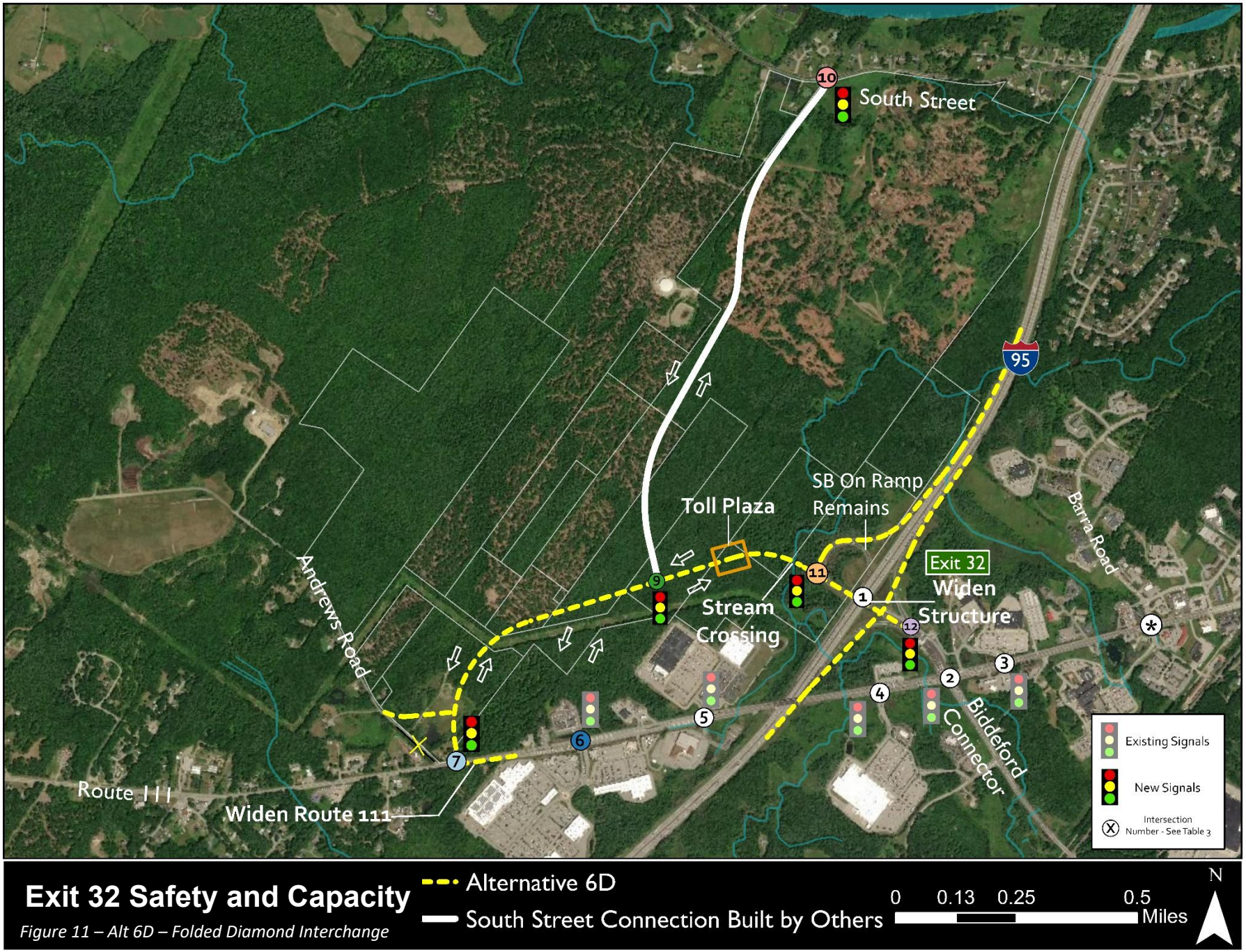


Figure 11 – Alt 6D – Folded Diamond Interchange

3.2 ALTERNATIVE ANALYSIS

The following sections describe the results of each alternatives analysis comparing costs, longevity and operational results to the long-term no build condition.

3.2.1 Alternative 1: Additional Southbound Off-Ramp Lane

As shown in **Figure 5** (page 19), Alternative 1 features the addition of a second Southbound Off-Ramp lane that would start on the mainline and tie in just north of the toll plaza. Major work for this item would involve widening of the mainline to account of additional deceleration length needs, widening of the loop ramp southbound and widening of the Exit 32 Bridge over I-95.

The impact of this analysis on the Exit 32 Southbound Off Ramp and the Exit 32 Southbound Approach at the intersection of Exit 32 and Route 111, costs, and longevity estimates are shown in **Table 5**. Full results are shown in **Appendix B**.

Table 5: Alternative 1 2036 Long-Term Analysis Results

	1. Exit 32 SB Off			2. Exit 32 SB approach			Cost	Longevity
	Delay	LOS	Queue	Delay	LOS	Queue		
No Build	88.22	F	*	110.3	F	*	-	-
Alt 1	69.96	F	*	128.2	F	*	$5.4M	5 years

* Queues exceed default threshold.

Operationally, the additional off-ramp has little effect if it is implemented without ongoing signal and corridor improvements. The advantage of this alternative is the additional mile of queue storage provided prior to the intersection. This improvement is not expected to alleviate mainline queues under long-term conditions.

3.2.2 Alternative 2: Addition of a New Connection from the Southbound Off Ramp to Route 111

As depicted in **Figure 6** (page 20), Alternative 2 includes a one-lane, one-way connector roadway that would divert westbound traffic from the I-95 southbound off-ramp away from the existing intersection of Exit 32 and Route 111 and adjacent intersections along Route 111 to relieve congestion to the high crash location and the Route 111 Corridor.

Four variations of this alternative were evaluated:

- Alternative 2A: Connection from SB Off to Mariner Way
- Alternative 2B: Connection from SB Off to Andrews Road
- Alternative 2C: Connection from SB Off to Route 111 between Andrews Road and Mariner Way
- Alternative 2D: A second southbound Off ramp lane with a connection from southbound off ramp to Andrews Road (a connection to Mariner would be investigated under further study)

It is estimated, with slight variance based on the connection point, that with the singular Southbound Off Ramp lane approximately 500 vehicles, 25% of the volume of the southbound approach, would utilize a new connection to Route 111 and that a second Southbound Off Ramp lane would increase that volume to 650 vehicles.

The Route 111 Connection was assumed to be constructed as a two-lane road but striped for a single lane road until the proposed South Street Connection was constructed by others. Other key design elements include:

- Construction of the Route 111 Connector (for all alternatives) and an additional Southbound Off Ramp lane (Alternative 2D only);
- Drainage improvements;
- Structural improvements including widening of the Exit 32 Bridge over I-95 for Alternative 2D, and a structure to cross the existing stream to the west of the Southbound Off Ramp;
- Either alternation of the existing signal at Mariner Way or the addition of a new signal on Route 111 or at Andrews Road;
- A new exit gantry to the west of the Southbound Off Ramp; and
- Improvements required by a new connection to Route 111.

The impact of this analysis on the Exit 32 Southbound Off-Ramp and the Exit 32 Southbound Approach at the intersection of Exit 32 and Route 111, costs, and longevity estimates shown in **Table 6**. Full results are shown in **Appendix B**.

Table 6: Alternative 2 2036 Long-Term Analysis Results

	Connection to Route 111	# SB Off-Ramp Lanes	1. Exit 32 SB Off			2. Exit 32 SB approach			Cost	Longevity
			Delay	LOS	Queue	Delay	LOS	Queue		
No Build	N/A	1	88.2	F	*	110.3	F	*	-	-
Alt 2A	Mariner Way	1	74.8	F	*	69.6	E	703	$7M	5 years
Alt 2B	Andrews Rd	1	76.6	F	*	60.08	E	608	$9.1M	5 years
Alt 2C	New Intersection	1	75.7	F	*	55.89	E	602	$8.1M	5 years
Alt 2D	Andrews Rd	2	56.4	F	*	52.9	E	621	$14.8M	10 years

* Queues exceed default threshold.

This alternative does not negate the need for further improvements. The additional connection to Route 111 essentially provides additional storage and removes vehicles from the Exit 32 intersection. However, even with this improvement, the queues would be present again in approximately 5-10 years, no matter what the connection. Refinement of the connection point would be part of additional analysis if selected; this alternative is recommended to be part of an overall phased approach.

3.2.3 Alternative 3: Collector-Distributor Road

Alternative 3, depicted in **Figure 7** (page 21), includes a two-lane, one-way, collector-distributor (C-D) roadway designed to divert westbound traffic from I-95 southbound away from the intersection of Exit 32 and Route 111 by creating a new southbound off ramp to the west. Statewide model estimates this volume could be as high as 800 vehicles that would use this to go westbound on Route 111 during PM Peak providing a lifespan of between 5 and 10 years.

Key elements include:

- Construction of the collector-distributor;
- Drainage improvements;
- Barrier;
- Structural improvements to the Exit 32 Bridge over I-95 and the Route 111 bridge as well as two box culverts; and
- A new exit gantry for the westbound movement of the Southbound Off Ramp.

The impact of this analysis on the Exit 32 Southbound Off-Ramp and the Exit 32 Southbound Approach at the intersection of Exit 32 and Route 111, costs, and longevity estimates shown in **Table 7**. Full results are shown in **Appendix B**.

Table 7: 2036 Alternative 3 Long-Term Analysis Results

	Connection to Route 111	# SB Off-Ramp Lanes	1. Exit 32 SB Off			2. Exit 32 SB approach			Cost	Longevity
			Delay	LOS	Queue	Delay	LOS	Queue		
No Build	N/A	1	88.2	F	*	110.3	F	*	-	-
Alt 3	N/A	1	54.0	F	*	49.9	D	416	$27.2M	5-10 years

* Queues exceed default threshold.

Due to high construction costs and difficult physical implementation with no additional regional mobility gain and a relatively short life span, this alternative was discarded without additional analysis.

3.2.4 Alternative 4: Addition of a New Connection from the Southbound Off Ramp to Route 111 and South Street

Figure 8 (page 22) depicts Alternative 4, a new two-lane, two-way roadway connecting Route 111 west of the Maine Turnpike and South Street. Under this alternative, movements from the Southbound Off Ramp would remain one-way. Volumes would be pushed out of the Exit 32 and Route 111 intersection by:

- Providing a connection between South Street and Route 111 allowing users to bypass the intersection of Exit 32 and Route 111 as well as downtown Biddeford;
- Providing a direct Southbound Off Ramp movement to South Street; and
- Providing a direct Southbound Off Ramp movement to Route 111

Two variations of this alternative were evaluated:

- Alternative 4A: Connection from SB Off to Route 111 to Mariner Way with a connection from South Street to the Route 111 Connector.
- Alternative 4B: Connection from SB Off to Andrews Road with a connection from South Street to the Route 111 Connector.

It is estimated that approximately 150 vehicles in each direction during the PM Peak would take advantage of the new connection from South Street to Route 111. Similar to Alternative 2, it is estimated that approximately 500 vehicles would take the movement from the Southbound Off Ramp to a new Route 111 Connection. Finally, it is estimated that approximately 100 vehicles would make the movement from the Southbound Off-Ramp to a new South Street Connection. Refinement of the connection point would be part of additional analysis if selected; this alternative is recommended to be part of an overall phased approach.

Key design elements include:

- Construction of the Route 111 Connector;
- Construction of a South Street Connector (by others);
- Drainage improvements;
- Structural improvements including bridge widening, extension of a box culvert and placement of a new culvert;
- A signal modification at Mariner Way or new Signal at Andrews Road as well as a new signal at South Street (by others)
- A new exit gantry to the west of the Southbound Off Ramp; and
- Improvements to Route 111 at Andrews Road Connection.

The impact of this analysis on the Exit 32 Southbound Off-Ramp and the Exit 32 Southbound Approach at the intersection of Exit 32 and Route 111, costs, and longevity estimates shown in **Table 8**. Full results are shown in **Appendix B**.

Table 8: Alternative 4 2036 Long-Term Analysis Results										
	Connection to Route 111	# SB Off-Ramp Lanes	1. Exit 32 SB Off			2. Exit 32 SB approach			Cost	Longevity
			Delay	LOS	Queue	Delay	LOS	Queue		
No Build	N/A	1	88.2	F	*	110.3	F	*	-	-
Alt 4A	Mariner Way	1	66.4	F	*	54.5	D	482	$6.9M**	10 years
Alt 4B	Andrews Road	1	62.3	F	*	53.1	D	527	$9.0M**	10 years

* Queues exceed default threshold

** The construction of the South Street Connection (by others) is estimated to cost an additional $5.5M.

The addition of a Route 111 and South Street Connection is expected to improve regional connectivity while removing approximately 900 vehicles from the Exit 32 and Route 111 Intersection during the PM Peak Hour. Although this alternative has a positive impact, it is anticipated that queues would return to the mainline in approximately 10 years. Based on previous analyses, a second Southbound Off Ramp Lane would achieve approximately five additional years. Refinement of the connection point would be part of additional analysis if selected; this alternative is recommended to be part of an overall phased approach.

3.2.5 Alternative 5: Fly-Over Interchange

Utilizing the connection from the SB Off-Ramp to Route 111 and South Street, **Figure 9** (page 23) depicts the addition of a connection to I-95 NB On using a flyover. The use of a flyover prevents the need for signalized intersections required by other alternatives that provide similar connectivity benefits.

Key design elements include:

- Construction of the Route 111 Connector;
- Construction of a South Street Connector (by others);
- Drainage improvements;
- Structural improvements including a flyover bridge, bridge widening, extension of a box culvert and placement of a new culvert;
- A new signal at Andrews Road;
- A new toll plaza to the west of the Southbound Off Ramp; and
- Improvements to Route 111 at Andrews Road Connection.

The impact of this analysis on the Exit 32 Southbound Off-Ramp and the Exit 32 Southbound Approach at the intersection of Exit 32 and Route 111, costs, and longevity estimates shown in **Table 9**. Full results are shown in **Appendix B**.

Table 9: Alternative 5 2036 Long-Term Analysis Results										
	Connection to Route 111	# SB Off-Ramp Lanes	1. Exit 32 SB Off			2. Exit 32 SB approach			Cost	Longevity
			Delay	LOS	Queue	Delay	LOS	Queue		
No Build	N/A	1	88.2	F	*	110.3	F	*	-	-
Alt 5	Mariner Way	1	72.4	F	*	39.0	D	305	$64.8M**	10 years

* Queues exceed default threshold

** The construction of the South Street Connection (by others) is estimated to cost an additional $5.5M.

Volumes are redistributed similar to Alternative 4 with the addition of the new Northbound On Ramp movement with volumes anticipated of approximately 30 vehicles from South Street and nearly 300 vehicles from the Route 111 Connection. While initially this distribution of volumes would appear to increase the longevity of Alternative 5 over Alternative 4, the additional intersection movements at Intersection 9 (where the new Route 111 Connector and South Street Connector intersect) actually work against the alternative, providing a similar lifespan. Based on previous analyses, a second Southbound Off Ramp Lane would achieve approximately five additional years. Refinement of the connection point would be part of additional analysis if selected. At this time, this alternative is not recommended to be part of an overall phased approach.

3.2.6 Alternative 6: Diamond Interchange Configuration

The final alternative, similar to Alternative 4, is shown in **Figures 10 and 11** (pages 24-25), and depicts a new two-lane, two-way connector roadway from the Exit 32 southbound off-ramp to Route 111 west of the Maine Turnpike to South Street with a diamond interchange configuration providing full interchange movements. Two variations on the diamond interchange are analyzed – a conventional and folded diamond interchange – as well as the performance of the alternative with one or two Southbound Off Ramp lanes. Specifically:

- Alternative 6A: A conventional diamond interchange with a connection to Route 111 via Mariner Way, a connection to South Street and a single lane Southbound Off Ramp;
- Alternative 6B: A conventional diamond interchange with a connection to Route 111 via Andrews Road, a connection to South Street and a two lane Southbound Off Ramp;
- Alternative 6C: A conventional diamond interchange with a connection to Route 111 via Mariner Way, a connection to South Street and a two lane Southbound Off Ramp; and
- Alternative 6D: A folded diamond interchange with a connection to Route 111 via Andrews Road, a connection to South Street and a two lane Southbound Off Ramp.

Key design elements include:

- Construction of the Route 111 Connector;
- Construction of a South Street Connector (by others);

- Drainage improvements;
- Structural improvements including bridge widening, extension of a box culvert and placement of a new culvert;
- A signal modification at Mariner Way (6A/6C), a new signal at Andrews Road (6B/6D), and new signals at the diamond ramp intersections, the connection between Route 111 and South Street, and at the eastly South Street Connection;
- A new toll plaza to the west of the Southbound Off Ramp; and
- Improvements to Route 111 at Andrews Road Connection (6B/6D).

The impact of this analysis on the Exit 32 Southbound Off-Ramp and the Exit 32 Southbound Approach at the intersection of Exit 32 and Route 111, costs, and longevity estimates shown in **Table 10**. Full results are shown in **Appendix B**.

Table 10: Alternative 6 2036 Long-Term Analysis Results

	Interchange Configuration	Connection to Route 111	# SB Off-Ramp Lanes	1. Exit 32 SB Off			2. Exit 32 SB approach			Cost	Longevity
				Delay	LOS	Queue	Delay	LOS	Queue		
No Build	Trumpet	N/A	1	88.2	F	*	110.3	F	*	-	-
Alt 6A	Conventional Diamond	Mariner Way	1	78.0	F	*	32.8	C	217	$31M**	10-15 years
Alt 6B	Conventional Diamond	Andrews Rd	2	15.5	B	-	35.1	D	255	$34.5M**	20+ years
Alt 6C	Conventional Diamond	Mariner Way	2	15.3	B	-	33.0	C	232	$32.7M**	20+ years
Alt 6D	Folded Diamond	Andrews Rd	2	19.2	B	-	33.8	C	240	$24.4M**	20+ years

* Queues exceed default threshold

** The construction of the South Street Connection (by others) is estimated to cost an additional $5.5M.

The combination of the redistribution of volumes and flexibility of movements created by the diamond interchange provides the most regionally beneficial alternative with the greatest longevity. To provide a 20+ year lifespan, a second southbound-off ramp lane is required along with the Route 111 and South Street Connection.

In terms of interchange configuration, both the conventional and folded diamond operate adequately. The folded diamond has a much-reduced cost and is the recommended long-term solution, allowing for the phased construction of Alternatives 2 and 4. Refinement of the connection point would be part of additional analysis.

4 CONCLUSIONS

This broad transportation study shows that traffic congestion on the Maine Turnpike near the Exit 32 Southbound Off Ramp stems from high volumes, the intersection of Route 111 with the Exit 32 ramps and the geometry of the Exit 32 Southbound Off Ramp. At the toll plaza, more than half of the traffic from the northbound off-ramp is destined to turn left onto Route 111 causing a heavy weaving movement vehicles that can block the right turn lanes on the approach to Route 111 and cause longer queues. The following conclusions were made:

- The combination of the short-term improvements of queue detection and an extended deceleration lane can provide interim benefit by removing stopped vehicles from the mainline. These are readily implementable and should be combined with ongoing efforts to improve and maintain signal performance along the Route 111 corridor, to examine geometric needs at the intersection of Route 111 and the Exit 32 Ramps, and to maintain vegetation along the ramps.
- New connections to Route 111 are a key component to improving the operations at the intersection of Exit 32 and Route 111. While the connection point does not significantly change the longevity, further analysis is required to determine the best location.
- The South Street Connection is assumed to be done by others, however it is a critical piece of regional mobility. The volumes removed from the Route 111 and Exit 32 Intersection as a result of this connection provide benefit by improving safety and capacity;
- A second Southbound Off-Ramp increases the longevity of each alternative by approximately five years;
- Operationally, both the conventional diamond and folded diamond provide regional mobility and operate at acceptable levels of service, however the folded diamond achieves these results at a significant cost savings with less impact; and
- A phased approach allows for incremental application without significant rework.

Please note that currently, coordination between the MTA and the City of Biddeford has resulted in ongoing improvements to the six signals on the Route 111 Corridor from Mariner Way to Barra Road including:

- Updates to signal timing, phasing and coordination – see **Appendix C** for preliminary plans including adding Barra Road to the coordination plan;
- Physical signal maintenance and improvements at the Exit 32 Intersection with City coordination for other locations along the corridor.
- Incorporation of the signals into MTA's Centracs Signal Performance Measure software;
- Examination of potential geometric improvements at the Exit 32 and Route 111 Signal;
- Ongoing signal monitoring of maintenance, and coordination of those needs with the City of Biddeford; and
- Exploration of queue detector activation as a pre-emption into the signal system coordination program.

These signal improvements are ongoing and are not included in this short-term analysis. As this is a high-level transportation evaluation only, further evaluations including a regional study and environmental assessment, is recommended to determine the larger effects of these potential improvement alternatives.

5 RECOMMENDATIONS

The ultimate configuration that provides the greatest regional mobility with the least cost and best operational benefits is the folded diamond interchange with two southbound off-ramp lanes and connections between Route 111 and South Street. Based on the analysis results regarding longevity, a phased approach would include:

- Phase 1: Queue detection, an extended southbound off ramp deceleration lane, and current ongoing work;
- Phase 2: Construction of a connection from Exit 32 SB Off to Rte. 111 and second Southbound Off Ramp with follow up evaluation of the Exit 32 and Route 111 intersection for potential additional improvements;
- Phase 3: *South Street Connection* (by others); and
- Phase 4: Reconstruction of the interchange to a folded diamond.