



NORTHSHORE DRIVE CORRIDOR STUDY

Final Report

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Prepared by



KCI
TECHNOLOGIES



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1.0 Introduction

Extending approximately 16 miles from the western border of Knox County to Interstate 40/75 in Knoxville, Northshore Drive (SR 332) is a major corridor in the Knoxville region, serving as a critical connection between Knoxville, the Town of Farragut, and other portions of western Knox County as shown in Figure 1-1.

The majority of Northshore Drive is a two-lane minor arterial with a posted speed limit of 40 mph though the design and character of the corridor is largely driven by surrounding land uses. The more rural sections of the roadway are surrounded by low-density residential development. The typical cross section in these areas includes a single 12-foot travel lane in each direction, 2-foot shoulder widths with rumble strips, and grass ditch for drainage. There are numerous private driveways and public roads that intersect the more rural sections of the corridor though most of these intersections lack turn lanes. Though the corridor lacks consistent bicycle and pedestrian facilities along the roadway, greenways exist within nearby recreational areas.



Northshore Drive near Wallace Road

There are some portions of Northshore Drive that are more urban in nature, specifically near the Rocky Hill and I-140/Pellissippi Parkway interchange areas where more commercial development patterns exist. The typical cross section in the Rocky Hill area includes a single 12-foot travel lane in each direction with larger shoulder widths ranging from two to eight feet and a curb-and-gutter drainage system. Turn lanes exist at major intersections as do intermittent sidewalks. Near the I-40 interchange area, the cross section includes two 12-foot travel lanes in each direction, larger shoulder widths up to 12 feet, curb and gutter drainage, and intermittent sidewalks. Turn lanes exist at the major intersections and there is a two-way-left-turn-lane through the commercial areas east of the interchange.



Northshore Drive near Thunderhead Road

Despite the predominantly rural design, the corridor carries upwards of 16,000 vehicles per day in many locations. Even though west Knox County has continued to see growth, established developments along the corridor and Fort Loudoun Lake to the south constrain expansion of this facility to meet increasing transportation demands.

1.1 Purpose of Study

Recognizing the needs along Northshore Drive, recent studies have made recommendations for improving traffic operations, safety, corridor capacity, and bicycle and pedestrian accessibility, all founded on technical analysis and input from stakeholders and residents. The [Knoxville Regional Transportation Planning Organization's \(TPO\) Mobility Plan 2045](#), adopted in April 2021, identified system level improvements throughout the region and set the stage for additional analysis including the Northshore Corridor Study¹ area. From a regional perspective, Mobility Plan 2045 documents the need for additional turn lanes and bicycle/pedestrian facilities at multiple locations along the corridor. In addition, Knox County's 2020 Greenway Corridor Study recommends greenway alignments along the corridor from the Knox County/Loudon County line to Lakeshore Park.

1.2 Study Locations

The Northshore Drive Corridor Study includes an evaluation of existing and future conditions at specific locations along the corridor and a recommended improvements program built upon previous recommendations to support the County's long-term vision for the corridor. More specifically, eight study locations are identified for analysis in the Northshore Drive Corridor Study. These eight locations include a total of 10 study intersections considered some of the most deficient along the corridor. Each location represents an area where operational issues have been identified for further analysis and improvement. The eight study locations are listed below and shown in Figure 1-2.

1. Segment from Concord Park Boat Launch to Eagle Glen Drive
2. Intersection of Northshore Drive and Bluegrass Road/Chandler Road
3. Segment from Hart Road to Admiral Farragut Park Access
4. Intersection of Northshore Drive and Thunderhead Road
5. Intersection of Northshore Drive and Ebenezer Road
6. Intersection of Northshore Drive and Toolles Bend Road
7. Segment from Wallace Road to Whitower Drive
8. Segment from Duncan Road/Cherry Drive to Lyons View Pike

¹ Mobility Plan 2045 included two projects on Northshore Drive: 09-645 and 09-646

Figure 1-1. Regional Context of Northshore Drive

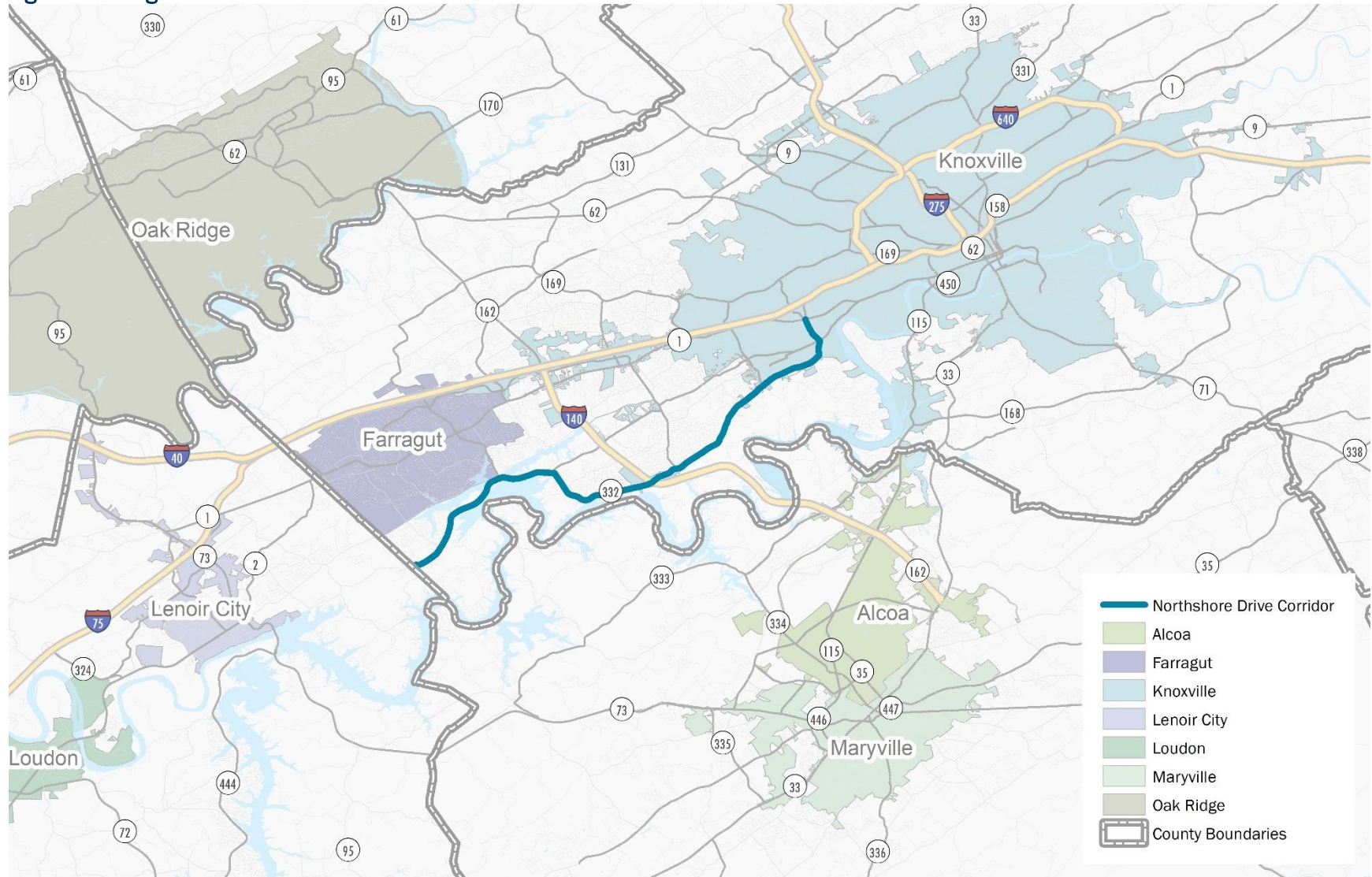
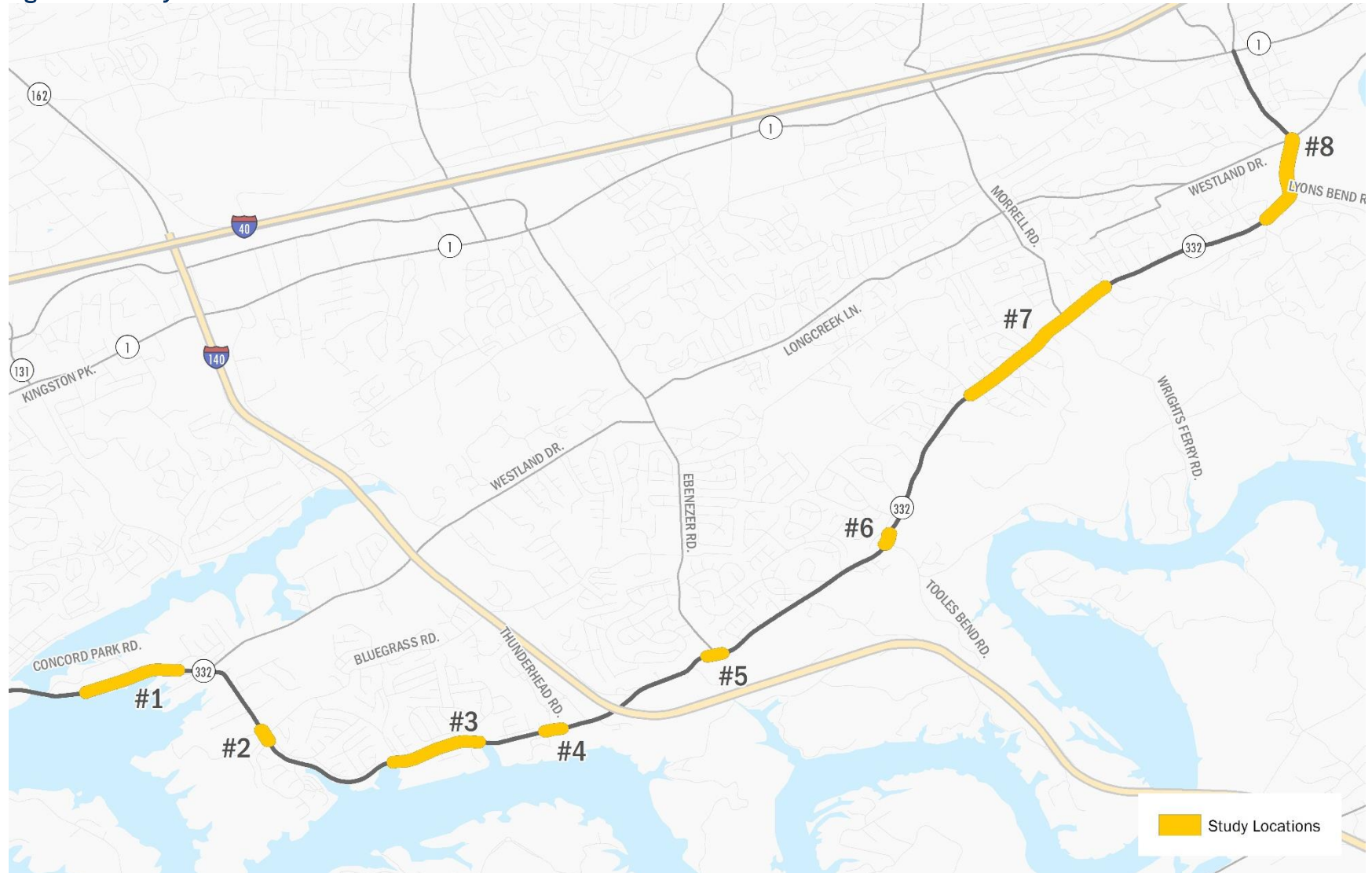


Figure 1-2. Study Locations



2.0 Existing and Future Conditions

The existing and future conditions analysis for the Northshore Drive Corridor Study will serve as the foundation for the recommended improvements plan. This chapter details the data sources and methodologies used to assess safety trends, development patterns, and operational conditions along the corridor. The results of this analysis are summarized by location with more detailed information on the analysis provided in the Appendices.

2.1 Data Sources and Analysis Methods

Multiple data sources were used to assess the existing and future conditions along the Northshore Drive corridor. The existing conditions analysis included a review of historic crash trends, assessment of access and driveway density, bicycle and pedestrian infrastructure availability, and operational analysis of study intersections.

Safety

Historic crash data at the study locations was sourced from the Tennessee Department of Transportation's (TDOT) Enhanced Tennessee Roadway Information Management System (ETRIMS) database. Due to the COVID-19 pandemic and its impact on travel trends during 2020, the safety analysis included a review of crash frequency, severity, and type for 2015-2019.

Access Density

The frequency and placement of intersections and driveways can contribute to both operational and safety deficiencies along a corridor. As such, the existing conditions assessment included an overview of access density for each of the study locations. Sourced largely from aerial imagery, the number of existing intersections and driveways is documented. Within 500 feet of the study intersections, more detailed information on the access control, stop control, and approximate distance from the intersection is also presented.

Bicycle and Pedestrian Infrastructure

The presence of non-motorized infrastructure along the corridor was assessed using GIS data provided by the Knoxville-Knox County Planning Department. Specifically, existing sidewalks, bikeways, and off-street greenway facilities were documented near each study location.

Vehicular Speeds and Corridor Congestion

To assess the operation of the entire Northshore Drive corridor, congestion data was queried using the Regional Integrated Transportation Information System (RITIS), which is made available to TDOT's planning partners. This database serves as a warehouse for historical vehicular speed and incident data collected using passive cell phone technology. Specifically, this dataset was queried to examine the vehicular speeds along the corridor during April 2021 to coincide with the intersection data collection efforts of this study.

Traffic Operations

The existing and future operations at the 10 study intersections were analyzed using PTV's Vistro software. Using Vistro, intersection laneage, speed limits, turning movement counts, and local signal

timing data were incorporated into a traffic model that analyzed each intersection's capacity and demand using the methodology outlined in the 6th Edition of the *Highway Capacity Manual (HCM)*. To support model development, peak hour turning movement volumes were conducted for both AM (7:00 – 9:00) and PM (4:00 – 6:00) peak hours during April 2021.

To measure the operational efficiency of each intersection in both existing and future conditions, the following four metrics were used.

- **Volume-to-Capacity Ratio** - The volume-to-capacity (v/c ratio) measures the percentage of capacity being utilized by existing vehicular demands where capacity is defined as the maximum number of vehicles that can use an intersection within any given hour. According to the HCM, an intersection with a v/c ratio less than 0.85 is operating under capacity, an intersection with a v/c ratio at 1.0 is operating at capacity, and an intersection with a v/c ratio greater than 1.0 is operating over capacity.
- **Vehicular Delay** - The vehicular delay for an intersection or approach represents the average amount of time any given vehicle will spend at that location.
- **Level of Service** - The Level of Service (LOS) is a measurement used to identify how well a roadway segment or intersection is able to accommodate traffic volumes within the existing capacity. Based on the amount of delay experienced, LOS is assigned a "grade" between LOS A and LOS F. LOS A is the highest condition rating with vehicles experiencing minimal delay, while LOS F is considered the worst with vehicles experiencing excessive delay.
- **Queue Lengths** - Particularly for intersections that may be reaching capacity, it can be equally meaningful to look at queue lengths for intersection approaches. These values measure the extent in feet of a queue formed while vehicles wait to go through an intersection. Typically reported as the 95th percentile queues, this queue length statistically has only a 5% chance of being exceeded during the peak hour.

It is important to note that the analysis of future traffic conditions assumes no improvements or changes are made to the intersections. Therefore, approach laneage and signal timing are not adjusted to account for increased traffic demands. The need for these types of changes to improve traffic operations will be evaluated to inform recommendations at the study intersections.

Future Growth and Development

To support the analysis of future traffic conditions, land use and zoning data were used in conjunction with historical and projected traffic volumes to determine the potential for growth along the Northshore Drive corridor over a 10-year horizon. The future growth and development projections included two components:

- **Background Growth** - As a parallel route to Interstate 40/75, Northshore Drive serves both local and regional traffic movements. As such, it can be expected that continued growth outside the immediate vicinity of the corridor will impact the operations of study intersections. TDOT's historical traffic counts were used to calculate the average percent growth observed in the Annual Average Daily Traffic (AADT) along the corridor. For comparison, projected annual growth rates were also established using data from the TPO's regional travel demand model, specifically the 2018 base year and 2045 future year model runs. Ultimately, the projected growth rates from the travel demand model were used to

establish annual increases in traffic along the Northshore Drive corridor expected regardless of specific developments along the corridor.

- **Planned Development** – Along the corridor, there are various parcels that have already been approved for development but that are currently incomplete. Because these developments are not occupied, their trip generation is not reflected in traffic data collection. To account for the impact of these known developments, parcels having more than 70 approved residential units, parcels with more than five residential units that have direct access or frontage on the corridor, and 10+ acre parcels on the south side of Northshore Drive with at least five residential units were all included as planned developments. These criteria are based on development levels that would require a Traffic Impact Study in Knox County and/or accessibility of development to the Northshore Drive corridor. Trip generation estimates for these parcels were established using ITE's *Trip Generation*, 10th Edition with the new peak hour trips then distributed and assigned to the model network. Based on access to the Northshore Drive corridor and similar land uses, these developments were grouped into 12 zones.

The data supporting the existing and future conditions analyses, as described above, is included in the Appendices. Specifically, the Appendices include existing turning movement counts, background growth assumptions, a map of planned developments, trip generation estimates for planned developments, trip distributions and assignments for future growth, and reports generated by the operation analysis.

2.2 Analysis Summary

The various data sources and analysis methods described above informed the existing and future conditions analysis for the 10 study intersections, which is summarized in two sections related to safety and congestion.

Safety Analysis

Across the eight study locations, there were 458 crashes over the 5-year period spanning 2015-2019. Figure 2-1 illustrates the density of these crashes along the corridor and in the study locations. As shown, the density of crashes is typically highest near intersections along the corridor. Crash density alone does not account for the exposure of vehicles to crash events. Oftentimes, the crash rate is considered a better representation of safety issues. As such, the segment crash rates along Northshore Drive were calculated using daily traffic estimates from TDOT and are expressed as the rate of crashes per million 100 million vehicle miles traveled. Specifically, the crash rates are shown in relation to the applicable statewide averages for urban state routes (based on laneage) and are classified as follows:

- **Below Average:** Locations with crash rates below the statewide average
- **Average:** Locations with crash rates at or within 15% above the statewide average
- **Above Average:** Locations with crash rates between 15% and 100% above the statewide average
- **Significantly Above Average:** Locations with crash rates greater than or equal to 100% higher than the statewide average

As shown in Figure 2-2, once traffic volumes on the roadway are factored in, many of the more rural portions of the corridor are highlighted as having safety issues. In fact, nearly all of Northshore Drive has a segment crash rate higher than the average when compared to similar facilities across the state. Approximately 60%, or 273, of the total corridor crashes occurred within 250 feet of a study intersection.

Table 2-1 highlights the safety trends at each of the 10 study intersections based on crash data ranging from 2015-2019 during the peak hours (7:00-9:00 AM and 4:00-6:00 PM) and off-peak hours. The number of crashes occurring within 250 feet of the intersection is presented first. This data is then broken down based on crash severity and type.

Of the study intersections, Northshore Drive at Wrights Ferry Road/Morrell Road, Ebenezer Road, and Lyons View Pike/Westland Drive had the most crashes during this time period with 42, 52, and 63 crashes, respectively. All other intersections had less than 25 crashes in the same time period. This same observation also applies when examining the intersection crash rate, calculated as the number of accidents per million entering vehicles (MEV). Based on existing traffic volumes collected, these three intersections also have the highest crash rate when accounting for volume. Across all locations, there were no fatalities and only three crashes resulted in a serious injury; all others were classified as potential minor injuries or crashes that resulted in property damage. Approximately 47% of crashes were rear-end crashes and 30% were angle crashes. There were no vehicular crashes with bicycles or pedestrians during the analysis period.

Figure 2-1. Density of Crashes along Northshore Drive (2015-2019)

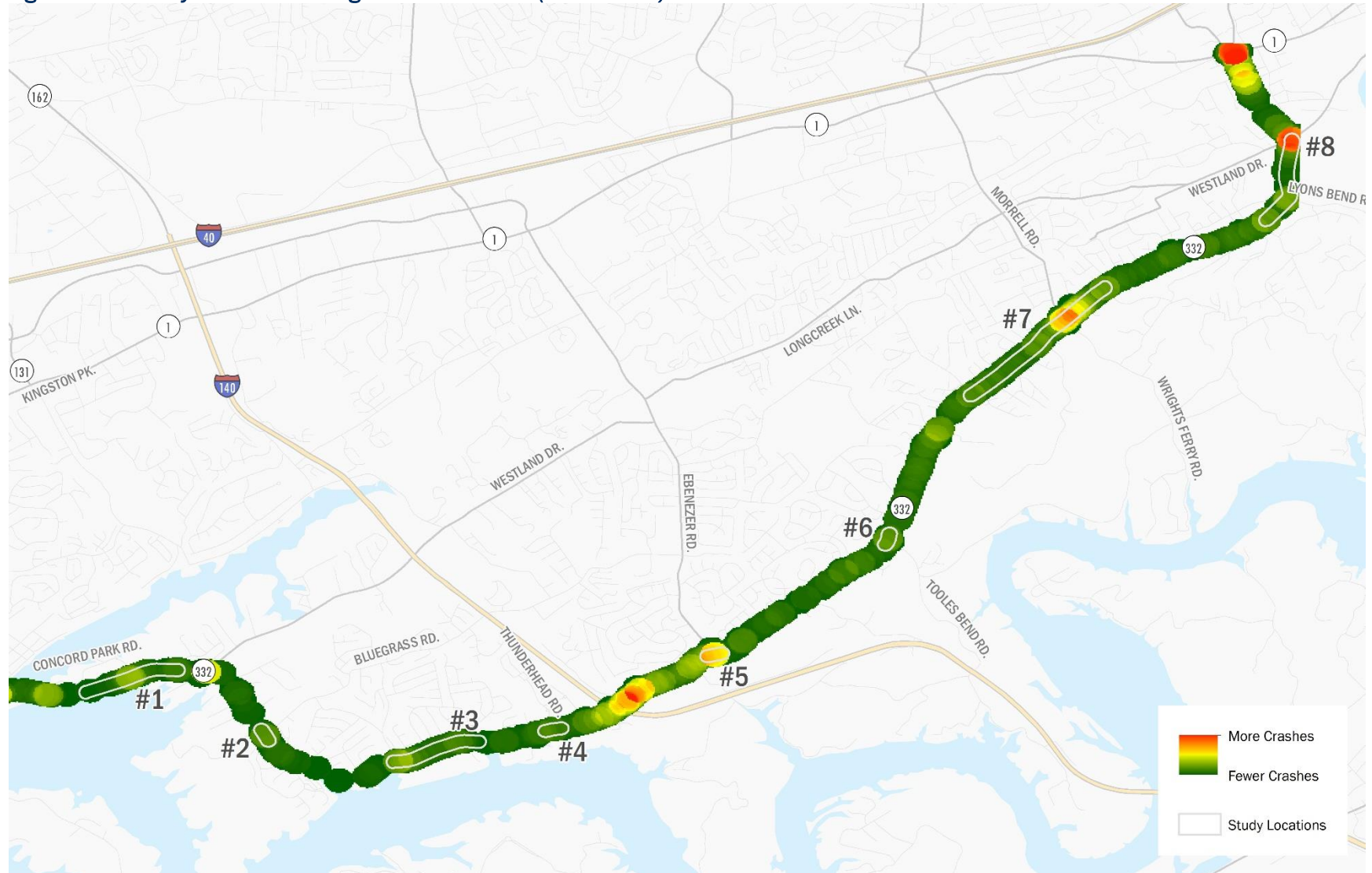


Figure 2-2. Segment Crash Rates along Northshore Drive (2015-2019)



Table 2-1. Summary of Historic Safety Analysis by Study Intersection (2015-2019)

Study Location	Study Intersection	Crash Rate	Time	Total Crashes	Crash Severity			Crash Type			
					Fatal	Serious Injury	Other	Rear End	Angle	Bike/Ped	Other
1	Northshore Dr and Concord Park Rd	0.67	Peak	4	0	0	4	2	1	0	1
			Off-Peak	18	0	1	17	12	5	0	1
2	Northshore Dr and Chandler Rd/Bluegrass Rd	0.74	Peak	2	0	0	2	1	1	0	0
			Off-Peak	13	0	0	13	8	4	0	1
3	Northshore Dr and Hart Rd	0.82	Peak	4	0	0	4	3	0	0	1
			Off-Peak	13	0	0	13	4	6	0	3
4	Northshore Dr and Thunderhead Rd	0.59	Peak	5	0	0	5	0	1	0	4
			Off-Peak	12	0	1	11	6	1	0	5
5	Northshore Dr and Ebenezer Rd	1.07	Peak	14	0	0	14	5	5	0	4
			Off-Peak	38	0	0	38	13	15	0	10
6	Northshore Dr and Tooles Bend Rd	0.58	Peak	7	0	1	6	2	2	0	3
			Off-Peak	10	0	0	10	4	2	0	4
7	Northshore Dr and Wallace Rd	0.23	Peak	2	0	0	2	0	2	0	0
			Off-Peak	5	0	0	5	2	2	0	1
	Northshore Dr and Wrights Ferry Rd/Morrell Rd	1.14	Peak	20	0	0	20	5	13	0	2
			Off-Peak	22	0	0	22	12	8	0	2
8	Northshore Dr and Lyons Bend Rd	0.73	Peak	5	0	0	5	4	1	0	0
			Off-Peak	16	0	0	16	10	2	0	4
	Northshore Dr and Lyons View Pk/Westland Dr	1.28	Peak	16	0	0	16	14	1	0	1
			Off-Peak	47	0	0	47	21	11	0	15

Congestion Analysis

To analyze congestion along the corridor, vehicular speed data was queried from the RITIS platform by direction and hour of the day. This data is illustrated in Figure 2-3 and Figure 2-4 for the eastbound and westbound directions of travel, respectively. In the AM peak, eastbound traffic speeds on Northshore Drive are mostly 35 mph or above on average. However, observed traffic speeds drop below 30 mph near the I-140 ramps, Ebenezer Road, and Lyons View Road/Westland Drive intersections. For comparison, during off-peak conditions the I-140 ramps are the only locations that show decreased vehicular speeds for eastbound traffic.

During the PM peak, average speeds for vehicles traveling westbound are significantly lower than the 40 mph posted speed limit, typically near major intersections such as Concord Road, the I-140 ramps, Morrell Road/Wrights Ferry Road, and Lyons Bend Road. In these areas, observed speeds are frequently below 25 mph during the PM peak. Similar to the eastbound traffic patterns, westbound vehicular speeds decrease near the I-140 ramps and near Lyons Bend Road even in off-peak conditions.

The corridor speed data largely points to major intersections as the source of many congestion issues on Northshore Drive. As such, more detailed capacity analysis was conducted for the 10 study intersections under two scenarios. The first examines existing traffic conditions based on turning movement counts conducted in April 2021. The second examines a future year scenario where approved developments are fully occupied. For both unsignalized and signalized intersections seconds of vehicular delay and LOS are presented for the overall intersection according to the descriptions outlined in Table 2-2.

Table 2-2. Descriptions of LOS

LOS	Description	Unsignalized Control Delay (sec/veh)	Signalized Control Delay (sec/veh)
A	Little or no delay	≤ 10.0	≤ 10.0
B	Short traffic delay	>10 and ≤ 15	>10 and ≤ 20
C	Average traffic delay	>15 and ≤ 25	>20 and ≤ 35
D	Long traffic delay	>25 and ≤ 35	>35 and ≤ 55
E	Very long traffic delay	>35 and ≤ 50	>55 and ≤ 80
F	Extreme traffic delay	> 50.0	> 80.0

Source: *Highway Capacity Manual*, 6th Edition

Table 2-3 summarizes the results of the existing and future traffic analyses for both the AM and PM peak hours as well as the overall volume increase projected for the intersection over this assumed 10-year horizon. Under existing conditions, two intersections operate at unacceptable LOS for urban areas (E or F) during one of the peak hours, both of which are signalized intersections. The unsignalized intersections all operate at acceptable LOS overall. However, the stop-controlled minor street approaches at these locations are often not at capacity in terms of v/c ratio, but vehicles on the side streets experience significant delays when attempting to make certain movements (e.g., left turns onto Northshore Drive), which results in poor LOS for those specific approaches. This situation is only exacerbated by future growth along the corridor. As shown, the peak hour volumes for the

study intersections are expected to increase by approximately 30% during the AM and PM peak hours on average. These increases are primarily due to the trips generated by general growth expected in west Knox County, the expected land uses for future development, and the lack of alternate east-west routes south of Interstate 40/75. Similar to existing conditions, through traffic along the corridor is expected to continue causing significant delays on many of the side streets like Bluegrass Road, Toolles Bend Road, Wallace Road, and others without mitigation.

Following Table 2-3 a profile for each study location is presented with a narrative and map of the location, a summary of the safety data collected, description of the intersection laneage and control, and results of the traffic analysis. Existing and future LOS, delay, and 95th percentile queues are depicted graphically for each approach at the 10 study intersections. Additional details of the traffic analyses can be found in the Appendices.

Figure 2-3. Typical Vehicular Speeds Along Eastbound Northshore Drive

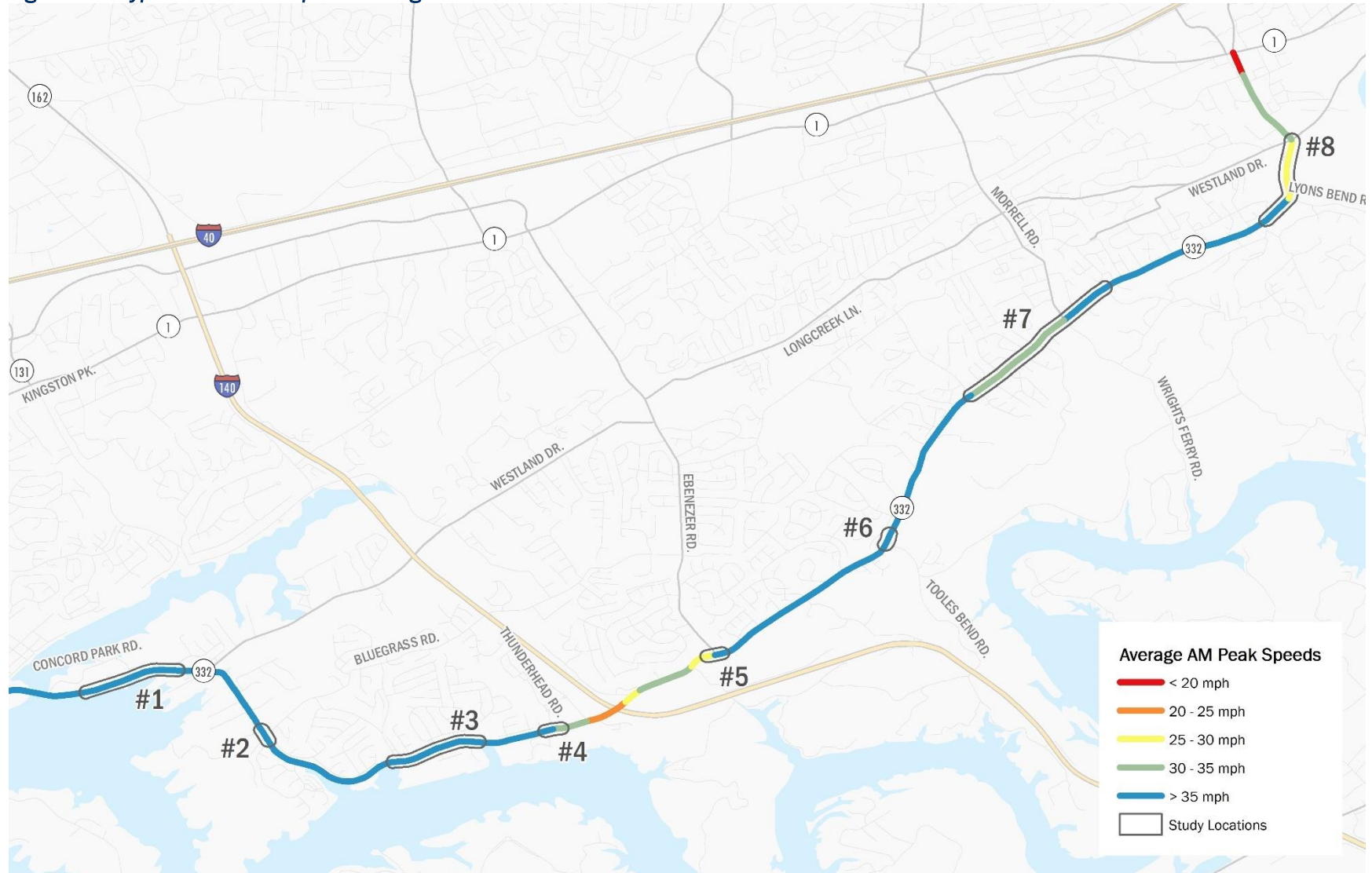


Figure 2-4. Typical Vehicular Speeds Along Westbound Northshore Drive

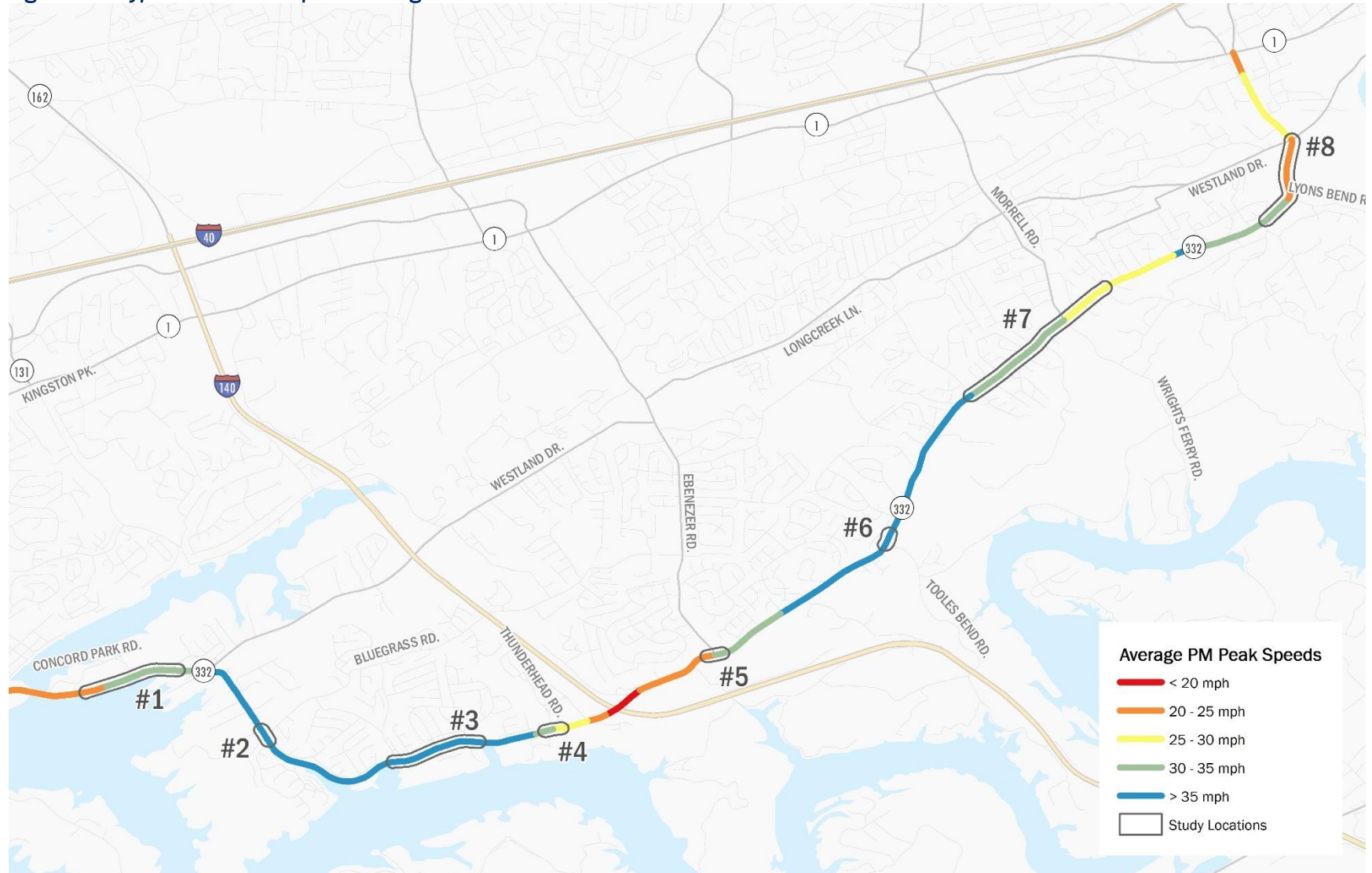


Table 2-3. Summary of Existing and Future Traffic Conditions by Study Intersection

Study Location	Study Intersection	Peak Hour	Existing Conditions		Peak Hour Volume Increase	Future Conditions	
			Delay (sec.)	LOS		Delay (sec.)	LOS
1	Northshore Dr and Concord Park Rd	AM	0.2	A	+644 (+48%)	0.2	A
		PM	2.5	A	+860 (+47%)	18.0	C
2	Northshore Dr and Chandler Rd/Bluegrass Rd	AM	1.6	A	+489 (+53%)	2.6	A
		PM	2.1	A	+634 (+56%)	4.8	A
3	Northshore Dr and Hart Rd	AM	2.9	A	+468 (+48%)	10.8	B
		PM	1.7	A	+581 (+50%)	6.2	A
4	Northshore Dr and Thunderhead Rd	AM	18.8	B	+576 (+39%)	23.2	C
		PM	16.1	B	+658 (+41%)	34.1	C
5	Northshore Dr and Ebenezer Rd	AM	61.8	E	+470 (+22%)	109.9	F
		PM	51.6	D	+595 (+22%)	106.4	F
6	Northshore Dr and Toolles Bend Rd	AM	1.2	A	+265 (+22%)	1.5	A
		PM	1.1	A	+339 (+21%)	1.6	A
7	Northshore Dr and Wallace Rd	AM	1.5	A	+271 (+22%)	1.9	A
		PM	2.0	A	+352 (+21%)	4.9	A
	Northshore Dr and Wrights Ferry Rd/Morrell Rd	AM	25.3	C	+283 (+20%)	25.6	C
		PM	31.0	C	+369 (+18%)	39.8	D
8	Northshore Dr and Lyons Bend Rd	AM	6.3	A	+232 (+15%)	11.9	B
		PM	4.5	A	+282 (+17%)	8.3	A
	Northshore Dr and Lyons View Pk/Westland Dr	AM	37.0	D	+263 (+12%)	40.9	D
		PM	61.0	E	+339 (+12%)	84.9	F

Note: Unsignalized intersections are highlighted in blue while signalized intersections are highlighted in yellow.

#1. NORTHSHORE DRIVE BETWEEN CONCORD PARK ROAD & EAGLE GLEN DRIVE

Study Location #1 extends along Northshore Drive from the Concord Park Boat Launch to Eagle Glen Drive. This portion of the corridor is a 2-lane cross section, with a single travel lane in each direction that allows for passing on some stretches. Though surrounded by recreational facilities and an off-road greenway system, no on-street pedestrian or bicycle facilities exist in this location.

Between 2015 and 2019, there were a total of 43 crashes along this portion of the corridor with one crash resulting in a serious injury and no crashes involving bicycles or pedestrians. Half of the crashes (22) were intersection-related. Rear-end crashes were the most prevalent type of crash.

There is one full-access, unsignalized intersection located approximately 250 feet west of the study intersection of Northshore Drive and Concord Park Drive that provides access to the Concord Park boat launch.



Looking south on Concord Park Road at Northshore Drive



Looking east on Northshore Drive west of Concord Park Access



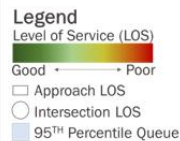
Looking west on Northshore Drive west of Concord Park Access

#1. NORTHSHORE DRIVE BETWEEN CONCORD PARK ROAD & EAGLE GLEN DRIVE

Evaluation of Study Location #1 includes operational analysis of the intersection of Concord Park Road and Northshore Drive. This intersection is unsignalized with three approaches. The southbound approach of Concord Park Road is stop controlled with an exclusive left turn lane and an exclusive right turn lane with approximately 100 feet of storage. The Northshore Drive approaches are uncontrolled with a single lane for all movements.

Under existing conditions, the overall intersection operates at LOS A during both peak hours. As expected, highest delays and thereby worst LOS is experienced by vehicles exiting Concord Park on the southbound approach. While not reflected by the analysis, queues for eastbound left turn movements can block adjacent intersection access due to the proximity of other intersections.

With projected growth, future levels of service are expected to deteriorate mostly on the southbound approach of Concord Park Road. However, the eastbound and westbound approaches of Northshore Drive are still expected to operate at LOS A.



EXISTING OPERATIONS

AM Peak Hour



PM Peak Hour



FUTURE OPERATIONS

AM Peak Hour



PM Peak Hour

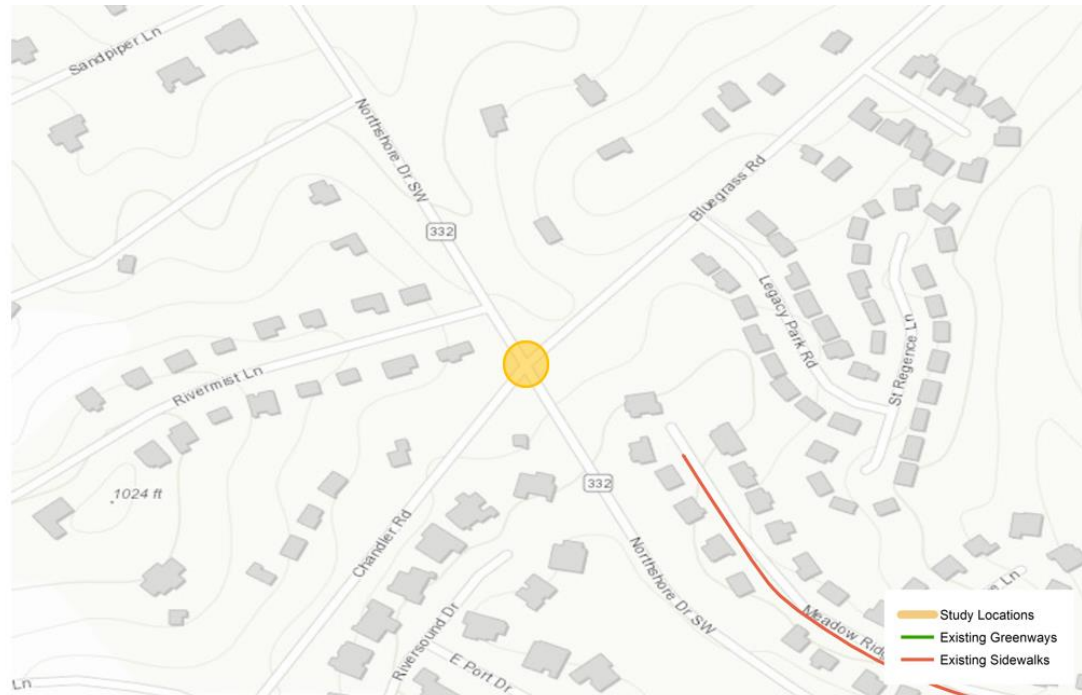


#2. NORTSHORE DRIVE AT BLUEGRASS ROAD /CHANDLER ROAD

Study Location #2 is the unsignalized intersection of Northshore Drive with Bluegrass Road/Chandler Road to the south. All of these roadway facilities include a single travel lane in each direction. There are no existing on-street pedestrian or bicycle facilities in this location.

There were 15 total crashes at this intersection from 2015-2019, over half of which were rear-end crashes. None of the crashes resulted in serious injury or involved a bicyclist or pedestrian. Intersection sight distance is limited for vehicles traveling east on Northshore Drive due to vertical curvature of the roadway. Warning signs and flashers are present to warn drivers of the potential need to stop when vehicles are detected on Bluegrass Drive.

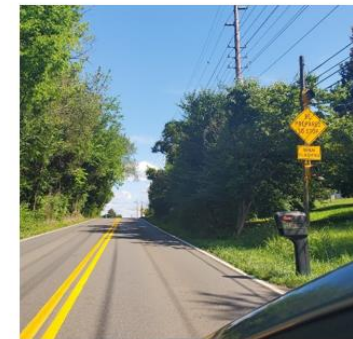
There is one full access, unsignalized intersection located approximately 170 feet west of the study intersection of Northshore Drive and Bluegrass Road/Chandler Road at Rivermist Lane.



Looking south on Bluegrass Road towards Northshore Drive



Looking west on Northshore Drive east of Bluegrass Road/Chandler Road



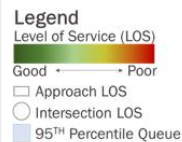
Looking east on Northshore Drive west of Bluegrass Road/Chandler Road

#2. NORTHSHORE DRIVE AT BLUEGRASS ROAD /CHANDLER ROAD

Study Location #2 includes the operational analysis of the intersection of Northshore Drive and Bluegrass Road /Chandler Road.

The unsignalized intersection has four approaches and no turn lanes. Both Bluegrass Road – the southbound approach - and Chandler Road – the northbound approach - are stop controlled with a single lane for all movements. Both eastbound and westbound Northshore Drive approaches have a single lane for all movements and are uncontrolled.

Under existing conditions, all intersection approaches operate at acceptable LOS. After accounting for planned developments, side street delays and queue lengths are expected to increase significantly causing the minor street approaches of Bluegrass and Chandler Roads to operate at LOS D or worse in at least one of the peak hours.



EXISTING OPERATIONS

AM Peak Hour



PM Peak Hour

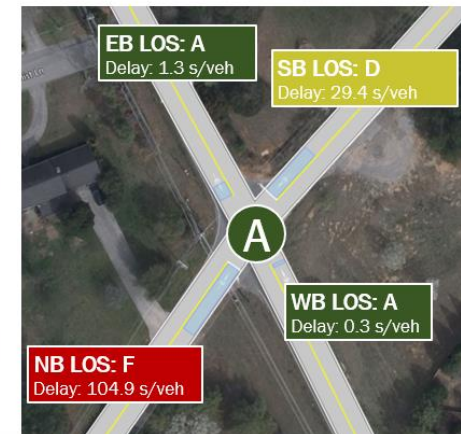


FUTURE OPERATIONS

AM Peak Hour



PM Peak Hour



#3. NORTHSHORE DRIVE BETWEEN HART ROAD & ADMIRAL FARRAGUT PARK ACCESS

Study Location #3 extends along Northshore Drive from the Hart Road to the entrance of Admiral Farragut Park. This portion of the corridor is a 2-lane cross section, with a single travel lane in each direction. In addition to primarily residential uses, this section of the corridor also contains a church and school. There are no existing on-street pedestrian or bicycle facilities in this location, though the park contains recreational facilities. However, there are no controlled crossings that would facilitate pedestrian between the residential and recreational areas on either side of Northshore Drive.

Between 2015 and 2019, there were a total of 45 crashes along this portion of Northshore Drive with 17 occurring at the Hart Road intersection. One pedestrian was involved in a crash near the entrance of Admiral Farragut Park. Rear-end crashes were the most common type of crash.

Four intersections and nine private driveways are located along this 0.6-mile segment mostly serving residential developments. There are two full access, unsignalized driveways within 250 feet of the study intersection at Hart Road.



Looking south on Hart Road towards Northshore Drive



Looking east on Northshore Drive west of Hart Road



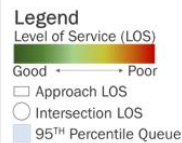
Looking west on Northshore Drive east of Hart Road

#3. NORTHSHORE DRIVE BETWEEN HART ROAD & ADMIRAL FARRAGUT PARK ACCESS

Study Location #3 includes an operational analysis of the intersection of Hart Road and Northshore Drive.

The Hart Road intersection is unsignalized with three approaches. The southbound approach along Hart Drive is stop controlled with a single lane for all movements. Though there are no exclusive turn lanes on this approach, the radius and shoulder width along the west side of Hart Road provides sufficient space for a right turning vehicle to queue simultaneously as a left turning vehicle. The eastbound and westbound Northshore Drive approaches are uncontrolled with a single lane for all movements.

Similar to other unsignalized intersections along the corridor, the minor street approach of Hart Road currently operates at an acceptable LOS during both peak hours but future growth in traffic volumes along Northshore Drive are expected to increase delays for vehicles on Hart Road.



EXISTING OPERATIONS

AM Peak Hour



PM Peak Hour



FUTURE OPERATIONS

AM Peak Hour



PM Peak Hour

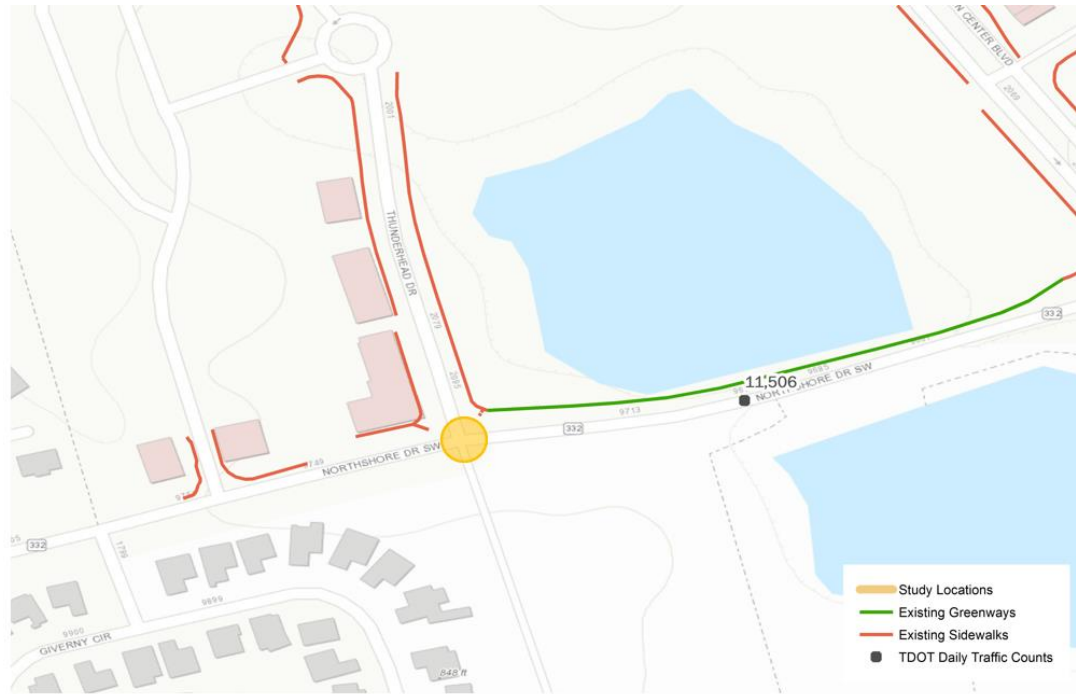


#4. NORTHSHORE DRIVE AT THUNDERHEAD ROAD

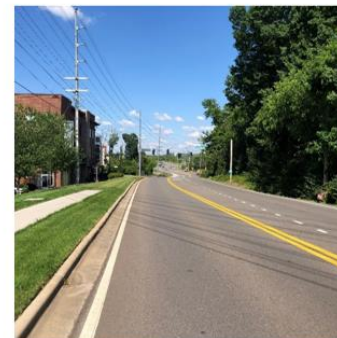
Study Location #4 is the signalized intersection of Northshore Drive with Thunderhead Road, which serves as a primary access to the Northshore Town Center development. West of this intersection, Northshore Drive is the typical 2-lane cross section, but east of this intersection the corridor expands to a 4-lane cross section with turn lanes at intersections. Sidewalks exist on both sides of Thunderhead Road with a crosswalk on the southbound approach of the intersection. In addition, a shared use path is located on the north side of Northshore Drive, connecting the two sides of the Town Center development.

Between 2015 and 2019, 13 total crashes occurred at this intersection with one crash resulting in a serious injury. There were no crashes involving bicycles or pedestrians. Nearly half of the crashes occurred in nighttime hours. The most prevalent crash type was rear-end crashes.

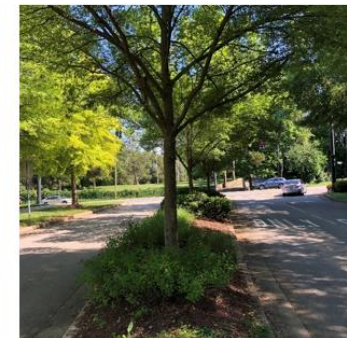
Two driveways are located near the study intersection – one private driveway approximately 325 feet to the east and another right-in-right-out driveway located approximately 340 feet west.



Looking west on Northshore Drive east of Thunderhead Road



Looking east on Northshore Drive west of Thunderhead Road



Looking south on Thunderhead Road towards Northshore Drive

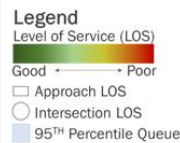
#4. NORTHSHORE DRIVE AT THUNDERHEAD ROAD

Study Location #4 includes an operational analysis of the intersection of Thunderhead Road and Northshore Drive.

The intersection is signalized with four approaches. The southbound approach of Thunderhead Road includes an exclusive left and right turn lane, both with approximately 100 feet of storage. The northbound approach is a private driveway.

The eastbound approach of Northshore Drive has a single through lane and an exclusive left turn lane with 100 feet of storage and protected-permitted left turn phasing. The westbound approach of Northshore Drive has a single through lane and an exclusive right turn lane with approximately 325 feet of storage.

Under existing conditions, this intersection generally operates with acceptable LOS with the exception of the southbound approach. The AM peak hour LOS and delays for this approach are generally worse than the PM peak hour, likely due to school traffic exiting the Town Center development. Under future conditions, queues along Northshore Drive are projected to increase significantly, at times extending to adjacent intersections.



EXISTING OPERATIONS

AM Peak Hour



PM Peak Hour



FUTURE OPERATIONS

AM Peak Hour



PM Peak Hour



#5. NORTSHORE DRIVE AT EBENEZER ROAD

Study Location #5 is located at the signalized intersection of Northshore Drive with Ebenezer Road. East of this intersection, the corridor is a 2-lane cross section with turn lanes only at major intersections. West of this intersection, the corridor is a 5-lane cross section, with two travel lanes in each direction and a two-way-left-turn-lane (TWLTL) to the west. Sidewalks extend to the north on both sides of Ebenezer Road and to the east and west on the northern side of Northshore Drive. As such, the intersection includes pedestrian signals for crossing the southbound approach only.

There were 52 crashes at this intersection between 2015 and 2019. None of these crashes resulted in serious injury or involved non-motorists. Angular crashes were the most common in the past five years.

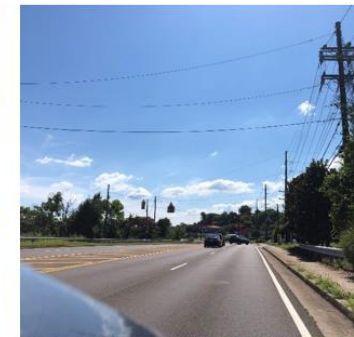
Within 500' of the intersection, there is a single driveway to a private residence and three full access, unsignalized driveways to a convenience station, located in the northwest quadrant of the intersection.



Looking south on Ebenezer Road towards Northshore Drive



Looking east on Northshore Drive west of Ebenezer Road



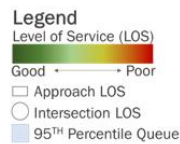
Looking west on Northshore Drive east of Ebenezer Road

#5. NORTSHORE DRIVE AT EBENEZER ROAD

Study Location #5 includes operational analysis of the signalized intersection of Ebenezer Road and Northshore Drive.

The signalized intersection contains three approaches. The southbound approach of Ebenezer Road includes both an exclusive right and left turn lane at the intersection. The eastbound approach of Northshore Drive includes two through lanes and a TWLTL that transitions to an exclusive left turn lane with 100 feet of storage. The westbound approach of Northshore Drive includes an exclusive through lane and a shared through/right turn lane. Protected-permitted left turn phasing is implemented for the eastbound approach with a concurrent right turn overlap phase for the southbound approach.

Under existing conditions, the southbound right turn volumes are significant causing the overall approach of Ebenezer Road to operate at LOS F. After accounting for future growth in the area, the overall intersection as well as the southbound approach are expected to operate at LOS F in both peak hours.



EXISTING OPERATIONS

AM Peak Hour



PM Peak Hour



FUTURE OPERATIONS

AM Peak Hour



PM Peak Hour

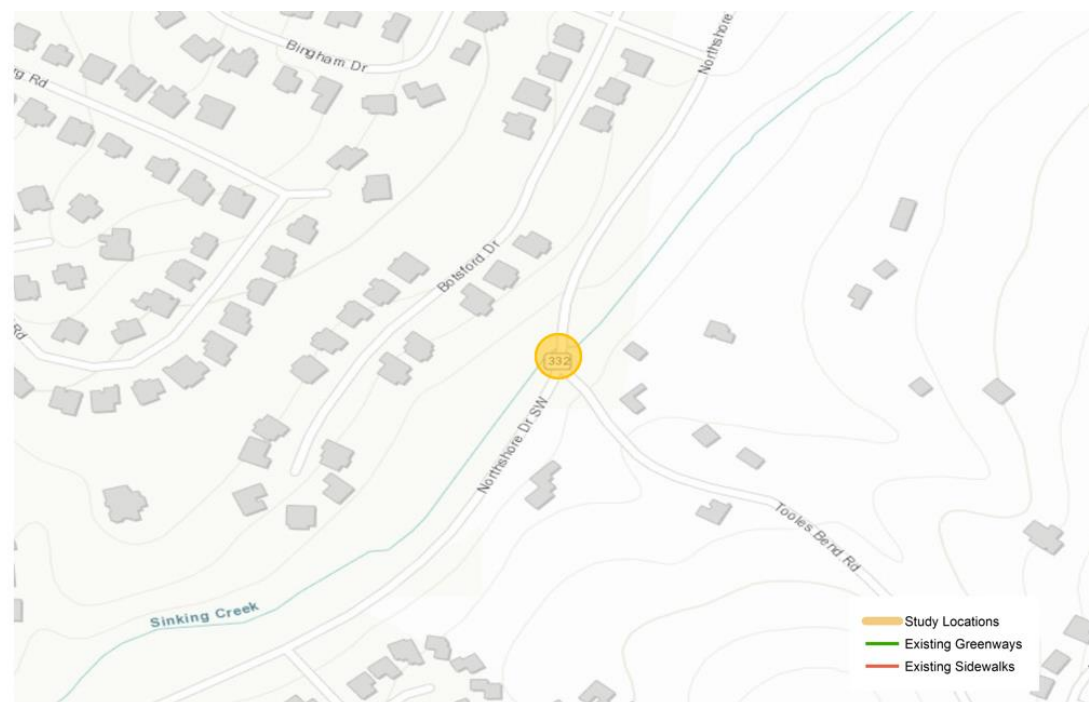


#6. NORTSHORE DRIVE AT TOOLES BEND ROAD

Study Location #6 is the unsignalized intersection of Northshore Drive with Tooles Bend Road. On both sides of the intersection, Northshore Drive is a 2-lane cross section with a single travel lane in each direction, limited shoulder, and guardrail on the northern side. There are no pedestrian or bicycle facilities located at the intersection.

Between 2015 and 2019, there were a total of 17 crashes at the intersection, one of which resulted in a serious injury. None of the crashes involved bicycles or pedestrians. Crashes as a result of a rear-end collision were the most common. The horizontal curvature of Northshore Drive and vegetation during certain seasons could impact the intersection sight distance for vehicles making a left turn from Tooles Bend Road onto Northshore Drive.

There is one full access, unsignalized driveway located approximately 430 feet west of the intersection of Northshore Drive and Tooles Bend Road that leads to the Northshore Heights Assisted Living facility. In addition, there are multiple private driveways along Tooles Bend Road south of the intersection.



Looking west on Tooles Bend Road towards Northshore Drive



Looking south on Northshore Drive north of Tooles Bend Road



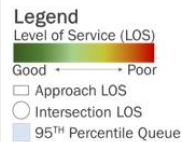
Looking north on Northshore Drive west of Tooles Bend Road

#6. NORTHSHORE DRIVE AT TOOLES BEND ROAD

Study Location #6 includes operational analysis of the intersection of Tooles Bend Road and Northshore Drive.

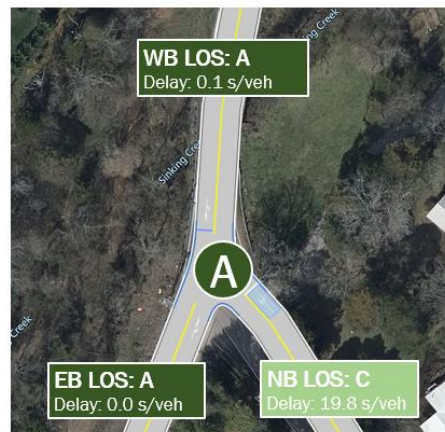
The unsignalized intersection has three approaches. The northbound approach of Tooles Bend Road is stop controlled with a single lane for all movements. Both the eastbound and westbound approaches of Northshore Drive include a single shared lane for all movements.

Under existing conditions, the intersection operates at acceptable LOS during both peak hours despite the higher delays on the northbound approach of Tooles Bend Road. Future growth in the area and specifically south on Tooles Bend Road is expected to increase both delays and queues on this approach. However, the overall intersection will continue to operate at LOS A despite the deterioration in operation for the northbound approach under future conditions.



EXISTING OPERATIONS

AM Peak Hour



PM Peak Hour



FUTURE OPERATIONS

AM Peak Hour



PM Peak Hour

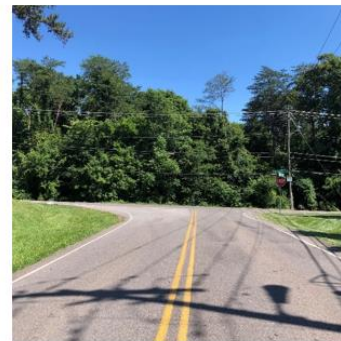


#7. NORTHSHORE DRIVE BETWEEN WALLACE ROAD & WHITOWER DRIVE

Study Location #7 extends approximately one mile along Northshore Drive from Wallace Road to Whitower Drive. The majority of this section along Northshore Drive is a 2-lane cross section with turn lanes at major intersections. There are no consistent bicycle or pedestrian facilities along this stretch of the corridor though minimal sidewalks exist near the Morrell Road intersection.

Between 2015 and 2019, there were 156 crashes along this portion of Northshore Drive, with five serious injuries. One pedestrian was injured in a crash that occurred in this area. Crash types were split nearly equally between rear-end and angle crashes. Approximately one-third of crashes occurred at a study intersection with seven at Wallace Road and 42 at Morrell Road.

There are 19 intersections within this 1-mile segment of the facility most of which provide access to residential developments. Additionally, there are 35 private driveways along this portion of the corridor. Within 500 feet of the study intersections of Wallace Road and Morrell Road, there are 18 full access, unsignalized driveways on Northshore Drive alone.



Looking south on Wallace Road towards Northshore Drive



Looking west on Northshore Drive east of Morell Road/Wrights Ferry Road



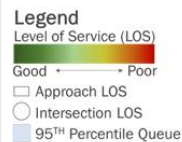
Looking east on Northshore Drive west of Morell Road/Wrights Ferry Road

#7. NORTHSHORE DRIVE BETWEEN WALLACE ROAD & WHITOWER DRIVE

Study Location #7 includes an operational analysis of the intersection of Wallace Road and Northshore Drive.

The unsignalized intersection has three approaches. The southbound approach of Wallace Road is stop controlled with a single lane for all movements. Both the eastbound and westbound approaches of Northshore Drive are uncontrolled and include a single shared lane for all movements. The vertical curvature of Northshore Drive could increase vehicle speeds along the westbound approach at the intersection.

Under existing conditions, the southbound approach of Wallace Road operates at LOS C and LOS E in the AM and PM peak hour, respectively. Future growth in traffic volumes along Northshore Drive and on Wallace Road causes these movements to deteriorate to LOS A and LOS F in the AM and PM peak hours, respectively, under future conditions. Significant increases in delay and queues are expected in the PM peak hour.



EXISTING OPERATIONS

AM Peak Hour



PM Peak Hour



FUTURE OPERATIONS

AM Peak Hour



PM Peak Hour

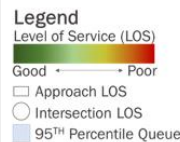


#7. NORTHSHORE DRIVE BETWEEN WALLACE ROAD & WHITOWER DRIVE

Study Location #7 includes an operational analysis of the intersection of Morrell Road/Wrights Ferry Road and Northshore Drive.

The signalized intersection contains four approaches. The southbound approach of Morrell Road includes one exclusive right turn lane with approximately 115 feet of storage and one shared through/left turn lane. The northbound approach of Wrights Ferry Road includes one exclusive right turn lane with 75 feet of storage and a shared through/left turn lane. With this lane configuration, the signal currently operates with split phasing. Both the eastbound and westbound approaches of Northshore Drive include a shared through/right turn lane and an exclusive left turn lane with 175 feet and 135 feet of storage, respectively.

Under existing and future conditions, the overall intersection operates acceptably. In both scenarios, traffic volumes on the northbound and southbound approaches of Wrights Ferry Road and Morrell Road, respectively, cause at least one minute of delay per vehicle on average.



EXISTING OPERATIONS

AM Peak Hour



PM Peak Hour



FUTURE OPERATIONS

AM Peak Hour



PM Peak Hour

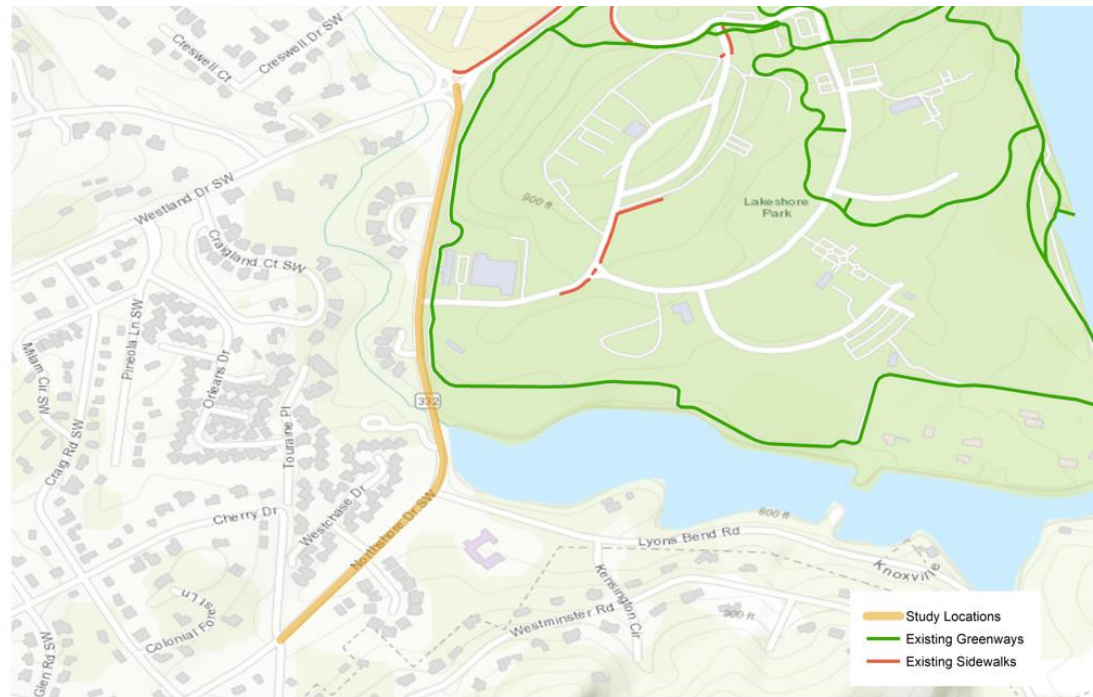


**#8. NORTHSHORE DRIVE BETWEEN
DUNCAN ROAD/CHERRY DRIVE &
WESTLAND DRIVE/LYONS VIEW PIKE**

Study Location #8 begins at the unsignalized intersection of Northshore Drive with Duncan Road/Cherry Street and extends to Westland Drive/Lyons View Pike. This portion of the corridor is a 2-lane cross section with a single travel lane in each direction and turn lanes at some intersections. The eastern portion of the study location borders Lakeshore Park, which contains a greenway that runs alongside Northshore Drive. Beyond this greenway, there are no bicycle or pedestrian facilities along this stretch of the corridor.

Between 2015 and 2019, 117 crashes occurred along this portion of the corridor. Over half of these crashes occurred at study intersections with 21 at Lyons View Road and 63 at Westland Drive. There were no serious injuries or crashes involving a bicyclist or pedestrian. Rear-end crashes were the most prevalent type of crash.

Within this 0.7-mile segment, there are eight intersections and seven driveways. In addition, there are three full access, unsignalized driveways within 500 feet of the study intersections.



Looking west on Lyons Bend Road towards Northshore Drive



Looking east on Westland Drive west of Northshore Road



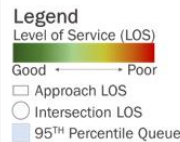
Looking south on Northshore Drive north of Westland Drive/Lyons View Pike

#8. NORTHSHORE DRIVE BETWEEN DUNCAN ROAD/CHERRY DRIVE & WESTLAND DRIVE/LYONS VIEW PIKE

Study Location #8 includes operational analysis of the intersection of Lyons Bend Road and Northshore Drive.

This unsignalized intersection has three approaches. The northbound approach of Lyons Bend Road is stop controlled with a single shared lane for all movements. Similarly, the eastbound and westbound approaches of Northshore Drive also include a single shared lane for all movements. A limited shoulder and guardrail is generally present on both sides of Northshore Drive.

Under existing conditions, the northbound approach of Lyons Bend Road operates at poor LOS in both peak hours. Conversely, as free-flowing movements, the Northshore Drive approaches operate at LOS A in both peak hours. Future growth in the area will only increase delays and queues on the minor street approach of Lyons Bend Road, but the overall intersection will continue to operate acceptably.



EXISTING OPERATIONS

AM Peak Hour

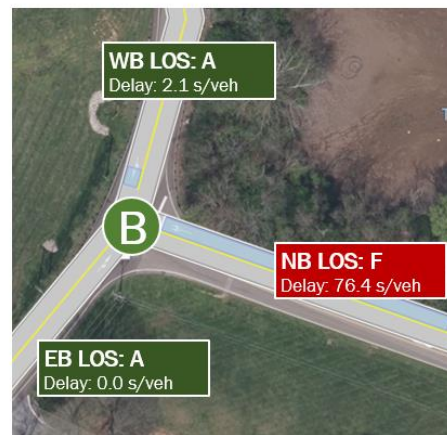


PM Peak Hour

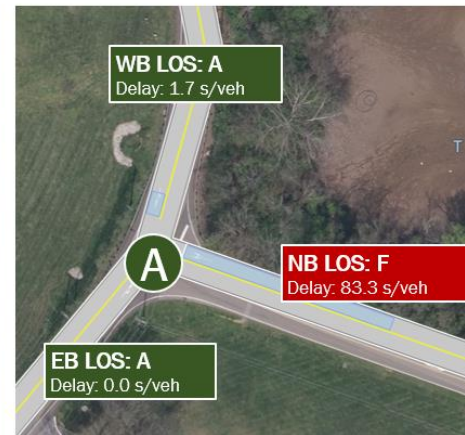


FUTURE OPERATIONS

AM Peak Hour



PM Peak Hour

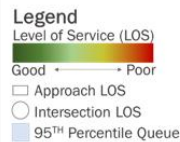


#8. NORTHSHORE DRIVE BETWEEN DUNCAN ROAD/CHERRY DRIVE & WESTLAND DRIVE/LYONS VIEW PIKE

Study Location #8 includes operational analysis of the intersection of Westland Drive/Lyons View Pike with Northshore Drive.

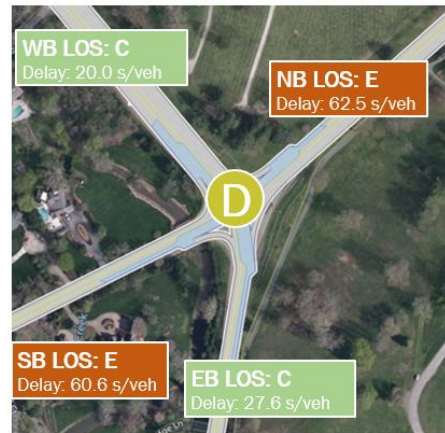
The intersection is signalized with four approaches. Each approach has an exclusive left turn lane, an exclusive through lane, and a channelized right turn lane. Left turn lanes on the southbound and northbound approaches have 100 and 60 feet of storage, respectively. Left turn lanes on the eastbound and westbound approaches have 100 and 175 feet of storage, respectively.

Under existing conditions, the southbound approach of Westland Drive and northbound approach of Lyons View Pike experience the most delay in both peak hours. The overall intersection and the northbound approach of Lyons View Pike both operate at unacceptable levels of service in the existing scenario, a trend that is expected to continue with future growth.



EXISTING OPERATIONS

AM Peak Hour



PM Peak Hour

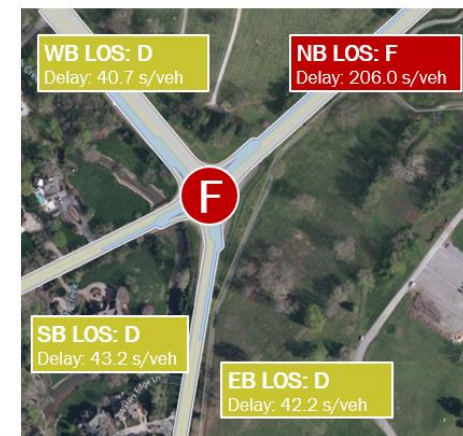


FUTURE OPERATIONS

AM Peak Hour



PM Peak Hour



2.3 Key Takeaways

The growth in traffic volumes along Northshore Drive, combined with the corridor's natural constraints, have created operational and safety issues at many of the study intersections. The key findings from the existing and future conditions analysis, listed below, informed the development of recommendations at the study locations.

- Most of the study intersections currently operate at acceptable LOS for urban areas. The primary exception is found on the corridor's many unsignalized, minor street approaches. At these locations, vehicles can experience significant delays in the peak hours which causes significant queues along these facilities.
- Historical growth in daily volumes along the corridor has primarily occurred to the west of Interstate 140, a trend that is expected to continue over the 10-year study horizon. Traffic on Northshore Drive east of Interstate 140 is expected to grow by approximately 0.4% per year while traffic west of Interstate 140 is expected to grow by approximately 1.2-1.7% per year depending on location. These increases in traffic volumes are expected even without future development in the study area.
- It was projected that, based on the availability of vacant land near the corridor as well as already approved developments, approximately 1,600 residential units could have direct impacts to the corridor. Those additional units represent a future scenario in this area of Knox County, depicting potential traffic conditions in the next 10 years. In total, those residential units are projected to generate approximately 13,000 daily trips, 950 AM peak hour trips, and 1,200 PM peak hour trips.
- Based on existing turning movement counts, trip distributions were developed to assign the new trips generated by planned development. In general, trips generated by new development are expected to travel along Northshore Drive with minimal turning movements at the study intersections. The primary exception occurs where side streets provide direct access to an area with planned developments.
- Intersections farther west are expected to see more significant volume increases from development over the 10-year horizon compared to those intersections to the east. This is mainly due to the increased density of alternate routes east of Interstate 140 and the expectation that drivers will divert from Northshore Drive as congestion increases at intersections closer to Downtown Knoxville.
- Analysis of future traffic conditions shows that left turns at both unsignalized and signalized intersections are the predominate failing movement at the study intersections. At signalized locations, this could potentially be attributed to the signal timing for left turn phases, inadequate turn lane storage, or queue blocking from increased through movement volumes. At unsignalized locations, this is likely due to increased through traffic along Northshore Drive which makes finding adequate gaps difficult for left turning vehicles on both the major and minor street approaches.

3.0 Proposed Recommendations

Based on the findings from analysis of traffic operations at 10 study intersections, recommendations were proposed to address the specific operational and safety issues. For each study intersection, this section documents the following:

- Specific deficiencies resulting from the operational analysis of existing and future traffic conditions and the analysis of safety trends;
- Discernable causes of the operational issues;
- Description of the proposed roadway and traffic improvements;
- Description of the proposed improvements to bicycle and pedestrian infrastructure stemming from the Knox County Greenway Corridor Study;
- Expected improvement in vehicular traffic operations delay resulting from proposed improvements; and
- Functional drawings of recommended improvements.

3.1 Northshore Drive and Concord Park Road

Under existing conditions, the overall intersection of Northshore Drive and Concord Park Road operates at acceptable Level of Service (LOS), defined as LOS D or better for urban areas, during both the AM and PM peak hours. However, the southbound approach of Concord Park Road currently operates at LOS E in the PM peak hour and is expected to operate at LOS F with planned growth along the corridor as shown in Figure 3-1. Because the southbound approach is stop controlled along a high-volume arterial, poor LOS is not unexpected. The available gaps in mainline traffic are not long enough to allow vehicles to exit Concord Park Road onto Northshore Drive. This is especially true for vehicles making a left-turn from the southbound approach to head east on Northshore Drive. Stakeholders also noted that vehicles, particularly those with boat trailers, making a left-turn from the eastbound approach of Northshore Drive to head north on Concord Park Road to the marina experience significant delays, which is also related to the heavy through volumes along the corridor. This occurrence contributes to increased queues on the eastbound approach given the lack of a left-turn lane on Northshore Drive at this location. In addition, the entrance to the Concord Park Boat Launch located approximately 250 feet to the west of the intersection on the southside of Northshore Drive creates an issue with overlapping left-turn movements.

Based on these findings, it is recommended to widen Northshore Drive to a three-lane cross section between the Concord Park Boat Launch and Eagle Glen Drive. This section of the corridor would include a single through lane in each direction and a two-way left-turn lane (TWLTL) as depicted in Figure 3-2. The LOS and vehicular delay for critical movements at this intersection under future conditions before and after implementation of this improvement are shown in Table 3-1. It should be noted the delay to eastbound through traffic on Northshore Drive caused by left-turning vehicles is not accounted for in Highway Capacity Manual (HCM) calculations. However, the addition of a TWLTL will remove these left-turning vehicles from the through lane and alleviate delay. In addition, a TWLTL will provide space for vehicles to queue reducing the likelihood of rear-end crashes, which were the predominant crash type at this study intersection.

As mentioned, the Concord Park Road marina access and the Concord Park Boat Launch access are closely spaced, which can cause issues with interlocking left-turn movements from Northshore Drive. With the implementation of the recommended improvements, relocation of the Concord Park Boat Launch driveway should be explored as a means of minimizing the impact of these driveways on safety and operation along the corridor. This would likely include moving the driveway approximately 150 feet west of its current location as well as restriping of the parking lot to reflect the change in traffic flow.

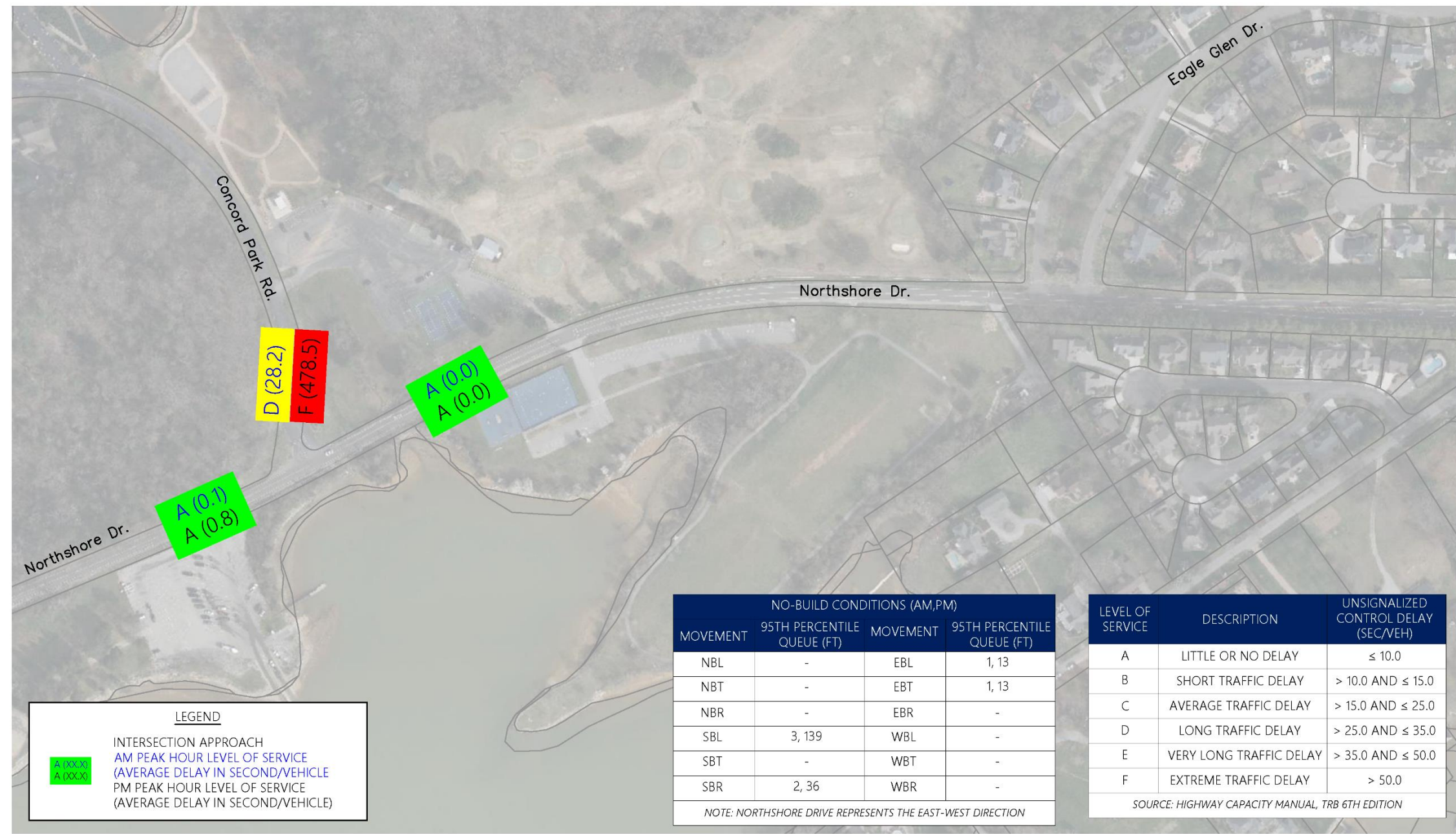
In addition to the TWLTL, it is recommended that a 10-foot greenway be constructed on the north side of Northshore Drive extending from the eastern access to Concord Park to Eagle Glenn Road consistent with the Knox County Greenway Corridor Study. Advance warning signage, restriping of the existing crosswalk, installation of a Rectangular Rapid Flashing Beacon (RRFB), and construction of a raised concrete median are also recommended at the Concord Park access.

Table 3-1. Northshore Drive and Concord Park Road LOS Comparison

Movement	No-Build Scenario		Build Scenario	
	AM	PM	AM	PM
Southbound Left-Turn	F (60.6)	F (>1000)	F (59.9)	F (741.3)
Southbound Right-Turn	C (16.1)	E (35.3)	C (16.1)	E (35.3)
Eastbound Left-Turn	A (9.9)	B (13.7)	A (9.9)	B (13.7)

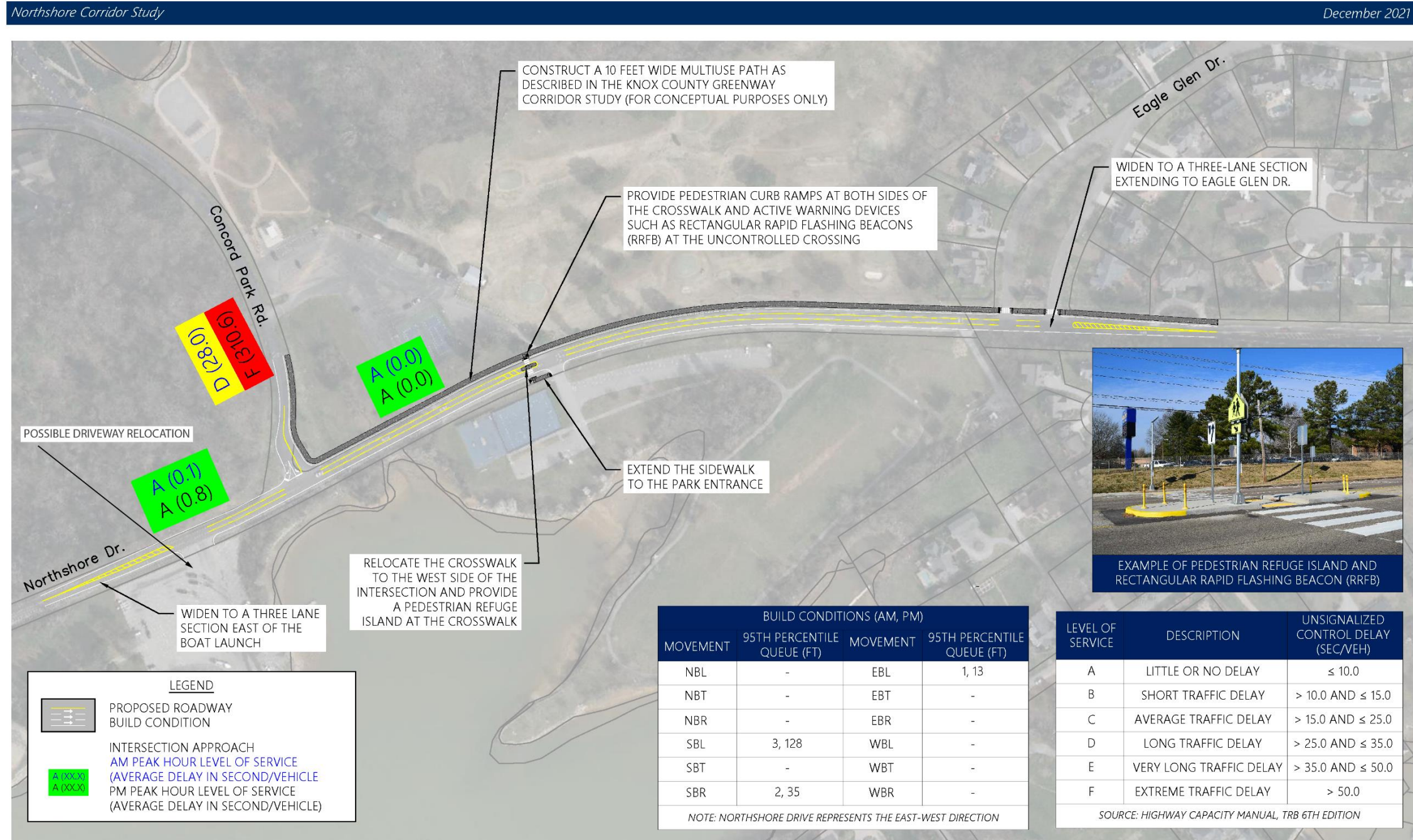
Note: LOS and delay are not shown for through and right-turn movements for free-flowing approaches due to limitations in the HCM methodology outputs.

Figure 3-1. Future No-Build Conditions at Northshore Drive and Concord Park Road



No-Build Conditions at Concord Park Road
GRAPHIC SCALE: 0' 200' 400'

Figure 3-2. Recommended Improvements at Northshore Drive and Concord Park Road



3.2 Northshore Drive and Bluegrass Road/Chandler Road

Under both existing and future conditions, the overall intersection of Northshore Drive and Bluegrass Road/Chandler Road operates at acceptable LOS. However, the northbound approach of Chandler Road experiences poor LOS under future conditions in the PM peak hour as shown in Figure 3-3. Because this approach is stop controlled along a high-volume arterial, poor LOS is not unexpected. The available gaps in traffic along Northshore Drive are not long enough to allow vehicles to enter from Chandler Road, particularly for vehicles turning left from Northbound Chandler Road to head west on Northshore Drive.

Two operational improvements were explored at this location with the primary goal of reducing delays on the minor street approaches. Specifically, the exploratory analysis included modeling this intersection as a traffic signal and roundabout. For the traffic signal analysis, it was assumed that none of the approaches would be widened thereby retaining the same laneage and including permissive left turn phasing only. Similarly, the roundabout analysis assumed a single entry lane on all approaches. The traffic signal analysis showed that, even with optimized timings, the vehicular delays on the minor street approach were still unacceptable in the PM peak hour. Specifically, both the northbound and southbound approaches of Chandler Road and Bluegrass Road, respectively, are expected to operate at LOS E during the PM peak hour under future conditions with this improvement. Reconfiguring this intersection as a single lane roundabout significantly reduced the delays on these approaches in both peak hours. However, the eastbound and westbound approaches of Northshore Drive are expected to see some increase in delay and queue lengths as a result though each approach movement is still expected to operate acceptably under future conditions.

Based on the improvement to minor street operations during peak periods, the desire to minimize impacts to off-peak traffic on Northshore Drive, and safety benefits, it is recommended to install a single lane roundabout at this intersection. As documented in the existing conditions, there are sight distance issues due to vertical grade at this location that will need to be addressed with the implementation of this recommendation. According to [NCHRP Report 672](#), approach roadways with grades steeper than $\pm 4\%$, make it more difficult for entering drivers to slow or stop on the approach. At roundabouts on crest vertical curves with steep approaches, a driver's sight lines may also be compromised, and the roundabout may violate driver expectancy. As such, the vertical profile of Northshore Drive should be addressed and additional advanced warning signage should be implemented with this recommendation. The LOS and vehicular delay for critical movements at this intersection under future conditions are shown in Table 3-2. As shown, all approaches are expected to operate at acceptable LOS with minimal delays under future conditions with implementation of this improvement as shown in Figure 3-4.

With the roundabout recommendation, it is recommended that a 10-foot greenway path be constructed on the south side of Northshore Drive west of the intersection and on the north side of Northshore Drive east of the intersection, consistent with the Knox County Greenway Corridor Study. Advance warning signage and crosswalks are recommended on all approaches.

Table 3-2. Northshore Drive and Bluegrass Road/Chandler Road LOS Comparison

Movement	No-Build Scenario		Build Scenario	
	AM	PM	AM	PM
Northbound Left-Turn	E (47.8)	F (148.7)	A (6.6)	A (8.6)
Northbound Through	E (37.2)	F (115.7)	A (6.6)	A (8.6)
Northbound Right-Turn	C (20.6)	F (65.0)	A (6.6)	A (8.6)
Southbound Left-Turn	E (37.6)	F (88.7)	A (7.1)	A (8.4)
Southbound Through	D (32.3)	F (74.5)	A (7.1)	A (8.4)
Southbound Right-Turn	C (15.2)	C (22.5)	A (7.1)	A (8.4)
Eastbound Left-Turn	A (8.78)	A (9.7)	A (9.0)	C (15.1)
Eastbound Through	--	--	A (9.0)	C (15.1)
Eastbound Right-Turn	--	--	A (9.0)	C (15.1)
Westbound Left-Turn	A (8.9)	A (9.5)	A (8.5)	B (13.5)
Westbound Through	--	--	A (8.5)	B (13.5)
Westbound Right-Turn	--	--	A (8.5)	B (13.5)

Note: LOS and delay are not shown for through and right-turn movements for free-flowing approaches due to limitations in the HCM methodology outputs. In addition, roundabout delays are calculated using SIDRA software while unsignalized intersection delays are calculated using Vistro software.

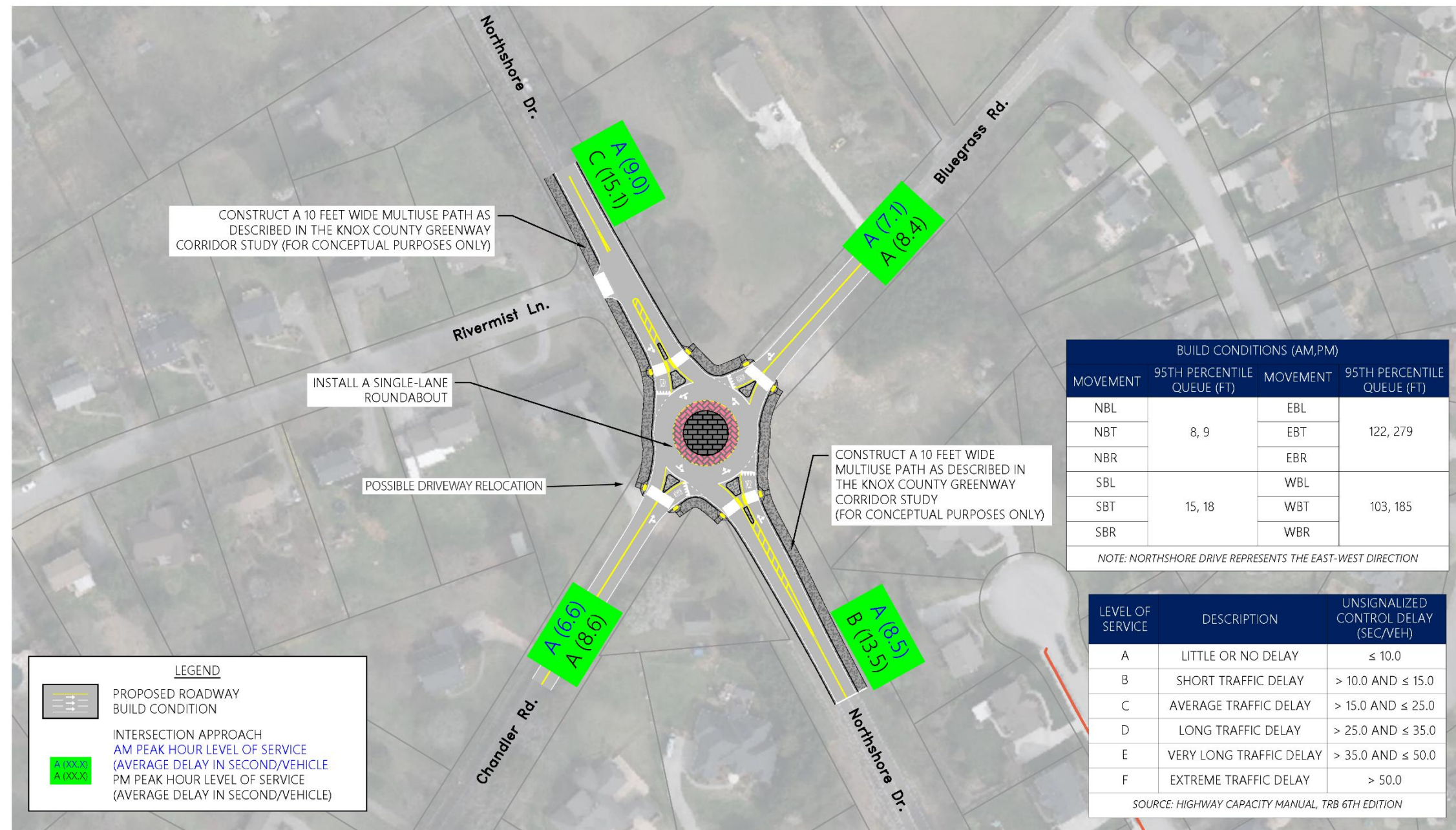
Figure 3-3. Future No-Build Conditions at Northshore Drive and Bluegrass Road/Chandler Road



No-Build Conditions at Bluegrass Road / Chandler Road

GRAPHIC SCALE: 0' 100' 200'

Figure 3-4. Recommended Improvements at Northshore Drive and Bluegrass Road/Chandler Road



Build Conditions at Bluegrass Road / Chandler Road
 GRAPHIC SCALE: 0' 100' 200'

3.3 Northshore Drive and Hart Road

Under both existing and future conditions, the overall intersection of Northshore Drive and Hart Road operates at acceptable LOS during both peak hours. However, like many of the other unsignalized intersections along the corridor, the minor street approach operates at poor LOS during both the AM and PM peak hours under future conditions as shown in Table 3-3. With a single-lane approach and significant volumes along Northshore Drive, vehicles turning left from southbound Hart Road and headed east on Northshore Drive likely have difficulty finding acceptable gaps, causing significant delays for both left- and right-turning vehicles. A review of crash data at this location showed that approximately 75% of crashes in the past five years were either rear-end or angle crashes, most of which occurred during off-peak traffic conditions. This pattern could be a result of the horizontal curvature of Northshore Drive both east and west of the intersection, which could limit sight distance for turning vehicles, and potentially be influenced by vehicle speeds during uncongested conditions.

While operational improvements to this intersection are warranted, geometric constraints caused by the Tennessee River and existing driveways prevent widening on the eastbound and southbound approaches. It should be noted that Hart Road provides access to a number of residential neighborhoods, many of which also have access to the corridor via other local streets, including Bluegrass Road. With the recommended improvements to the Bluegrass Road/Chandler Road intersection, it is anticipated that some of the traffic volumes currently accessing Northshore Drive via Hart Road will shift to Bluegrass Road based on the reduced delays at that intersection. For that reason, there are no operational improvements recommended for this intersection. However, as future development or redevelopment occurs, there may be opportunities to improve this intersection with a traffic signal or roundabout. Of note is that, consistent with the other study locations, the Knox County Greenway Corridor Study does recommend a 10-foot greenway be constructed on the north side of Northshore Drive through this intersection.

Table 3-3. Existing and Projected LOS at Northshore Drive and Hart Road

Movement	Existing Scenario		No-Build Future Scenario	
	AM	PM	AM	PM
Southbound Left-Turn	C (21.9)	C (24.8)	F (91.1)	F (106.1)
Southbound Right-Turn	C (16.4)	C (16.6)	F (78.3)	F (83.6)
Eastbound Left-Turn	A (8.0)	A (8.5)	A (8.5)	A (9.8)
Eastbound Through	--	--	--	--
Westbound Through	--	--	--	--
Westbound Right-Turn	--	--	--	--

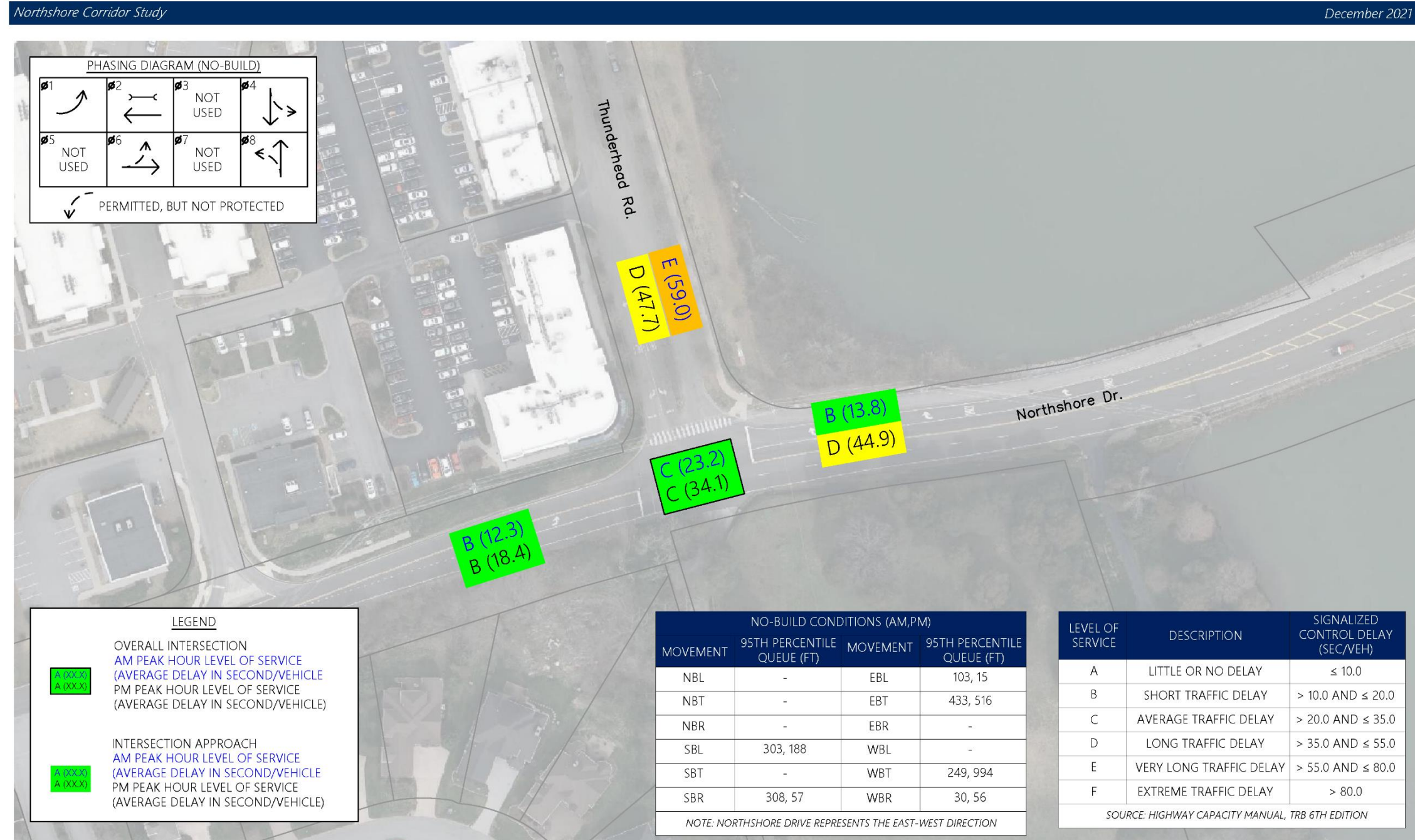
Note: LOS and delay are not shown for through and right-turn movements for free-flowing approaches due to limitations in the HCM methodology outputs.

3.4 Northshore Drive and Thunderhead Road

Under both existing and future conditions, the signalized intersection of Northshore Drive and Thunderhead Road operates at acceptable LOS during both peak hours. The southbound approach of Thunderhead Road does operate at LOS E during the AM peak, likely because of school-related traffic exiting the Town Center development. However, each intersection approach is expected to see minimal increases in delay during the AM peak hour. During the PM peak hour, the westbound approach of Northshore Drive is expected to see an increase in delay but still operate acceptably at

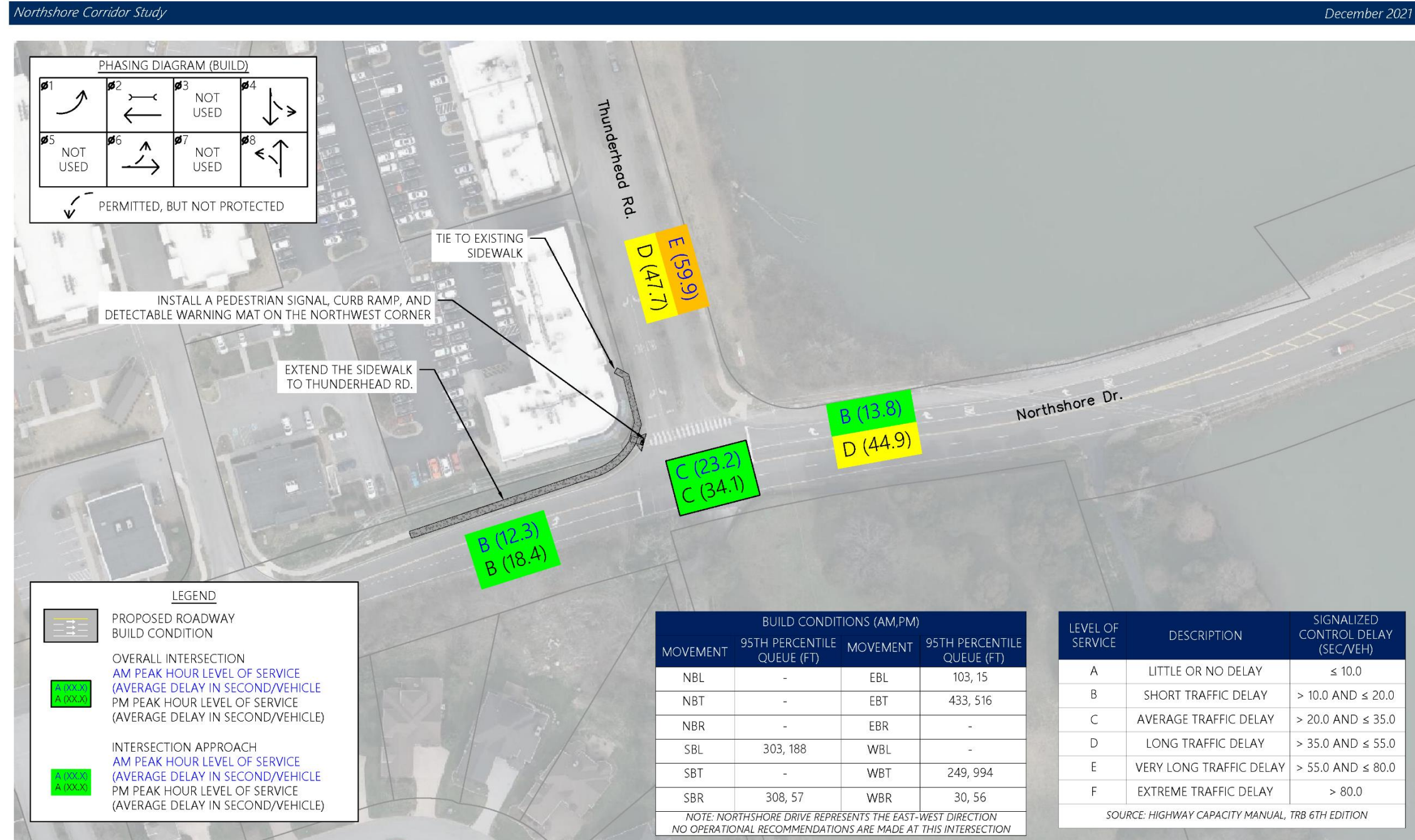
LOS D as shown in Figure 3-5. Therefore, it is recommended that the signal timings be reevaluated and adjusted as needed to reflect changes in traffic patterns due to growth and development along the Northshore Drive corridor. In addition, given the land uses surrounding this intersection and the existing multimodal infrastructure, it is recommended that the existing sidewalk on the north side of Northshore Drive, west of Thunderhead Road, be extended to the intersection with curb ramps and pedestrian signals installed on the northwest quadrant of the intersection. Constructing this connection will fill a gap in the existing sidewalk network and will support any future expansions of the infrastructure consistent with the Knox County Greenway Corridor Study recommendations. These recommended improvements are shown in Figure 3-6.

Figure 3-5. Future No-Build Conditions at Northshore Drive and Thunderhead Road



No-Build Conditions at Thunderhead Road
 GRAPHIC SCALE: 0' 80' 160'

Figure 3-6. Recommended Improvements at Northshore Drive and Thunderhead Road



3.5 Northshore Drive and Ebenezer Road

The signalized intersection of Northshore Drive and Ebenezer Road provides access to the corridor for multiple residential developments, causing it to operate poorly even under existing conditions. More specifically, the overall intersection operates at LOS E during the AM peak hour. Under future conditions, the intersection is expected to operate at LOS F in both peak hours as shown in Figure 3-7. The critical approach at this location is the southbound approach of Ebenezer Road, specifically the southbound right-turn movement where vehicles will experience delays upwards of six minutes under future peak hour conditions. The current traffic signal configuration and timing already includes a southbound right-turn overlap phase that runs concurrently with the eastbound left-turn phase. The eastbound left-turn movement also operates at LOS F in the PM peak hour under future conditions.

Two intersection configurations were analyzed to discern potential operational improvements. The first included the implementation of a [Continuous Green-T \(CGT\)](#) intersection. In this configuration, through traffic on the eastbound approach of Northshore Drive would be able to pass through the intersection without stopping. All movements on the westbound approach of Northshore Drive, the eastbound left turn movements, and southbound movements from Ebenezer Road would be controlled by a traffic signal. The southbound left-turn vehicles from Ebenezer Road would use a channelized receiving lane on the Northshore Drive to merge into the eastbound through traffic. While this configuration would not require changes to the southbound approach, the channelization would require removing a westbound through lane. Given the through movement on this approach, removal of any through capacity caused significant increases in peak hour delays. In addition, this configuration would create a complicated merge situation in the currently limited merge space on Northshore Drive. Based on these factors as well as the implications for pedestrian crossing at this type of intersection, a CGT configuration is not recommended at this location.

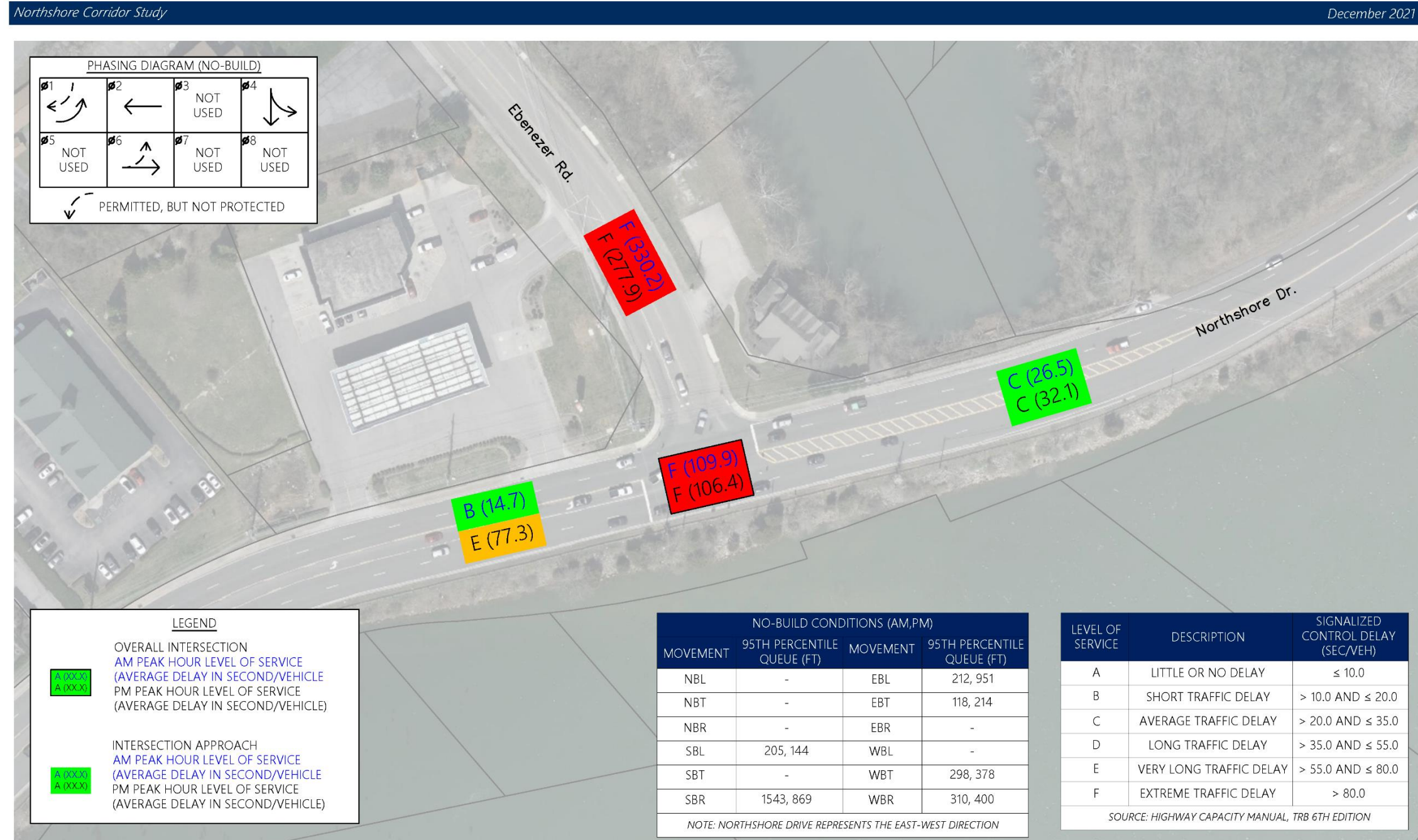
Instead, reconfiguring the Ebenezer Road leg of the intersection to increase capacity of the southbound approach and alleviate delays is recommended. There are currently two receiving lanes on Ebenezer Road even though there is no situation in which both are necessary simultaneously. Therefore, it is recommended that one of these receiving lanes be converted to an additional southbound lane. Based on operational analysis of various lane configurations, it was determined that the most efficient configuration for the southbound approach of Ebenezer Road includes a single exclusive left-turn lane and two exclusive right-turn lanes. Future traffic operations and these improvements are depicted in Figure 3-8. The traffic signal should be reconfigured and retimed to reflect these changes. There has been previous discussion on converting Ebenezer Road north of Northshore Drive to a 3-lane cross section specifically to address rear-end crash trends at neighborhood accesses. In this situation, the cross section would include a single through lane in each direction, a TWLTL, and multimodal facilities. The concept recommended in Figure 3-8 would be consistent with this recommendation.

In addition, the existing sidewalk on the north side of Northshore Drive, west of Ebenezer Road, should be expanded to a 10-foot greenway consistent with the Knox County Greenway Corridor Study. East of the intersection, a 10-foot greenway should be constructed on the south side of Northshore Drive. To facilitate the crossing of this intersection, crosswalks should be provided on the southbound and westbound approaches of Ebenezer Road and Northshore Drive, respectively. As a result, all critical movements are expected to operate at acceptable LOS during both peak hours under future conditions as shown in Table 3-4.

Table 3-4. Northshore Drive and Ebenezer Road LOS Comparison

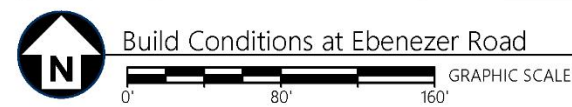
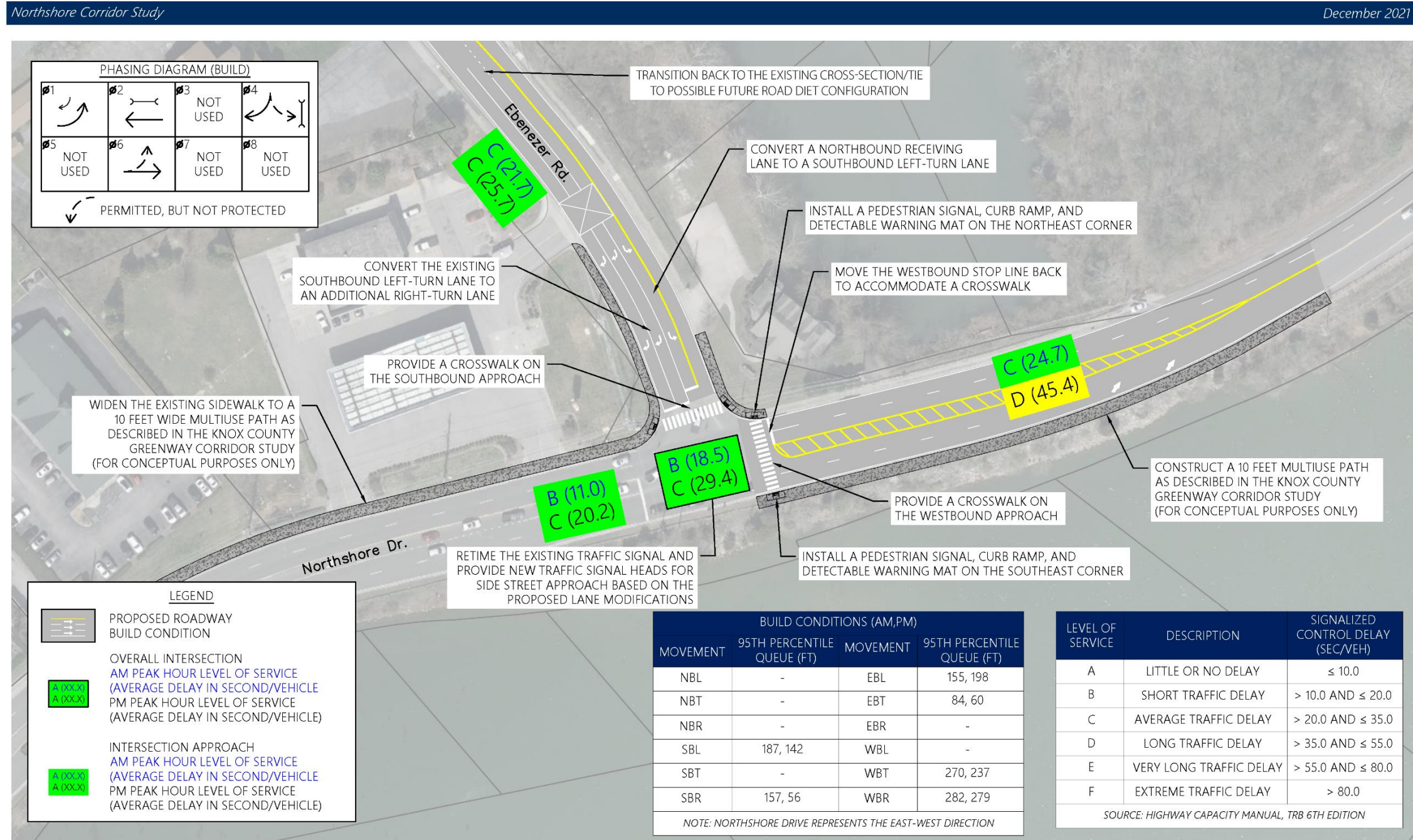
Movement	No-Build Scenario		Build Scenario	
	AM	PM	AM	PM
Overall Intersection	F (109.9)	F (106.4)	B (18.5)	C (29.2)
Southbound Left-Turn	D (38.1)	D (41.24)	C (34.7)	D (54.9)
Southbound Right-Turn	F (444.1)	F (393.2)	B (16.6)	B (11.4)
Eastbound Left-Turn	C (23.3)	F (166.1)	B (17.6)	D (42.7)
Eastbound Through	A (9.0)	B (10.8)	A (6.6)	A (6.3)
Westbound Through	C (26.2)	C (31.6)	C (24.4)	D (43.6)
Westbound Right-Turn	C (27.4)	C (33.9)	C (25.6)	D (51.5)

Figure 3-7. Future No-Build Conditions at Northshore Drive and Ebenezer Road



No-Build Conditions at Ebenezer Road
 GRAPHIC SCALE: 0' 80' 160'

Figure 3-8. Recommended Improvements at Northshore Drive and Ebenezer Road



3.6 Northshore Drive and Toolles Bend Road

The unsignalized intersection of Northshore Drive and Toolles Bend Road currently operates at acceptable LOS during both peak hours for existing and future conditions. However, the northbound approach of Toolles Bend Road operates at LOS E and LOS F during the PM peak hour under existing and future conditions, respectively. The increase in vehicular delay under future conditions is largely due to the planned development to the south as well as increased volumes expected along Northshore Drive, making it difficult for vehicles to turn onto the corridor from Toolles Bend Road. However, because the approach is stop controlled along a high-volume arterial, the poor LOS is not unexpected.

Knox County is currently working with a private development located along Toolles Bend Road regarding improvements at the intersection of Northshore Drive and Toolles Bend Road, specifically the likely installation of a traffic signal. Therefore, further mitigation of existing operational deficiencies is not recommended as part of this study. Consistent with the other study locations, the Knox County Greenway Corridor Study does recommend a 10-foot greenway be constructed on the south side of Northshore Drive through this intersection.

3.7 Northshore Drive and Wallace Road

The unsignalized intersection of Northshore Drive and Wallace Road operates at acceptable LOS during both peak hours for both existing and future conditions. However, as one of few direct north-south connections between Northshore Drive and Nubbin Ridge Road, the southbound approach of Wallace Road currently operates at LOS E in the PM peak hour, and this approach is expected to deteriorate to LOS F with future growth in the corridor as shown in Figure 3-9. Similar to other intersections along the corridor, unsignalized minor street approaches along the high-volume arterial are expected to operate poorly as available gaps in mainline traffic are not long enough to allow vehicles to enter, particularly for left-turning vehicles.

To address the delays caused by southbound vehicles on Wallace Road turning left onto Northshore Drive to head east, it is recommended that Wallace Road be widened to include an exclusive left-turn lane and an exclusive right-turn lane with 75 feet of storage on the southbound approach. Of note is that Northshore Drive currently consists of a two-lane cross section with turn lanes near the intersections of Dunwoody Boulevard and Branton Boulevard. Therefore, it is also recommended to convert Northshore Drive to a three-lane cross section with a TWLTL between Dunwoody Boulevard and Branton Boulevard. This improvement will not only improve consistency in driver expectations through this section of the corridor but will also provide storage for eastbound left-turning vehicles that are destined north on Wallace Road. In tandem with the expansion of the roadway cross section, a 10-foot greenway should be constructed on the north side of Northshore Drive west of Wallace Road and on the east side of Wallace Road. In addition, a crosswalk should be installed on the southbound approach of Wallace Road. Future traffic operations as well as the resulting recommendations are depicted in Figure 3-10.

The resulting LOS for critical movements at this intersection both before and after implementation of these improvements are shown in Table 3-5. Without stopping the through volumes on Northshore Drive, for instance through installation of a traffic signal, the southbound left-turns are still expected to operate at LOS E and LOS F in the future AM and PM peak hours, respectively. However, provisions of the eastbound left-turn lane on Northshore Drive may provide additional gaps in traffic

which results in some decrease in expected delay. In addition, provision of the exclusive left-turn lane on the southbound approach reduces the delay incurred by right-turning vehicles.

Table 3-5. Northshore Drive and Wallace Road LOS Comparison

Movement	No-Build Scenario		Build Scenario	
	AM	PM	AM	PM
Southbound Left-Turn	E (39.3)	F (140.1)	E (38.3)	F (121.6)
Southbound Right-Turn	C (18.8)	F (83.9)	B (12.4)	C (17.3)
Eastbound Left-Turn	A (8.8)	B (10.3)	A (8.8)	B (10.3)

Note: LOS and delay are not shown for through and right-turn movements for free-flowing approaches due to limitations in the HCM methodology outputs.

Figure 3-9. Future No-Build Conditions at Northshore Drive and Wallace Road

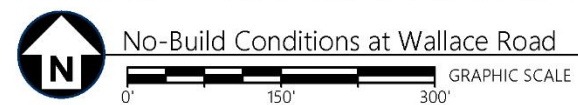
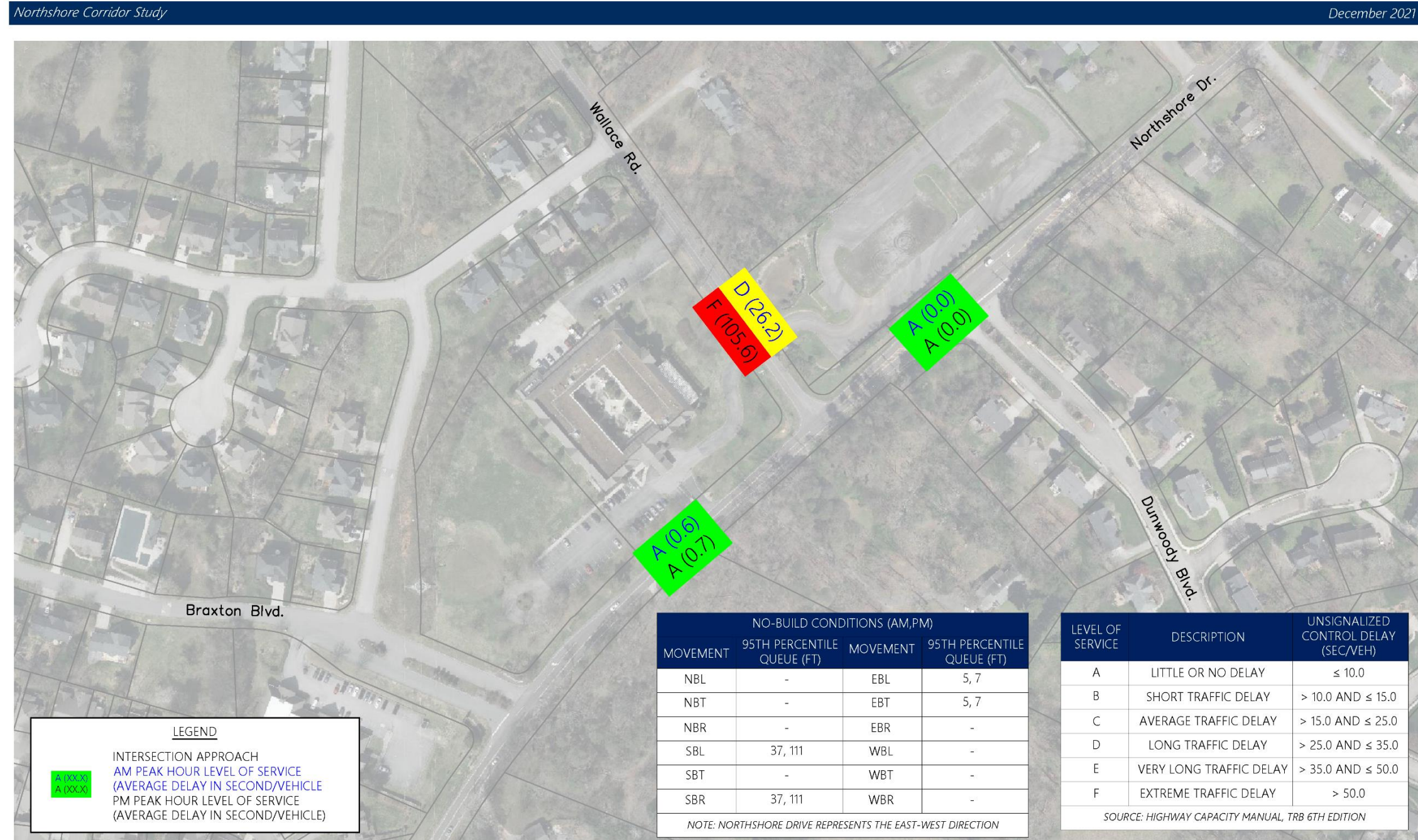
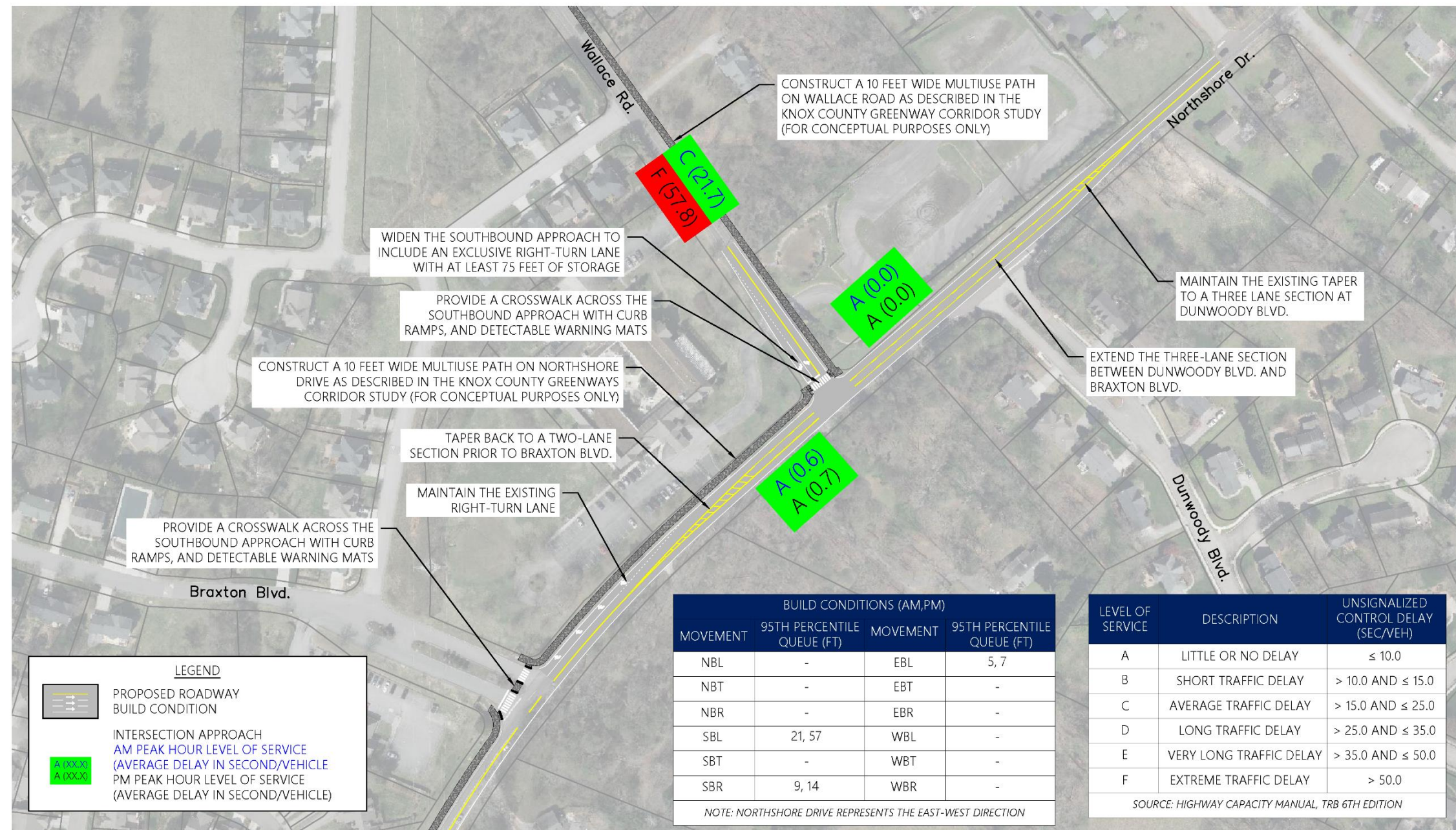


Figure 3-10. Recommended Improvements at Northshore Drive and Wallace Road



3.8 Northshore Drive and Morrell Road/Wrights Ferry Road

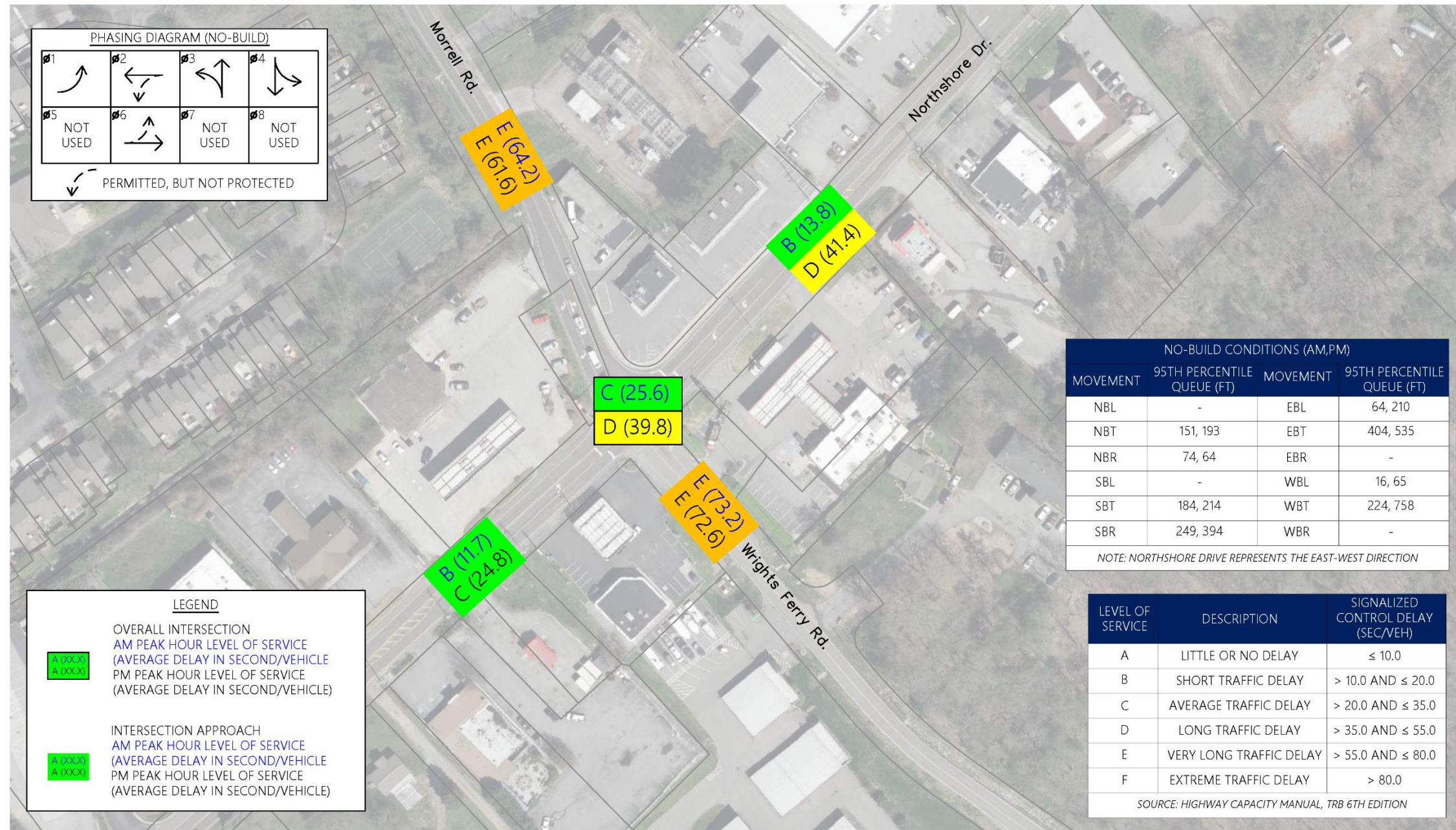
The signalized intersection of Northshore Drive and Morrell Road/Wrights Ferry Road provides access to the commercial, residential, and recreational areas in the Rocky Hill neighborhood. In addition, this intersection provides access to I-40/I-75 and the West Town Mall area. As such, this intersection sees significant traffic volumes during both peak hours. Under both existing and future conditions, the overall intersection operates at acceptable LOS during both peak hours. However, the current split phasing for the northbound and southbound approaches of Wrights Ferry Road and Morrell Road, respectively, results in poor LOS for these approaches currently and with future growth expected in the area. More specifically, these approaches both operate at LOS E in the AM and PM peak hour under existing and future conditions as shown in Figure 3-11.

The existing right-of-way (ROW) limitations, proximity of commercial businesses, and numerous driveway accesses make geometric improvements difficult at this intersection. Based on this and the existing signal phasing, it is recommended to reconfigure the northbound and southbound lane assignments to remove the split phasing from these approaches. More specifically, both the Morrell Road and Wrights Ferry Road approaches should be redesigned and restriped to include an exclusive left-turn lane and a shared through/right-turn lane. This improvement would allow the northbound and southbound left-turn movements to run concurrently and the northbound and southbound through movements to run concurrently. Under this configuration, the southbound left-turn lane would need to be extended approximately 30 feet to contain the 95th percentile queue. With this new configuration, the traffic signal should be adjusted to standard NEMA phasing with protected left-turn phasing due to sight distance issues and the splits should be retimed. In addition, the existing sidewalk on the east side of Morrell Road should be widened to a 10-foot greenway consistent with the Knox County Greenway Corridor Study. These improvements are depicted in Figure 3-12 with the improvements to each critical movement LOS detailed in Table 3-6.

Table 3-6. Northshore Drive and Morrell Road/Wrights Ferry Road LOS Comparison

Movement	No-Build Scenario		Build Scenario	
	AM	PM	AM	PM
Overall Intersection	C (25.6)	D (39.8)	B (18.1)	D (35.4)
Northbound Left-Turn	E (77.4)	E (77.2)	C (27.6)	D (52.1)
Northbound Through	E (77.4)	E (77.2)	C (28.7)	D (37.6)
Northbound Right-Turn	E (65.2)	E (60.3)	C (28.7)	D (37.6)
Southbound Left-Turn	E (57.4)	D (48.0)	C (29.6)	D (39.45)
Southbound Through	E (57.4)	D (48.0)	D (38.9)	E (56.4)
Southbound Right-Turn	E (69.3)	E (69.8)	D (38.9)	E (56.4)
Eastbound Left-Turn	A (8.2)	D (37.5)	A (7.63)	D (38.0)
Eastbound Through	B (12.4)	C (20.2)	B (13.3)	B (19.8)
Eastbound Right-Turn	B (12.4)	C (20.2)	B (13.3)	B (19.8)
Westbound Left-Turn	C (26.4)	D (49.0)	C (28.4)	D (48.5)
Westbound Through	B (13.3)	D (40.6)	B (14.6)	D (38.0)
Westbound Right-Turn	B (13.3)	D (40.6)	B (14.6)	D (38.0)

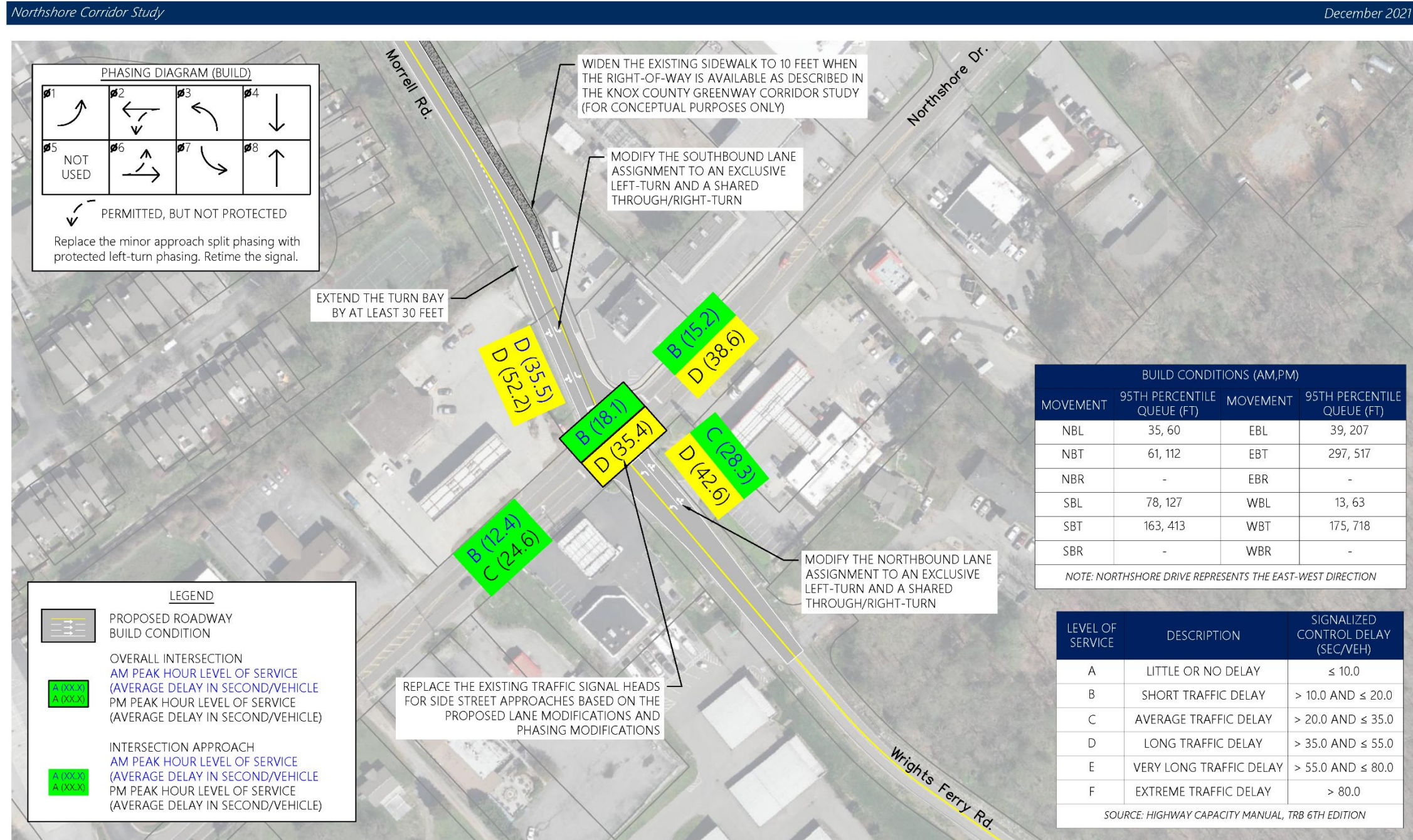
Figure 3-11. Future No-Build Conditions at Northshore Drive and Morrell Road/Wrights Ferry Road



No-Build Conditions at Morrell Road/Wrights Ferry Road



Figure 3-12. Recommended Improvements at Northshore Drive and Morrell Road/Wrights Ferry Road



Build Conditions at Morrell Road/Wrights Ferry Road

GRAPHIC SCALE: 0' 100' 200'

3.9 Northshore Drive and Lyons Bend Road

The unsignalized intersection of Northshore Drive and Lyons Bend Road currently operates at acceptable LOS in both peak hours under both existing and future conditions. However, the northbound approach of Lyons Bend Road operates at LOS E in both the AM and PM peak hour under existing conditions. With future growth, this approach is expected to deteriorate to LOS F in both peak hours as shown in Figure 3-13. Because the approach is stop controlled along a high-volume arterial, the poor LOS is not unexpected as available gaps in traffic along Northshore Drive are not long enough to allow vehicles to enter from Lyons Bend Road, particularly for left-turning vehicles.

Initially, widening of the northbound approach of Lyons Bend Road was explored as the primary solution to address the heavy right-turn volume and approach delays. This was complemented by adding a westbound left-turn lane on Northshore Drive. Under these conditions, minor street movement delays were still unacceptable during both peak hours, likely resulting from the difficulty for vehicles to find sufficient gaps in traffic when turning onto Northshore Drive from Lyons Bend Road. As such, signalization of this intersection was explored in tandem with these physical capacity improvements to reduce delay for vehicles on the minor street approach. A signal warrant analysis was prepared using the methodology provided in the *Manual for Uniform Traffic Control Devices* (MUTCD) using data developed for the future conditions analysis, and it was determined a traffic signal will be warranted at this intersection. Details of the signal warrant analysis can be found in the Appendix. To complement the signalization of this intersection, it is recommended the westbound approach of Northshore Drive include an exclusive through lane and an exclusive left-turn lane. The northbound approach of Lyons Bend Road should also be widened to include exclusive left and right-turn lanes. In addition, a 10-foot greenway should be constructed on north side of Northshore Drive from Lyons Bend Road to the Lakeshore Park access on the east side of the Fourth Creek bridge. Advanced warning signage and a crosswalk should be installed on Northshore Drive to facilitate safe crossing for cyclists and pedestrians accessing the parks existing walking trails. These improvements are depicted in Figure 3-14. It is important to note that a potential project northeast of this intersection has also been discussed, specifically constructing a westbound left turn lane on Northshore Drive at the entrance to Lakeshore Park. Although not currently funded, any future improvement to that entrance should coordinate and/or incorporate the proposed recommendations presented as part of this study as a means of minimizing costs and traffic disruptions.

Improvements to LOS for all critical movements are shown in Table 3-7. As shown, all but one movement is expected to operate at acceptable LOS during both peak hours with the proposed improvements. The one exception is the northbound left-turn on Lyons Bend Road, which is expected to operate at LOS E although with approximately half the delay when compared to the unimproved future conditions at this intersection.

Table 3-7. Northshore Drive and Lyons Bend Road LOS Comparison

Movement	No-Build Scenario		Build Scenario	
	AM	PM	AM	PM
Overall Intersection	--	--	C (25.9)	B (13.6)
Northbound Left-Turn	F (103.7)	F (133.9)	D (51.5)	E (62.2)
Northbound Right-Turn	F (75.0)	F (74.2)	D (46.7)	D (50.4)
Eastbound Through	--	--	C (30.5)	B (14.6)
Eastbound Right-Turn	--	--	C (30.5)	B (14.6)
Westbound Left-Turn	B (10.9)	B (10.4)	C (24.0)	B (10.6)
Westbound Through	--	--	A (5.0)	A (4.8)

Note: LOS and delay are not shown for through and right-turn movements for free-flowing approaches due to limitations in the HCM methodology outputs.

Figure 3-13. Future No-Build Conditions at Northshore Drive and Lyons Bend Road

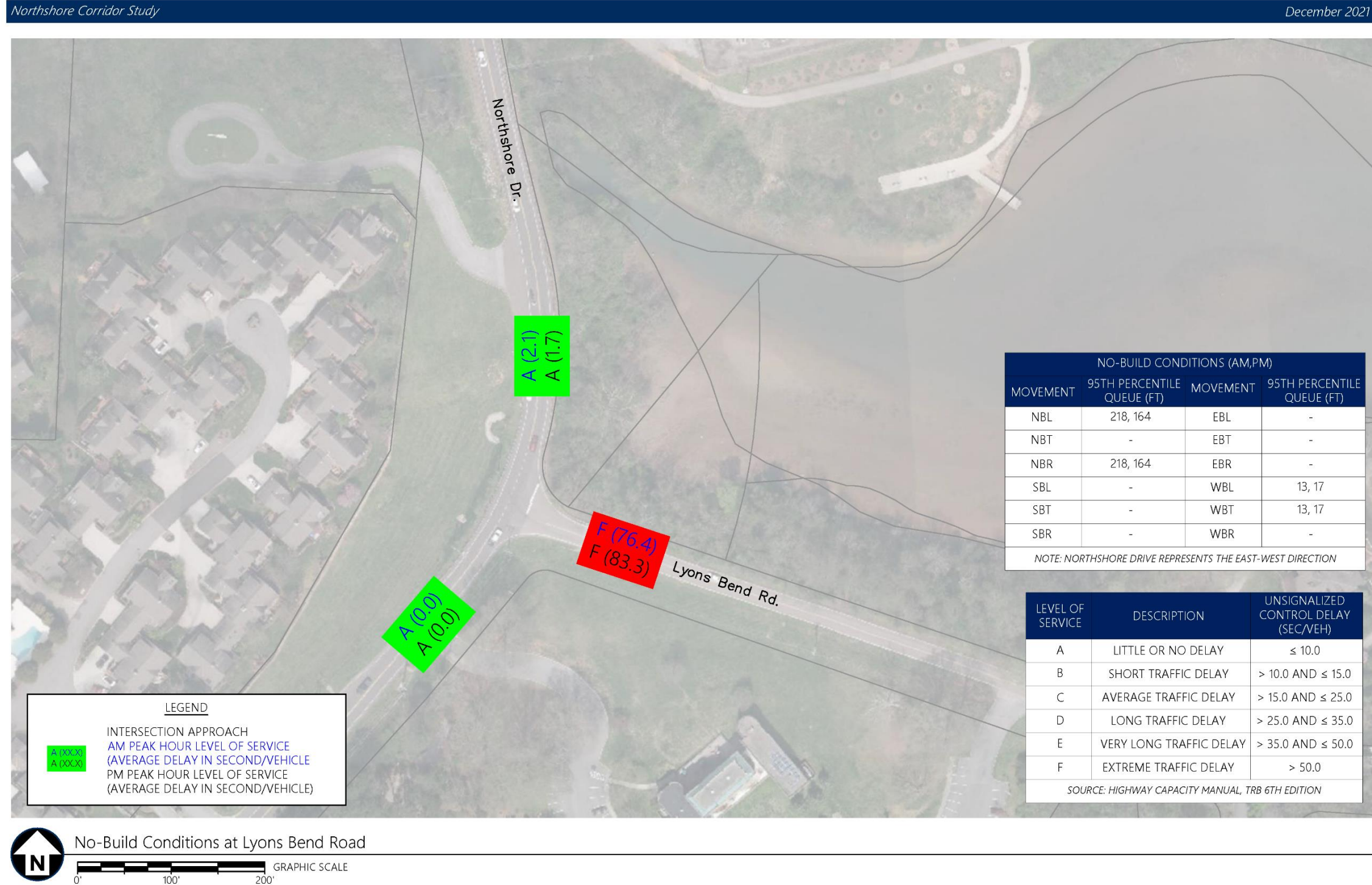
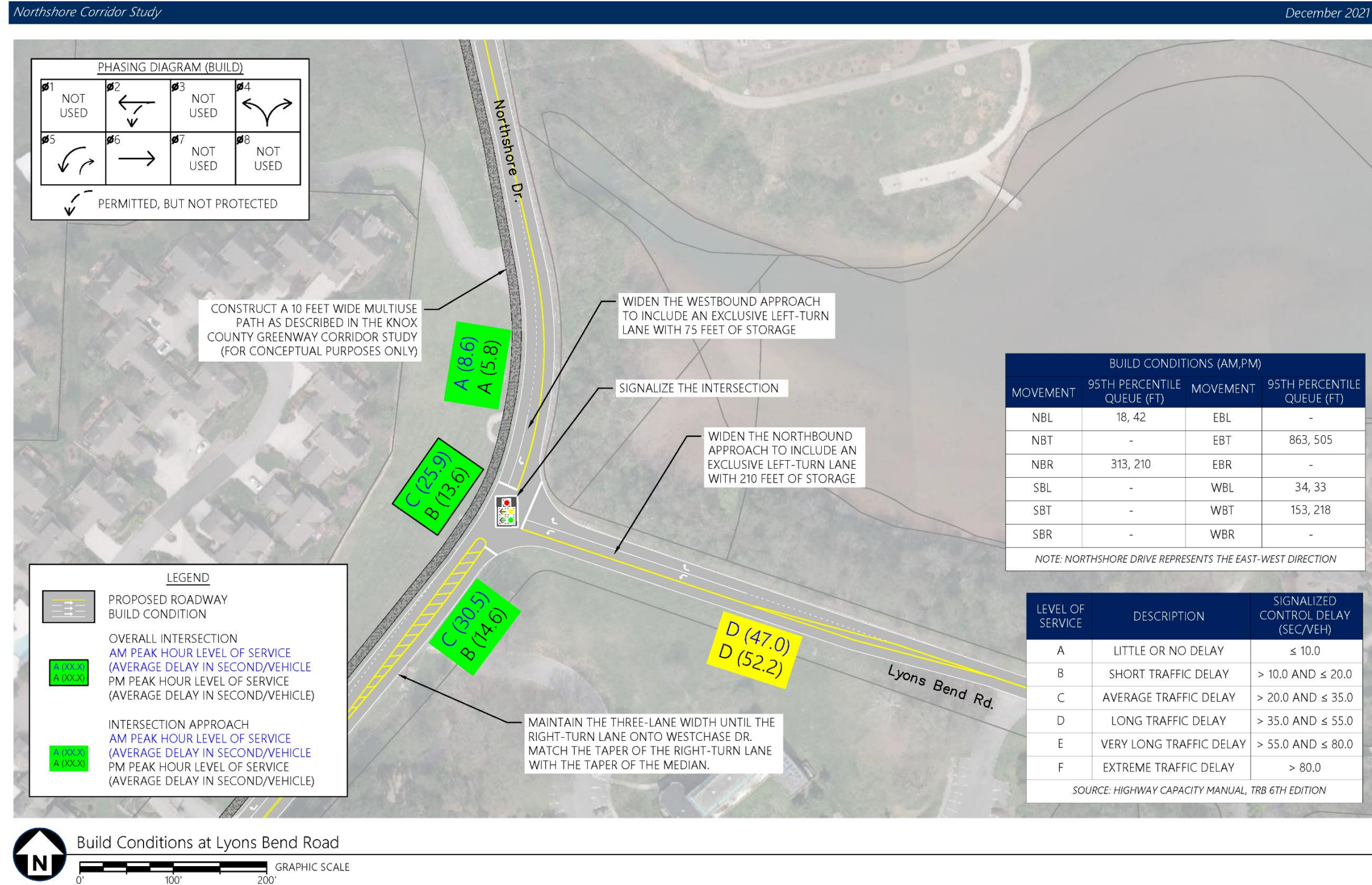


Figure 3-14. Recommended Improvements at Northshore Drive and Lyons Bend Road



3.10 Northshore Drive and Lyons View Pike/Westland Drive

The signalized intersection of Northshore Drive and Lyons View Pike/Westland Drive serves as a gateway from the commercial land uses to the north, residential land uses to the south and west, and recreational land uses to the east at Lakeshore Park. It sees considerable traffic volumes during both peak hours and, as such, currently operates at LOS D and LOS E during the AM and PM peak hours, respectively. Future growth along the corridor is expected to cause the overall intersection to deteriorate to LOS F in the PM peak hour under future conditions as shown in Figure 3-15. The northbound approach of Lyons View Pike and the southbound approach of Westland Drive utilize split signal phasing which results in poor LOS in at least one or both peak hours.

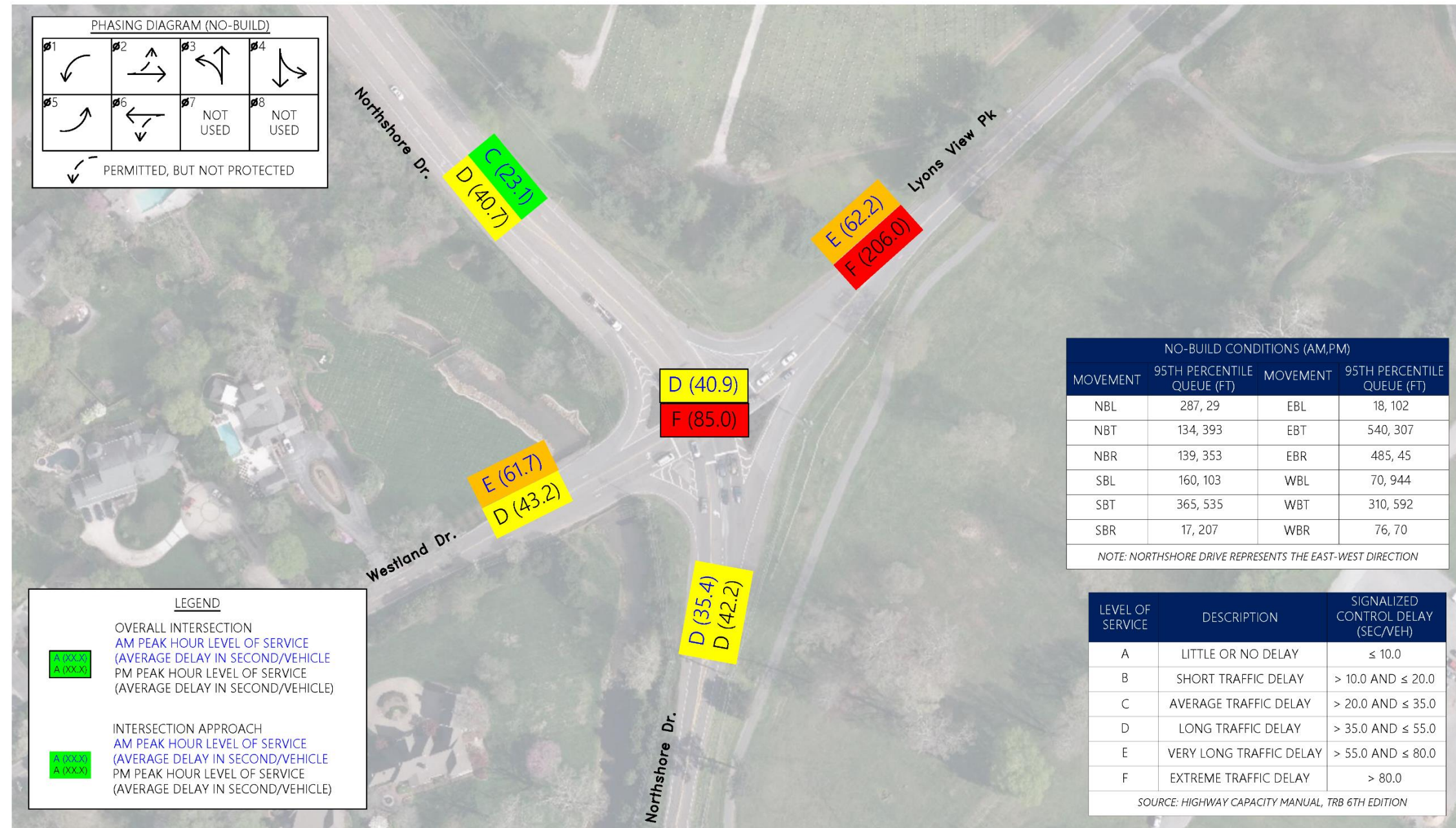
With the current build out of the approach laneage, change in land use character on various sides of the intersection, and traffic patterns, it is recommended that the existing traffic signal be removed and replaced with a two-lane roundabout. Each approach will require two approach lanes and a single receiving lane. With the exception of Northshore Drive, which already includes two lanes northbound towards Kingston Pike, all other approaches will include a single receiving lane to the east, west, and south of the intersection as currently exists. In tandem with this operational improvement, it is recommended that all approaches of the roundabout include islands, crosswalks, and warning signs to facilitate safe pedestrian access from residential areas to Lakeshore Park. These improvements are depicted in Figure 3-16 with the resulting LOS for critical movements shown in Table 3-8. It is important to note that the delay thresholds for LOS differ between signalized and unsignalized intersections in the HCM methodology. Therefore, the recommended improvements result can result in a worse LOS but improved vehicular delays as is the case with the Westbound through movement. In general, delays across most movements decrease with the recommendations.

Table 3-8. Northshore Drive and Lyons View Pike/Westland Drive LOS Comparison

Movement	No-Build Scenario		Build Scenario	
	AM	PM	AM	PM
Overall Intersection	D (40.9)	F (85.0)	B (14.0)	C (23.7)
Northbound Left-Turn	E (72.9)	F (279.5)	B (11.5)	C (16.2)
Northbound Through	D (50.4)	F (153.9)	A (10.0)	B (13.5)
Northbound Right-Turn	D (53.1)	D (37.0)	A (10.0)	B (13.5)
Southbound Left-Turn	D (46.9)	C (33.0)	A (8.2)	B (13.8)
Southbound Through	E (69.9)	D (49.1)	B (11.0)	E (36.0)
Southbound Right-Turn	D (40.7)	C (30.9)	B (11.0)	E (36.0)
Eastbound Left-Turn	B (14.7)	C (21.2)	C (20.8)	C (15.4)
Eastbound Through	D (35.4)	D (42.5)	C (20.5)	B (15.2)
Eastbound Right-Turn	D (36.7)	D (44.6)	C (19.4)	B (14.3)
Westbound Left-Turn	C (23.6)	C (22.3)	A (7.4)	E (37.2)
Westbound Through	C (24.2)	D (52.2)	A (7.2)	E (35.8)
Westbound Right-Turn	B (18.7)	C (27.6)	A (7.0)	D (34.3)

Note: LOS thresholds change when converting from a traffic signal to a roundabout. In addition, roundabout delays are calculated using SIDRA software while signalized intersection delays are calculated using Vistro software.

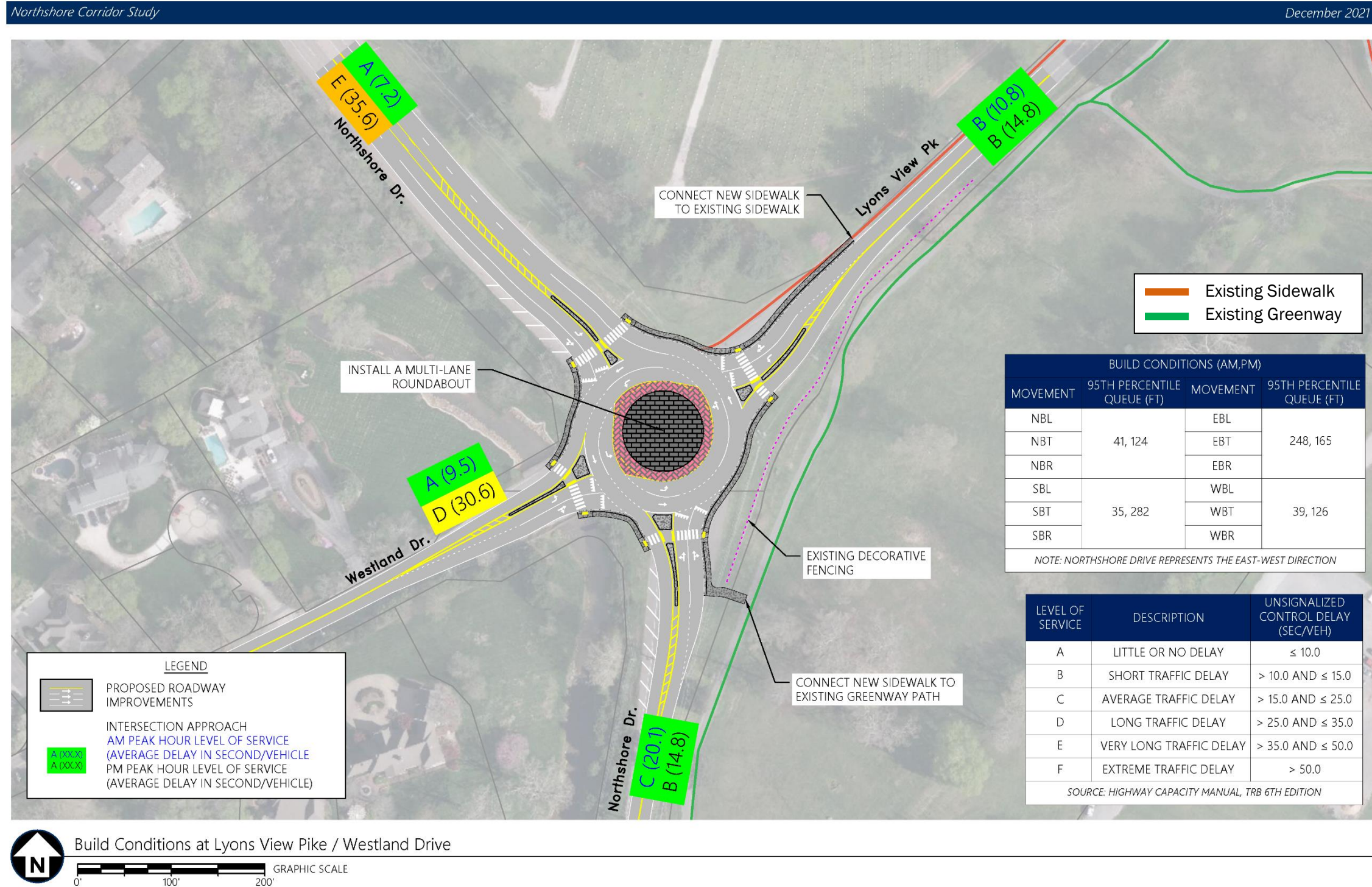
Figure 3-15. Future No-Build Conditions at Northshore Drive and Lyons View Pike/Westland Drive



No-Build Conditions at Lyons View Pike / Westland Drive

GRAPHIC SCALE: 0' 100' 200'

Figure 3-16. Recommended Improvements at Northshore Drive and Lyons View Pike/Westland Drive



4.0 Cost Estimates and Implementation Timeframes

Following the identification of recommended improvements at each of the 10 study intersections, planning level cost estimates were developed using TDOT's cost estimation tool. This spreadsheet tool utilizes regionally specific unit prices to estimate costs for the various project elements including preliminary engineering and design, ROW acquisition, utility relocation, and construction. Based on this tool, Table 4-1 shows the estimated cost for the improvements at each intersection in 2020 dollars.

The timeframe for implementing these recommended improvements is dependent on many factors, many of which relate to the need for funding. As shown, many of these improvements will necessitate acquisition of right-of-way and/or the relocation of utilities, both of which can take significant time, money, and coordination. However, future development and redevelopment along the corridor creates the opportunity for cost sharing between private developers and the public implementing agencies. Given these factors, the City of Knoxville, Knox County, and TDOT should work to prioritize and ultimately implement these recommendations with consideration for existing deficiencies, timing of future development, funding availability, and constructability.

Table 4-1. Estimated Costs and Implementation Timeframe of Recommended Improvements

Study Location	Study Intersection	Recommended Improvements	Construction Cost	ROW/Utilities Cost	PE Costs	Total Cost
1	Northshore Drive and Concord Park Road	Convert Northshore Drive to a three-lane cross section with TWLTL from the Concord Park Boat Launch to Eagle Glenn Road; construct 10-foot greenway path along Northshore Drive extending from the eastern access of Concord Park to Eagle Glenn Road including advanced warning signage and restriping of crosswalk at Concord Park	\$1,260,000	\$350,000	\$126,000	\$1,740,000
2	Northshore Drive and Chandler Road /Bluegrass Road	Convert intersection to a single-lane roundabout including pedestrian accommodations and signage on all approaches; construct a 10-foot greenway path on the south side of Northshore Drive west of the intersection and on the north side of Northshore Drive east of the intersection	\$1,345,000	\$35,000	\$134,000	\$1,510,000
3	Northshore Drive and Hart Road	None	--	--	--	--
4	Northshore Drive and Thunderhead Road	Adjust signal splits as development occurs; fill existing sidewalk gap on north side of Northshore Drive, west of Thunderhead Road, and construct curb ramp and pedestrian signal on the northwest corner of the intersection	\$241,000	\$40,000	\$24,100	\$305,000
5	Northshore Drive and Ebenezer Road	Reconfigure the southbound approach of Ebenezer Road to include a single exclusive left-turn lane and two exclusive right-turn lanes by removing one of the receiving lanes and adjust signal timings accordingly; expand existing sidewalk on the north side of Northshore Drive west of the intersection to a 10-foot greenway path and construct 10-foot greenway section on the south side of Northshore Drive east of the intersection; stripe crosswalks on southbound and westbound approaches of Ebenezer Road and Northshore Drive, respectively	\$583,000	\$85,000	\$58,300	\$726,000
6	Northshore Drive and Tooles Bend Road	None	--	--	--	--
7	Northshore Drive and Wallace Road	Convert Northshore Drive to a three-lane cross section with TWLTL from Branton Boulevard to Dunwoody Road; install a southbound right-turn lane on Wallace Road with at least 75 feet of storage; construct 10-foot greenway path on the north side of Northshore Drive west of the intersection and on the south side of Northshore Drive east of the intersection; stripe crosswalks on southbound and westbound approaches of Wallace Road and Northshore Drive, respectively	\$1,000,000	\$300,000	\$100,000	\$1,400,000
	Northshore Drive and Wrights Ferry Road /Morrell Road	Reconfigure laneage on northbound and southbound approaches to include an exclusive left-turn lane and a shared through/right-turn lane; extend the southbound left-turn lane storage by approximately 30 feet; remove split phasing on these approaches and replace with protected/permitted left-turn phasing and adjust signal timings accordingly; widen existing sidewalk on the east side of Morrell Road to a 10-foot greenway path	\$143,000	\$0	\$14,300	\$157,000
8	Northshore Drive and Lyons Bend Road	Install traffic signal at the intersection with a westbound left-turn lane on Northshore Drive that includes approximately 225 feet of storage; construct a 10-foot greenway path on north side of Northshore Drive from Lyons Bend Road to Lakeshore Park access east of the Fourth Creek bridge; include crosswalk and advanced warning signage on Northshore Drive at this location	\$2,050,000	\$245,000	\$205,000	\$2,500,000
	Northshore Drive and Lyons View Pike/Westland Drive	Convert signalized intersection to a two-lane roundabout; construct islands with crosswalks and warning signage on all approaches	\$1,868,000	\$50,000	\$187,000	\$2,110,000

5.0 Conclusion

Northshore Drive is a critical corridor for the residents and businesses in west Knox County. Its proximity to the interstate, surrounding development patterns, and limited multimodal infrastructure have contributed to the significant growth in traffic volumes in recent years. Traffic operation analyses at 10 major intersections provided the following key findings:

- Based on existing land use patterns, availability of land, and roadway infrastructure, future development along and near the Northshore Drive corridor is expected to be largely single-family residential, which has one of the highest trip generation rates for residential development.
- While the corridor is predominantly residential in nature, there are non-residential uses such as retail, restaurant, school, and office developments. These land uses can serve as the trip attractors for trips generated by the surrounding households. Those trips could potentially be made by walking and biking should adequate infrastructure be in place. However, the Northshore Drive corridor lacks a safe and connected network of sidewalks or bikeways to facilitate such movements.
- The topography of the area presents challenges to improving the corridor and may contribute to safety issues. In many locations, sight distance along the corridor and at intersections is limited based on the horizontal and vertical curvature of the roadway.
- Access along the corridor also presents both safety and operational concerns. The prevalence of private driveways and neighborhood accesses necessitates vehicles stopping on Northshore Drive to wait for an acceptable gap in traffic to make left turns into these areas. Left turn lanes and deceleration lanes for right turns are provided where feasible along the corridor. However, where these facilities are not present, safety issues arise, which can be confirmed by the analysis of crash trends and rates presented.
- There are significant constraints to improving the Northshore Drive corridor. In many locations, Fort Loudoun Lake to the south limits the ability to widen the corridor. In addition, overhead utilities are present on both sides of the corridor often in close proximity to the edge of pavement necessitating guardrails outside the limited shoulders.

Based on the analysis of both existing and future conditions along the Northshore Drive corridor, recommendations for eight study intersections were developed that included operational, geometric, and capacity improvements to Northshore Drive and its major connecting roadways. Recommendations at the study intersections incorporate the long-term vision for a multimodal greenway along the corridor as outlined in the Knox County Greenway Corridor Study. Implementation of these improvements is expected to cost approximately \$10.4 million and will ensure efficient traffic operations as future development occurs.