FINAL

INTERSTATE 81 - EXIT 17

Interchange Modification Report

February 2017

Prepared by

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Prepared for

VDOT

STARS

VDOT

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EXECUTIVE SUMMARY

In its existing condition, the Exit 17 interchange experiences operational deficiencies along State Route 75 at the two signalized off/on-ramp termini intersections and particularly to the south of the I-81 NB off/on-ramp intersection, and subsequently, along the I-81 mainline in the vicinity of the off-ramp gore areas during peak traffic periods. The geometric constraints associated with the existing interchange (i.e., signalized intersection spacing of approximately 300 feet and left-turn lane storage lengths (less than 100 feet) insufficient to contain queued vehicles, resulting in blocked adjacent through lanes) limits the growth and developmental potential of the State Route 75 corridor and creates poor operating conditions for drivers. The Virginia Department of Transportation (VDOT) has identified the need to improve this interchange and this study evaluated improvement alternatives and associated preliminary roadway design plans for the recommended improvements at Exit 17 on I-81. The ultimate goal of this Interchange Modification Report (IMR) is to develop cost-effective implementable improvements that address the deterioration of traffic operations at the I-81 eastbound and westbound off-ramp termini and along the Route 75 corridor, as well as resolve operational and safety concerns on the I-81 interstate mainline in the vicinity of the interchange off-ramps (specifically the I-81 eastbound off-ramp).

In order to improve interchange operations, adequate spacing distance between the two I-81 off/on-ramp signalized intersections along State Route 75 must be implemented in an effort to mitigate the operational impacts and the subsequent adverse safety conditions on State Route 75, the I-81 off-ramps, and along the I-81 mainline. The increased spacing between intersections will provide the left-turn lane storage lengths that are necessary to accommodate existing and projected left-turn movement volumes and associated queues. This will diminish the potential for queued left-turning vehicles (often as few as two or three) from blocking the northbound and southbound through lanes along State Route 75, resulting in improved ramp intersection operations, as well as enhance overall interchange operational and safety conditions. The following six (6) different interchange alternative concepts were considered as part of this analysis:

- Alternative 1 - No-Build
- Alternative 2 - Expanded Diamond (i.e., New I-81 EB Off/On-Ramps, relocate existing traffic signal 300 feet to the south of its current location, resulting in approximately 600 feet of separation between signals)
- Alternative 3 - Partial Cloverleaf (i.e., New I-81 EB Off-Ramp/On-Loop, relocate existing traffic signal approximately 300 feet to the south, resulting in approximately 600 feet of separation between signals)
- Alternative 4 - Partial Cloverleaf (i.e., New I-81 WB Off-Ramp/On-Loop, relocate existing traffic signal approximately 300 feet to the north, resulting in approximately 600 feet of separation between signals)
- Alternative 5 - Partial Cloverleaf (i.e., New I-81 EB Off-Loop/On-Ramp, relocate existing traffic signal approximately 300 feet to the south, resulting in approximately 600 feet of separation between signals)
- Alternative 6 - Full Interchange Reconstruction

A comparison matrix was created that reviewed different elements for each alternative that included:

- Traffic operations
- Impacts to existing tax base
- Impacts to property owners/need for additional right-of-way
- Environmental impacts
- Safety enhancements
- Scope of Construction
- Constructability

Each alternative was considered under these factors to determine their relative impact. Based on this review and discussions with VDOT, Alternatives 2 and 3 were selected as Concept #1 and Concept #2, respectively, for further analysis. These concepts are expected to best address the constrained operational conditions and enhance driver safety at the interchange with comparatively lower project costs, while also minimizing impacts to adjacent properties and the environment.

As determined from the results of the IMR, each of the build concepts improve operational and safety conditions at the Exit 17 interchange and at adjacent study area intersections when compared to the No-Build scenario. By providing more space between the I-81 ramp termini, creating additional left turn-lane storage capacity, and better traffic signal optimization, traffic operations will be improved at the I-81 Off/On-Ramp signalized intersections as well as along the State Route 75 corridor under both build concepts. Additionally, the proposed access management strategies introduced with each of the build concepts reduces the number of driveways and intersections in the immediate vicinity of the interstate ramp termini, which helps improve traffic operations and reduce the number of potential conflict points. However, Concept #2 – Partial Cloverleaf (is projected to operate with less delay and shorter queue lengths than Concept #1, since what was once a heavy left-turn movement to access I-81 eastbound now becomes a channelized YIELD right-turn movement with the loop ramp configuration. Therefore, the preferred concept for this IMR is Concept #2 – Partial Cloverleaf Southwest Quadrant, as shown in Figure E1, due to the overall operational benefits associated with the proposed design.

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Interstate 81 - Exit 17

Interchange Modification Report

Preferred Interchange Concept

FIGURE

E1

Responses to FHWA 8-Point Policy on Interstate Highway Access Modifications

The FHWA Interstate System Access Information Guide, August 2010, and VDOT Instructional and Informational Memorandum [on Interstate and Non-Interstate Systems] (IJR/IMR) (IIM-LD-200.7), June 2013 document the requirements to justify any proposed access changes to the Interstate System. The policy statement and eight specific requirements are listed below. A response to each policy requirement as it pertains to the preferred alternative is also provided: It is in the national interest to preserve and enhance the Interstate System to meet the needs of the 21st Century by assuring that it provides the highest level of service in terms of safety and mobility. Full control of access along the Interstate mainline and ramps, along with control of access on the crossroads located at interchanges, is critical to providing such service. Therefore, FHWA's decision to approve new or revised access points to the Interstate System must be supported by substantiated information justifying and documenting that decision (refer to Appendix K for a copy of the Exit 17 *Prompt-List for Reviewing Interstate Access Requests*). The FHWA's decision to approve a request is dependent on the proposal satisfying the following policy requirements:

Policy Point 1: Need for the Access Point Revision

The need being addressed by the request cannot be adequately satisfied by existing interchanges to the Interstate, and/or local roads and streets in the corridor can neither provide the desired access, nor can they be reasonably improved (such as access control along surface streets, improving traffic control, modifying ramp terminals and intersections, adding turn bays or lengthening storage) to satisfactorily accommodate the design-year traffic demands (23 CFR 625.2(a))).

RESPONSE: The primary components of the need for the proposed access point revision are a result of the deterioration of traffic operations at the I-81 eastbound and westbound off-ramp termini and along the Route 75 corridor. Sustained levels of growth and development in the Town of Abingdon and Washington County, as well as increasing levels of traffic destined to/from seasonal recreational attractions in the region (Bristol Motor Speedway, South Holston Lake, Historic Downtown Abingdon) have resulted in a significant deterioration of traffic operations at the I-81/Route 75 (Cummings Street) Exit 17 Off/On-Ramp signalized intersections and along the Route 75 corridor.

The impact of increasing traffic volumes through the interchange is further complicated by an inadequate ramp deceleration distance, interchange termini intersection spacing (i.e., approximately 300 feet between signals underneath the I-81 overpass bridge), turn-lane storage lengths insufficient to accommodate queued vehicles along Route 75 resulting in northbound and southbound through movements being intermittently blocked during AM and PM peak periods, and corridor operations that deteriorate to the extent that queued vehicles at the off-ramps periodically reach lengths that influence interstate mainline operations.

The purpose of the I-81/Route 75 (Exit 17) interchange improvement project is to implement targeted and cost-effective roadway and intersection improvements that enhance interstate accessibility and overall operations at the Exit 17 interchange using implementable common sense engineering (CSE) concepts. The cost-effective modifications that were developed as a result of the alternatives analysis in the Interchange Modification Report (IMR), directly improve traffic operations at the interchange off/on-ramp signalized intersections, eliminate or mitigate the associated off-ramp queuing conditions, as well as provide broader overarching benefits along the intersecting arterial (State Route 75) corridor.

Additionally, the improvements are expected to be implemented in a short timeframe to address existing issues at the interchange, while extending the functional life of the interchange for some fifteen to twenty more years or until a more holistic, ultimate alternative can be designed, analyzed, and funded.

Policy Point 2: Reasonable Alternatives

The need being addressed by the request cannot be adequately satisfied by reasonable transportation system management (such as ramp metering, mass transit, and HOV facilities), geometric design, and alternative improvements to the Interstate without the proposed change(s) in access (23 CFR 625.2(a)).

RESPONSE: The proposed interchange modifications are necessary to improve operational and safety conditions on the I-81 mainline and the State Route 75 arterial corridor created by significant traffic flow and congestion during the AM and PM peak periods. The need being addressed by this request cannot be adequately satisfied solely through reasonable alternative transportation system management treatments or options (e.g., *traffic signal optimization, ramp metering, mass transit, or HOV facilities)*. Because the existing Exit 17 interchange ramp termini signals operate on a single traffic controller with phased overlaps, there are limited modifications that can be implemented at this stage to accommodate the volume of traffic that needs to be processed during peak periods while minimizing operational conflicts. Alternative phasings and timings were initially considered at this interchange and were determined by VDOT to not adequately address the underlying issue (i.e., the ramp termini are spaced too closely to one another (approximately 300 feet) to allow for proper vehicle storage (i.e., northbound/southbound left-turn lanes on along Route 75). However, with the preferred interchange concept, traffic signal upgrades, optimization, and coordination can now be applied to the interchange termini.

Policy Point 3: Operational and Collision Analyses

An operational and safety analysis has concluded that the proposed change in access does not have a significant adverse impact on the safety and operation of the Interstate facility (which includes the mainline lanes, existing, new, or modified ramps, ramp intersection with crossroad) or on the local street network based on both the current and the planned future traffic projections. The analysis shall, particularly in urbanized areas, include at least the first adjacent existing or proposed interchange on either side of the proposed change in access (23 CFR 625.2(a), 655.603(d) and 771.111(f)). The crossroads and the local street network, to at least the first major intersection on either side of the proposed change in access, shall be included in this analysis to the extent necessary to fully evaluate the safety and operational impacts that the proposed change in access and other transportation improvements may have on the local street network (23 CFR 625.2(a) and 655.603(d)). Requests for a proposed change in access must include a description and assessment of the impacts and ability of the proposed changes to safely and efficiently collect, distribute and accommodate traffic on the Interstate facility, ramps, intersection of ramps with crossroad, and local street network (23 CFR 625.2(a) and 655.603(d)). Each request must also include a conceptual plan of the type and location of the signs proposed to support each design alternative (23 U.S.C. 109(d) and 23 CFR 655.603(d)).

RESPONSE: In conducting the operational and safety analysis for this IMR, the study area associated consists of interstate, ramps, ramp intersections, and an arterial corridor with its associated intersections. The preferred interchange concept is expected to impact only the interchange at I-81 and State Route 75 (i.e., Exit 17). According to I&IM-LD-200.8, the operational analysis study area must extend through at least the first adjacent interchange on either side of the proposed modifications.

While this would require that the Old Jonesboro Road (Exit 14) and Lee Highway (Exit 19) interchanges be included in the operational analysis, it was determined that the analysis will focus only on the Exit 17 interchange, per discussions with FHWA and VDOT.

Therefore, the two adjacent interchanges are not being included with this study since the proposed improvements are likely to have little or no impact on these interchanges (with respect to changes in traffic volume or operations). The two adjacent interchanges are located more than two miles from Exit 17. Ultimately, Exits 14, 17, and 19 are operationally isolated or independent from one another and the roadway connectivity to/from these interchanges is limited in the surrounding areas, as described below.

U.S. Route 11, which is located approximately 4,000 feet to the north of Exit 17 and runs parallel to I-81 through the majority of study area (i.e., U.S. Route 11 crosses through Exit 19 and transitions to an alignment that parallels I-81 to the south). Access to U.S. Route 11 via the adjacent interchanges is distinctly influenced by the character of historic downtown Abingdon (e.g., posted speed limit of 25 mph, two travel lanes with on-street parking, and through truck traffic restrictions), congestion along the commercial/retail corridor of State Route 75, commercial/retail and institutional destinations at Exit 19, institutional and commercial/retail destinations at Exit 14, as well as truck travel patterns. Truck traffic trying to access U.S. Route 19 toward Bluefield or other destinations west and/or north of Abingdon use Exit 14 since truck traffic through downtown Abingdon is prohibited. Exit 14 is also the primary means of access to retail destinations along Route 140 (Jonesboro Road), Virginia Highlands Community College (VHCC), Southwest Virginia Higher Education Center, and/or the Heartwood Cultural Center.

Exit 19 serves as a means of access to a growing retail destination and Johnston Memorial Regional Hospital and Cancer Center to the south in Washington County and Abingdon High School as well as commercial/retail and residential development within the eastern limits of the Town of Abingdon to the north. Exit 17 and its interchange with State Route 75 serves traffic traveling to/from historic downtown Abingdon, employment centers in town, commercial/retail opportunities along the State Route 75 corridor, and U.S. Route 11. To the south, State Route 75 provides a key means of access for numerous residential developments to/from I-81 as well as an alternate access route to/from the recreational destinations of South Holston Lake and the Bristol Motor Speedway.

Land uses, associated destinations, as well as roadway functional classification, and extent of the transportation network found at each interchange, combined with the distance between each of the interchanges results in travelers selectively choosing which interchange to use that best suits their needs. The option to use Exit 14 or Exit 19 allows travelers to avoid congestion, facility limitations, or vehicle type restrictions. The land use, travel pattern, and roadway network characteristics described above as well as the physical separation between interchanges results in little operational interaction or inter-dependence between the adjacent interchanges and Exit 17. Therefore, the Exit 17 interstate mainline study area will extend from a location approximately 4,000 west of the Exit 17 interchange to a location approximately 4,000 feet east of the interchange.

Also, per VDOT I&IM-LD-200.8, crossroad intersections to either side of the proposed modification in access will be included in the analysis. Since the proposed modification in access is at the eastbound ramp termini with State Route 75, the other required intersections would be the westbound ramp termini with State Route 75 to the north and the State Route 75 at Commerce Drive intersection to the south. This study exceeds that requirement by including all intersections to the north up to the State Route 75 at Cook Street signalized intersection and all intersections to the south down to the State Route 75 at Vances Mill Road/Fairway Drive unsignalized intersection.

The study area (Figure 1 and Figure 2) for this IMR encompasses the following areas:

- Interstate 81
  - Eastbound between Milepost 16.75 and Milepost 17.75
  - Westbound between Milepost 16.75 and Milepost 17.75
- State Route 75: from the Cook Street intersection to the Vances Mill Road/Fairways Drive intersection
- Study Area Intersections:
  - State Route 75 at Cook Street – Signalized
  - State Route 75 at Green Spring Road – Unsignalized
  - State Route 75 at Towne Centre Drive – Unsignalized
  - State Route 75 at Washington Crossings Entrance – Unsignalized
  - State Route 75 at I-81 Westbound Off/On-Ramp – Signalized
  - State Route 75 at I-81 Eastbound Off/On-Ramp – Signalized
  - State Route 75 at Commerce Drive – Unsignalized
  - State Route 75 at Country Club Drive – Unsignalized
  - State Route 75 at Abingdon Place – Unsignalized
  - State Route 75 at Birdie Drive – Unsignalized
  - State Route 75 at Gravel Lake Road – Unsignalized
  - State Route 75 at Vances Mill Road/Fairway Drive – Unsignalized

The traffic operations included the analysis of several freeway and arterial components within the defined study area. Along the freeway; mainline freeway segments and ramp merge/diverges were all analyzed. Along the arterials, study area signalized and unsignalized intersections were evaluated in terms of their operational performance. Both freeway and arterial segments were analyzed under Existing, No-Build, and Build scenarios.

The Highway Capacity Software (HCS), CORSIM, Synchro V9, and SimTraffic software packages were used in the operational analyses to evaluate existing and future conditions. HCS was used to analyze the freeway and ramp locations within the project study area using the “Freeway Facilities” module. CORSIM was used to analyze the same study area locations as HCS; however, CORSIM was also used to factor the arterial conditions into the interstate operations as a single, comprehensive network. Synchro was used to analyze the intersection operations and SimTraffic was relied on to report intersection queue lengths.

The results of this analysis illustrated that by providing more space between the I-81 ramp termini, creating additional left turn-lane storage capacity, and better traffic signal optimization, improved traffic operations within the study area were to be expected with the preferred interchange concept. The lengthening of the eastbound off-ramp allows for more cars to queue without potentially impacting interstate mainline operations.

The extended left-turn lanes provide more storage for vehicles to safely queue on State Route 75 under the I-81 overpass, limiting impacts to through movement traffic flow. The proposed access management strategies introduced with the preferred interchange concept reduces the number of driveways and intersections in the immediate vicinity of the interstate ramp termini, which helps improve traffic operations and reduce the number of potential conflict points along the roadway network.

Therefore, the preferred interchange concept is not expected to increase the number of severe crashes and provides an overall safer environment by reducing the number of potential conflict points and decreasing congestion. Finally, conceptual signing plans have also been developed for both interchange improvement alternatives and are included in this IMR (Figure 16 and Figure 17).

Policy Point 4: Access Connections and Design

The proposed access connects to a public road only and will provide for all traffic movements. Less than "full interchanges" may be considered on a case-by-case basis for applications requiring special access for managed lanes (e.g., transit, HOVs, HOT lanes) or park and ride lots. The proposed access will be designed to meet or exceed current standards (23 CFR 625.2(a), 625.4(a) (2), and 655.603(d)).

RESPONSE: The preferred interchange concept consists of modifying the I-81 eastbound off/on-ramp terminals by shifting the access points to the south approximately 300 feet on State Route 75. The proposed access points will be connected to a public road and will accommodate full-movement access. The access points are proposed to meet or exceed the current roadway design standards.

Policy Point 5: Land Use and Transportation Plans

The proposal considers and is consistent with local and regional land use and transportation plans. Prior to receiving final approval, all requests for new or revised access must be included in an adopted Metropolitan Transportation Plan, in the adopted Statewide or Metropolitan Transportation Improvement Program (STIP or TIP), and the congestion management Process within transportation management areas, as appropriate, and as specified in 23 CFR part 450, and the transportation conformity requirements of 40 CFR parts 51 and 93.

RESPONSE: This project evaluates physical conditions as well as operational and traffic safety related constraints. Included in these evaluations are planned development site plans and planned roadway improvements provided by VDOT, the Town of Abingdon, and Washington County. Along with evaluating planned development site plans and planned roadway improvements, the Bristol Metropolitan Planning Organization (MPO) provided supplemental socio-economic data to validate the proposed annualized growth rates in the study area. At the regional level, the project has the support of the Bristol MPO, Town of Abingdon, and Washington County. The I-81 Exit 17 project is identified and referenced in the Bristol Tennessee/Virginia Urban Area Metropolitan Planning Organization (MPO) Long Range Transportation Plan Year 2040, the Mount Rogers Planning District Commission 2035 Long Range Transportation Plan, as well as a needed improvement in both the Washington County Comprehensive Plan (2014) and the Town of Abingdon Comprehensive Plan (2013). The I-81 Exit 17 ramp improvement project is listed in the Bristol Tennessee/Virginia Urban Area MPO FY17-20 Transportation Improvement Program (TIP), as well as the VDOT FFY2015-2018 State Transportation Improvement Program (STIP). VDOT has obligated the financial resources necessary to fully fund the anticipated costs associated with design, right-of-way, and construction of the Exit 17 improvement project.

Policy Point 6: Future Interchanges

In corridors where the potential exists for future multiple interchange additions, a comprehensive corridor or network study must accompany all requests for new or revised access with recommendations that address all of the proposed and desired access changes within the context of a longer-range system or network plan (23 U.S.C. 109(d), 23 CFR 625.2(a), 655.603(d), and 771.111).

RESPONSE: Per the VDOT FY16 Six Year Improvement Program (SYIP), there is a funded project to modify the eastbound off/on-ramps at the I-81 Exit 14 interchange. Construction of these improvements is currently underway. Due to the distance between the Exit 14 and Exit 17 interchanges and how traffic operates in this area as discussed previously, the Exit 14 ramp modification project will not influence operations at the Exit 17 interchange.

Policy Point 7: Coordination

When a new or revised access point is due to a new, expanded, or substantial change in current or planned future development or land use, requests must demonstrate appropriate coordination has occurred between the development and any proposed transportation system improvements (23 CFR 625.2(a) an d655.603(d)). The request must describe the commitments agreed upon to assure adequate collection and dispersion of the traffic resulting from the development with the adjoining local street network and Interstate access point (23 CFR 625.2(a) and 655.603(d)).

RESPONSE: There are no proposed access revisions in this project that are being recommended due to a new, expanded, or substantial change in current or planned future development.

Policy Point 8: Environmental Processes

The proposal can be expected to be included as an alternative in the required environmental evaluation, review and processing. The proposal should include supporting information and current status of the environmental processing (23 CFR 771.111).

RESPONSE: A database review of information obtained from various standard environmental data sources related to wetlands and other surface waters, floodplains, threatened and endangered species, cultural and historic resources, and hazardous materials was conducted as part of this IMR. Additional field investigations of the project area were conducted that confirmed local existing conditions, verified the results of the database review, and collected data for sites not identified in the database review but observed in the field. This consisted of field surveys from existing rights of way (ROW) to verify the results of the database review. Areas of concern not identified during the database review, but observed in the field, were also investigated and documented as necessary. This process was used for the environmental assessment to examine and identify potential environmental impacts associated with the proposed interchange improvements.

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1. INTRODUCTION

1.1. Background

The Town of Abingdon and Washington County continue to experience the demands of growth on their local streets and primary arterials. State Route 75 (Cummings Street) has been identified as a key retail corridor for both new and redevelopment opportunities due to its proximity within the Town and access to I-81. Sustained levels of growth and development in the Town of Abingdon and Washington County, as well as increasing levels of traffic destined to seasonal recreational attractions in the region (Bristol Motor Speedway, South Holston Lake, Historic Downtown Abingdon) have resulted in a significant deterioration of traffic operations at the I-81/Route 75 (Cummings Street) Exit 17 Off/On-Ramp signalized intersections and along the Route 75 corridor.

In its existing condition, the Exit 17 interchange experiences operational deficiencies along State Route 75 at the two signalized off/on-ramp termini intersections and particularly to the south of the I-81 NB off/on-ramp intersection, and subsequently, along the I-81 mainline in the vicinity of the off-ramp gore areas during peak traffic periods. The geometric constraints associated with the existing interchange (i.e., signalized intersection spacing of approximately 300 feet and left-turn lane storage lengths (less than 100 feet) insufficient to contain queued vehicles, resulting in blocked adjacent through lanes) limits the growth and developmental potential of the State Route 75 corridor and creates poor operating conditions for drivers. The Virginia Department of Transportation (VDOT) has identified the need to improve this interchange and this study evaluated improvement alternatives and associated preliminary roadway design plans for the recommended improvements at Exit 17 on I-81. The ultimate goal of this Interchange Modification Report (IMR) is to develop cost-effective implementable improvements that address the deterioration of traffic operations at the I-81 eastbound and westbound off-ramp termini and along the Route 75 corridor, as well as resolve operational and safety concerns on the I-81 interstate mainline in the vicinity of the interchange off-ramps (specifically the I-81 eastbound off-ramp).

Funding from the Strategically Targeted Affordable Roadway Solutions (STARS) program was used to develop a preferred interchange alternative to be programmed into the VDOT Six-Year Improvement Program (SYIP). Based on discussions with VDOT and the Federal Highway Administration (FHWA), this IMR documents the future conditions of different interchange alternatives, to help in selecting a preferred interchange concept.

1.2. Previous Studies

To address the growing concerns over the operational conditions of the Exit 17 interchange, VDOT has reviewed alternative interchange configurations for this area in the past. An initial concept was developed and required the interchange to be completely reconstructed and modified. This configuration required significant construction, extensive ROW acquisitions, and impacts to surrounding area properties and business owners (i.e., overpass bridge piers to be moved, structural modifications to the bridge, road widening, and extensive interchange ramp and loop footprint). Cost estimates for this level of interchange modification were projected to exceed $170 million. Due to recent changes to funding source amounts and policies within VDOT, it was deemed unlikely that this design could realistically get funded and ultimately constructed in the next fifteen to twenty years. Therefore, to address the operational conditions at Exit 17, VDOT has adopted a more "common sense" approach to improving the interchange by developing targeted cost-effective alternative interchange configurations that address the critical operational and safety issues within the Department's current funding limitations for the 2040 design year.

1.3. Study Area

The proposed interchange modification at the intersection of I-81 and State Route 75 (Exit 17) is located partially in Washington County and partially within the Town limits of Abingdon, VA. It is noted that I-81 is signed as a northbound/southbound interstate facility. However, through the study area and in particular at this interchange location, I-81 is oriented in an east-west cardinal direction and State Route 75 is oriented in a north-south cardinal direction. For the purposes of this document I-81 will be referenced as "eastbound" and "westbound" and State Route 75 will be referenced as "northbound" and "southbound".

The study area for this IMR, as shown in Figure 1, encompasses the following areas:

- Interstate 81
  - Eastbound between Milepost 16.75 and Milepost 17.75
  - Westbound between Milepost 16.75 and Milepost 17.75
- State Route 75: from the Cook Street intersection to the Vances Mill Road/Fairways Drive intersection

The following intersections were also identified for analysis as part of the study area (as shown in Figure 2):

1. State Route 75 at Cook Street – Signalized
2. State Route 75 at Green Spring Road – Unsignalized
3. State Route 75 at Towne Centre Drive – Unsignalized
4. State Route 75 at Washington Crossing Entrance – Unsignalized
5. State Route 75 at I-81 Westbound Off/On-Ramp – Signalized
6. State Route 75 at I-81 Eastbound Off/On-Ramp – Signalized
7. State Route 75 at Commerce Drive – Unsignalized
8. State Route 75 at Country Club Drive – Unsignalized
9. State Route 75 at Abingdon Place – Unsignalized
10. State Route 75 at Birdie Drive – Unsignalized
11. State Route 75 at Gravel Lake Road – Unsignalized
12. State Route 75 at Vances Mill Road/Fairway Drive – Unsignalized

1.4. Project Purpose and Need

The primary components of the need for the proposed access point revision are the result of the deterioration of traffic operations at the I-81 eastbound and westbound off-ramp termini and along the Route 75 corridor. Sustained levels of growth and development in the Town of Abingdon and Washington County, as well as increasing levels of traffic destined to/from seasonal recreational attractions in the region (Bristol Motor Speedway, South Holston Lake, Historic Downtown Abingdon) have resulted in a significant deterioration of traffic operations at the I-81/Route 75 (Cummings Street) Exit 17 Off/On-Ramp signalized intersections and along the Route 75 corridor. The impact of increasing traffic volumes through the interchange is further complicated by an inadequate ramp deceleration distance, interchange termini intersection spacing (i.e., approximately 300 feet between signals underneath the I-81 overpass bridge), turn-lane storage lengths insufficient to accommodate queued vehicles along Route 75 resulting in northbound and southbound through movements being intermittently blocked during AM and PM peak periods, and corridor operations that deteriorate to the extent that queued vehicles at the off-ramps periodically reach lengths that influence interstate mainline operations.

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Study Area

FIGURE
1

STARS VDOT	Interstate 81 - Exit 17 Interchange Modification Report	Study Area Intersections	FIGURE **2**

The purpose of the I-81/Route 75 (Exit 17) interchange improvement project is to implement targeted and cost-effective roadway and intersection improvements (e.g., increasing ramp termini spacing, increasing left-turn storage lane lengths, creating YIELD and right-turn overlap conditions, and optimization of coordinated signal timings) that enhance interstate accessibility and overall operations at the Exit 17 interchange using implementable common sense engineering (CSE) concepts. The cost-effective modifications that were developed as a result of the alternatives analysis in the Interchange Modification Report (IMR), directly improve traffic operations at the interchange off/on-ramp signalized intersections, eliminate or mitigate the associated off-ramp queuing conditions, as well as provide broader overarching benefits along the intersecting arterial (State Route 75) corridor, as part of VDOT's Strategically Targeted and Affordable Roadway Solutions (STARS) program. When compared to the No-Build Alternative, the proposed interchange modifications result in overall improved operational conditions. Additionally, the improvements are expected to be implemented in a short timeframe to address existing issues at the interchange, while extending the functional life of the interchange for some fifteen to twenty more years or until a more holistic, ultimate alternative can be designed, analyzed, and funded.

1.5. Related Studies

The following studies were considered and reviewed to understand the impacts of the proposed interchange modification on the study corridor and surrounding traffic infrastructure as well as to gather relevant data concerning the study corridor.

Relevant data from the studies listed below were used as appropriate to support this IMR:

- *STARS Congestion Mitigation Program – Route 75 and I-81 North Ramp*, Prepared by Kimley-Horn and Associates, June 2011
    - Key Information: Alternatives screening and analysis
- *The Meadows Traffic Impact Study*, prepared by CDM Smith, December 2015
    - Key Information: trip generation information, future roadway improvements

1.6. Key Assumptions

A framework document was created that outlines the approach to be used in developing the IMR and its methodology assumptions. This document was developed in conjunction with VDOT and FHWA. The approval of the framework document occurred in October 2015. A copy of the approved framework document for the Exit 17 IMR is provided in Appendix A. The following sections summarize the methods and assumptions approved for use in preparing this IMR.

1.6.1. Study Area

The study area (as shown in Figure 1) is approximately one (1) mile along I-81 between milepost 16.75 and milepost 17.75 and approximately one (1) mile along State Route 75 from Cook Street to Vances Mill Road/Fairway Drive. The proposed interchange modification at Exit 17 is located in Washington County, and partially within the Town limits of Abingdon, VA.

1.6.2. Analysis Tools and Assumptions

The methodology for traffic and operational analysis primarily consisted of evaluating the traffic operations along State Route 75, between Vances Mill Road/Fairway Drive and Cook Street, and I-81 within the Exit 17 influence area.

This analysis was used to determine the appropriate lane configurations for the intersections (including the ramp termini) along State Route 75 and to assess any operational issues along I-81 and the local street network. Highlights of the traffic and operational analysis update are summarized below:

- The operational analysis was performed during AM and PM peak hour conditions for the following analysis years: 2015 existing conditions; 2020 assumed as opening year for the proposed interchange modifications and 2040 will be the Design Year for the interchange modifications. This operational analysis was performed using traffic operational microsimulation CORSIM models along with HCS and Synchro models.
- The CORSIM simulation model was calibrated for one (1) 60-minute interval for each of the analysis scenarios in accordance with the VDOT Traffic Operations Analysis Tool Guidebook (TOATG) and the Traffic Operations and Safety Analysis Manual (TOSAM). Calibration was limited to the following measures of effectiveness (MOE's):
    - Mainline I-81 calibrated using volume and speed.
    - Mainline Route 75 calibrated using volume and queue length.
    - I-81 off-ramps calibrated using volume and queue length.
    - All simulated volumes compared to their base counts for the respective scenario and analysis year to be within a 10 percent difference.
- Operational analysis for the merge, diverge, and weaving segments was conducted in HCS (Version 6.50). The MOE's reported for HCS were speed, density, and LOS. If a merge, diverge, or weave failed in the HCM standard capacity checks, a density and LOS result was not reported (HCM equations are no longer applicable). A separate upstream and downstream analysis was done for each ramp if there was a/are ramp(s) serving State Route 75 upstream or downstream (no adjacent interchange ramps were considered as a part of this study). Mainline merge, diverge, and freeway segments were analyzed with methodologies consistent with the 2010 Highway Capacity Manual (HCM). All analyses were performed using 2010 HCS, and comply with guidelines included in VDOT's TOATG and TOSAM, as appropriate.
- Operational analyses for signalized and unsignalized intersections along State Route 75 were analyzed using Synchro Professional (Version 9.1 – Build 903, Revision 76). MOE's in Synchro were comprised of: level of service, delay, density, and speed at each analysis location, as appropriate. Synchro Professional was used to optimize signal timings at all study area intersections. Once timings at each signalized intersection were optimized, they were analyzed using 2000 HCM methodologies included within Synchro and the SimTraffic microsimulation module of Synchro. Synchro was only used to analyze intersection operations at all study area intersections. Synchro was not used to analyze ramp, interchange, or interstate operations.
    - It should be noted that Synchro currently provides the ability to conduct analyses using either HCM 2000 or HCM 2010 methodologies. However, there are several limitations using HCM 2010 (e.g., only NEMA phasing can be used, no more than four legs can be analyzed, etc.). This creates differences in computation methodologies between the two HCM releases, resulting in different output values. Therefore, since the study corridor includes several non-standard NEMA signals, all Synchro related analysis will only utilize the HCM 2000 methodologies.
    - SimTraffic models were calibrated per the guidelines included in VDOT's TOATG and TOSAM, as appropriate.

1.6.3. Projected Start Year and Design Year

The advertisement (Ad) date for the Exit 17 Improvement project is expected to be 2018, the opening year is anticipated to be 2020, and the design year for the IMR would thus be 2040 (Ad date plus 22 years). Therefore, the following analysis scenarios and alternatives will be analyzed in HCS, Synchro, and CORSIM:

- Existing Conditions
- No-Build – 2020 Opening Year and 2040 Horizon Year
- Concept #1 – 2020 Opening year and 2040 Horizon Year
- Concept #2 – 2020 Opening Year and 2040 Horizon Year

1.6.4. Traffic Data

Traffic volumes were collected throughout the study area between April and June 2014. 12-Hour Turning Movement Counts (TMC) were collected 7:00 AM – 7:00 PM on Thursday, April 24, 2014, at the following study area intersections:

- State Route 75 at Green Spring Road
- State Route 75 at Cook Street

12-Hour Turning Movement Counts (TMC) were collected 7:00 AM – 7:00 PM on Tuesday, April 29, 2014, at the following study area intersections:

- State Route 75 at Towne Centre Drive
- State Route 75 at Washington Crossing

12-Hour Turning Movement Counts (TMC) were collected 7:00 AM – 7:00 PM on Wednesday, April 30, 2014, at the following study area intersections:

- State Route 75 at I-81 Westbound Ramps
- State Route 75 at I-81 Eastbound Ramps

12-Hour Turning Movement Counts (TMC) were collected 7:00 AM – 7:00 PM on Thursday, May 1, 2014, at the following study area intersection:

- State Route 75 at Country Club Drive

12-Hour Turning Movement Counts (TMC) were collected 7:00 AM – 7:00 PM on Tuesday, May 6, 2014, at the following study area intersection:

- State Route 75 at Commerce Drive

12-Hour Turning Movement Counts (TMC) were collected 7:00 AM – 7:00 PM on Wednesday, May 7, 2014, at the following study area intersections:

- State Route 75 at Birdie Drive
- State Route 75 at Abingdon Professional Center

12-Hour Turning Movement Counts (TMC) were collected 7:00 AM – 7:00 PM on Wednesday, May 7, 2014, at the following study area intersections:

- State Route 75 at Gravel Lake Road
- State Route 75 at Fairway Drive/Vances Mill Road

24-Hour volumes, vehicle classifications, and speed data was collected for I-81 from a permanent count site on Sunday, June 22, 2014, through Sunday, June 29, 2014, at the following locations:

- Eastbound I-81 between Exit 14 and Exit 17
- Westbound I-81 between Exit 14 and Exit 17

All detailed traffic count and speed data is included in Appendix B. Additional details regarding the existing traffic data collected for this study can be found in Sections 2.7.1 - Existing Traffic Volumes and Peak Hour Factors.

1.6.5. Crash Data

A crash analysis was completed within the study area. The latest five years of crash data, collected between January 1, 2011, and December 31, 2015, was compiled and summarized within the study area. Existing safety conditions are summarized in Section 2.9 - Existing Safety Conditions.

1.6.6. Peak Periods for Analysis

The weekday AM and PM peak hours were identified as the critical periods for analysis purposes. The weekday AM and PM peak hours were generally determined to be 7:30 – 8:30 AM and 4:30 – 5:30 PM for the majority of the study area intersections.

1.6.7. Future Traffic Forecast

The Bristol Metropolitan Planning Organization (MPO) regional travel demand model does not currently include the subject study area. Therefore, the traffic volume projections were based upon annualized, linear growth rates using information provided by VDOT. The following linear growth rates were determined and agreed to by the project team:

- 1.8% on I-81
- 1.5% on I-81 ramps (for consistency when balancing volumes between the I-81 mainline and Route 75)
- 1.0% on State Route 75

The annualized growth rate for I-81 is based on a historical traffic volume database maintained by VDOT for the I-81 corridor reflecting traffic volume trends from 1975 to 2013. The annualized growth trend from this database reflects an anticipated trend line of 1.8%. The relatively modest growth rate along State Route 75 was computed and averaged based on available historical traffic data from VDOT.

The proposed linear growth rate for State Route 75 is a representative average as it traverses through the Exit 17 interchange. VDOT historic (i.e., 2001 through 2013) AADT data reflects distinct growth rate trends north of the interchange (-0.98 % annually) and south of the interchange (1.90%), as shown in Table 1.

Historic traffic data north of the interchange reflects a flat to negative growth trend. South of the interchange, data reflect a positive growth trend. To be conservative and to address the distinction in growth rates through the

interchange, it was determined that an average 1% linear growth rate should be applied in preparing future traffic volume projections.

Table 1: State Route 75 Historical AADT Data

Roadway	Segment		VDOT Historical Data (AADT)												
	From	To	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
State Route 75	I-81	US 11	18,000	18,000	18,000	18,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	16,000
State Route 75	I-81	Country Club Drive	6,300	6,400	6,300	5,800	8,300	8,300	9,000	8,500	8,600	7,800	7,700	7,500	7,900

Source: VDOT

1.7. Traffic Analysis Methodology

The nature of the proposed improvements and traffic characteristics of the study area indicate that the Transportation Research Board's (TRB) 2010 Highway Capacity Manual methodologies are appropriate for evaluating operations for this IMR. Therefore, the approved IMR Framework Document (Appendix A) identified HCS 2010 and Synchro/SimTraffic Version 9.1 (Build 903, Revision 76) as the analysis tools for evaluating traffic operations for Exit 17 and the surrounding roadways. CORSIM Version 6.3 was used to supplement the HCS capacity analysis.

I-81 (Mainline and Ramps): Based on a review of the specific characteristics of this project and the alternatives considered, it was concluded that the combined analysis tools of HCS and CORSIM would be most appropriate to evaluate operations along the mainline interstate and associated ramps. Along the interstate and interchange ramps, speed, vehicle density, and LOS (based on vehicle density) were the main measures of effectiveness (MOEs) from HCS. Key MOEs derived from CORSIM were "unadjusted density" and speed. CORSIM's unadjusted density is measured in vehicles-per-mile-per-lane (veh/mi/ln), whereas HCM density is measured in passenger car equivalents-per-mile-per-lane (pc/mi/ln). Since CORSIM cannot report a passenger car equivalent density and there is no defined conversion to do so, LOS is not able to be obtained from CORSIM results. Given the units for density that CORSIM uses in the output, it should be expected for the density from CORSIM to consistently be slightly less than the density given from the HCS module. Regardless, a comparison of densities between CORSIM and HCS was still conducted despite limitations. HCS and CORSIM MOEs were used to compare the No-Build and Build Alternatives and to verify that the proposed interchange modifications will result in more efficient traffic operations along the freeway. The results of the HCS and CORSIM analyses (Existing and Future Conditions) are summarized in Chapter 2 - Existing Conditions and Chapter 6 - Traffic Operations of this report.

State Route 75 (Local Roadway Network): In accordance with the standard methodologies presented in the 2010 Highway Capacity Manual, the software package Synchro Version 9.1 (Build 903, Revision 76) was used to assess operations of the at-grade intersections within the study area. MOEs reported from Synchro (applying the HCM Reports feature) for the signalized and unsignalized intersections along Cummings Street include level of service (LOS) and delay. Additionally, the companion SimTraffic software package was utilized to estimate the maximum queue lengths for the study intersections. Additional information regarding the operations of the local roadway network can be found in Chapter 2 - Existing Conditions and Chapter 6 - Traffic Operations of this report.

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2. EXISTING CONDITIONS

2.1. Demographics

Adjacent to the study area and within the Bristol Metropolitan Planning Organization (MPO) area is the Virginia County of Washington, the City of Bristol, and the Town of Abingdon—this area has a 2014 combined total population of approximately 80,900. In 2014, the U.S. Census Bureau estimated that Washington County had a population of approximately 54,700 while the City of Bristol and the Town of Abingdon had total populations of 17,800 and 8,100, respectively.

The Bristol MPO area which also includes counties and municipalities in Tennessee, has a 2015 total population estimate of approximately 107,700. Since 2010, the Bristol MPO area has seen a population growth of approximately 1.3%. Based on recent projections, this area is expecting to grow 8.3% by 2040 to reach a total population of approximately 115,000.

Employment trends within the study area and the surrounding region mentioned above indicate that the Bristol MPO will have a work force of approximately 79,300 employees by 2040; a growth of 46.1% from the 54,300-employee work force in 2010. Projected population and employment changes within the study area are described in more detail in Chapter 7 - Land Use and Demographics.

2.2. Existing Land Use and Zoning

The area immediately adjacent to the Exit 17 study area within the Town of Abingdon and Washington County consist of residential, commercial, and agricultural land uses. Parcels in this area are generally zoned for gateway office/commercial, agricultural, and low-density residential uses. For Washington County, parcels within the study area are zoned as General Agriculture (A2) and General Business District (B2). Additional detail on the existing and future land uses within the study area can be found in Chapter 7 - Land Use and Demographics.

2.3. Existing Roadway Network

The study area for this IMR consists of roadways of varying types, ranging from an interstate facility to local rural facilities as discussed below:

I-81: I-81 is a limited access highway classified by FHWA as an Interstate within the study area. The segment of I-81 in the study area has a posted speed limit of 70 mph. It is a divided facility that carries traffic along two 12-foot lanes in each direction.

State Route 75: State Route 75 is a primary route that connects Downtown Abingdon to the north and various areas of Washington County to the south with I-81. The segment of State Route 75 north of the I-81 overpass is a 5-lane typical section roadway (i.e., 4 travel lanes, with exclusive left-lanes at key intersections and/or a two-way left-hand turn-lane (TWLTL) and with a functional classification designation of minor arterial. South of I-81, the roadway is a 2-lane undivided facility with a functional classification of major collector. State Route 75 has a posted speed limit of 35 mph within the study area.

Other Rural Local Roads: The following study area local streets were also considered in this study at their intersections with State Route 75:

- Cook Street: Cook Street is a four-lane, undivided road with a posted speed limit of 25 mph. Cook Street provides access to the Veterans Memorial Park, Town Center shopping center, and several residential neighborhoods via Oakland Street. This road intersects State Route 75 at a signalized intersection about a quarter mile north of the Exit 17 interchange.
- Green Spring Road: Green Spring Road is a two-lane, undivided roadway with a posted speed limit of 25 mph. This road intersects State Route 75 directly south of Cook Street and the Green Spring Road approach is stop controlled.
- Towne Centre Drive: Towne Centre Drive is a two-lane, undivided access road with an unposted speed limit assumed to be 25 mph. It provides access to the Abingdon Towne Centre shopping center and other commercial facilities. This road intersects State Route 75 directly south of Green Spring Road and the approach is stop controlled.
- Washington Crossings: Washington Crossings is a two-lane, unmarked, undivided access road with an unposted speed limit assumed to be 25 mph. This road intersects State Route 75 directly south of Towne Centre Drive and the Washington Crossings approach is stop controlled.
- Commerce Drive: Commerce Drive is a two-lane, undivided roadway with a posted speed limit of 25mph that provides access to a hotel, a couple of residential facilities, and ultimately an industrial facility. This road intersects State Route 75 directly south of the I-81 northbound off ramps and the Commerce Drive approach is stop controlled. To the west, Commerce Drive creates a loop that eventually bears south turning into Gravel Lake Road (see below).
- Country Club Drive East: Country Club Drive East is a two-lane, undivided road with a posted speed limit of 35 mph and provides access to several residential communities. This road intersects State Route 75 directly south of Commerce Drive and the approach is stop controlled.
- Abingdon Place: Abingdon Place is a two-lane, unmarked, undivided access road with an unposted speed limit assumed to be 25 mph that provides access solely to the Abingdon Professional Center. This driveway intersects State Route 75 directly south of Country Club Drive East. Although no stop signs are present, it is assumed to operate as a two-way stop controlled intersection with the business driveway directly across from Abingdon Place acting as the second stop-control.
- Birdie Drive: Birdie Drive is a two-lane, unmarked, undivided local road with a posted speed limit of 25 mph that provides access to a residential community. This road intersects State Route 75 directly south of Abingdon Place and the Birdie Drive approach is stop controlled.
- Gravel Lake Road: Gravel Lake Road is a two-lane, unmarked, undivided road with a posted speed limit of 25 mph that provides access to an industrial facility. This driveway intersects with State Route 75 at an intersection directly south of Birdie Drive and the approach is stop controlled.
- Fairway Drive: Fairway Drive is a two-lane, unmarked, undivided local road with a posted speed limit of 25 mph that provides access to a residential community. This driveway intersects with State Route 75 at a two-way stop controlled intersection south of Gravel Lake Road and across from Vances Mill Road. This intersection is assumed to operate as a traditional four-legged intersection, despite the slight offset it has with Vances Mill Road.
- Vances Mill Road: Vances Mill Road is a two-lane, undivided road with a posted speed limit of 35 mph. This road intersects with State Route 75 at a two-way stop controlled intersection with Fairway Drive.

2.4. Alternative Travel Modes

There are minimal options within the study area and surrounding area for the use of alternative travel modes. Limited transit services are provided via the District Three Public Transit. This public transit program is available to all age groups and helps serve shopping routes, shuttle services and college commuter routes throughout the rural areas in the study area. Reservations to use the service are required.

Bicycle and pedestrian facilities are also limited within the study area. There are some sidewalks provided north of the Exit 17 interchange along State Route 75 in the Town of Abingdon. There are no bicycle or pedestrian accommodations along State Route 75 south of the Exit 17 interchange. Additionally, the Virginia Creeper Trail is located just north of the study area. This trail is a converted railroad bed and stretches 34 miles from Abingdon, Virginia to Damascus, Virginia.

2.5. Interchanges

A description of the configuration of the study interchange for this report is provided below:

I-81 at State Route 75 Interchange (Exit 17): The I-81 at State Route 75 Interchange is a typical diamond interchange consisting of one on and one off diagonal ramp in each direction of travel. Along I-81 eastbound, there is a 560-foot taper with a 410-foot deceleration lane leading into a single exit lane. Similarly, a single lane enters I-81 eastbound through a 1,050-foot acceleration lane with a 740-foot taper. In the westbound direction, traffic exits I-81 with a 265-foot taper and 800-foot deceleration lane leading into a single exit lane; while a single lane enters I-81 westbound through an 805-foot acceleration lane with an approximate 650-foot taper. Ramps in both directions are controlled by signalization at each ramp's terminus with State Route 75.

2.6. Environmental Constraints

The project study area is located in Abingdon, Virginia, extending to the north and south of the I-81 interchange along Cummings Street from Cook Street in the north to Vances Mill Road to the south (Figure 1). Based on the comprehensive review of data obtained from various standard environmental data sources related to wetlands and other surface waters, floodplains, threatened and endangered species, cultural and historic resources, and hazardous materials, there is a potential that natural and historic resources may be impacted as a result of the proposed project (specifically in the vicinity of the proposed Vances Mill Road/State Route 75 intersection improvement). Additional data regarding the environmental studies for this project can be found in Chapter 9 of this report.

2.7. Traffic and Safety Data

Various data sources were used to compile the necessary inputs for the operational analyses. Traffic volumes, peak hour factors, heavy vehicle percentages, acceleration/deceleration lane lengths, lane designations, turn-lane storage lengths, speed data, and crash data were all established from current data collection efforts.

2.7.1. Existing Traffic Volumes and Peak Hour Factors

As mentioned previously in Section 1.6.4 - Traffic Data, traffic counts were collected for the study area intersections, ramps, and interstate segments. The peak hour for the AM and PM time periods were determined for each study intersection from the available count data. Volumes, peak hour factors, heavy vehicle percentages for each intersection's peak period was used for this analysis. Next, the 2014 count data was then adjusted to year 2015 in accordance with the linear growth rates previously discussed in accordance with the study's analysis years.

Once the AM and PM peak hours were established for 2015, the intersection peak hour volumes were balanced and peak hour factors were determined. In general, volume balancing was performed in accordance with TOATG guidance, where imbalances between intersections were mitigated proportionally across all lane groups. However, there are instances where the numerous driveways accessing State Route 75 contribute to the imbalances in volumes along the corridor. Instances where driveways would not significantly contribute to correcting for an imbalance were appropriately balanced. The following segments were left with volume imbalances:

1. State Route 75 (southbound) between Cook Street and I-81 Westbound On-Ramp
1. State Route 75 (northbound) between I-81 Westbound Off-Ramp and Washington Crossings Entrance
2. State Route 75 (northbound/southbound) between Country Club Drive and Birdie Drive

AM and PM balanced peak hour volumes are illustrated in Figure 3. The AM and PM peak hour factors, by lane group, are illustrated in Figure 4.

2.7.2. Existing Heavy Vehicle Percentages

All collected intersection and interstate peak hour count data included vehicle classification breakdowns. This data was used to establish peak hour heavy vehicle percentages throughout the study area. Intersection heavy vehicle percentages were established by movement, while interstate heavy vehicle percentages (based on FHWA Vehicle Classification 4 and higher) were established for each direction. Figure 5 summarizes the heavy vehicle percentages obtained throughout the study area for the AM and PM peak hours.

2.7.3. Existing Geometric, Lane Designation, and Speed Data

Posted speed limits, lane lengths, and lane designations are illustrated in Figure 6. The following section summarizes the roadway conditions for the intersections along State Route 75.

Along State Route 75, north of the Exit 17 interchange, the signalized intersection at Cook Street was analyzed. This is a three-legged intersection with Cook Street as the eastbound approach. State Route 75 comprises the northbound and southbound approaches. The Cook Street approach is comprised of one exclusive left-turn lane and one exclusive right-turn lane. The northbound approach along State Route 75 consists of two exclusive through lanes and one exclusive left-turn lane. The southbound approach along State Route 75 consists of one shared through/right-turn lane and one exclusive through lane.

Along State Route 75, south of Cook Street, the one-way stop controlled intersection at Green Spring Road was analyzed. The northbound and southbound approaches along State Route 75 operate freely while the westbound approach along Green Spring Road is stop controlled. At the intersection, southbound State Route 75 operates as two through travel lanes, while the northbound approach operates as one shared through/right-turn lane and one exclusive through lane. There is also a two-way left-turn (TWLTL) lane along State Route 75 at this intersection. Green Spring Road is comprised of one shared right/left-turn lane.

Along State Route 75, south of Green Spring Road, the one-way stop controlled intersection at Towne Centre Drive was analyzed. Towne Centre Drive is the eastbound approach while State Route 75 comprises the north and south bound approaches. State Route 75 operates freely with Towne Centre Drive being stop controlled. At this intersection, southbound State Route 75 operates with one shared through/right-turn lane, and one exclusive through lane. Northbound State Route 75 operates as two exclusive through lanes. Eastbound Towne Centre Drive consists of one right-turn only lane.

Along State Route 75, south of Towne Centre Drive, the one-way stop controlled intersection at Washington Crossings was analyzed. Washington Crossings is the westbound approach while State Route 75 comprises the north and south bound approaches. State Route 75 operates freely with Washington Crossings being stop controlled. At this intersection, southbound State Route 75 consists of two exclusive through lanes and one exclusive left-turn lane. Northbound State Route 75 consists of one shared through/right-turn lane and one exclusive through lane. Westbound Washington Crossings consists of one shared right/left-turn lane. It should be noted that a McDonalds entrance is also adjacent to Washington Crossings as the eastbound approach. This driveway was not counted, but volumes were assumed as it related to balancing the roadway network.

The next intersections analyzed were the I-81 ramp terminals with State Route 75. Both intersections are signalized and operate under the same controller.

At the I-81 westbound off/on-ramp terminal, State Route 75 is the northbound and southbound approaches to the signalized intersection. The northbound approach consists of one exclusive left-turn lane and one exclusive through lane; while the southbound approach consists of one exclusive right-turn lane and one exclusive through lane. The I-81 westbound off-ramp approach consists of one exclusive right-turn lane and one exclusive left-turn lane.

At the I-81 eastbound off/on-ramp terminal, State Route 75 is the northbound and southbound approaches to the signalized intersection. The northbound approach consists of one exclusive right-turn lane and one exclusive through lane; while the southbound approach consists of one exclusive left-turn lane and one exclusive through lane. The I-81 eastbound off-ramp approach is configured to provide one exclusive right-turn lane and one exclusive left-turn lane.

Along State Route 75, south of the I-81 eastbound ramp terminal, the one-way stop controlled intersection at Commerce Drive was analyzed. Commerce Drive is the eastbound approach while State Route 75 comprises the north and south bound approaches. State Route 75 operates freely with Commerce Drive being stop controlled. At the intersection, northbound State Route 75 consists of one shared through/left-turn lane and southbound State Route 75 consists of one shared through/right-turn lane. The eastbound approach consists of one exclusive right-turn lane and one exclusive left-turn lane.

Along State Route 75, south of Commerce Drive, the one-way stop controlled intersection at Country Club Drive was analyzed. Country Club Drive is the westbound approach while State Route 75 comprises the northbound and southbound approaches. State Route 75 operates freely with Country Club Drive being stop controlled. At the intersection, northbound State Route 75 consists of one shared through/right-turn lane and the southbound approach consists of one shared through/left-turn lane. The westbound approach consists of one exclusive right-turn lane and one exclusive left-turn lane.

Along State Route 75, south of Country Club Drive, the two-way stop controlled intersection at Abingdon Place was analyzed. Abingdon Place is the westbound approach while State Route 75 comprises the northbound and southbound approaches. A small business driveway directly across from Abingdon Place was analyzed as the eastbound approach. State Route 75 operates freely with Abingdon Place and the eastbound driveway being stop controlled. At the intersection, all approaches consist of one shared right/through/left-turn lane.

Along State Route 75, south of Abingdon Place, the two-way stop controlled intersection at Birdie Drive was analyzed. Birdie Drive is the westbound approach while State Route 75 comprises the northbound and southbound approaches. A small business driveway directly across from Birdie Drive was analyzed as the westbound approach. State Route 75 operates freely with Birdie Drive and the eastbound driveway being stop controlled. At the intersection, all approaches consist of one shared right/through/left-turn lane.

Along State Route 75, south of Birdie Drive, the one-way stop controlled intersection at Gravel Lake Road was analyzed. Gravel Lake Road is the westbound approach while State Route 75 comprises the northbound and southbound approaches. State Route 75 operates freely with Gravel Lake Road being stop controlled. At the intersection, northbound State Route 75 consists of one shared through/left-turn lane and the southbound approach consists of one shared through/right-turn lane. The westbound approach consists of one shared right/left-turn lane.

Along State Route 75, south of Gravel Lake Road, the two-way stop controlled intersection at Vances Mill Road and Fairway Drive was analyzed. Vances Mill Road is the westbound approach and Fairway Drive is the eastbound approach while State Route 75 comprises the north and south bound approaches. State Route 75 operates freely with Vances Mill Road and Fairway Drive being stop controlled. Northbound State Route 75 along with Vances Mill Road and Fairway Drive consist of one shared right/through/left-turn lane for each approach. The southbound approach consists of one exclusive right-turn lane and one shared through/left-turn lane.

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NOT TO SCALE

Legend

- Study Area Intersection
- XX (XX) - AM (PM) Peak Hour Traffic Volumes
- Traffic Signal
- Stop Control

1,586 (1,702)

(1,797) 1,304

1,488 (1,771)

(1,863) 1,372

Cummings Street

75

81

Green Spring Rd
19 (56)
38 (21)
183 (127)
723 (610)
(45) 24
(834) 472

Washington Crossing
7 (37)
4 (16)
12 (11)
903 (701)
(21) 16
(818) 375

I-81 SB Off-Ramp
I-81 SB On-Ramp
366 (273)
69 (83)
584 (506)
132 (83)
(558) 269
(342) 205

Country Club Dr
78 (72)
12 (9)
11 (11)
508 (367)
(66) 37
(500) 238

Birdie Dr
Driveway
47 (18)
0 (0)
6 (1)
3 (2)
474 (302)
3 (0)
(38) 11
(393) 232
(0) 1
(8) 0
(0) 0
(3) 4

Gravel Lake Rd
459 (287)
4 (7)
(392) 210
(5) 32
(17) 21
(11) 5

Cook St
635 (462)
107 (204)
(628) 393
(232) 62
(194) 68
(223) 93

Towne Centre Dr
906 (737)
4 (1)
(818) 466
(25) 5
(65) 22

I-81 NB On-Ramp
I-81 NB Off-Ramp
134 (109)
470 (342)
(251) 141
(390) 197
(247) 246
(179) 97

Commerce Dr
582 (435)
4 (4)
(548) 269
(21) 25
(16) 22
(18) 6

Abingdon Pl
Driveway
4 (38)
0 (2)
4 (1)
499 (280)
(11) 32
(460) 230
(6) 1
(7) 2
(0) 0
(2) 1

Fairway Dr
Vances Mill Rd
33 (16)
7 (0)
6 (1)
3 (2)
381 (221)
75 (16)
(18) 7
(315) 172
(70) 36
(57) 49
(10) 2
(65) 46

STARS VDOT

Interstate 81 - Exit 17
Interchange Modification Report

Existing AM and PM Peak Hour Traffic Volumes

FIGURE
3

NOT TO SCALE

Legend

- Study Area Intersection
- XX (XX) - AM (PM) Peak Hour Factors
- Traffic Signal
- Stop Control

Green Spring Rd: 0.89 (0.76) 0.89 (0.76) | 0.84 (0.88) 0.84 (0.88) | (0.88) 0.86 (0.88) 0.86

Washington Crossing: 0.69 (0.66) 0.69 (0.66) | 0.91 (0.82) 0.91 (0.82) | (0.87) 0.93 (0.87) 0.93

I-81 SB Off-Ramp: 0.80 (0.92) 0.80 (0.92) | 0.90 (0.88) 0.90 (0.88) | (0.89) 0.94 (0.89) 0.94

I-81 SB On-Ramp

Country Club Dr: 0.72 (0.71) 0.72 (0.71) | 0.88 (0.91) 0.88 (0.91) | (0.78) 0.84 (0.78) 0.84

Birdie Dr: 0.74 (0.59) 0.74 (0.59) 0.74 (0.59) | 0.86 (0.79) 0.86 (0.79) 0.86 (0.79) | (0.90) 0.86 (0.90) 0.86 (0.90) 0.86

Driveway: (0.55) 0.33 (0.55) 0.33 (0.55) 0.33

Gravel Lake Rd: 0.79 (0.90) 0.79 (0.90) | (0.95) 0.82 (0.95) 0.82 | (0.70) 0.72 (0.70) 0.72

Cummings Street

75

INTERSTATE 81

Cook St: 0.95 (0.93) 0.95 (0.93) | (0.83) 0.87 (0.83) 0.87 | (0.94) 0.95 (0.94) 0.95

Towne Centre Dr: 0.92 (0.86) 0.92 (0.86) | (0.90) 0.95 (0.90) 0.95 | (0.84) 0.72

I-81 NB On-Ramp: 0.92 (109) 0.92 (342) | (0.95) 0.96 (0.95) 0.96

I-81 NB Off-Ramp: (0.70) 0.85 (0.70) 0.85

Commerce Dr: 0.93 (0.98) 0.93 (0.98) | (0.88) 0.81 (0.88) 0.81 | (0.71) 0.70 (0.71) 0.70

Abingdon Pl: 0.50 (0.59) 0.50 (0.59) | 0.95 (0.89) 0.95 (0.89) | (0.87) 0.87 (0.87) 0.87 (0.87) 0.87

Driveway: (0.75) 0.38 (0.75) 0.38 (0.75) 0.38

Fairway Dr: 0.68 (0.71) 0.68 (0.71) 0.68 (0.71) | 0.84 (0.94) 0.84 (0.94) 0.84 (0.94) | (0.90) 0.82 (0.90) 0.82 (0.90) 0.82

Vances Mill Rd: (0.81) 0.81 (0.81) 0.81 (0.81) 0.81

STARS | VDOT

Interstate 81 - Exit 17

Interchange Modification Report

Existing AM and PM Peak Hour Factors

FIGURE

4

NOT TO SCALE

Legend

- Study Area Intersection
- XX% (XX%) - AM (PM) Peak Hour Heavy Vehicles
- Traffic Signal
- Stop Control

Green Spring Rd
5% (0%)
3% (0%)
1% (1%)
3% (1%)
(0%) 8%
(1%) 3%

Washington Crossing
14% (0%)
0% (0%)
17% (0%)
1% (1%)
(0%) 0%
(1%) 3%

I-81 NB On-Ramp

I-81 SB Off-Ramp
2% (2%)
5% (1%)
1% (1%)
0% (0%)
(1%) 1%
(0%) 2%

I-81 SB On-Ramp

Country Club Dr
0% (1%)
8% (0%)
27% (0%)
2% (1%)
(0%) 11%
(3%) 4%

Birdie Dr
2% (6%)
0% (0%)
0% (0%)
0% (0%)
5% (4%)
0% (0%)
(3%) 9%
(1%) 11%
(0%) 0%
Driveway
(0%) 0%
(0%) 0%
(0%) 0%

Gravel Lake Rd
2% (3%)
50% (86%)
(1%) 7%
(40%) 53%
(11%) 90%
(46%) 40%

Cummings Street

75

INTERSTATE 81

Cook St
2% (1%)
5% (1%)
(1%) 2%
(0%) 11%
(0%) 7%
(2%) 7%

Towne Centre Dr
2% (1%)
0% (0%)
(1%) 2%
(0%) 0%
(0%) 0%

I-81 NB On-Ramp
1% (3%)
1% (2%)
(3%) 4%
(0%) 3%
(2%) 1%
(0%) 3%

I-81 NB Off-Ramp

16% (16%)

(15%) 15%

Commerce Dr
3% (2%)
0% (0%)
(1%) 10%
(0%) 0%
(0%) 0%
(0%) 0%

Abingdon Pl
0% (0%)
0% (0%)
0% (100%)
4% (4%)
(0%) 0%
(3%) 11%
(0%) 0%
Driveway
(0%) 0%
(0%) 0%
(0%) 0%

Fairway Dr
0% (0%)
0% (0%)
0% (0%)
0% (0%)
2% (6%)
1% (6%)
(0%) 0%
(2%) 9%
(6%) 3%
Vances Mill Rd
(2%) 10%
(0%) 0%
(0%) 2

STARS

VDOT

Interstate 81 - Exit 17
Interchange Modification Report

Existing AM and PM Peak Hour
Heavy Vehicle Percentages

FIGURE
5

NOT TO SCALE

Legend

- Study Area Intersection
- Roadway Laneage
- Channelization
- Traffic Signal
- Stop Control
- XX' - Effective Storage Length
- XX' - Distance to Adjacent Intersection
- Posted Speed Limit

SPEED LIMIT 70

SPEED LIMIT 35

SPEED LIMIT 45

75

Cummings Street

INTERSTATE 81

Green Spring Rd
STOP
150'
145'

Washington Crossings
STOP
500'
75'
50'

I-81 SB Off-Ramp
765'
250'
285'
85'
500'
500'
I-81 SB On-Ramp

Country Club Dr
120'
STOP
510'
50'

Birdie Dr
STOP
890'
575'
STOP
Driveway

Fairway Dr
STOP
415'
150'
STOP
Vances Mill Rd

Towne Centre Dr
50'
150'
STOP

Cook St
145'
125'

I-81 NB On-Ramp
75'
60'
160'
285'
1,105'
115'
I-81 NB Off-Ramp

Commerce Dr
50'
60'
STOP
110'

Abingdon Pl
STOP
575'
510'
STOP
Driveway

Gravel Lake Rd
415'
890'
STOP

STARS VDOT

Interstate 81 - Exit 17

Interchange Modification Report

Existing Geometric Conditions

FIGURE 6

2.7.4. Existing Crash Data

The latest five (5) years of crash data, collected between January 1, 2011, and December 31, 2015, was compiled and summarized within the study area. Further safety analysis discussion may be found in in Section 2.9 - Existing Safety Conditions.

2.8. Existing Traffic Operations

The existing traffic operations for this IMR consists of the analysis of several freeway and arterial components within the study area. Along the freeway; mainline freeway segments and ramp merge/diverges were all analyzed. Along the arterials, study area signalized and unsignalized intersections were evaluated in terms of their operational performance. Both freeway and arterial segments were analyzed under Existing, No-Build, and Build scenarios.

The Highway Capacity Software (HCS), CORSIM, Synchro V9.1, and SimTraffic software packages were used in the operational analyses to evaluate existing conditions. HCS was used to analyze the freeway and ramp locations within the project study area using the "Freeway Facilities" module. CORSIM was used to analyze the same study area locations as HCS; however, CORSIM was also used to factor the arterial conditions into the interstate operations in a single, comprehensive network. Synchro was used to analyze the intersection operations and SimTraffic to report intersection queue lengths. The following sections describe the results from each of the operational analysis tools for the existing conditions. Further discussion on the traffic operation analysis methodology and assumptions are presented in Chapter 6 - Traffic Operations.

2.8.1. HCS Existing Conditions Results

The results of the existing conditions analysis from the HCS software depict density and level of service (LOS) along I-81 within the study area. A summary of the HCS existing conditions is shown in Table 2 and depicts density, in passenger cars per mile per lane, and level of service (LOS) by location (i.e., off-ramp junction, on-ramp junction, freeway segment, weave, lane transition) in both eastbound and westbound directions. Graphically, speed and density results are depicted in the HCS result graphics. Detailed graphical representations of the HCS results are also provided in Appendix C and illustrate the modeled hourly demands, acceleration/deceleration lane lengths, segment influence lengths, and the number of lanes along I-81.

Based on the results of the existing conditions analysis, the mainline freeway segments and ramp merge/diverges within the study area are currently operating at LOS B or better during the AM and PM peak hours.

2.8.2. CORSIM Existing Conditions Results

The results of the existing conditions analysis from the CORSIM software depict density by location (i.e., off-ramp junction, on-ramp junction, freeway segment, weave, lane transition) in both eastbound and westbound directions on I-81. Since CORSIM does not account for passenger car equivalents, its density will always be lower than that of HCS; therefore, densities from CORSIM generally above 35 veh/ln/mi reflect operations similar to HCM LOS E and worse. A summary of the existing CORSIM analysis is shown in Table 3. Detailed graphical representations of the CORSIM results are provided in Appendix D and illustrate the simulated speed and density results as lane schematics, showing the "by-link" and "by-lane" summaries.

Based on the results of the existing conditions analysis, mainline I-81 is operating at acceptable conditions as speeds are maintained and vehicle densities are below 35 veh/ln/mi.

Table 2: HCS Existing Conditions Results

Segment	Facility	AM Peak		PM Peak	
		Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS
Eastbound					
4,000' west of Exit 17 Off-Ramp	Freeway	11.1	B	15.2	B
Diverge to Exit 17 Off-Ramp	Diverge	13.0	B	17.8	B
Freeway between diverge and merge for Exit 17	Freeway	8.9	A	12.3	B
Merge from Exit 17 On-Ramp	Merge	11.7	B	16.3	B
4,000' east of Exit 17 On-Ramp	Freeway	10.7	A	14.8	B
Westbound					
4,000' east of Exit 17 Off-Ramp	Freeway	13.1	B	14.2	B
Diverge to Exit 17 Off-Ramp	Diverge	15.3	B	16.6	B
Freeway between diverge and merge for Exit 17	Freeway	10.2	A	12.0	B
Merge from Exit 17 On-Ramp	Merge	13.6	B	16.3	B
4,000' west of Exit 17 On-Ramp	Freeway	12.4	B	14.7	B

Table 3: CORSIM Existing Conditions Results

Segment	Facility Type	Density (veh/ln/mi)	
		AM	PM
Eastbound			
West of Exit 17 Off-Ramp	Freeway	10.1	13.8
Diverge to Exit 17 Off-Ramp	Ramp	7.6	10.4
Freeway between diverge and merge for Exit 17	Freeway	7.5	10.4
Merge from Exit 17 On-Ramp	Ramp	6.6	9.4
East of Exit 17 On-Ramp	Freeway	9.6	13.3
Westbound			
East of Exit 17 Off-Ramp	Freeway	11.6	12.5
Diverge to Exit 17 Off-Ramp	Ramp	8.8	9.4
Freeway between diverge and merge for Exit 17	Freeway	8.6	9.8
Merge from Exit 17 On-Ramp	Ramp	8.0	9.4
West of Exit 17 On-Ramp	Freeway	11.2	13.0

2.8.3. Synchro/SimTraffic Existing Conditions Results

The adjusted intersection turning movement counts, as described in Section 2.7.1 - Existing Traffic Volumes and Peak Hour Factors, were used in conjunction with existing geometric data (i.e., number of lanes, turn-lane storage lengths, intersection traffic control, etc.) to determine the existing vehicle delay, levels of service, and queue lengths for each study area intersection. Table 4 summarizes the AM and PM peak hour vehicular delay and LOS for each movement, approach, and overall intersection operations. Values highlighted in bold represent movements operating at LOS E or worse. Table 5 summarizes the maximum simulated queues for each movement during the AM and PM peak hours. Detailed outputs for the existing conditions analysis are provided in Appendix E. Values highlighted as "bold*" represent queue lengths that exceed the available storage lengths/spill back to an upstream intersection and values highlighted in red represent queue lengths that are excessively long. Generally, all intersection movements are operating at LOS D or better. The following intersections experience high levels of delay and/or long queue lengths, as discussed below:

I-81 WB Off/On-Ramps at State Route 75

- State Route 75 northbound left-turn lane queues exceed the available amount of storage during the AM and PM peak hours
    - Due to geometric constraints, there is only approximately 85 feet of effective storage length available for vehicles to queue while waiting to turn-left to access the I-81 westbound on-ramp. This results in left-turning vehicles consistently exceeding the available storage length and therefore blocking the through vehicles traveling north on State Route 75.

I-81 EB Off/On-Ramps at State Route 75

- I-81 eastbound off-ramp left-turn movement experiences LOS E (62.1 sec/veh) during the PM peak hour
- I-81 eastbound right-turn movement queues exceed the available amount of storage during the AM and PM peak hours
    - Right-turning vehicles only have approximately 115 feet of effective storage length to queue while waiting to access southbound State Route 75.
    - This results in conditions where vehicles wanting to turn right are queued to the extent that they block the vehicles on the eastbound off-ramp from accessing the left-turn lane to travel northbound State Route 75.
- State Route 75 northbound through queue spills back to/through the Commerce Drive and Country Club Drive intersections
    - The northbound AM and PM peak hours through queues spill back and impact the upstream intersections (Commerce Drive and Country Club Drive) 95 feet and 165 feet to the south respectively.
- State Route 75 southbound left-turn queue lengths nearly exceed the available amount of storage during the AM and PM peak hours
    - Left-turning vehicles only have approximately 160 feet of effective storage length to queue when trying to access the I-81 eastbound on-ramp.
    - This often results in conditions where vehicles wanting to turn left block the through vehicles on southbound State Route 75.

Commerce Drive at State Route 75

- State Route 75 northbound through queues spill back to the next upstream intersection (Country Club Drive)
    - There is approximately 65 feet to the south before the next upstream intersection begins to be impacted by queuing vehicles.
    - The northbound through queues consistently exceed this distance during both the AM and PM peak hours.

Country Club Drive at State Route 75

- Southbound through queue spills back to the next upstream intersection (Commerce Drive)
    - There is approximately 90 feet to the north before the next upstream intersection begins to be impacted by queuing vehicles.
    - The southbound through queues consistently exceed this distance during the AM and PM peak hours.

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Table 4: Existing Intersection LOS Summary

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
1 Cook Street at State Route 75			Cook Street								State Route 75				State Route 75					
	Signal	Left	17.6	B	27.9	C	-	-	-	-	3.6	A	9.2	A	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-	3.7	A	4.5	A	10.4	B	20.1	C	7.0	15.2
		Right	8.2	A	11.3	B	-	-	-	-	-	-	-	-					LOS	LOS
		Approach	12.1	B	19.0	B	-	-	-	-	3.7	A	5.9	A	10.4	B	20.1	C	A	B
2 Green Spring Road at State Route 75			-				Green Spring Road				State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-					-	-	-	-	2.0	A	2.0	A	Delay	Delay
		Through	-	-	-	-	17.6	C	13.6	B	0.0	A	0.0	A					0.9	1.1
		Right	-	-	-	-									-	-	-	-	LOS	LOS
		Approach	-	-	-	-	17.6	C	13.6	B	0.0	A	0.0	A	0.7	A	0.7	A	A	A
3 Towne Centre Drive at State Route 75			Towne Centre Drive								State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-	-	-	-	-	0.1	A	0.0	A	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-					0.0	A	0.0	A	0.2	0.4
		Right	9.8	A	9.5	A	-	-	-	-	-	-	-	-					LOS	LOS
		Approach	9.8	A	9.5	A	-	-	-	-	0.0	A	0.0	A	0.0	A	0.0	A	A	A
4 Washington Crossing at State Route 75			McDonald's Driveway				Washington Crossing				State Route 75				State Route 75					
	One-Way Stop	Left									0.0	A	0.0	A	10.3	B	9.7	A	Delay	Delay
		Through	10.6	B	9.4	A	15.7	C	14.8	B	0.0	A	0.0	A	0.0	A	0.0	A	0.9	1.0
		Right																	LOS	LOS
		Approach	10.6	B	9.4	A	15.7	C	14.8	B	0.0	A	0.0	A	0.3	A	0.2	A	A	A
5 I-81 WB Ramp at State Route 75			-				I-81 WB Off-Ramp				State Route 75				State Route 75					
	Signal	Left	-	-	-	-	41.9	D	43.4	D	9.8	A	37.1	D	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-	4.5	A	7.3	A	37.0	D	46.4	D	24.4	30.6
		Right	-	-	-	-	43.1	D	42.3	D	-	-	-	-	31.0	C	25.9	C	LOS	LOS
		Approach	-	-	-	-	42.9	D	42.6	D	5.5	A	11.5	B	34.4	C	38.6	D	C	C
6 I-81 EB Ramp at State Route 75			I-81 EB Off-Ramp				-				State Route 75				State Route 75					
	Signal	Left	44.4	D	62.1	E	-	-	-	-	-	-	-	-	18.1	B	10.9	B	Delay	Delay
		Through	-	-	-	-	-	-	-	-	29.9	C	40.9	D	1.3	A	2.5	A	26.7	30.9
		Right	32.1	C	38.5	D	-	-	-	-	20.9	C	29.2	C	-	-	-	-	LOS	LOS
		Approach	40.9	D	52.2	D	-	-	-	-	27.9	C	38.1	D	8.3	A	5.8	A	C	C
7 Commerce Drive at State Route 75			Commerce Drive				-				State Route 75				State Route 75					
	One-Way Stop	Left					-	-	-	-	0.1	A	0.1	A	-	-	-	-	Delay	Delay
		Through	17.5	C	17.3	C	-	-	-	-					0.0	A	0.0	A	0.7	0.8
		Right					-	-	-	-	-	-	-	-					LOS	LOS
		Approach	17.5	C	17.3	C	-	-	-	-	0.1	A	0.1	A	0.0	A	0.0	A	A	A
8 Country Club Drive at State Route 75			-				Country Club Drive				State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-					-	-	-	-	1.6	A	1.9	A	Delay	Delay
		Through	-	-	-	-	14.6	B	13.4	B	0.0	A	0.0	A					2.3	2.3
		Right	-	-	-	-									-	-	-	-	LOS	LOS
		Approach	-	-	-	-	14.6	B	13.4	B	0.0	A	0.0	A	1.6	A	1.9	A	A	A
9 Abingdon Place at State Route 75			Driveway				Abingdon Place				State Route 75				State Route 75					
	Two-Way Stop	Left																	Delay	Delay
		Through	15.6	C	19.4	C	11.6	B	10.9	B	0.0	A	0.0	A	1.4	A	0.3	A	0.7	1.2
		Right																	LOS	LOS
		Approach	15.6	C	19.4	C	11.6	B	10.9	B	0.0	A	0.0	A	1.4	A	0.3	A	A	A
10 Birdie Drive at State Route 75			Driveway				Birdie Drive				State Route 75				State Route 75					
	Two-Way Stop	Left																	Delay	Delay
		Through	9.7	A	19.3	C	13.8	B	11.4	B	0.1	A	0.0	A	0.5	A	1.1	A	1.4	1.4
		Right																	LOS	LOS
		Approach	9.7	A	19.3	C	13.8	B	11.4	B	0.1	A	0.0	A	0.5	A	1.1	A	A	A
11 Gravel Lake Road at State Route 75			Gravel Lake Road								State Route 75				State Route 75					
	One-Way Stop	Left					-	-	-	-	0.1	A	0.3	A	0.0	A	0.0	A	Delay	Delay
		Through	20.8	C	14.5	B	-	-	-	-									0.9	0.9
		Right					-	-	-	-	-	-	-	-	-	-	-	-	LOS	LOS
		Approach	20.8	C	14.5	B	-	-	-	-	0.1	A	0.3	A	0.0	A	0.0	A	A	A
12 Vances Mill Road/Fairway Drive at State Route 75			Vances Mill Road				Fairway Drive				State Route 75				State Route 75					
	Two-Way Stop	Left													0.4	A	0.6	A	Delay	Delay
		Through	22.5	C	16.9	C	15.1	C	10.0	A	1.9	A	0.7	A					4.8	3.8
		Right													0.0	A	0.0	A	LOS	LOS
		Approach	22.5	C	16.9	C	15.1	C	10.0	A	1.9	A	0.7	A	0.3	A	0.5	A	A	A

Table 5: Existing Intersection Queuing Summary

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND			WESTBOUND			NORTHBOUND			SOUTHBOUND		
			Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)
1 Cook Street at State Route 75			Cook Street			-			State Route 75			State Route 75		
	Signal	Left	-	98	181	-	-	-	125	84	121	-	-	-
		Through	-	-	-	-	-	-	145	104	125	-	125	305
		Right	-	87	183	-	-	-	-	-	-			
2 Green Spring Road at State Route 75			-			Green Spring Road			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-				-	-	-	145	120	149*
		Through	-	-	-	-	82	120	150	35	23			
		Right	-	-	-							-	-	-
3 Towne Centre Drive at State Route 75			Towne Centre Drive			-			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-	-	-	-	50	28	12	-	-	-
		Through	-	-	-	-	-	-				150	7	6
		Right	-	15	58	-	-	-	-	-	-	150	0	19
4 Washington Crossing at State Route 75			McDonald's Driveway			Washington Crossing			State Route 75			State Route 75		
	One-Way Stop	Left							-	0	0	75	24	24
		Through	-	83	70	-	47	89	500	2	1	50	73*	81*
		Right												
5 I-81 WB Ramp at State Route 75			-			I-81 WB Off-Ramp			State Route 75			State Route 75		
	Signal	Left	-	-	-	250	126	134	85	106*	106*	-	-	-
		Through	-	-	-	-	-	-	285	166	191	500	287	473
		Right	-	-	-	765	186	144	-	-	-	500	240	331
6 I-81 EB Ramp at State Route 75			I-81 EB Off-Ramp			-			State Route 75			State Route 75		
	Signal	Left	1,105	373	463	-	-	-	-	-	-	160	167*	184*
		Through	-	-	-	-	-	-	60	175*	165*	285	122	213
		Right	115	186*	324*	-	-	-	75	59	59	-	-	-
7 Commerce Drive at State Route 75			Commerce Drive			-			State Route 75			State Route 75		
	One-Way Stop	Left	-	170	80	-	-	-	50	130*	123*	-	-	-
		Through	-	-	-	-	-	-				60	85*	116*
		Right	110	44	50	-	-	-	-	-	-			
8 Country Club Drive at State Route 75			-			Country Club Drive			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-	-	130	74	-	-	-	50	139*	134*
		Through	-	-	-	-	-	-	510	326	189			
		Right	-	-	-	120	131*	109				-	-	-
9 Abingdon Place at State Route 75			Driveway			Abingdon Place			State Route 75			State Route 75		
	Two-Way Stop	Left												
		Through	-	30	32	-	28	52	575	0	0	510	68	53
		Right												
10 Birdie Drive at State Route 75			Driveway			Birdie Drive			State Route 75			State Route 75		
	Two-Way Stop	Left												
		Through	-	31	40	-	71	54	890	11	0	575	30	73
		Right												
11 Gravel Lake Road at State Route 75			Gravel Lake Road			-			State Route 75			State Route 75		
	One-Way Stop	Left				-	-	-	415	20	70	-	-	-
		Through	-	103	78	-	-	-				890	4	10
		Right				-	-	-	-	-	-			
12 Vances Mill Road/Fairway Drive at State Route 75			Vances Mill Road			Fairway Drive			State Route 75			State Route 75		
	Two-Way Stop	Left										415	56	43
		Through	-	80	86	-	56	37	-	60	46			
		Right										150	8	2

2.9. Existing Safety Conditions

A crash analysis was conducted to review the existing crash patterns on I-81 and State Route 75 within the study area. The latest five (5) years of crash data, collected between January 1, 2011, and December 31, 2015, was compiled and summarized within the study area. Limits of the crash analysis on I-81 extends approximately 1.0 mile in either direction from Exit 17 and includes the Exit 17 on and off ramps. The limits of the crash analysis on State Route 75 extends approximately 1.0 mile from Cook Street to Vances Mill Road.

2.9.1. Crashes by Severity

During the five-year period, a total of 188 crashes occurred on the study area corridors. Table 6 summarizes a breakdown of crash severity (i.e., proportion of the crashes involving an injury, fatality, or property damage only). The majority of crashes that occurred in the study area were property damage only (PDO) crashes, making up 70 percent of the total crashes. Twenty-nine percent of the crashes resulted in an injury. One fatal crash occurred on eastbound I-81 during the five-year period.

Table 6: Crash Severity

Segment	Direction	Severity						Total
		PDO		Injuries		Fatalities		
I-81	EB	14	61%	8	35%	1	4%	23
	WB	34	74%	12	26%	0	0%	46
	Exit 17 Ramps	8	53%	7	47%	0	0%	15
Corridor Subtotal		56	67%	27	32%	1	1%	84
State Route 75		76	73%	28	27%	0	0%	104
Corridor Subtotal		76	73%	28	27%	0	0%	104
Overall Total		132	70%	55	29%	1	1%	188

Number of Crashes | Percentage of Crashes

2.9.2. Crash Rates

Bi-directional crash rates were computed for the study corridors for the five-year study period as shown in Table 7. Crash rates are based on the number of crashes on the specified section, the Annual Average Daily Traffic (AADT) on the roadway, the time-period of analysis, and the length of the section. All crash rates are expressed in terms of crashes per 100 million vehicle-miles traveled (MVMT). The crash rates for the study section were compared to the latest available 2013 average statewide crash rates for interstates, rural minor arterials, and rural major collectors.

The overall crash rate on I-81 to the west of State Route 75 experienced a slightly higher crash rate when compared to the statewide average. Additionally, both sections on State Route 75 had significantly higher crash rates compared to the statewide average for similar facilities. Injury crash rates along I-81 in the study area were lower than the statewide averages. However, injury crash rates on State Route 75 between Cook Street and I-81 were significantly higher than the statewide averages. With the one fatal crash reported along I-81 to the east of State Route 75 during the five-year time-period, the fatal crash rate was calculated to be higher than the statewide average. However, no fatalities were reported on State Route 75 in the study area.

Table 7: Study Area Crash Rates

Crashes			Injury			Fatal		
# of Total Crashes	Section Crash Rate	2013 Statewide Average Crash Rate	# of Injury Crashes	Section Injury Rate	2013 Statewide Average Injury Rate	# of Fatal Crashes	Section Fatal Crash Rate	2013 Statewide Fatal Crash Rate
I-81 – East of State Route 75								
34	43.9	52.76^	11	14.2	22.41^	0	0	0.35^
I-81 – West of State Route 75								
35	56.3	52.76^	9	11.6	22.41^	1	1.6	0.35^
State Route 75 - between Cook Street and I-81								
84	883.8	118.76*	25	263.0	65.41*	0	0	1.82*
State Route 75 - between I-81 and Gravel Lake Road								
20	179.2	140.19+	3	26.9	74.99+	0	0	3.01+

Notes:
Analysis Period = 5 Years (January 1, 2011 to December 31, 2015)
^ Crash Rate by District (1 Bristol) / Interstate Roads / Year 2013
* Crash Rate by Primary Road / Functional Class / Rural Minor Arterial / Year 2013
+ Crash Rate by Primary Road / Functional Class / Rural Major Collector / Year 2013
Crash rate = Total Crashes / [(ADT) x (365) x (Time Frame of Analysis (Years)) x (Section Length)] / 100,000,000
Crash rates are expressed in crashes per 100 million vehicle-miles traveled (MVMT)

	Section Length	Total of Average Annual Daily Traffic (AADT) between 2011 and 2015
I-81 – East of Exit 17	1 miles	212,000
I-81 – West of Exit 17	1 miles	213,000
Cummings Street – between Cook Street and I-81	0.31 miles	84,000
Cummings Street – between I-81 and Gravel Lake Road	0.78 miles	39,200

2.9.3. Crash Conditions

Table 8, Table 9, and Table 10 summarize crash trends given weather, lighting, and time-of-day conditions, respectively. The following conclusions are noted from this data for the study area:

- Poor weather was not a major contributing factor with 76 percent of the overall crashes occurring under clear/cloudy conditions for the study corridors.
- A majority of crashes (78 percent) occurred during daylight hours with 18 percent of crashes occurring during dark/night time conditions. Only 4 percent of the crashes occurred during dawn/dusk. Street lighting is provided along the State Route 75 segment of the study area.
- Approximately 21 percent and 31 percent of the crashes occurred during the AM (6:00 am to 10:00 am) and PM (3:00 pm to 7:00 pm) peak periods, respectively.

Table 8: Crash Summary – Weather Condition

Segment	Direction	Weather Condition								Total
		Clear		Fog		Rain/Mist		Snow/Sleet/ Hail/Other		
I-81	EB	15	65%	0	0%	6	26%	2	9%	23
	WB	38	83%	0	0%	8	17%	0	0%	46
	Exit 17 Ramps	13	87%	0	0%	2	13%	0	0%	15
Corridor Subtotal		66	79%	0	0%	16	19%	2	2%	84
State Route 75		77	74%	2	2%	22	21%	3	3%	104
Corridor Subtotal		77	74%	2	2%	22	21%	3	3%	104
Overall Total		143	76%	2	1%	38	20%	5	3%	188
Number of Crashes | Percentage of Crashes										

Table 9: Crash Summary – Lighting Condition

Segment	Direction	Lighting Condition						Total
		Daylight		Dawn/Dusk		Dark		
I-81	EB	13	57%	1	4%	9	39%	23
	WB	31	68%	2	4%	13	28%	46
	Exit 17 Ramps	12	80%	2	13%	1	7%	15
Corridor Subtotal		56	67%	5	6%	23	27%	84
State Route 75		91	87%	2	2%	11	11%	104
Corridor Subtotal		91	87%	2	2%	11	11%	104
Overall Total		147	78%	7	4%	34	18%	188
Number of Crashes | Percentage of Crashes								

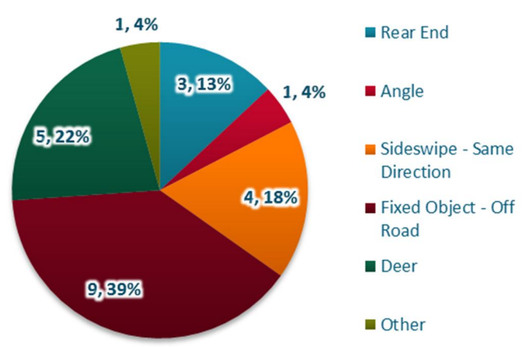
Table 10: Crash Summary – Time of Day

Segment	Direction	Peak Period				Off Peak		Total
		AM (6:00 - 10:00)		PM (3:00 - 7:00)				
I-81	EB	7	30%	3	13%	13	57%	23
	WB	16	35%	8	17%	22	48%	46
	Ramps	4	27%	6	40%	5	33%	15
Corridor Subtotal		27	32%	17	20%	40	48%	84
State Route 75		13	13%	41	39%	50	48%	104
Corridor Subtotal		13	13%	41	39%	50	48%	104
Overall Total		40	21%	58	31%	90	48%	188
Number of Crashes | Percentage of Crashes								

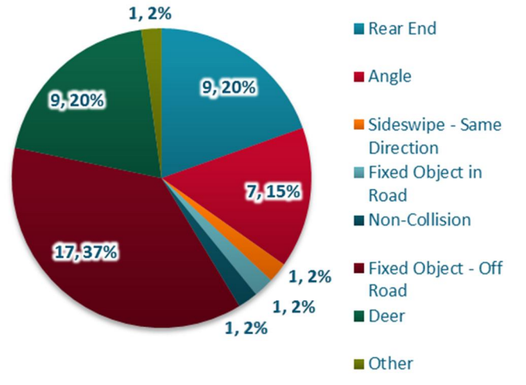
2.9.4. Crash by Type

Figure 7 summarizes crash type percentages throughout the study corridors by direction. The predominant crash type on I-81 within the study section for both eastbound and westbound directions was "fixed object – off road", consisting of approximately 40 percent of the crashes on the corridor. Rear end crashes were the second most prevalent crash type along I-81 with 13 and 20 percent of the crashes for eastbound and westbound, respectively. On the Exit 17 ramps, approximately 93 percent of the crashes were rear end collisions, as shown in Figure 7 (c). Along State Route 75, angle crashes made up the majority of the crashes followed by rear end with 53 and 31 percent, respectively.

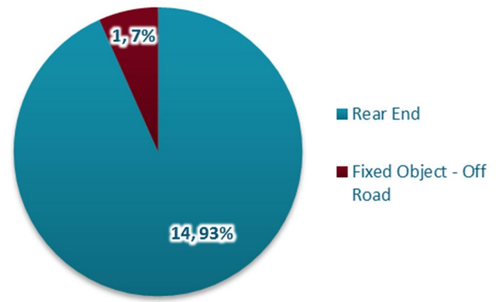
Figure 7: Crash Type Summary



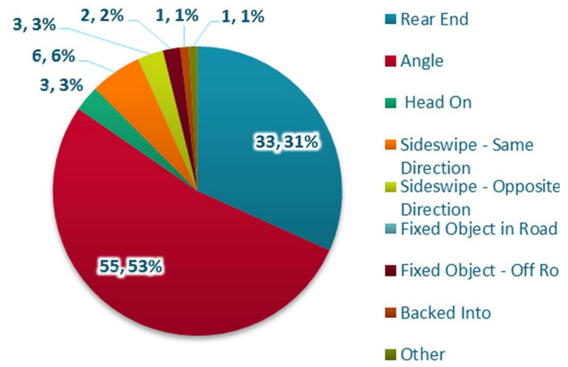
(a.) I-81 - Eastbound Direction



(b.) I-81 – Westbound Direction



(c.) I-81 - Exit 17 Ramps



(d.) SR 75 (Cummings Street)

2.9.5. Crash Density

Crash density is represented along the study corridors in Figure 8 through Figure 10.

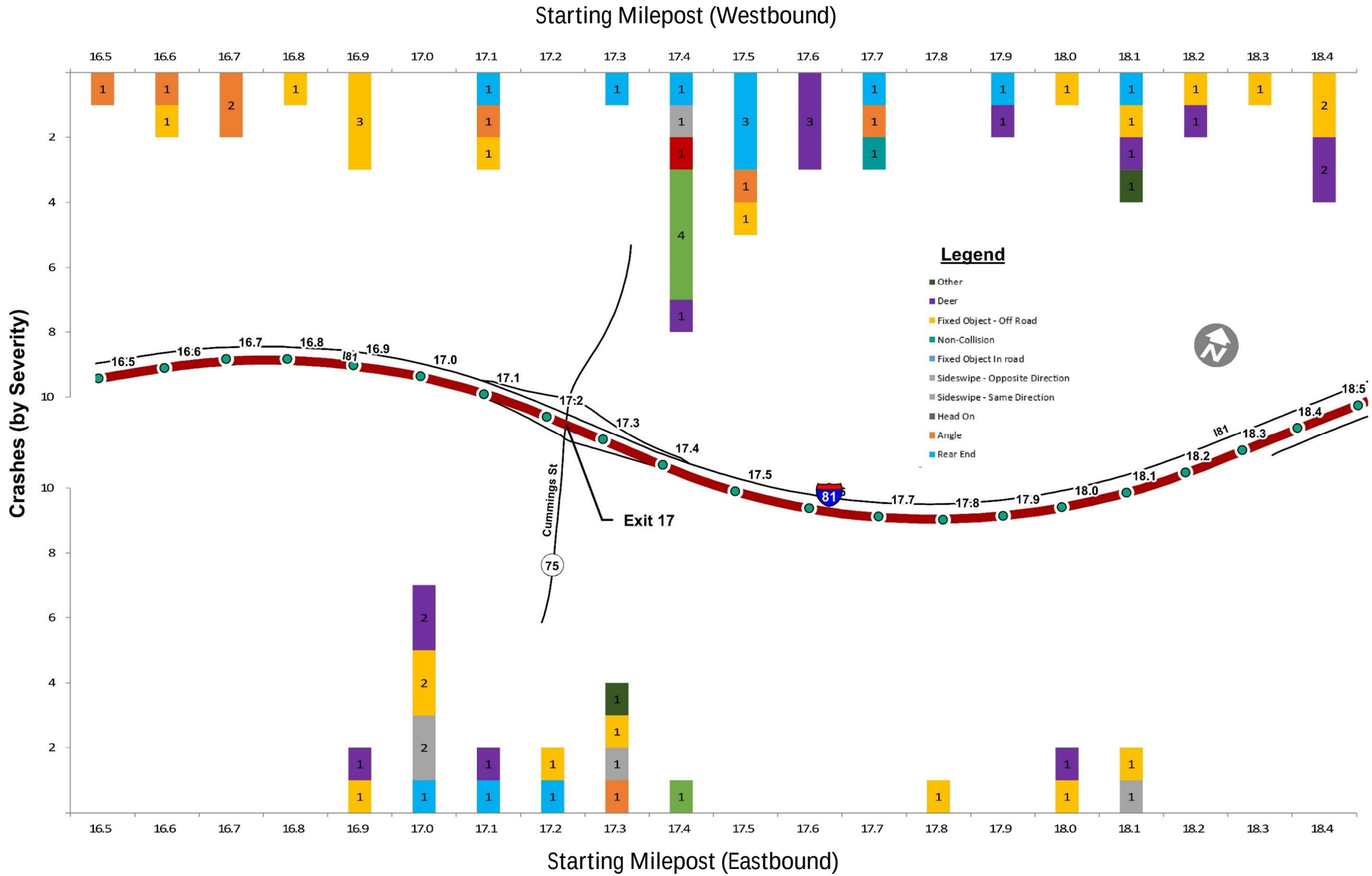


Figure 8: I-81 Crash Histogram (by Type)

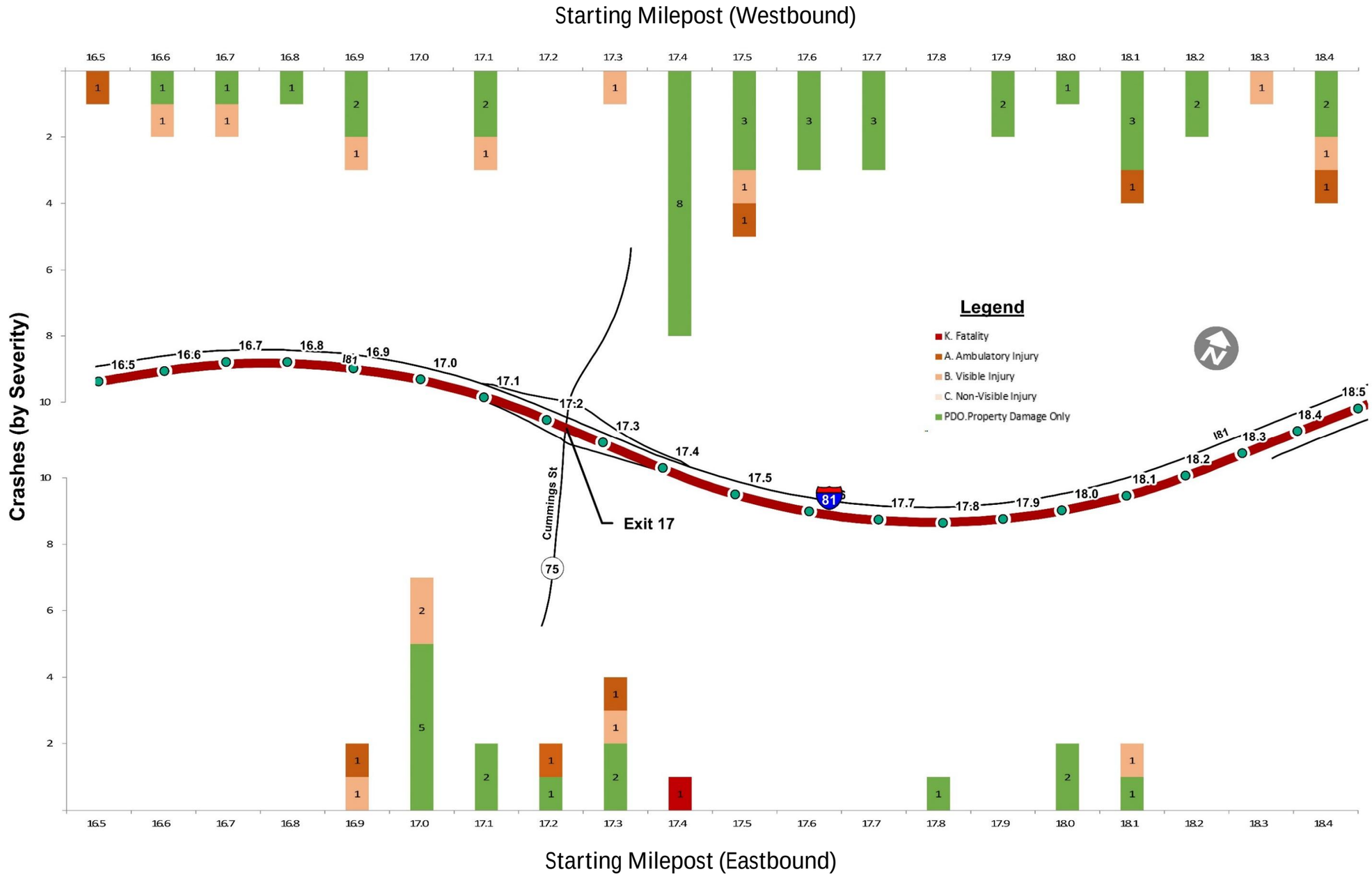


Figure 9: I-81 Crash Histogram (by Severity)

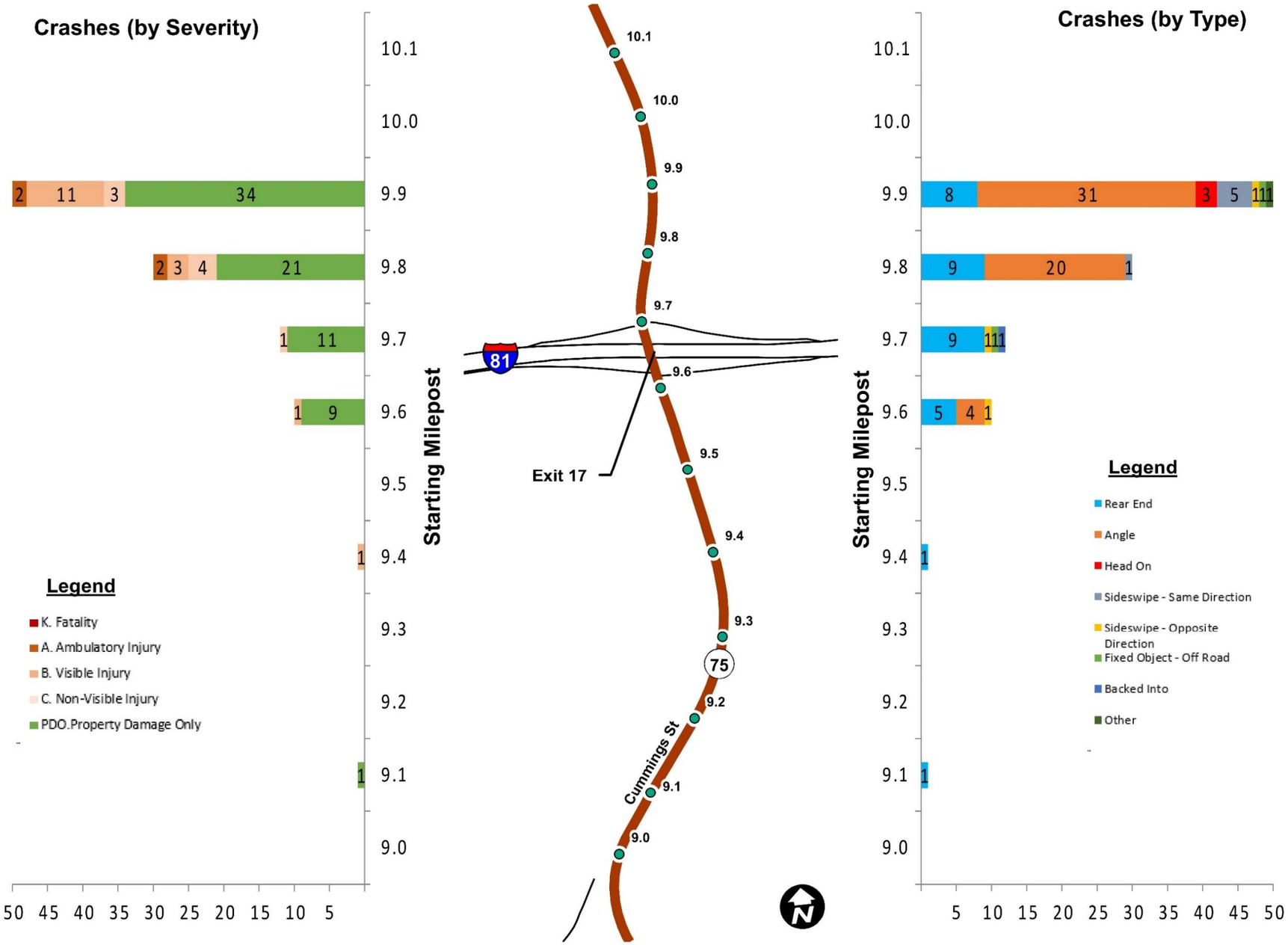


Figure 10: SR 75 (Cummings Street) Crash Histogram

3. Alternatives Considered

In order to improve interchange operations, an adequate spacing distance between the two I-81 off/on-ramp signalized intersections along State Route 75 must be implemented in an effort to mitigate the operational impacts along State Route 75 in the immediate vicinity of the interchange, the I-81 eastbound and westbound off-ramps, and along the I-81 mainline in the vicinity of the off-ramp gore areas. The increased spacing between intersections is intended to provide more adequate left-turn storage lane lengths underneath the bridge. This will diminish the potential for queued left-turning vehicles (often as few as two or three) from blocking the northbound and southbound through lanes along State Route 75, resulting in improved ramp intersection operations by mitigating blocked receiving/travel lanes and significant queues, as well as enhance overall interchange operational conditions.

Six (6) different interchange alternative concepts were considered and are described in more detail below:

- Alternative 1 - No-Build
- Alternative 2 - Expanded Diamond (i.e., New I-81 EB Off/On-Ramps, relocate existing traffic signal to the south approximately 300 feet from its current location resulting in 600 feet of separation between signals)
- Alternative 3 - Partial Cloverleaf (i.e., New I-81 EB Off-Ramp/On-Loop, relocate existing traffic signal to the south approximately 300 feet from its current location resulting in 600 feet of separation between signals)
- Alternative 4 - Partial Cloverleaf (i.e., New I-81 WB Off-Ramp/On-Loop, relocate existing traffic signal to the north approximately 400 feet from its current location resulting in 700 feet of separation between signals)
- Alternative 5 - Partial Cloverleaf (i.e., New I-81 EB Off-Loop/On-Ramp, relocate existing traffic signal to the south approximately 300 feet from its current location resulting in 600 feet of separation between signals)
- Alternative 6 - Full Interchange Reconstruction

3.1. No-Build Conditions

Alternative 1, or the No-Build option, represents the current roadway conditions with just planned or programmed improvements within the study area. The No-Build option does not satisfy the purpose and need of addressing the operational constraints and concerns that exist at the interchange today nor does it address the future deterioration in operational conditions as a result of expected natural growth in the study area. It is included in the analysis as a point of comparison to the other alternatives considered if no improvements were made to the existing interchange configuration.

The No-Build Condition does incorporate known future developments within the study area. Specifically, a new shopping center called “The Meadows” is proposed for construction in the northeast quadrant of State Route 75 and Cook Street/Realigned Green Spring Road intersection in 2018. A separate traffic impact study was conducted to analyze the traffic impacts of this proposed development and to provide the following recommendations that were incorporated into the 2020 and 2040 No-Build roadway network:

- Realign existing Green Spring Road with Cook Street at State Route 75 – creates a conventional four-legged intersection and the traffic signal will upgraded/modified to accommodate all approaches.
- Add a second 325-foot southbound left turn lane at State Route 75 and Cook Street/Realigned Green Spring Road, or extend the existing southbound left-turn lane to 550-feet
- Add a northbound right-turn lane at State Route 75 and Cook Street/Realigned Green Spring Road

3.2. Build Conditions

The following build alternatives attempt to satisfy the purpose and need in addressing the deficiencies of the current interchange operations.

3.2.1. Alternative 2 - Expanded Diamond

Alternative 2 reflects an Expanded Diamond (i.e., New I-81 EB Off/On-Ramps, relocate existing traffic signal to the south approximately 300 feet from its current location, resulting in increased spacing between signalized intersections of approximately 600 feet). The new off/on-ramps would both be lengthened as a result of the eastbound off/on-ramp intersection relocation. The new on-ramp would tie into the existing acceleration lane and taper in an effort to limit or avoid any additional improvements along the I-81 eastbound mainline. Improvements would occur in the southwest and southeast quadrants of the existing interchange. This alternative is illustrated in Figure 11.

3.2.2. Alternative 3 - Partial Cloverleaf (Southwest Quadrant)

Alternative 3 reflects a Partial Cloverleaf (i.e., New I-81 EB Off-Ramp/On-Loop in the southwest quadrant of the existing interchange, relocate existing traffic signal to the south approximately 300 feet from its current location, resulting in increased spacing between signalized intersections of approximately 600 feet, and widening of bridge to accommodate the acceleration lane associated with new on-loop). This will result in the opportunity to extend the existing acceleration lane from 1,050 feet to approximately 2,150 feet. This lengthening will be further supplemented by flex-post delineators as on-loop traffic is encouraged to gain or achieve a travel speed consistent with the I-81 eastbound traffic prior to merging into mainline travel lane. This will allow for the opportunity to proactively enhance the operational condition of the on-loop acceleration lane as vehicles merge into the I-81 eastbound mainline travel lane. Improvements would occur primarily in the southwest quadrant of the existing interchange. This alternative is illustrated in Figure 12.

3.2.3. Alternative 4 - Partial Cloverleaf (Northeast Quadrant)

Alternative 4 reflects a Partial Cloverleaf (i.e., New I-81 WB Off-Ramp/On-Loop in the northeast quadrant of the existing interchange, relocate existing traffic signal to the north approximately 400 feet from its current location, resulting in increased spacing between signalized intersections, and widening of bridge to accommodate acceleration lane associated with new on-loop). This will result in the opportunity to extend the existing acceleration lane from 725 feet to approximately 1,525 feet. Improvements would occur in the northeast quadrant of the existing interchange. It was noted that this concept had adverse effects on a significant component of the Town’s tax base due to its footprint impacting a gas station, a restaurant, and the Washington Crossing Shopping Center. This alternative is illustrated in Figure 13.

3.2.4. Alternative 5 - Partial Cloverleaf (Southeast Quadrant)

Alternative 5 reflects a Partial Cloverleaf (i.e., New I-81 EB Off-Loop/On-Ramp in the southeast quadrant of the existing interchange, relocate existing traffic signal to the south approximately 300 feet from its current location, resulting in increased spacing between signalized intersections, and widening of bridge to accommodate deceleration lane associated with new off-loop). Improvements would occur in the southeast quadrant of the existing interchange.

For the new/relocated signalized intersections traditional traffic control measures and intersection geometry are proposed. It is noted that this alternative was significantly impactful to a number of private properties located within or adjacent to the proposed improvements, it also left the need for additional access management strategies to be implemented for the numerous business site driveways located along the west side State Route 75. This alternative is illustrated in Figure 14.

3.2.5. Alternative 6 - Full Interchange Reconstruction

Alternative 6 reflects an "ultimate" interchange configuration previously under consideration by VDOT. This alternative reflects a new urban diamond interchange and would require the complete reconstruction of the Exit 17 interchange and realignment of Cummings Street. Specifically, it would require the overpass bridge piers to be moved, both bridges to be lengthened, and modifications to all four quadrants of the interchange. The realignment of Cummings Street consists of additional capacity for the through and turning lanes as well as the introduction of a raised median. Cummings Street would be widened to four lanes and dual left turning lanes for the movements entering the I-81 on ramps. The section of Cumming Street under the I-81 bridge would be widened to allow the dual left-turn lanes to be adjacent to each other, meaning this cross-section would effectively be widened to eight lanes. Ramp termini would also include additional turn lanes at the signalized intersections. The local roads of Commerce Street and Country Club Drive would be relocated and realigned approximately 350 to 450 feet to the south to provide additional spacing/separation from the I-81 eastbound off/on-ramp termini. This alternative is illustrated in Figure 15.

ALTERNATIVE #2 - DIAMOND INTERCHANGE

660' SIGNALIZED INTERSECTION SPACING

760' R
50 MPH

760' R
50 MPH

251' R
30 MPH

215' R
30 MPH

215' R
30 MPH

251' R
30 MPH

440' UNSIGNALIZED INTERSECTION SPACING

STARS

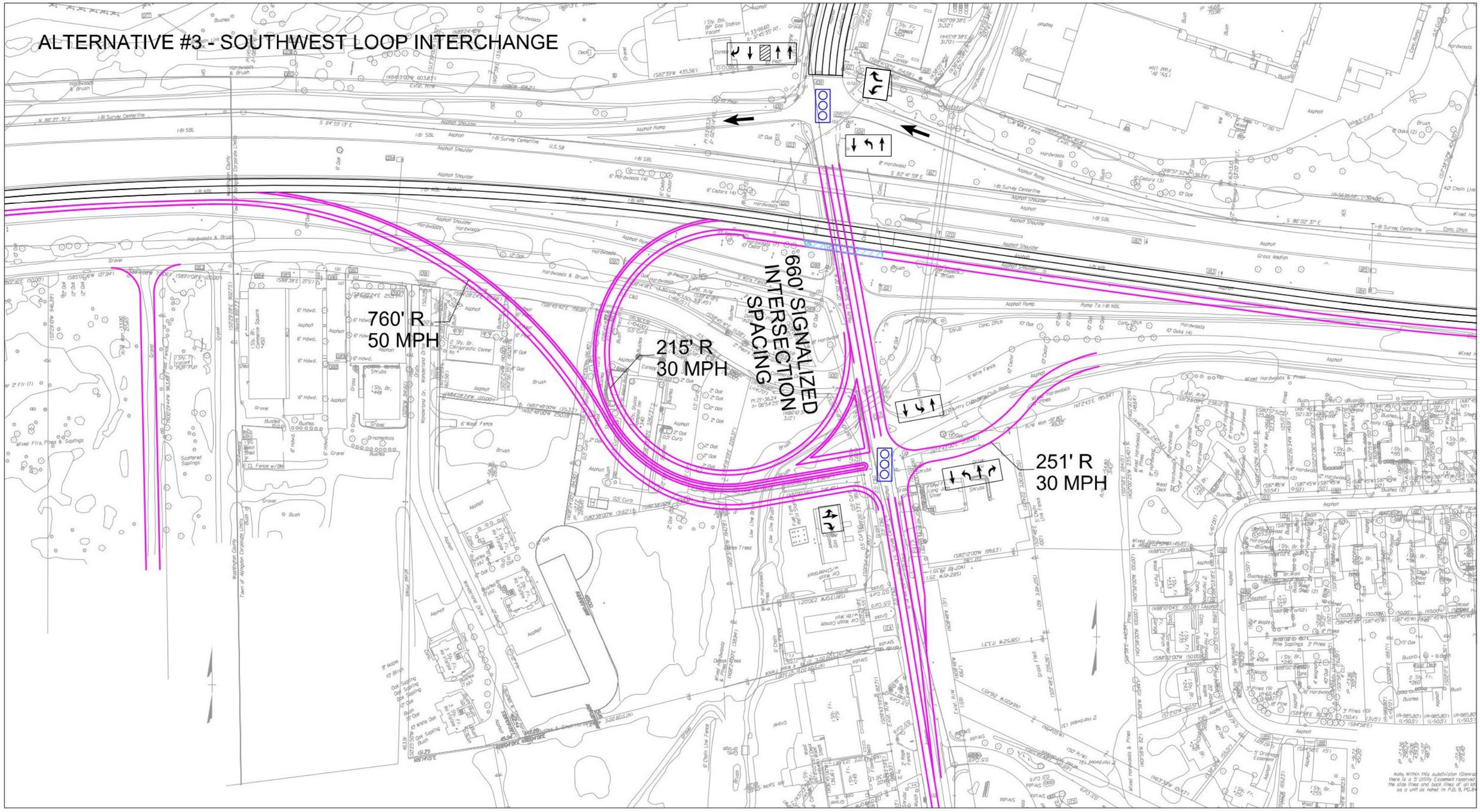
VDOT

Interstate 81 - Exit 17
Interchange Modification Report

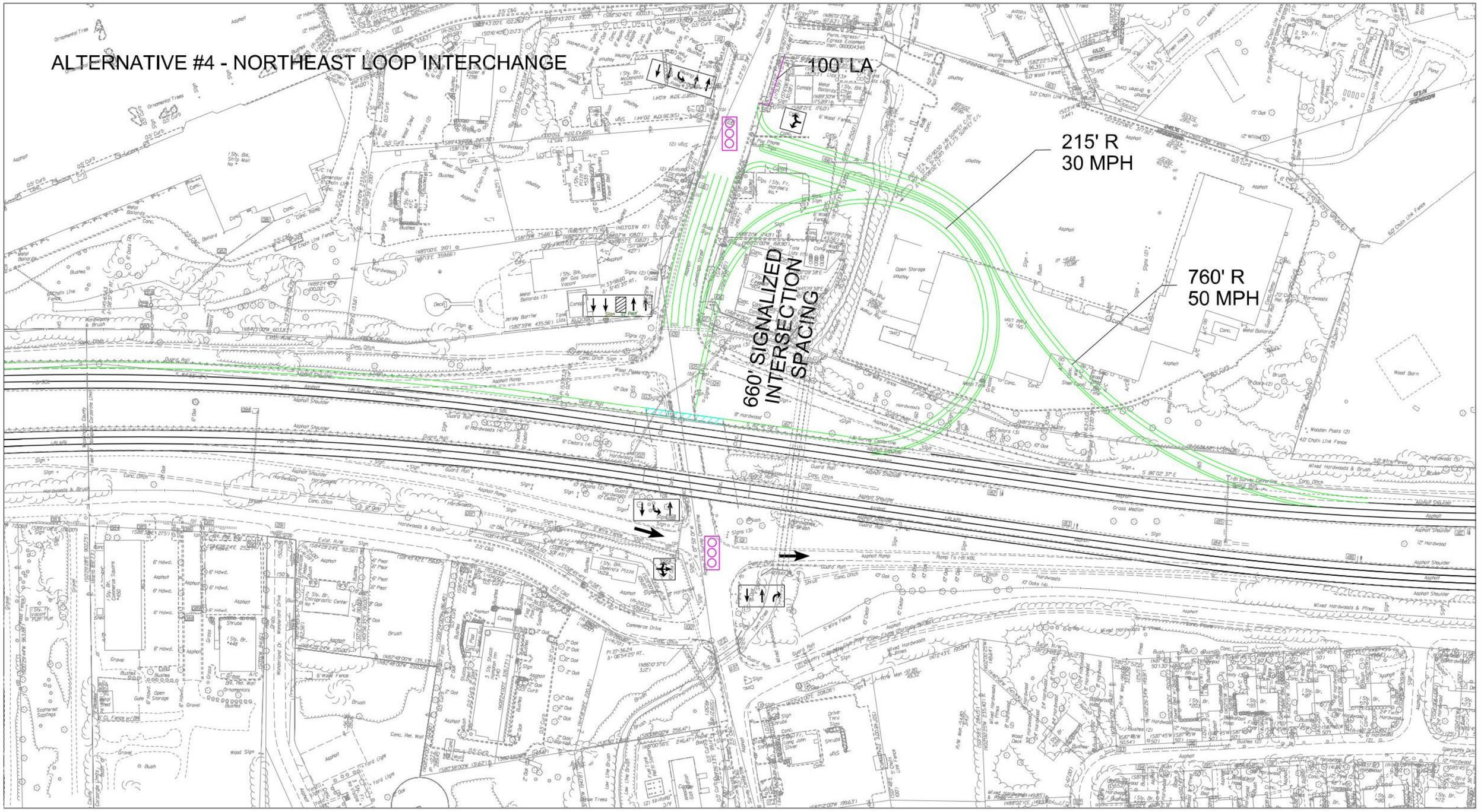
Alternative #2 - Expanded Diamond

FIGURE
11

ALTERNATIVE #3 - SOUTHWEST LOOP INTERCHANGE



STARS VDOT	Interstate 81 - Exit 17 Interchange Modification Report	Alternative #3 - Partial Cloverleaf FIGURE **12**



STARS VDOT

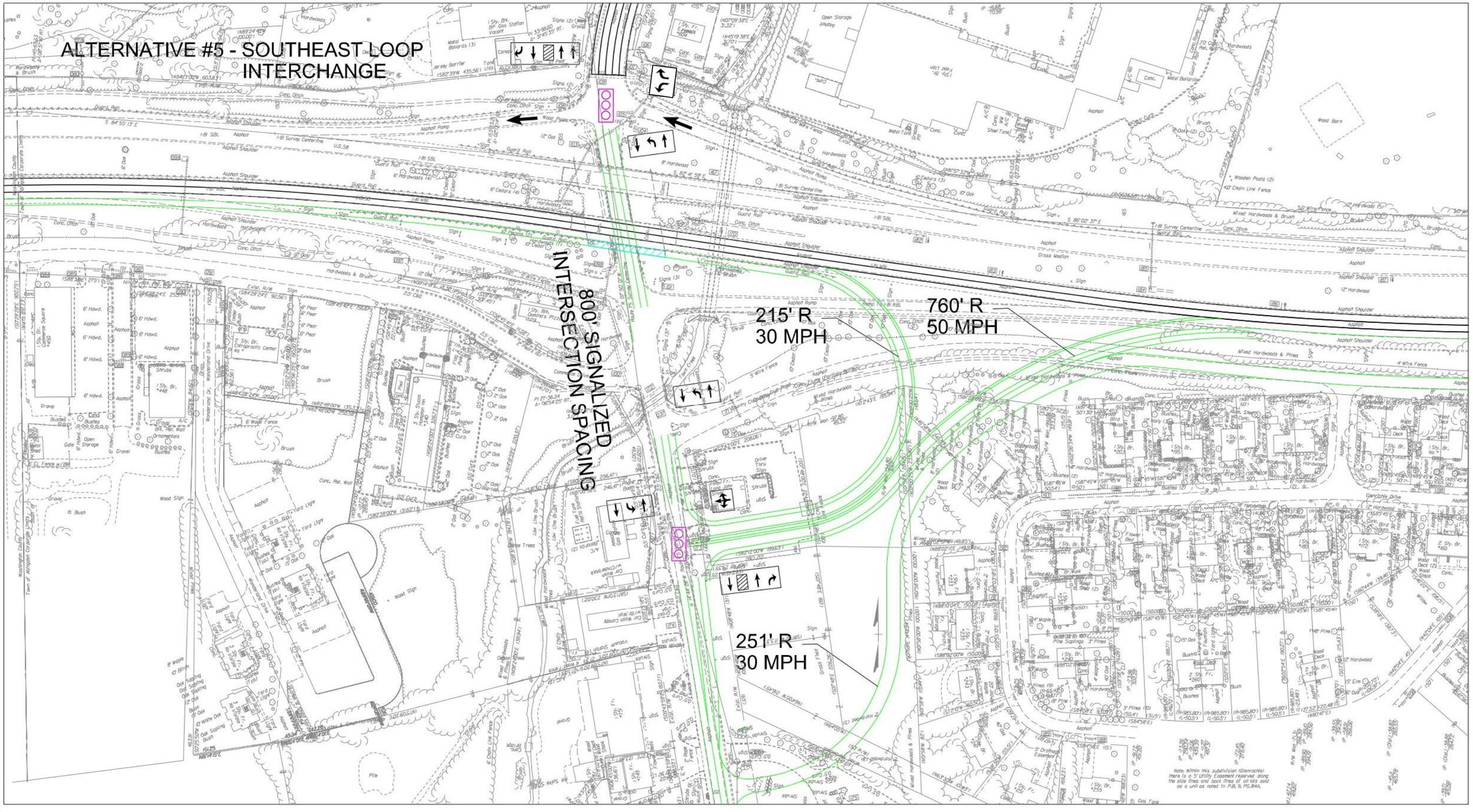
Interstate 81 - Exit 17

Interchange Modification Report

Alternative #4 - Partial Cloverleaf

FIGURE

13



Interstate 81 - Exit 17

Interchange Modification Report

Alternative #5 - Partial Cloverleaf

FIGURE

14

NOT TO SCALE

Proposed Pavement
Proposed Bridge
Proposed Full Depth Paved Shoulder

Interstate 81 - Exit 17
Interchange Modification Report

Alternative #6 - Full Interchange Reconstruction

FIGURE
15

3.2.6. Additional Considerations

It should be noted that during the preliminary development of the alternative intersection improvement concepts, roundabouts were also considered as potential traffic control measures to replace the currently signalized intersections at the ramp termini. This concept consisted of two single lane roundabouts with minimum inscribed circle diameters of 115 feet. It was determined that the size of the roundabouts necessary to accommodate future traffic volumes at the interchange would exceed the operational capacity of a single lane roundabout. Increasing the capacity of a roundabout to two lanes would be required to address the existing and anticipated levels of day-to-day congestion.

However, in accommodating a two-lane roundabout, the geometric requirements (e.g., minimum inscribed circle diameter of 150 feet and the need to increase the distance between the two intersections/roundabouts) would likely result in the need to impact/replace the existing bridge piers, significantly increasing construction costs, supplementary constructability constraints, and increased impacts to nearby properties, businesses, business owners, and a significant component of the Town's retail tax base.

In addition to the consideration of roundabouts serving as traffic control at the off/on-ramp intersections, a directional diamond interchange (DDI) concept was also discussed with Bristol District staff as an alternative improvement measure. The DDI concept was taken out of consideration due to a lack of space to adequately accommodate the roadway laneage, roadway/intersection geometry and alignment, and spacing between the intersections after the shifting of traffic from one side of the road to the other and then back again. Accommodating this geometry would likely result in the need to impact/replace the existing bridge piers, greatly increasing construction costs, and adversely impacting adjacent businesses.

As a result of this early determination, the DDI and roundabout concepts were not included for additional comparison and evaluation against the other alternatives previously described.

3.3. Transportation System Management Options

The proposed interchange modifications are necessary to improve the operational conditions on the Interstate 81 off-ramps, and along the State Route 75 arterial corridor due to significant traffic flow and congestion during the AM and PM peak periods. The need being addressed by the interchange modification request will not be satisfied solely through the application of reasonable alternative transportation system management treatments or options (e.g., *traffic signal optimization, ramp metering, mass transit, or HOV facilities)*. However, the implementation of traffic signal optimization and the upgrading of existing traffic signal timing equipment is an important component to maximizing the operational benefits of the proposed geometric improvements to the existing interchange configuration. Relocation of the eastbound Interstate 81 off/on-ramps approximately 300 feet to the south of their current location creates greater separation between the two signalized intersections that serve the interchange today. This not only provides additional storage/capacity to serve the northbound and southbound left-turn movements along State Route 75, but the increased separation, combined with upgraded traffic signal timing and vehicle detection equipment, will enhance the effectiveness of traffic signal optimization through improved traffic progression and reduced periods of delay for the State Route 75 corridor as well as the Interstate 81 eastbound and westbound off-ramp approaches. The proposed traffic signal optimization improvement is the only transportation system management treatment that can reasonably be implemented with the overarching interchange modifications.

3.4. Removal of Options for Further Study

Based on a qualitative comparison analysis of the proposed interchange improvement options, two alternatives were selected as the best candidates for furthermore detailed analysis as part of the IMR. A comparison matrix (Table 11) was created that reviewed different elements for each alternative that included:

- Traffic operations
- Impacts to existing tax base
- Impacts to property owners/need for additional right-of-way
- Environmental impacts
- Safety enhancements
- Scope of Construction
- Constructability

Each alternative was considered under these factors to determine their relative impact. Based on this review and discussions with VDOT, Alternatives 2 and 3 were selected as the best candidates for further analysis. Both of these alternatives are expected to address the geometric constraints and the resulting poor operational conditions at the interchange with comparatively lower construction costs, while also minimizing impacts to adjacent properties and the environment. In addition, Alternative 1, or No-Build, was analyzed to serve as a point of comparison for the other alternatives.

It should also be noted that for herein out in the analysis, Alternative 2 (Expanded Diamond) and Alternative 3 (Expanded Cloverleaf – Southwest Quadrant) will be referred to as Concept #1 and Concept #2, respectively.

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Table 11: Interchange Alternative Comparative Matrix

Qualitative Factors	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Traffic Operations	1. Existing traffic congestion conditions at on-ramps will continue and increase with additional growth. 2. Left-turn movement queue lengths underneath the bridge will continue to impede through movements and traffic flow along State Route 75. 3. Impedances to traffic flow on State Route 75 will impede traffic operations on the I-81EB and WB Off-Ramp intersections resulting queue lengths that periodically extend to the point that they impact mainline I-81 operations.	1. Separation between Off/On-Ramp signalized intersections allows for increased left-turn storage bays along State Route 75 at the two signalized intersections. 2. This will mitigate the potential for queued vehicles to block through traffic on State Route 75 underneath the I-81 overpass bridge. 3. Increased left-turn lane storage capacity mitigates impedances to traffic flow on State Route 75 which will also mitigate potential impedances to traffic operations on the I-81EB and WB Off-Ramp intersections.	1. Southbound State Route 75 left-turn onto I-81 EB under existing conditions becomes a channelized YIELD right-turn lane accommodated by an On-Loop. 2. This removes a heavy PM peak hour left-turn movement from the intersection resulting in improved intersection and corridor operations. 3. The existing right-turn movement to access I-81 EB becomes a left-turn movement. However, this is a relatively small volume during the AM and PM peak, thus not creating an adverse operational condition. 4. The heavy left-turn movement and the lack of storage length are two key factors impacting traffic flow along State Route 75 during the PM peak hour. 5. Extension of On-Loop acceleration lane from 1,050 feet to 2,150 feet provides vehicles with a longer distance to achieve an operational travel speed consistent with eastbound I-81 prior to merging into the mainline travel lane (i.e., 60 to 70 mph).	1. The northbound left-turn onto I-81 WB under existing conditions becomes a channelized YIELD right-turn accommodated by an On-Loop. 2. Although beneficial to I-81 Off/On-Ramp signalized intersections and State Route 75 corridor operations, the left-turn movement to access I-81 WB during the AM and PM Peak hours is not as significant as the left-turn movement to access I-81 EB during the PM peak hour.	1. The I-81 EB Off-Ramp left-turn movement under existing conditions becomes a right-turn movement accommodate by the Off-Loop. 2. The proposed Off-Loop improvement removes a relatively high demand left-turn movement during both the AM and PM peaks from the signalized intersection resulting in improved intersection operations. 3. However, Off-Loop accommodating the right-turn movement at this location would have to stop at the signal (creating a potential queuing condition on the Off-Loop) or if free-flow would create the need for widening and a merge condition that would need to occur prior to going under the bridge.	1. Improvements include widening/additional capacity along State Route 75 improving traffic flow through the interchange. 2. Additional EB/WB exclusive left-turn lanes to access I-81 will help mitigate the impacts of queued left-turn movements blocking through traffic during the AM and PM peaks. 3. Additional exclusive turn-lanes/laneage for off-ramps will improve off-ramp operations at signalized intersections. 4. Lengthening of ramps improves ability to accommodate longer queues and mitigate spill back onto the I-81 mainline.
Impacts to Existing Tax Base	None	1. Proposed improvements require acquisition of the Hampton Inn hotel in the southwest quadrant of interchange, Dominos, Long John Silver's, and a portion of the Exxon gas station on the west side of State Route 75.	1. Proposed improvements require acquisition of the Hampton Inn hotel in the southwest quadrant of interchange, Dominos, Long John Silver's, and a portion of the Exxon gas station along the west side of State Route 75.	1. Proposed improvements require acquisition of Washington Crossings Shopping Center located in the northeast quadrant of interchange as well as the Exxon gas station, an adjacent former gas station site, and the Hardee's. The impact to Washington Crossings Shopping Center alone was determined to be a fatal flaw.	1. Proposed improvements require acquisition of Long John Silver's, several undeveloped properties along the east side of State Route 75, and at least one residence.	1. Proposed improvements require acquisition of Hardee's, Exxon, Long John Silver's, local Car Wash, Dominos and Candy Store, etc. located in the northeast, southeast, and southwest quadrants of the interchange. 2. Acquisitions will involve the purchasing and closing of several active tax revenue generating businesses.
Right-of-Way Impacts	None	1. Proposed improvements require acquisition of the Hampton Inn hotel, Dominos, Long John Silver's, the Exxon gas station, a portion of the Chiropractor's Office, and potentially the Car Wash on the west side of State Route 75. 2. Additional ROW impacts include acquisition from multiple residential/private properties as well as several commercial parcels along State Route 75 to accommodate the realignments of Country Club Drive and Commerce Drive.	1. Proposed improvements require acquisition of the Hampton Inn hotel, Dominos, Long John Silver's, and the Exxon gas station and potentially the Car Wash on the west side of State Route 75. 2. Additional ROW impacts include the acquisition of additional commercial parcels along the west side of State Route 75 to accommodate the proposed ramp and on-loop configuration. 3. Overall ROW impacts and costs are less than Alternative 2.	1. Proposed improvements require acquisition of Washington Crossings Shopping Center located in the northeast quadrant of interchange as well as the Exxon gas station, an adjacent former gas station site, and the Hardee's.	1. Proposed improvements require acquisition of Long John Silver's, a residence adjacent to relocated Country Club Drive, and vacant land north of the medical building and along the east side of State Route 75 to accommodate the realignment of Country Club Drive.	1. Proposed realignment and widening improvements require acquisition of Hardee's, Exxon, Long John Silver's, local Car Wash, Dominos and Candy Store businesses, and vacant land along the east and west sides of State Route 75 to accommodate the notable relocation and realignment of Country Club Drive and Commerce Drive to the south. 2. To the north of proposed new I-81 overpass the realignment of State Route 75 would require the acquisition of Exxon gas station, a former gas station site, and the Hardee's.

Table 11: Interchange Alternative Comparative Matrix

Qualitative Factors	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Environmental Impacts	None	1. Proposed improvements require acquisition of the Mobile gas station property which has been designated as a contaminated site. 2. Improvements also require extending a box culvert to accommodate widening an existing crossing over a stream (Town Creek).	1. Proposed improvements require acquisition of the Mobile gas station property which has been designated as a contaminated site. 2. Improvements also require extending a box culvert to accommodate widening a crossing over an existing stream (Town Creek).	1. Improvements include require widening a crossing over an existing stream (Town Creek). 2. Proposed improvements require acquisition of the Exxon gas station and the former Rocket Food Mart gas station. 3. The Rocket Food Mart site is listed on the EDR Leaking Underground Storage Tank (LUST) and Leaking Storage Tank databases.	1. Improvements include crossing an existing stream.	1. Improvements include crossing a stream at two to three locations and potential wetlands impacts with properties adjacent to the stream. 2. Acquisition of property that is currently a gas station (i.e., Exxon on north side of interchange), a Car Wash, across frontage of existing gas station (i.e., Mobile on south side of interchange).
Safety Enhancements associated with Operational Improvements	None	1. Increased spacing between signalized intersections creates more queuing distance and mitigates the potential for queued vehicles to impede State Route 75 though lane traffic. 2. Additional spacing between I-81 off/on-ramps termini signals and ingress/egress to Country Club Drive. 3. Enhanced access management along State Route 75 (i.e., closing and/or relocating full-movement intersections away from intersection influence area of I-81 EB ramp termini).	1. Increased spacing between I-81 off/on-ramps termini signalized intersections. 2. Allows ingress/egress from Country Club Drive to be controlled by signal. 3. Improvements include right turn lane to Country Club Drive. 4. Enhanced access management along State Route 75 (i.e., closing and/or relocating full-movement intersections away from intersection influence area of I-81 EB ramp termini). 5. Extension of On-Loop acceleration lane from 1,050 feet to 2,150 feet provides vehicles with a longer distance achieve an operational travel speed consistent with eastbound I-81 prior to merging into the mainline travel lane (i.e., 60 to 70 mph).	1. Increased spacing between I-81 off/on-ramps termini signalized intersections. 2. No improvements to southern side of interchange with intersection spacing issues between ramps and local access roads. 3. Enhanced access management along State Route 75 (i.e., closing and/or relocating full-movement intersections away from intersection influence area of I-81 WB ramp termini). 4. Extension of On-Loop acceleration lane from 725 feet to 1,525 feet provides vehicles with a longer distance achieve an operational travel speed consistent with eastbound I-81 prior to merging into the mainline travel lane.	1. Increased spacing between I-81 off/on-ramps termini signalized intersections and improved ingress/egress to Country Club Drive. 2. Deceleration lane presents a less safe condition than an acceleration lane. 3. Enhanced access management along State Route 75 (i.e., closing and/or relocating full-movement intersections away from intersection influence area of I-81 WB ramp termini).	1. Significant widening and moderate realignment of State Route 75 to accommodate four through lanes and two left-turn lanes (EB and WB) under the I-81 overpass. 2. Widening and additional turn-lane capacity intended to mitigate congestion and queuing from impacting ramp operations during AM and PM peak hours. 3. Enhanced access management along State Route 75 (i.e., closing and/or relocating full-movement intersections away from intersection influence area of I-81 ramp termini).
Scope of Construction	None	1. Construction costs include widening of existing State Route 75, signal improvements both north and south of I-81, the proposed new I-81 EB off and on-ramps, and the realignment of Country Club Drive. 2. Extend triple box culvert for Town Creek to accommodate proposed State Route 75 widening. 3. Noise wall in southeast quadrant between I-81 and residential neighborhood to the south of Country Club Drive. 4. No bridge widening is required.	1. Construction costs include widening of existing State Route 75, acceleration lane along I-81 EB, and the proposed new I-81 EB off-ramp and on-loop. 2. Bridge widening is required to accommodate the acceleration lane associated with the proposed I-81 EB On-Loop. 3. Extend triple box culvert for Town Creek to accommodate proposed State Route 75 widening. 4. Noise wall in southeast quadrant between I-81 and residential neighborhood to the south of Country Club Drive. 5. Possible MSE walls.	1. Construction costs include widening of existing State Route 75, acceleration lane along I-81 WB, and the proposed ramp and loop. 2. Bridge widening is required to accommodate the acceleration lane associated with the proposed I-81 WB On-Loop. 3. Extend triple box culvert for Town Creek to accommodate proposed State Route 75 widening. 4. Possible MSE walls.	1. Construction costs include widening of existing State Route 75, widening of bridge to accommodate deceleration lane along I-81 EB, and the proposed I-81 EB off-loop and on-ramp. 2. Extend triple box culvert for Town Creek to accommodate proposed State Route 75 widening. 3. Noise wall in southeast quadrant between I-81 and residential neighborhood to the south of Country Club Drive. 4. Possible MSE walls.	1. Construction costs include the complete reconstruction of the Exit 17 interchange (both bridges and ramps in all four quadrants. 2. Costs also include the widening of State Route 75 to a 5-lane typical section through the interchange and transitioning back to a 3-lane typical section to the south. 3. I-81 bridges would need to be replaced/reconstructed to accommodate the realignment and widening of State Route 75 (Cummings Street) 4. Relocation and reconstruction of Country Club Drive and Commerce Drive.

Table 11: Interchange Alternative Comparative Matrix

Qualitative Factors	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Constructability	Not Applicable	1. Proposed improvements include work along I-81 at the new ramp diverge and merge locations to also include existing deceleration and acceleration laneage. 2. The project length along I-81 from the western project limit to eastern project limit is anticipated to result in MOT costs that are be noticeably higher than the other Alternatives. 3. Acquisition of ROW along both the east and west sides of State Route 75 (i.e., negotiation with more property owners) has the potential to significantly impact and lengthen the project schedule.	1. Proposed improvements include work along I-81 particularly the widening of the exiting bridge, has the potential to create a longer construction schedule and increases MOT costs to the project. 2. Consideration of MSE walls to minimize footprint and best accommodate lengthened acceleration lane, tie in with bridge widening, On-loop and Off-ramp realignment.	1. Proposed improvements include work along I-81 particularly the widening of the existing bridge, creates a longer construction schedule and increases MOT costs to the project. 2. Consideration of MSE walls to minimize footprint and best accommodate lengthened acceleration lane, tie in with bridge widening, On-loop and Off-ramp realignment.	1. Proposed improvements include work along I-81 which creates a longer construction schedule and increases MOT costs to the project. 2. Consideration of MSE walls to minimize footprint and best accommodate lengthened deceleration lane, Off-loop and on-ramp realignment.	1. Proposed reconstruction of the Exit 17 interchange and the associated work along I-81 in both directions results in a relatively long construction schedule and significantly increases MOT costs to the projects. 2. Construction and MOT costs associated with State Route 75 widening and realignment. 3. Significant acquisition of ROW (i.e., negotiation with numerous property owners north and south of I-81) has the potential to significantly impact and lengthen the project schedule.

4. ROADWAY GEOMETRY

4.1. Conceptual Design Plans and Geometric Criteria

4.1.1. Geometric Criteria

Conceptual design plans for the modifications to the two I-81 off/on ramps were developed for Concept # 1 and Concept # 2 detailed in Chapter 3, Section 3.2 – Build Conditions. Table 12 provides details on the Design Criteria for this project. I-81 is a limited access highway classified by FHWA as an Interstate within the study area. The segment of I-81 in the study area has a posted speed limit of 70 mph. It is a divided facility that carries traffic along two 12-foot lanes in each direction. The VDOT Geometric Design Standard selected for I-81 within the project limits is GS-5 (GS-5 Design Standard refers to GS-1 Design Standard for minimum radius of design speeds for all freeways). State Route 75 is a primary route that connects Downtown Abingdon to the north and various areas of Washington County to the south with I-81. The segment of State Route 75 north of the I-81 overpass is a 5-lane typical section roadway (i.e., 4 travel lanes, with exclusive left-lanes at key intersections and/or a two-way left-hand turn-lane (TWLTL) and with a functional classification designation of Minor Arterial. South of I-81, the roadway is a 2-lane undivided facility with a functional classification of Major Collector. GS-6 (Minor Arterial System) and GS-7 (Collector Street System) are the VDOT Geometric Design standards selected for the north and south portions of State Route 75. State Route 75 has a posted speed limit of 35 mph within the study area. The proposed design criteria of the interchange ramps are in compliance with the Association of State Highway and Transportation Officials (AASHTO) standards and VDOT Geometric Design Standards for Interchange Ramps (GS-R).

4.1.2. Design Waivers / Exceptions

All conceptual plans developed are in accordance with applicable standards published by the AASHTO, VDOT Road Design Manual, Volume 1 (2011 and 2013 editions), and VDOT Road and Bridge Standards (VDOT 2008).

4.1.2.1 Potential Design Waivers

When design features do not meet VDOT minimums, but exceed AASHTO minimums, a design waiver is required and must be requested. Design standards for signalized intersection spacing along a Minor Arterial with a posted speed limit of 35 mph, requires 1,050 feet between signalized intersections (Table 2-2 in Appendix F of the VDOT Road Design Manual). The proposed intersection spacing improvements do not meet this requirement. Therefore, a design waiver will be required.

4.1.2.2 Potential Design Exceptions

All conceptual plans developed are in accordance with applicable standards published by the American Association of State Highway and Transportation Officials (AASHTO) and VDOT (2011 and 2013 editions, respectively). Based on the application of appropriate design guidelines it is not anticipated that any design exceptions will be required.

4.1.2.3 Access Management Waivers

Appendix F of the VDOT Road Design Manual details the current access management guidelines provided by VDOT. Table 2-4 provides minimum spacing standards for intersections and commercial entrances near interchange areas on two-lane roads. The minimum access management spacing between the interchange ramp and the first entrance/intersection is 750 feet. The proposed alternatives do not meet this requirement and an access management waiver will be required. Additionally, as a VDOT owned and maintained highway construction project an access management waivers will also be required along State Route 75 due to existing spacing.

4.1.3. Proposed Limited Access Line

At interchanges, the limited access lines are to encompass the entire periphery of the interchanges and shall extend beyond the ramp terminals to meet the Access Management Standards (VDOT Road Design Manual, *Appendix F*) for minimu4m spacing standards for entrances and intersections from interchange ramps. As the interchange ramps shift to the south of I-81 to provide additional spacing between intersections, the proposed limited access line will also extend to the south. To south of the proposed new interchange ramp termini, an approximate 300-foot limited access line/fence will be installed along the east side of Route 75, while a 200-foot limited access line/fence will be installed along the west side of the roadway.

4.2. Conceptual Signing and Marking Plan

Changes to the Exit 17 interchange geometry will require new pavement markings and guide signage in the study area. Therefore, conceptual signing and marking plans were developed for Concept #1 and Concept # 2, as shown in Figure 16 and Figure 17, respectively. These plans were developed according to FHWA's Manual on Uniform Traffic Control Devices using guidance from Section 2E and are considered as part of the operational analysis of the two concepts.

4.3. Other Modifications to Roadway Network

4.3.1. Commerce Drive/Gravel Lake Road

Commerce Drive is a local road that connects to State Route 75 directly south of the existing I-81 eastbound off/on-ramp intersection. Due to the proposed improvements of shifting the interchange ramps to the south, Commerce Drive will be terminated west of State Route 75. Access to the properties and businesses along Commerce Drive not impacted by the proposed interchange improvements will be maintained through a proposed connection with existing Gravel Lake Road. Gravel Lake Road is local road which intersects State Route 75 approximately half a mile south of I-81. Existing Gravel Lake Road will be brought up to current VDOT design standards and a new portion of Gravel Lake Road will be constructed on new alignment to connect Gravel Lake Road to Commerce Drive.

4.3.2. Country Club Drive

Country Club Drive is a local street that intersects State Route 75 just south of the existing interchange and provides the only connection to a large residential neighborhood located southeast of the interchange. In both Alternative 2 and Alternative 3, Country Club Drive will need to be relocated to the south in order to maximize the spacing between interchange ramps and the Country Club Drive access point. In Alternative 3, Country Club Drive is relocated to the south and becomes the fourth leg of the signalized intersection with State Route 75 and the I-81 off-ramp/on-loop.

4.3.3. Vances Mill Road

Gravel Lake Road will become a critical roadway connection serving the land southwest of the interchange. Adjacent to the intersection of Gravel Lake Road and State Route 75 is a local roadway connection which serves a large residential neighborhood, Vances Mill Road. Due to limited spacing between the Gravel Lake Road and Vances Mill Road intersections with State Route 75, combined with geometric deficiencies along Vances Mill Road, several conceptual intersection alternatives have been developed to improve and consolidate the roadway network of Gravel Lake Road, Vances Mill Road, Fairway Drive (located on the east side of State Route 75), and State Route 75.

Table 12: Design Criteria

Criteria	Interstate 81	Cummings St (North) SR 75	Cummings St (South) SR 75	Country Club Drive East	Interchange Ramp Northbound Off-Ramp/On-Ramp	Interchange Ramp Northbound On-Loop	References or Remarks
Functional Classification	Interstate	Urban Minor Arterial	Urban Collector	Urban Local	Interchange Ramp	Interchange Ramp	VDOT Functional Classification Map
VDOT Standard	GS-5 (1)	GS-6	GS-7	GS-7(10)	GS-R	GS-R	VDOT Road Design Manual, Appendix A, Pages A-11 thru A-20
Terrain (2)	Rolling	Rolling	Rolling	Rolling	Rolling	Rolling	Per VDOT L&D Guidance and consistency with I-81 Exit 7 and Exit 14 design criteria
Design Speed	70 mph	35 mph (6)	35 mph (6)	35 mph	40 mph (8)	30 mph	VDOT Road Design Manual, Appendix A, Pages A-11 thru A-20
Exist. Posted Speed	70 mph	35 mph	35 mph	35 mph	35 mph*	N/A	*35 mph Advisory Posted Only
Number of Lanes	2 each direction	2 each direction	1 each direction	1 each direction	1	1	
Minimum Width, Travel Lane	12'	12'	12'	12'	16'	16'	VDOT Road Design Manual, Appendix A, Pages A-11 thru A-20
Paved Shoulder Widths	LT: 4' RT: 10'	-- (4)	-- (4)	8' Shoulders	LT: 4' RT: 8'	LT: 4' RT: 8'	VDOT Road Design Manual, Appendix A, Pages A-11 thru A-20
Minimum Radius	1,821''	408' (6)	408' (6)	371'	446'	215'	VDOT Road Design Manual, Appendix A, Pages A-11 thru A-20
Normal Cross Slope	2%	2%	2%	2%	2%	2%	VDOT Road Design Manual, Appendix A, Pages A-11 thru A-20
Maximum Super elevation	8%	2%	2%	4%	8%	8%	VDOT Road Design Manual, Appendix A, Pages A-11 thru A-20
Minimum Stopping Sight Distance	730'	250'	250'	250'	305'	200'	VDOT Road Design Manual, Appendix A, Pages A-11 thru A-20
Maximum Grade (3)	5%	10%	12%	12%	6%	7%	VDOT Road Design Manual, Appendix A, Pages A-11 thru A-20 and AASHTO Green Book (2011) Page 5-2, Page 6-12, Page 7-29, and Page 8-4.
Minimum Median Width	--	--	--	--	--	--	
Clear Zone	30'	14'	14'	14'	20'	14'	VDOT Road Design Manual, Appendix A, Page A-27
Minimum Vertical Clearance	16.5'	16.5'	16.5'	--	--	--	Chapter 6 Geometrics from the Manual of the Structure and Bridge Division
Sidewalk Width	--	5'	5'	--	--	--	
Sidewalk Buffer Width	--	4' (9)	4' (9)	--	--	--	
Width of Ditch Front Slope	12'	--	4'	4'	10'	10'	VDOT Road Design Manual, Appendix A, Pages A-11 thru A-20
Existing Traffic Volumes (AADT)	45,000	17,000	7,500	1,000	3,900/4,000	4,000	VDOT Permanent County Site (June, 2014), VDOT Historic Counts (2012), Adjusted 12-Hour Turning Movement Counts
Minimum Acceleration Lane Length (7)	--	--	--	--	780'	1,510'	VDOT Road Design Manual, Appendix F, Page F-98, AASHTO Green Book (2011) Page 10-110
Minimum Deceleration Lane Length (7)	--	--	--	--	390'	--	VDOT Road Design Manual, Appendix F, Page F-98, AASHTO Green Book (2011) Page 10-115

Notes:

1) GS-5 Design Standard refers to GS-1 Design Standard for minimum radius of design speeds for all freeways.
2) No terrain classification is listed under GS-5 Design Standard.
3) Geometric Design Standards refer to AASHTO Green Book, Chapter 5-8, for maximum grade values.
4) Existing conditions on Cummings Street, north of I-81, include curb and gutter.
5) 14' outside lane widths should be provided to accommodate bikes.
6) Improvements along State Route 75 (Cummings Street) shall be in accordance with TC-5.11 Urban Low Speed (ULS)
7) Minimum acceleration and deceleration lane lengths will be adjusted during design based on grades greater than 2% and based on truck adjustment factors.
8) According to AASHTO Green Book, 55 MPH is the minimal design speed for ramps, however based on the design speed on State Route 75 (Cummings Street) and additional property impacts, a ramp speed of 40 mph was selected.
9) Buffer strip width in accordance with Appendix A, Section A-5 Bicycle and Pedestrian Facilities Guidelines
10) VDOT GS-7 standard was utilized for Country Club Drive based on a design speed of 35 mph. The application of VDOT GS-7 standard matches or exceeds AASHTO design standards.

Design Criteria listed in table includes two conceptual interchange layouts. One alternative relocates the I-81 eastbound off/on-ramp intersection approximately 300-feet south of its current location. This layout also requires relocating the Country Club Drive intersection with State Route 75 approximately 550-feet to the south. The second alternative includes relocation of the I-81 eastbound off/on-ramp terminus approximately 300-feet south of its current location, a eastbound off-ramp from I-81 that is positioned around a proposed on-loop to accommodate the eastbound I-81 movement. A slight realignment of Country Club Drive is required to tie into the proposed new signalized intersection. All design decisions regarding these criteria will be documented as part of the IMR.

STARS VDOT

Interstate 81 - Exit 17

Interchange Modification Report

Conceptual Signing and Marking Plan - Concept #1

FIGURE

16

STARS VDOT	Interstate 81 - Exit 17 Interchange Modification Report	Conceptual Signing and Marking Plan - Concept #2

FIGURE
17

5. Existing and Future Traffic Volumes

5.1. Existing Traffic Volumes

As described in Section 2.7 - Traffic and Safety Data, AM and PM peak hours were generally established to be 7:30 – 8:30 AM and 4:30 – 5:30 PM, respectively for the majority of the study area intersections. AM and PM peak hour volumes were previously illustrated in Figure 3.

5.2. Forecasting Methodology

As mentioned in previously, the Bristol Metropolitan MPO regional travel demand model does not currently include the subject study area. Therefore, the traffic volume projections were based upon annualized, linear growth rates using information provided by VDOT. The following linear growth rates were determined and approved by VDOT:

- 1.8% on I-81
- 1.5% on I-81 ramps
- 1% on State Route 75

5.3. Future Traffic Volumes

5.3.1. No-Build Conditions

The forecasted peak hour volumes for the No-Build Conditions were calculated from the linear growth rates developed to adjust the Base Year (2015) to the Opening Year (2020) and Design Year (2040) volumes. In addition, any known future development growth was also accounted for and applied to the future traffic volumes. As noted, a new shopping center is being planned for construction on the northeast quadrant of State Route 75 at Cook Street/Realigned Green Spring Road intersection. A separate traffic impact study was prepared for this development and its findings were incorporated into this report. This resulted in proposed changes to the existing roadway network and new traffic generated. The additional traffic was added and assigned to the network to account for changes in access to/from the site and along Route 75, as well as changes to the roadway geometry proposed by the new development, as discussed in Section 3.1 - No-Build Conditions. The 2020 and 2040 No-Build volumes for both AM and PM peak hours are illustrated in Figure 18 and Figure 19, respectively.

5.3.2. Concept #1 – Expanded Diamond

For Concept #1, the I-81 eastbound Off/On-ramps will be relocated approximately 300 feet to the south on State Route 75 to provide more space/distance (i.e., a total of 600 feet) between the interchange ramp termini (See Figure 11). This addresses a critical need for additional separation between the two off/on-ramp signalized intersections. Due to the ROW acquisition required for this project in the southwest quadrant of the existing interchange, along with the elimination of access to State Route 75 from Commerce Drive, access to existing parcels/businesses not impacted by the proposed improvements to Exit 17 will be maintained by realigning Gravel Lake Road and constructing a new unsignalized intersection at Gravel Lake Road and State Route 75. The existing intersection of Gravel Lake Road at State Route 75 will be removed and the relocated segment will now connect in the immediate vicinity of where the existing Vances Mill Road intersection is located today at Fairway Drive. The existing Vance Mill Road will then be realigned and relocated to a new intersection with State Route 75 to the south/west of its current location.

The traffic volumes developed as part of the No-Build Conditions were diverted based on the proposed modifications to the interchange and other changes to the roadway network, per Concept #1. As a result, traffic that originally accessed State Route 75 from Commerce Drive was shifted and added to the new relocated Gravel Lake Road to the south. The southbound right-turning volume into Commerce Drive now travels southbound along the corridor, through the other study area intersections and turns right at the relocated Gravel Lake Road intersection, as this road will provide access to the properties that Commerce Drive originally did. Northbound left-turning vehicles will also access the properties via the relocated Gravel Lake Road and no longer travel through the other study area intersections located to the north. Therefore, these vehicles were "removed" from these other intersections as part of the redistribution of volume. Vehicles that originally turned from Commerce Drive onto State Route 75 now do so at the relocated Gravel Lake Road. These vehicles were also redistributed to the network as the vehicles travel to the north/south through the network.

Additionally, with Country Club Drive being realigned and relocated approximately 500 feet to the south of its current intersection location, access to/from Abingdon Place now occurs via this new intersection. Traffic associated with using existing Abingdon Place access driveway was reassigned to the network via this new intersection. The southbound left-turning volume into Abingdon Place now travels down the corridor and turns left at the new realigned Country Club Drive intersection. Northbound right-turning vehicles will also access Abingdon Place via the relocated Country Club Drive by continuing to travel north until they turn. Vehicles that originally turned from Abingdon Place directly onto State Route 75 now do so at the relocated Country Club Drive intersection. These vehicles were also redistributed to the network as the vehicles travel to the north/south through the network, respectively.

The resulting 2020 and 2040 Concept #1 volumes for both AM and PM peak hours are illustrated in Figure 20 and Figure 21, respectively.

5.3.3. Concept #2 – Partial Cloverleaf Southwest Quadrant

Concept #2 results in a new partial cloverleaf interchange with the northbound on-ramp converted to a channelized YIELD and free-flow on-loop ramp as well as the lengthening of the eastbound off-ramp in the southwest quadrant of the interchange (See Figure 12). These improvements will result in the relocation of the existing signalized intersection that serves the I-81 eastbound off/on-ramps to the south, approximately 300 feet from its current location resulting in approximately 600 feet of separation between the two signalized intersections. This addresses a critical need for increased separation/spacing between the two signals that serve the interchange off/on-ramps termini. Country Club Drive will also need to be realigned/relocated approximately 75 feet to the south of its current location to accommodate the new ramp and intersection improvements. However, rather than being located to the south as a new intersection, County Club Drive will now tie into the new signalized intersection for the I-81 eastbound off-ramp/on-loop termini.

Similar to Concept #1, because of the ROW acquisition required for this project in the southwest quadrant of the existing interchange, along with the elimination of access to/from State Route 75 via Commerce Drive, access to existing parcels/businesses not impacted by the proposed improvements to Exit 17 will be maintained by realigning Gravel Lake Road and constructing a new unsignalized intersection at Gravel Lake Road and State Route 75. The existing intersection of Gravel Lake Road at State Route 75 will be removed and the relocated segment will now connect in the immediate vicinity of where the existing Vances Mill Road intersection is located today at Fairway Drive. The existing Vance Mill Road will then be realigned and relocated to a new intersection with State Route 75 to the south/west of its current location.

The traffic volumes developed as part of the No-Build Conditions were also diverted based on the proposed modifications to the interchange and other changes to the roadway network, per Concept #2. Therefore, traffic that originally accessed State Route 75 from Commerce Drive was shifted and added to the new relocated Gravel Lake Road to the south. The southbound right-turning volume into Commerce Drive now travels southbound along the corridor, through the other study area intersections and turns right at the relocated Gravel Lake Road intersection, as this road will provide access to the properties previously served by Commerce Drive. Northbound left-turning vehicles will also access the properties via the relocated Gravel Lake Road intersection approximately ½ mile to the south, and no longer travel through the other study area intersections located to the north.

As a result, these vehicles were "removed" from these other intersections as part of the redistribution of traffic volumes. Vehicles that originally turned from Commerce Drive onto State Route 75 now do so at the relocated Gravel Lake Road intersection. These vehicles were also redistributed to the network as the vehicles travel to the north/south through the network.

With the addition of the new I-81 eastbound on-loop ramp, traffic that originally turned left at the ramp termini now turns right as it enters the on-loop ramp. Additionally, with Country Club Drive being realigned with the new I-81 eastbound off-ramp to the south, traffic to/from Country Club Drive was redistributed to the network. Vehicles that originally turned right from Country Club Drive and then turned right to enter I-81 eastbound now become through movements at this new intersection. It was assumed the portion of traffic that travels through onto the interstate remains consistent with existing proportions (i.e., approximately 75% stays on State Route 75 and 25% enters I-81).

The 2020 and 2040 Concept #2 volumes for both AM and PM peak hours are illustrated in Figure 22 and Figure 23, respectively.

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NOT TO SCALE

Legend

- Study Area Intersection
- XX (XX) - AM (PM) Peak Hour Traffic Volumes
- Traffic Signal
- Stop Control

1,772 (1,907)

(2,014) 1,457

Washington Crossing
7 (39)
4 (17)
13 (12)
1,129 (970)
(22) 17
(1,069) 532

I-81 NB On-Ramp
144 (118)
534 (412)
(325) 186
(455) 241
I-81 NB Off-Ramp
(379) 350
(194) 104

Country Club Dr
99 (98)
13 (9)
12 (12)
555 (413)
(90) 53
(551) 268

Birdie Dr
59 (31)
0 (0)
7 (1)
3 (2)
510 (334)
3 (0)
(53) 20
(428) 252
(0) 1
Driveway
(8) 0
(0) 0
(3) 4

Gravel Lake Rd
494 (318)
4 (7)
(427) 229
(5) 34
(18) 22
(12) 5

INTERSTATE 81

75

Cummings Street

Green Spring Rd*
242 (368)
0 (0)
210 (324)
437 (416)
583 (378)
112 (214)
(416) 277
(522) 354
(244) 65
(204) 71
(0) 0
(234) 98
Cook St

1,132 (1,008)
4 (1)
(1,070) 628
(26) 5
Towne Centre Dr
(68) 23

650 (507)
4 (4)
(622) 315
(27) 30
Commerce Dr
(23) 28
(19) 6

Abingdon Pl
4 (40)
0 (2)
4 (1)
547 (325)
(12) 34
(510) 259
(6) 1
Driveway
(7) 2
(0) 0
(2) 1

I-81 SB Off-Ramp
435 (349)
77 (89)
742 (700)
142 (91)
(691) 350
(475) 288
I-81 SB On-Ramp

Fairway Dr
39 (23)
7 (0)
6 (1)
3 (2)
404 (237)
79 (17)
(24) 10
(336) 183
(79) 41
Vances Mill Rd
(65) 55
(11) 2
(68) 48

1,690 (2,035)

(2,144) 1,581

STARS VDOT

Interstate 81 - Exit 17
Interchange Modification Report

No Build (2020)
AM and PM Peak Hour
Traffic Volumes

FIGURE
18

NOT TO SCALE

Legend

- Study Area Intersection
- XX (XX) - AM (PM) Peak Hour Traffic Volumes*
- Traffic Signal
- Stop Control

2,345 (2,520)

(2,640) 1,925

Washington Crossing: 10 (45), 5 (20), 15 (15), 1,360 (1,155), (25) 20, (1,235) 620

I-81 NB Off-Ramp / I-81 NB On-Ramp: (390) 225, (530) 270, 185 (150), 615 (470), 425 (455), 135 (260)

Country Club Dr: 115 (115), 15 (10), 15 (15), 655 (485), (105) 60, (680) 320

Birdie Dr / Driveway: 70 (40), 0 (0), 10 (0), 5 (5), 600 (385), 5 (0), (65) 25, (545) 300, (0) 0, (10) 0, (0) 0, (5) 5

Gravel Lake Rd: 585 (370), 5 (10), (545) 275, (5) 40, (20) 25, (15) 5

INTERSTATE 81

75

Cummings Street

Green Spring Rd*: 245 (380), 0 (0), 220 (325), 475 (445), 755 (500), 135 (255), (425) 280, (650) 425, (290) 80, (245) 85, (0) 0, (280) 115

Cook St

Towne Centre Dr: 1,365 (1,200), 5 (0), (1,240) 730, (30) 5, (80) 30

Commerce Dr: 765 (595), 5 (5), (760) 370, (30) 35, (25) 35, (25) 10

Abingdon Pl / Driveway: 5 (50), 0 (5), 5 (0), 645 (385), (15) 40, (630) 310, (10) 0, (10) 5, (0) 0, (5) 0

Fairway Dr / Vances Mill Rd: 45 (25), 10 (0), 10 (0), 5 (5), 480 (280), 95 (20), (30) 15, (435) 210, (95) 55, (75) 65, (15) 5, (80) 60

I-81 SB Off-Ramp / I-81 SB On-Ramp: 550 (430), 95 (115), 860 (805), 180 (120), (805) 400, (580) 345

2,225 (2,675)

(2,815) 2,075

Note: Volumes rounded to the nearest 5 vehicles
** Green Spring Road is realigned to Cook Street*

STARS VDOT

Interstate 81 - Exit 17
Interchange Modification Report

No Build (2040)
AM and PM Peak Hour
Traffic Volumes

FIGURE
19

NOT TO SCALE

Legend

- Study Area Intersection
- XX (XX) - AM (PM) Peak Hour Traffic Volumes
- Traffic Signal
- Stop Control
- Road Closure

Washington Crossing: 7 (39), 4 (17), 13 (12), 1,129 (970), (22) 17, (1,069) 532

1,772 (1,907)

(2,014) 1,457

Country Club Dr: 103 (138), 13 (11), 16 (13), 575 (392), (102) 87, (547) 258

Birdie Dr: 59 (31), 0 (0), 7 (1), 3 (2), 534 (353), 3 (0), (53) 20, (436) 276, (0) 1, (8) 0, (0) 0, (3) 4, Driveway

Fairway Dr: 39 (23), 7 (0), 6 (1), 3 (2), 451 (291), 8 (11), (24) 10, (384) 213, (32) 64, (41) 50, (11) 2, (31) 11, Gravel Lake Rd

I-81

75

Cummings Street

Towne Centre Dr: 1,132 (1,008), 4 (1), (1,070) 628, (26) 5, (68) 23

Green Spring Rd*: 242 (368), 0 (0), 210 (324), 437 (416), 583 (378), 112 (214), (416) 277, (522) 354, (244) 65, (204) 71, (0) 0, (234) 98, Cook St

I-81 SB Off-Ramp: 435 (349), 77 (89), 742 (700), 142 (91), (691) 350, (475) 288

I-81 SB On-Ramp

I-81 NB On-Ramp: 144 (118), 534 (412), (325) 186, (455) 241

I-81 NB Off-Ramp: (379) 350, (194) 104

Gravel Lake Road

1,690 (2,035)

(2,144) 1,581

Vances Mill Rd: 407 (239), 79 (17), (337) 189, (79) 41, (65) 55, (68) 48

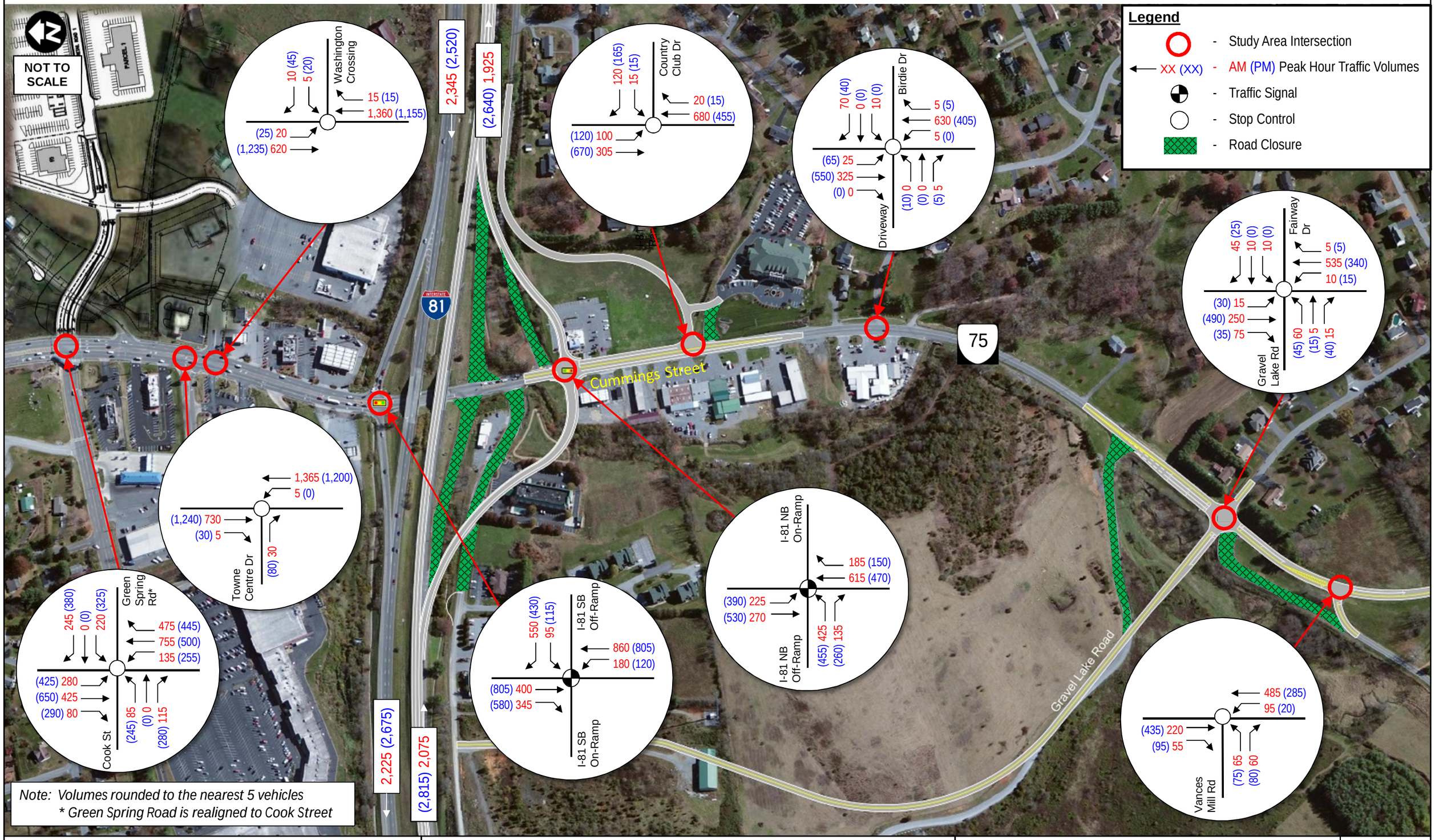
*Note: * Green Spring Road is realigned to Cook Street*

STARS VDOT

Interstate 81 - Exit 17
Interchange Modification Report

Concept #1 (2020)
AM and PM Peak Hour
Traffic Volumes

FIGURE
20



Note: Volumes rounded to the nearest 5 vehicles
** Green Spring Road is realigned to Cook Street*

STARS VDOT

Interstate 81 - Exit 17
Interchange Modification Report

Concept #1 (2040)
AM and PM Peak Hour
Traffic Volumes

FIGURE
21

NOT TO SCALE

Legend

- Study Area Intersection
- XX (XX) - AM (PM) Peak Hour Traffic Volumes
- Traffic Signal
- Stop Control
- Road Closure

Washington Crossing: 7 (39), 4 (17), 13 (12), 1,129 (970), (22) 17, (1,069) 532

1,772 (1,907)

(2,014) 1,456

I-81 NB Off/On-Ramp: 74 (73), 25 (25), 13 (9), Country Club Dr: 12 (12), 460 (339), 119 (93), (76) 45, (379) 196, (379) 350, (14) 9, (180) 96

Driveway: 59 (31), 0 (0), 7 (1), Birdie Dr: 3 (2), 534 (353), 3 (0), (53) 20, (436) 276, (0) 1, (8) 0, (0) 0, (3) 4

Gravel Lake Rd: 39 (23), 7 (0), 6 (1), Fairway Dr: 3 (2), 451 (291), 8 (11), (24) 10, (384) 213, (32) 64, (41) 50, (11) 2, (31) 11

Towne Centre Dr: 1,132 (1,008), 4 (1), (1,070) 628, (26) 5, (68) 23

I-81 NB On-Ramp: 884 (791), (455) 241, (325) 186

Driveway: 4 (40), 0 (2), Abingdon Pl: 4 (1), 571 (344), (12) 34, (518) 283, (6) 1, (7) 2, (0) 0, (2) 1

Cook St: 242 (368), 0 (0), 210 (324), Green Spring Rd*: 437 (416), 583 (378), 112 (214), (416) 277, (522) 354, (244) 65, (204) 71, (0) 0, (234) 98

I-81 SB Off-Ramp: 435 (349), 77 (89), 742 (700), 142 (91), (691) 350, (475) 288, I-81 SB On-Ramp

Vances Mill Rd: 407 (239), 79 (17), (337) 189, (79) 41, (65) 55, (68) 48

1,690 (2,035)

(2,144) 1,581

Cummings Street

Gravel Lake Road

75

81

*Note: * Green Spring Road is realigned to Cook Street*

STARS VDOT

Interstate 81 - Exit 17
Interchange Modification Report

Concept #2 (2020)
AM and PM Peak Hour
Traffic Volumes

FIGURE
22

NOT TO SCALE

Legend

- Study Area Intersection
- XX (XX) - AM (PM) Peak Hour Traffic Volumes
- Traffic Signal
- Stop Control
- Road Closure

Washington Crossing: 10 (45), 5 (20), (25) 20, (1,235) 620, 15 (15), 1,360 (1,155)

2,345 (2,520)

(2,640) 1,925

Country Club Dr: 85 (90), 30 (25), 15 (10), (90) 50, (440) 220, 15 (15), 530 (380), 155 (125), I-81 NB Off/On-Ramp, (455) 425, (15) 10, (245) 125

Birdie Dr: 70 (40), 0 (0), 10 (0), (65) 25, (550) 325, (0) 0, 5 (5), 630 (405), 5 (0), Driveway, (10) 0, (0) 0, (5) 5

Fairway Dr: 45 (25), 10 (0), 10 (0), (30) 15, (490) 250, (35) 75, 5 (5), 535 (340), 10 (15), Gravel Lake Rd, (45) 60, (15) 5, (40) 15

Cummings Street

75

Towne Centre Dr: 1,365 (1,200), 5 (0), (1,240) 730, (30) 5, (80) 30

I-81 NB On-Ramp: 1,040 (925), (530) 270, (390) 225

Abingdon Pl: 5 (50), 0 (5), (15) 40, (635) 335, (10) 0, 5 (0), 675 (405), Driveway, (10) 5, (0) 0, (5) 0

Green Spring Rd*: 245 (380), 0 (0), 220 (325), (425) 280, (650) 425, (290) 80, 475 (445), 755 (500), 135 (255), Cook St, (245) 85, (0) 0, (280) 115

I-81 SB Off-Ramp: 550 (430), 95 (115), (805) 400, (580) 345, 860 (805), 180 (120), I-81 SB On-Ramp

Gravel Lake Road

Vances Mill Rd: (435) 220, (95) 55, 485 (285), 95 (20), (75) 65, (80) 60

2,225 (2,675)

(2,815) 2,075

Note: Volumes rounded to the nearest 5 vehicles
** Green Spring Road is realigned to Cook Street*

STARS VDOT

Interstate 81 - Exit 17
Interchange Modification Report

Concept #2 (2040)
AM and PM Peak Hour
Traffic Volumes

FIGURE
23

6. Traffic Operations

The traffic operations included the analysis of several freeway and arterial components within the study area. Along the freeway; mainline freeway segments and ramp merge/diverges were all analyzed. Along the arterials, study area signalized and unsignalized intersections were evaluated in terms of their operational performance. Both freeway and arterial segments were analyzed under Existing, No-Build, and Build scenarios.

The Highway Capacity Software (HCS), CORSIM, Synchro Professional (Version 9.1 – Build 903, Revision 76), and SimTraffic software packages were used in the operational analyses to evaluate existing and future conditions. HCS was used to analyze the freeway and ramp locations within the project study area using the "Freeway Facilities" module. CORSIM was used to analyze the same study area locations as HCS; however, CORSIM was also used to factor the arterial conditions into the interstate operations as a single, comprehensive network. Synchro was used to analyze the intersection operations and SimTraffic was relied on to report intersection queue lengths. The following section describes the methodology and assumptions used for each of the operational analysis tools.

6.1.1. HCS Methodology and Assumptions

All freeway segments in the study area were evaluated using the Freeway Facilities module of HCS 2010 (Version 6.5). HCS 2010 includes several modules that evaluate operational performance using the methodologies contained within the 2010 Highway Capacity Manual (HCM). The Freeway Facilities module uses 15-minute interval demands and segment-based capacity calculations to estimate speed, density, throughput, and queuing for each 15-minute time-period analyzed. Unlike CORSIM; however, Freeway Facilities does not model individual vehicles, and results therefore become less reliable when multiple overlapping breakdowns or bottlenecks are present.

For each AM and PM HCS analysis (i.e., 2015 Existing, 2020 No-Build/Build, and 2040 No-Build/Build), an individual Freeway Facilities file was created for each analysis direction (i.e., one file for eastbound, one file for westbound). Per the TOATG, all HCS results are depicted in both a tabular and graphical format. All result tables depict density, in passenger cars per mile per lane (pc/mi/ln), and level of service by location (i.e., off-ramp junction, on-ramp junction, freeway segment, weave, lane transition) in both eastbound and westbound directions. Graphically, speed and density results are depicted in the HCS result graphics. Also depicted in the HCS result graphics, are modeled hourly demands, acceleration/deceleration lane lengths, segment influence lengths, and the number of lanes along the mainline and each ramp.

It should be noted that the HCM's computational procedure for ramp-freeway junctions only accounts for single-lane, right-side ramps, with ramp acceleration/deceleration lengths of 1,500 feet or less. This distance represents the area of influence the ramp merge/diverge has on the traffic operations. In some instances, the future concepts provide modifications to the freeway ramps that result in ramp acceleration/deceleration lengths greater than 1,500 feet. When this occurred, the maximum limit of 1,500 feet was used in the analysis, as the majority of traffic would have already merged over at this point.

Level of service is directly tied to density, although the thresholds vary between freeway segments and ramp and weaving segments. Ramp merge, diverge, and weave segment LOS ranges from A to E, while freeway segment LOS ranges from A to F. LOS A indicates a condition of lower density, while LOS E/F reflect conditions of an over-saturated system. While freeway segment analyses do consider LOS F as a quantifiable metric in terms of passenger cars per mile per lane (pc/mi/ln), the condition also considers the point at which demand exceeds capacity as LOS F, which could potentially occur below the thresholds listed below.

A separate demand to capacity check is also performed for each segment, and regardless of density, LOS F is reported for all segments where demand exceeds capacity. LOS criteria for merge, diverge, and freeway segments are provided in Table 13, as defined by the 2010 HCM.

Table 13: LOS Criteria for HCM Analysis

LOS	Merge/Diverge Segments	Freeway Segments
	Density (pc/ln/mi)	
A	≤ 10	≤ 11
B	> 10 – 20	> 11 – 18
C	> 20 – 28	> 18 – 26
D	> 28 – 35	> 26 – 35
E	> 35	> 35 – 45

*Note: A segment is considered to be LOS F if the demand flow rate to capacity ratio is greater than 1 ($v_d/c > 1.0$)

6.1.2. CORSIM Methodology and Assumptions

All study area freeway sections, ramps, and arterial intersections were simulated and evaluated using CORSIM (Version 6.3) traffic simulation software. CORSIM (CORridor microscopic SIMulation) is a microscopic traffic simulation and analytical tool which incorporates both urban and freeway travel characteristics. Unlike HCS, which provides a static analysis of mainline/ramp operations, CORSIM uses simulation to model individual vehicles traversing the network in order to assess the operational characteristics of the network as volumes and speeds fluctuate.

Four main steps were completed for each of the AM and PM CORSIM simulations (i.e., 2015 Existing, 2020 No-Build/Build, and 2040 No-Build/Build) in this study:

1) Network Development, Coding, and Model Inspection
2) Network Calibration
3) Inspection and Sample Size Determination
4) Analysis and Reporting

In the first step, Network Development and Coding, the link-node CORSIM networks were developed based on 2013 Virginia Base Map Program (VBMP) aerial photography. Since CORSIM does not easily model curvature, links and nodes were strategically placed such that approximate link distances were reflective of actual lengths. Once the link-node network was developed, inputs were coded throughout the network. VDOT's TOSAM provides guidance in developing input assumptions.

Through model inspection, each network was reviewed for appropriate lane alignment, appropriate lane designations, and traffic control before calibration was performed. In CORSIM, there are two calibration steps necessary to ensure that the software is providing valid results. The first calibration step is scenario specific (i.e., 2015 Existing) to ensure that the models are calibrated to actual existing conditions. To obtain these, a field visit was conducted of the study area on November 5, 2014. Based on that field visit, the model calibration was conducted for the 2015 Existing AM and PM models. Once the existing models calibrated to the observed field data, it was assumed that these similar travel behaviors would be maintained under future conditions.

The second step of calibration included comparing simulated volumes and travel speeds to the actual values. The speeds and volumes were calibrated according to the procedures outlined in VDOT's TOSAM. For traffic volumes, the top 85% (by volume) of network links should be within the following thresholds:

- Within ± 20% for < 100 vph
- Within ± 15% for ≥ 100 vph to < 300 vph
- Within ± 10% for ≥ 300 vph to < 1,000 vph
- Within ± 5% for ≥ 1,000 vph

Travel speeds were not collected for this project and therefore the posted speed limit along the interstate mainline within the study area was coded to the maximum speed in CORSIM of 70 mph. Simulated speed was only calibrated for freeways links to the CORSIM coded speed. The top 85% of the freeway links by volume calibrated if they met the threshold of ± 7 mph.

Once calibration was completed, multiple simulation runs were performed and inspected for accuracy. Items that were verified in the inspection process included:

- Network's ability to reach equilibrium
- Any vehicles denied entry into the network either due to capacity deficiencies or improper coding
- Vehicle and driver behaviors
- Signal timing and operations

Per the TOSAM, an initial sample size of 10 simulation runs was conducted before VDOT's Sample Size Determination process was performed to ensure an appropriate number of runs. Based on the sample size evaluation, a 10 simulation run sample size was verified as adequate for all models and scenarios analyzed in this study. The complete sample size evaluation results are contained in Appendix F.

For analysis and reporting, output results from each of the 10 simulation runs were averaged. Average speed (mph) and average density vehicles per lane per mile (veh/ln/mi) were obtained for all freeway mainline segments and lanes, while average control delay, queue, and LOS based on control delay were obtained for the arterial intersections. Arterial intersection results included control delay and LOS results for each movement, approach, and overall intersection.

Unlike HCS, CORSIM does not report LOS based on vehicle density along the freeway mainline. This is because CORSIM calculates density as *vehicles*/mi/ln, and not *passenger cars*/mi/ln, which is consistent with the HCM. Therefore, an HCM LOS designation cannot be assigned to CORSIM density results. Typically, overall link densities will appear higher in HCS than in CORSIM since heavy vehicles are converted to passenger car equivalents in the HCM demand flow rate calculations.

It is important to note that direct comparisons should not be made between HCS and CORSIM results. In addition to the difference between raw vehicles and passenger car equivalents, there are other important differences. First, CORSIM link densities are calculated differently than HCS. Since CORSIM is simulation-based, vehicle volumes and speeds in each lane fluctuate and are then averaged over each of the 10 simulation runs. Therefore, to calculate an overall link density value, a weighted average based on volume is performed across all lanes along each link. This means that volumes and speeds in CORSIM could be heavier or lighter than actual values and an acceleration/ deceleration lane with low density will skew the overall link density due to the weighted average.

Furthermore, in horizon year analyses, oversaturated conditions create additional variance between the two software results. CORSIM is better able to account for oversaturated conditions through simulation, where HCS equations are limited in their ability to evaluate saturated conditions.

Per the TOSAM, all CORSIM results are depicted in both a tabular and graphical format. Speed and density results are depicted in lane schematics, illustrating by-link and by-lane speed and density results. Also depicted in the lane schematics, are actual volumes, simulated volumes, acceleration/deceleration lane lengths, CORSIM node numbering, CORSIM link distances, and the number of lanes along the mainline and each ramp.

6.1.3. Synchro/SimTraffic Methodology and Assumptions

Intersection capacity analyses for signalized and unsignalized intersections were conducted under AM and PM peak hour conditions. Analyses were completed using Synchro Professional (Version 9.1 – Build 903, Revision 76), which uses methodologies contained in the Highway Capacity Manual (HCM). These models were based on existing data and were calibrated per TOATG/TOSAM guidance. For this analysis, the eastbound and westbound I-81 off-ramps were the critical roadway segment links selected for the calibration of observed queuing conditions. As shown in Table 14, the existing model simulated these queues to be within the thresholds referenced in the TOATG/TOSAM (i.e., ± 25%). Queue length observation data is included in Appendix B. Once the existing models calibrated to the observed field data, it was assumed that these similar travel behaviors would be maintained under future conditions.

Table 14: Observed and Simulated Ramp Queue Lengths Comparison

Queue	AM Peak Hour		Percent Difference	PM Peak Hour		Percent Difference
	Observed	Simulated		Observed	Simulated	
Westbound I-81 Off-Ramp	160′	126′	24%	120′	134′	11%
Eastbound I-81 Off-Ramp	380′	373′	2%	460′	463′	1%

In addition, an initial sample size of 10 simulation runs for the SimTraffic models were conducted using VDOT's Sample Size Determination process. This ensures that an appropriate number of runs have been conducted and that simulation results are reasonable. Based on the sample size evaluation, a 10 simulation run sample size was verified as adequate for all models and scenarios analyzed in this study. The complete sample size evaluation results are included in Appendix F of this report.

Peak hour intersection turning movement volumes were used, along with lane configurations and appropriate traffic control types, to determine existing and future levels of service. Similar to the ramp and freeway analyses, intersection LOS describes the degree of traffic congestion. LOS ranges from A to F—A indicating a condition of little or no congestion and F a condition with severe congestion, unstable traffic flow, and stop-and-go conditions. For intersections, LOS is based on the average delay experienced by all traffic using the intersection during the busiest 15-minute peak period. LOS A through D are generally considered acceptable in urban areas. Table 15 highlights the LOS thresholds by delay provided in the HCM for signalized and unsignalized intersections.

Table 15: LOS Thresholds by Delay for Synchro Analysis

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

Delay and associated LOS for both signalized and unsignalized intersections are reported from the Synchro analysis. The maximum queues are reported from an average of 10 simulation runs in SimTraffic.

6.2. Future Operational Conditions

This section describes the future operational conditions for the study area interstate, ramps, and intersections. Future operational analyses were conducted for the future 2020 and 2040 horizon year under the following conditions:

- 2020 AM and PM No-Build
- 2040 AM and PM No-Build
- 2020 AM and PM Concept #1 – Expanded Diamond
- 2040 AM and PM Concept #1 – Expanded Diamond
- 2020 AM and PM Concept #2 – Partial Cloverleaf Southwest Quadrant
- 2040 AM and PM Concept #2 – Partial Cloverleaf Southwest Quadrant

6.2.1. HCS Future Conditions Results

The results of the future conditions analysis from the HCS software depict density and LOS along I-81 within the study area. The future AM and PM peak hour operations for the interstate and ramp segments are shown in Table 16 and Table 17, respectively. These tables depict density, in passenger cars per mile per lane (pc/mi/In), and LOS by location (i.e., off-ramp junction, on-ramp junction, freeway segment, weave, lane transition) in both eastbound and westbound directions. Graphically, speed and density results are depicted in the HCS result graphics. Detailed graphical representations of the HCS results are also provided in Appendix G and illustrate the modeled hourly demands, acceleration/deceleration lane lengths, segment influence lengths, and the number of lanes along I-81.

Based on the results of the future conditions analysis, all mainline freeway segments and ramp merge/diverges within the study area are expected to operate at LOS C or better during the AM and PM peak. The existing capacity of the interstate is sufficient and no additional modifications are needed to the mainline segments. It should be noted that no changes were made to the westbound direction, therefore the results are all identical between scenarios. Additionally, the changes between the Build concepts and the No-build geometry along eastbound I-81 only resulted in minor variations in the anticipated operational conditions. The proposed build concepts do not result in significant geometric changes to the interstate mainline or influence areas of the ramps.

Table 16: HCS AM Peak Hour Future Conditions Results

Segment	2020 No-Build		2020 Concept #1		2020 Concept #2		2040 No-Build		2040 Concept #1		2040 Concept #2	
	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS
Eastbound												
4,000' west of Exit 17 Off-Ramp	12.8	B	12.8	B	12.8	B	17.1	B	17.0	B	17.0	B
Diverge to Exit 17 Off-Ramp	15.1	B	15.1	B	15.1	B	19.9	B	19.9	B	19.9	B
Freeway between diverge and merge for Exit 17	9.8	A	9.8	A	10.0	A	13.2	B	13.2	B	13.3	B
Merge from Exit 17 On-Ramp	13.2	B	13.2	B	13.2	B	17.6	B	17.6	B	17.6	B
4,000' east of Exit 17 On-Ramp	12.0	B	12.0	B	12.0	B	16.0	B	16.0	B	16.0	B
Westbound												
4,000' east of Exit 17 Off-Ramp	14.7	B	14.7	B	14.7	B	20.0	C	20.0	B	20.0	B
Diverge to Exit 17 Off-Ramp	17.2	B	17.2	B	17.2	B	23.0	C	22.9	C	22.9	C
Freeway between diverge and merge for Exit 17	11.3	B	11.3	B	11.3	B	15.2	B	15.1	B	15.1	B
Merge from Exit 17 On-Ramp	15.5	B	15.5	B	15.5	B	20.8	C	20.8	C	20.8	C
4,000' west of Exit 17 On-Ramp	14.0	B	14.0	B	14.0	B	18.9	C	18.9	C	18.9	C

Table 17: HCS PM Peak Hour Future Conditions Results

Segment	2020 No-Build		2020 Concept #1		2020 Concept #2		2040 No-Build		2040 Concept #1		2040 Concept #2	
	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS
Eastbound												
4,000' west of Exit 17 Off-Ramp	17.7	B	17.7	B	17.7	B	24.9	C	24.8	C	24.8	C
Diverge to Exit 17 Off-Ramp	20.6	C	20.6	C	20.6	C	27.2	C	27.2	C	27.2	C
Freeway between diverge and merge for Exit 17	13.6	B	13.7	B	13.8	B	18.4	C	18.3	C	18.5	C
Merge from Exit 17 On-Ramp	18.4	B	18.4	B	18.4	B	24.9	C	24.9	C	24.9	C
4,000' east of Exit 17 On-Ramp	16.7	B	16.7	B	16.7	B	23.1	C	23.1	C	23.1	C
Westbound												
4,000' east of Exit 17 Off-Ramp	16.2	B	16.1	B	16.1	B	22.3	C	22.3	C	22.4	C
Diverge to Exit 17 Off-Ramp	18.8	B	18.8	B	18.8	B	25.0	C	25.0	C	25.0	C
Freeway between diverge and merge for Exit 17	13.3	B	13.3	B	13.3	B	17.8	B	17.8	B	17.8	B
Merge from Exit 17 On-Ramp	18.9	B	18.9	B	18.9	B	25.6	C	25.6	C	25.7	C
4,000' west of Exit 17 On-Ramp	17.0	B	17.0	B	17.0	B	23.7	C	23.7	C	23.8	C

6.2.2. CORSIM Future Conditions Results

The results of the future conditions analysis from the CORSIM software depict density by location (i.e., off-ramp junction, on-ramp junction, freeway segment, weave, lane transition) in both eastbound and westbound directions on I-81. The future AM and PM peak hour operations for the interstate and ramp segments are shown in Table 18 and Table 19, respectively. Detailed graphical representations of the CORSIM results are provided in Appendix H and illustrate the simulated speed and density results as lane schematics, showing the "by-link" and "by-lane" summaries. Since CORSIM does not account for passenger car equivalents, its density will always be lower than that of HCS; therefore, densities from CORSIM generally above 35 veh/In/mi reflect operations similar to HCM LOS E and worse.

Based on the results of the future conditions analysis, mainline I-81 is operating at acceptable conditions as speeds are maintained and vehicle densities are below 35 veh/In/mi for all future scenarios. The only issue that was noted occurs during the 2040 No-Build PM peak hour for the eastbound off-ramp. As shown in the Appendix H lane schematic, the eastbound off-ramp is projected to operate over the 35 veh/In/mi threshold at approximately 44 veh/In/mi. This issue is mitigated under both build concepts as a result of lengthening the off-ramp and improved signalized intersection operations at the I-81 eastbound off/on-ramp termini.

Table 18: CORSIM AM Peak Hour Future Conditions Results

Segment	Facility Type	Density (veh/ln/mi)					
		2020 No Build	2020 Concept #1	2020 Concept #2	2040 No Build	2040 Concept #1	2040 Concept #2
Eastbound							
West of Exit 17 Off-Ramp	Freeway	11.7	11.7	11.7	15.4	15.5	15.5
Diverge to Exit 17 Off-Ramp	Ramp	8.9	8.9	8.7	12.2	11.7	11.4
Freeway between diverge and merge for Exit 17	Freeway	8.1	8.1	8.5	11.1	11.1	11.3
Merge from Exit 17 On-Ramp	Ramp	7.4	7.4	10.8	9.8	9.9	14.3
East of Exit 17 On-Ramp	Freeway	10.6	10.7	10.8	14.1	14.4	14.3
Westbound							
East of Exit 17 Off-Ramp	Freeway	13.0	13.0	13.0	17.4	17.4	17.4
Diverge to Exit 17 Off-Ramp	Ramp	9.9	9.9	9.9	13.4	13.3	13.3
Freeway between diverge and merge for Exit 17	Freeway	9.3	9.2	9.2	12.5	12.5	12.7
Merge from Exit 17 On-Ramp	Ramp	9.0	9.0	8.9	11.8	11.9	12.0
West of Exit 17 On-Ramp	Freeway	12.6	12.7	12.5	16.7	16.8	16.9

Table 19: CORSIM PM Peak Hour Future Conditions Results

Segment	Facility Type	Density (veh/ln/mi)					
		2020 No Build	2020 Concept #1	2020 Concept #2	2040 No Build	2040 Concept #1	2040 Concept #2
Eastbound							
West of Exit 17 Off-Ramp	Freeway	16.0	16.0	21.2	22.9	21.2	21.2
Diverge to Exit 17 Off-Ramp	Ramp	12.1	12.1	15.7	21.7	16.2	15.7
Freeway between diverge and merge for Exit 17	Freeway	11.6	11.4	15.8	16.0	15.4	15.8
Merge from Exit 17 On-Ramp	Ramp	10.5	10.3	20.0	13.9	13.8	20.0
East of Exit 17 On-Ramp	Freeway	15.1	14.9	20.0	20.0	19.9	20.0
Westbound							
East of Exit 17 Off-Ramp	Freeway	14.0	14.0	18.7	18.7	18.7	18.7
Diverge to Exit 17 Off-Ramp	Ramp	10.6	10.6	14.2	14.2	14.2	14.2
Freeway between diverge and merge for Exit 17	Freeway	10.9	10.9	14.7	14.7	14.7	14.7
Merge from Exit 17 On-Ramp	Ramp	10.9	10.8	14.6	14.7	14.5	14.6
West of Exit 17 On-Ramp	Freeway	15.3	15.2	20.2	20.7	20.4	20.2

6.2.3. Synchro/SimTraffic Future Conditions Results

The adjusted intersection turning movement counts for each of these conditions, as describe in Section 5.3 - Future Traffic Volumes, were used in conjunction with the proposed future roadway geometry to determine the vehicle delay, LOS, and queue lengths for each study area intersection. As part of this analysis, existing traffic signal timing plans were optimized for each condition to account for the changes in future volumes and roadway geometry. Tables 20–41 summarize the AM and PM peak hour vehicular delay/LOS and queuing for each movement, approach, and overall intersection operations for the study area. In the LOS/delay tables, values highlighted in bold represent movements operating at LOS E or worse. The queuing tables summarize the maximum simulated queues for each movement during the AM and PM peak hours. Values highlight as "bold*" represent queue lengths that exceed the available storage lengths/spill back to an upstream intersection and values heighted in red represent queue lengths that are excessively long.

Additionally, as part of the queuing analysis, "percent blocking" was noted in instances where significant queues impact adjacent turn- and/or through-lanes. This percentage represents the approximate amount of time during the peak hour when a lane was observed to be blocked (i.e., "10% blocking" represents the percentage of the peak hour when the turn lane storage was exceeded and impacted the adjacent lane). Detailed capacity summary data sheets are provided in Appendix I.

It should also be noted that for all the future build scenarios, iterations of simulations were conducted to evaluate different turn lane storage lengths to capture the entire simulated maximum queue. However, this was only done for turn lanes where an extension would be possible and not limited by any potential physical constraints or barriers (i.e., adjacent intersections, environmental constraints, etc.). Storage lengths that were modified through this process are noted and shown in the following tables as underlined numbers.

The following sections describe the future operational conditions for each study area intersection.

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State Route 75 at Cook Street/Realigned Green Spring Road

As mention previously, Green Spring Road will be realigned to the intersection of State Route 75 at Cook Street, creating a new fourth leg (westbound) in all future scenarios. The vehicle delay and LOS summary is shown in Table 20. For this intersection, it is projected that all movements will operate at LOS C or better during the future conditions.

Table 20: State Route 75 at Cook Street/Realigned Green Spring Road Future LOS Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND			WESTBOUND			NORTHBOUND			SOUTHBOUND		
			Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)
2020 No Build														
1 Cook Street/Realigned Green Spring Road at State Route 75	Signal	Left	-	114	206	250	200	223	125	114	142*	600	190	369
		Through							350	167	175			
		Right	-	87	155	730	123	200	400	167	192	-	162	296
2040 No Build														
1 Cook Street/Realigned Green Spring Road at State Route 75	Signal	Left	-	129	227	250	206	224	125	133*	149*	600	196	517
		Through							350	200	231			
		Right	-	93	217	730	133	256	400	178	220	-	193	689
Concept 1 2020														
1 Cook Street/Realigned Green Spring Road at State Route 75	Signal	Left	-	103	196	350	168	280	275	104	176	600	184	332
		Through							350	179	156			
		Right	-	93	138	730	144	185	400	176	220	-	157	315
Concept 1 2040														
1 Cook Street/Realigned Green Spring Road at State Route 75	Signal	Left	-	122	218	350	213	330	275	121	266	600	195	470
		Through							350	212	235			
		Right	-	103	188	730	147	200	400	202	237	-	198	489
Concept 2 2020														
1 Cook Street/Realigned Green Spring Road at State Route 75	Signal	Left	-	108	209	350	187	323	275	108	197	600	191	340
		Through							350	184	150			
		Right	-	99	137	730	126	187	400	189	216	-	147	312
Concept 2 2040														
1 Cook Street/Realigned Green Spring Road at State Route 75	Signal	Left	-	118	228	350	219	317	275	103	256	600	192	478
		Through							350	214	226			
		Right	-	103	200	730	146	228	400	163	232	-	192	475

Results for the queuing simulations are shown in Table 21. The following describes some of the notable queuing issues projected for this intersection:

No-Build

- The maximum queues for the northbound left-turn lane are expected to exceeded the available storage length of 125 feet during the following scenarios:
  - 2020 PM peak hour (142 foot queue)
  - 2040 AM peak hour (133 foot queue)
  - 2040 PM peak hour (149 foot queue)
- The southbound through movement during the 2040 PM peak hour is expected to be almost over 700 feet long. While this queue is significant, it is still able to generally clear every cycle.

With the provided future turn-lane lengths of the build concepts, no queues are expected to exceed the available amount of storage. Generally, there are minimal differences between the projected operational conditions for Concept #1 and Concept #2 at this intersection. Both options provide for improved operational conditions when compared to the No-Build Scenario.

Table 21: State Route 75 at Cook Street/Realigned Green Spring Road Future Queuing Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND			WESTBOUND			NORTHBOUND			SOUTHBOUND		
			Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)
2020 No Build														
1 Cook Street/Realigned Green Spring Road at State Route 75	Signal	Left	-	114	206	250	200	223	125	114	142*	600	190	369
		Through							350	167	175			
		Right	-	87	155	730	123	200	400	167	192	-	162	296
2040 No Build														
1 Cook Street/Realigned Green Spring Road at State Route 75	Signal	Left	-	129	227	250	206	224	125	133*	149*	600	196	517
		Through							350	200	231			
		Right	-	93	217	730	133	256	400	178	220	-	193	689
Concept 1 2020														
1 Cook Street/Realigned Green Spring Road at State Route 75	Signal	Left	-	103	196	350	168	280	275	104	176	600	184	332
		Through							350	179	156			
		Right	-	93	138	730	144	185	400	176	220	-	157	315
Concept 1 2040														
1 Cook Street/Realigned Green Spring Road at State Route 75	Signal	Left	-	122	218	350	213	330	275	121	266	600	195	470
		Through							350	212	235			
		Right	-	103	188	730	147	200	400	202	237	-	198	489
Concept 2 2020														
1 Cook Street/Realigned Green Spring Road at State Route 75	Signal	Left	-	108	209	350	187	323	275	108	197	600	191	340
		Through							350	184	150			
		Right	-	99	137	730	126	187	400	199	216	-	147	312
Concept 2 2040														
1 Cook Street/Realigned Green Spring Road at State Route 75	Signal	Left	-	118	228	350	219	317	275	103	256	600	192	478
		Through							350	214	226			
		Right	-	103	200	730	146	228	400	163	232	-	192	475

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State Route 75 at Towne Centre Drive

Future LOS and queues results for the State Route 75 at Towne Centre Drive unsignalized intersection are shown in Table 22 and Table 23, respectively. For this intersection, it is projected that all movements will operate at LOS B or better during the future conditions. Additionally, no significant queuing issues are expected at this intersection, except for the southbound through/right-turn movement during the 2040 No-Build PM peak hour. This lane is expected to exceed the effective storage length of 350 feet with a queue of approximately 370 feet. Much of this queue is a result of spillback from the I-81 westbound Off/On-ramp intersection to the south. This queuing issue is expected to be mitigated under either of the two concept scenarios as shown in Table 23.

Table 22: State Route 75 at Towne Centre Drive Future LOS Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
2020 No Build																				
3 Towne Centre Drive at State Route 75			Towne Centre Drive				-				State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-	-	-	-	-	0.1	A	0.0	A	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-					0.0	A	0.0	A	0.2	0.3
		Right	9.7	A	10.2	B	-	-	-	-	-	-	-	-					LOS	LOS
		Approach	9.7	A	10.2	B	-	-	-	-	0.0	A	0.0	A	0.0	A	0.0	A	A	A
2040 No Build																				
3 Towne Centre Drive at State Route 75			Towne Centre Drive				-				State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-	-	-	-	-	0.2	A	0.0	A	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-					0.0	A	0.0	A	0.2	0.3
		Right	9.8	A	9.8	A	-	-	-	-	-	-	-	-					LOS	LOS
		Approach	9.8	A	9.8	A	-	-	-	-	0.1	A	0.0	A	0.0	A	0.0	A	A	A
Concept 1 2020																				
3 Towne Centre Drive at State Route 75			Towne Centre Drive				-				State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-	-	-	-	-	0.1	A	0.0	A	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-					0.0	A	0.0	A	0.2	0.3
		Right	9.7	A	10.2	B	-	-	-	-	-	-	-	-					LOS	LOS
		Approach	9.7	A	10.2	B	-	-	-	-	0.0	A	0.0	A	0.0	A	0.0	A	A	A
Concept 1 2040																				
3 Towne Centre Drive at State Route 75			Towne Centre Drive				-				State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-	-	-	-	-	0.2	A	0.0	A	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-					0.0	A	0.0	A	0.2	0.3
		Right	9.8	A	9.9	A	-	-	-	-	-	-	-	-					LOS	LOS
		Approach	9.8	A	9.9	A	-	-	-	-	0.1	A	0.0	A	0.0	A	0.0	A	A	A
Concept 2 2020																				
3 Towne Centre Drive at State Route 75			Towne Centre Drive				-				State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-	-	-	-	-	0.1	A	0.0	A	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-					0.0	A	0.0	A	0.2	0.3
		Right	9.7	A	10.2	B	-	-	-	-	-	-	-	-					LOS	LOS
		Approach	9.7	A	10.2	B	-	-	-	-	0.0	A	0.0	A	0.0	A	0.0	A	A	A
Concept 2 2040																				
3 Towne Centre Drive at State Route 75			Towne Centre Drive				-				State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-	-	-	-	-	0.2	A	0.0	A	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-					0.0	A	0.0	A	0.2	0.3
		Right	9.8	A	9.9	A	-	-	-	-	-	-	-	-					LOS	LOS
		Approach	9.8	A	9.9	A	-	-	-	-	0.1	A	0.0	A	0.0	A	0.0	A	A	A

Table 23: State Route 75 at Towne Centre Drive Future Queuing Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND			WESTBOUND			NORTHBOUND			SOUTHBOUND		
			Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)
2020 No Build														
3 Towne Center Drive at State Route 75			Towne Center Drive			-			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-	-	-	-	50	32	14	-	-	-
		Through	-	-	-	-	-	-				350	4	75
		Right	-	14	53	-	-	-	-	-	-			
2040 No Build														
3 Towne Center Drive at State Route 75			Towne Center Drive			-			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-	-	-	-	50	41	0	-	-	-
		Through	-	-	-	-	-	-				350	27	368*
		Right	-	20	76	-	-	-	-	-	-			
Concept 1 2020														
3 Towne Center Drive at State Route 75			Towne Center Drive			-			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-	-	-	-	50	35	11	-	-	-
		Through	-	-	-	-	-	-				350	3	2
		Right	-	15	64	-	-	-	-	-	-			
Concept 1 2040														
3 Towne Center Drive at State Route 75			Towne Center Drive			-			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-	-	-	-	50	47	2	-	-	-
		Through	-	-	-	-	-	-				350	24	67
		Right	-	23	62	-	-	-	-	-	-			
Concept 2 2020														
3 Towne Center Drive at State Route 75			Towne Center Drive			-			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-	-	-	-	50	28	10	-	-	-
		Through	-	-	-	-	-	-				350	10	12
		Right	-	19	51	-	-	-	-	-	-			
Concept 2 2040														
3 Towne Center Drive at State Route 75			Towne Center Drive			-			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-	-	-	-	50	35	3	-	-	-
		Through	-	-	-	-	-	-				350	20	65
		Right	-	21	71	-	-	-	-	-	-			

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State Route 75 at Washington Crossings Entrance

Future LOS and queues results for the State Route 75 at Washington Crossings Entrance unsignalized intersection are shown in Table 24 and Table 25, respectively. For this intersection, it is projected that all movements will operate at LOS C or better during the future conditions. For the projected queue lengths, the southbound through lanes have simulated maximum queue lengths that extend to the next upstream intersection (State Route 75 at Towne Centre Drive). However, it should be noted that the distance to the next upstream intersection is within less than 100 feet and the through traffic is expected to queue up and block the southbound left-turn lane. While these southbound through queues do not change significantly between the different scenarios, the amount of blocked time differs significantly between 2040 PM peak hour. During the No-Build condition, the southbound through movement blocks the left-turn lane approximately 24% of the time. For the two build concepts, the percent blocking time decreases to approximately 1% of the time.

Table 24: State Route 75 at Washington Crossings Entrance Future LOS Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
2020 No Build																				
4 Washington Crossing at State Route 75			McDonald's Driveway				Washington Crossing				State Route 75				State Route 75					
	Two-Way Stop	Left	10.8	B	11.1	B	18.3	C	17.2	C	0.0	A	0.0	A	11.5	B	10.7	B	Delay	Delay
		Through									0.0	A	0.0	A	0.0	A	0.0	A	0.8	0.9
		Right																	LOS	LOS
		Approach	10.8	B	11.1	B	18.3	C	17.2	C	0.0	A	0.0	A	0.3	A	0.2	A	A	A
2040 No Build																				
4 Washington Crossing at State Route 75			McDonald's Driveway				Washington Crossing				State Route 75				State Route 75					
	Two-Way Stop	Left	11.0	B	10.8	B	22.8	C	21.9	C	0.0	A	0.0	A	13.3	B	11.8	B	Delay	Delay
		Through									0.0	A	0.0	A	0.0	A	0.0	A	0.9	1.2
		Right																	LOS	LOS
		Approach	11.0	B	10.8	B	22.8	C	21.9	C	0.0	A	0.0	A	0.4	A	0.2	A	A	A
Concept 1 2020																				
4 Washington Crossing at State Route 75			McDonald's Driveway				Washington Crossing				State Route 75				State Route 75					
	Two-Way Stop	Left	10.8	B	11.1	B	18.3	C	17.2	C	0.0	A	0.0	A	11.5	B	10.7	B	Delay	Delay
		Through									0.0	A	0.0	A	0.0	A	0.0	A	0.8	0.9
		Right																	LOS	LOS
		Approach	10.8	B	11.1	B	18.3	C	17.2	C	0.0	A	0.0	A	0.3	A	0.2	A	A	A
Concept 1 2040																				
4 Washington Crossing at State Route 75			McDonald's Driveway				Washington Crossing				State Route 75				State Route 75					
	Two-Way Stop	Left	11.0	B	11.1	B	22.8	C	22.0	C	0.0	A	0.0	A	13.3	B	11.8	B	Delay	Delay
		Through									0.0	A	0.0	A	0.0	A	0.0	A	0.8	1.2
		Right																	LOS	LOS
		Approach	11.0	B	11.1	B	22.8	C	22.0	C	0.0	A	0.0	A	0.4	A	0.2	A	A	A
Concept 2 2020																				
4 Washington Crossing at State Route 75			McDonald's Driveway				Washington Crossing				State Route 75				State Route 75					
	Two-Way Stop	Left	10.8	B	11.1	B	18.3	C	17.2	C	-	-	-	-	11.5	B	10.7	B	Delay	Delay
		Through									0.0	A	0.0	A	0.0	A	0.0	A	0.8	0.9
		Right																	LOS	LOS
		Approach	10.8	B	11.1	B	18.3	C	17.2	C	0.0	A	0.0	A	0.3	A	0.2	A	A	A
Concept 2 2040																				
4 Washington Crossing at State Route 75			McDonald's Driveway				Washington Crossing				State Route 75				State Route 75					
	Two-Way Stop	Left	11.0	B	11.1	B	22.8	C	22.0	C	0.0	A	0.0	A	13.3	B	11.8	B	Delay	Delay
		Through									0.0	A	0.0	A	0.0	A	0.0	A	0.8	1.2
		Right																	LOS	LOS
		Approach	11.0	B	11.1	B	22.8	C	22.0	C	0.0	A	0.0	A	0.4	A	0.2	A	A	A

Table 25: State Route 75 at Washington Crossings Entrance Future Queuing Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND			WESTBOUND			NORTHBOUND			SOUTHBOUND		
			Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)
2020 No Build														
4 Washington Crossing at State Route 75			McDonald's Driveway			Washington Crossing			State Route 75			State Route 75		
	Two-Way Stop	Left	-	82	98	-	54	145	-	-	-	60	24	23
		Through							500	4	7	60	71*	81*
		Right												
2040 No Build														
4 Washington Crossing at State Route 75			McDonald's Driveway			Washington Crossing			State Route 75			State Route 75		
	Two-Way Stop	Left	-	91	130	-	74	629	-	-	-	60	24	32
		Through							500	3	3	60	77*	87*
		Right												
Concept 1 2020														
4 Washington Crossing at State Route 75			McDonald's Driveway			Washington Crossing			State Route 75			State Route 75		
	Two-Way Stop	Left	-	92	98	-	49	130	-	-	-	60	24	33
		Through							500	0	2	60	71*	78*
		Right												
Concept 1 2040														
4 Washington Crossing at State Route 75			McDonald's Driveway			Washington Crossing			State Route 75			State Route 75		
	Two-Way Stop	Left	-	98	114	-	90	402	-	-	-	60	24	25
		Through							500	8	6	60	73*	79*
		Right												
Concept 2 2020														
4 Washington Crossing at State Route 75			McDonald's Driveway			Washington Crossing			State Route 75			State Route 75		
	Two-Way Stop	Left	-	75	92	-	60	162	-	-	-	60	24	25
		Through							500	3	8	60	71*	78*
		Right												
Concept 2 2040														
4 Washington Crossing at State Route 75			McDonald's Driveway			Washington Crossing			State Route 75			State Route 75		
	Two-Way Stop	Left	-	87	119	-	76	437	-	-	-	60	24	24
		Through							500	4	7	60	72*	79*
		Right												

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State Route 75 at I-81 Westbound Off/On-Ramps

Future LOS and queues results for the State Route 75 at I-81 Westbound Off/On-Ramps signalized intersection are shown in Table 26 and Table 27, respectively. Based on the analysis of this intersection, the following operational issues are noted for each scenario:

No-Build

- The overall level of service at this intersection is expected to deteriorate significantly under the 2040 No-Build AM peak hour conditions when compared to the 2020 No-Build scenarios, dropping from an overall LOS C to LOS E.
- Westbound traffic from the I-81 off-ramp is projected to operate at LOS E or worse under No-Build conditions.
    - The westbound right-turn lane is over capacity and contributing to these conditions.
        - 62.5 seconds of delay per vehicle (LOS E) during the AM peak hour under 2020 No-Build conditions
        - 184 seconds of delay per vehicle (LOS F) during the AM peak hour under 2040 No-Build conditions
        - 63 seconds of delay per vehicle (LOS E) during the PM peak hour under 2040 No-Build conditions
    - Under 2040 PM peak hour No-Build conditions, the maximum queue of 323 feet for the westbound left-turn lane is expected to exceed to the effective storage length of 250 feet. Due to the volume of traffic for this movement, in the right-turning vehicles block the adjacent left-turn lane approximately 40% of the time.
- The southbound through movement during the PM peak hour is also expected to operate at LOS F (83 seconds of delay per vehicle) under 2040 No-Build conditions, which results in the opportunity for a significant queue to form and impact upstream intersection operations.
    - There is approximately 500 feet to the north before the next upstream intersection (Washington Crossings Entrance) can be impacted by queuing vehicles. The 2040 No-Build PM peak hour southbound through queues are projected to exceed this distance.
- Additionally, the northbound left-turn lane maximum queues exceed the effective storage (85 feet) for all No-Build scenarios. As a result, the capacity of the turn-lane is exceeded and the amount of time the turning traffic blocks the adjacent through lane increases between 2020 and 2040, as the length of the queue increases.
    - 109 foot queue with the adjacent through lane being blocking by the left-turn lane 14% of the time during the 2020 No-Build AM peak hour
    - 108 foot queue with the adjacent through lane being blocking by the left-turn lane 14% of the time during the 2020 No-Build PM peak hour
    - 110 foot queue with the adjacent through lane being blocking by the left-turn lane 18% of the time during the 2040 No-Build AM peak hour
    - 109 foot queue with the adjacent through lane being blocking by the left-turn lane 21% of the time during the 2040 No-Build PM peak hour

Concept #1

- Year 2040 operations are expected to be significantly improved when compared to the 2040 No-Build conditions, improving from LOS E to LOS C for the overall intersection.
- With the additional space provided for a longer northbound left-turn lane under Concept #1, the queuing issues projected under the No-Build conditions for this movement are generally mitigated.
- The AM peak hour in 2040 shows the maximum queue exceeding the effective storage length (i.e., 324 feet vs. 300 feet), This is attributed to the adjacent through traffic blocking access to this turn lane. However, it is only projected to occur 10% of the time during the peak hour. There are also instances of the westbound right-turn lane from the off-ramp blocking the adjacent left-turn lane 23% to 42% of the time) across all years and peak hours.

Concept #2

- Year 2040 operations are expected to be significantly improved when compare to the 2040 No-Build conditions, improving from LOS E to LOS C for the overall intersection.
- With the additional space provided for a longer northbound left-turn lane under Concept #2, the queuing issues projected under the No-Build conditions for this movement are essentially mitigated.
    - The AM peak hour in 2040 shows the maximum queue just exceeding the effective storage length (i.e., 329 feet vs. 325 feet). This is attributed to the adjacent through traffic blocking access to this turn lane, however it is only projected to occur 5% of the time during the peak hour.
- There are also instances of the westbound right-turn lane from the off-ramp blocking the adjacent left-turn lane (20% to 43% of the time) across all years and peak hours.

When comparing the conditions between the two concepts, the westbound off-ramp is projected to operate very similarly in terms of delay, LOS, and queue lengths. As noted previously, based on the queuing analysis, the northbound through movement is anticipated to queue to the next upstream intersection (I-81 Eastbound Off/On Ramps), resulting in blocking the access to the adjacent turn lane 10% of time for Concept #1. When compared to Concept #2, the instance of this blocking is reduced to 5%. This indicates that traffic can flow more efficiently along State Route 75 under Concept #2, with results in less potential queuing issues. When considering the impacts of the two build concepts at this intersection, operations are projected to be slightly better under Concept #2.

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Table 26: State Route 75 at I-81 Westbound Off/On-Ramps Future LOS Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
2020 No Build																				
5 I-81 WB Ramp at State Route 75			-				I-81 WB Off-Ramp				State Route 75				State Route 75					
	Signal	Left	-	-	-	-	46.8	D	55.0	E	17.3	B	54.0	D	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-	5.2	A	8.2	A	33.8	C	50.2	D	28.1	33.6
		Right	-	-	-	-	62.5	E	52.1	D	-	-	-	-	28.3	C	25.4	C	LOS	LOS
		Approach	-	-	-	-	60.1	E	52.7	D	7.2	A	13.4	B	31.3	C	40.1	D	C	C
2040 No Build																				
5 I-81 WB Ramp at State Route 75			-				I-81 WB Off-Ramp				State Route 75				State Route 75					
	Signal	Left	-	-	-	-	47.3	D	63.5	E	50.1	D	66.3	E	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-	9.3	A	11.7	B	39.1	D	83.6	F	61.5	47.4
		Right	-	-	-	-	184.1	F	63.1	E	-	-	-	-	31.0	C	28.1	C	LOS	LOS
		Approach	-	-	-	-	164.0	F	63.2	E	16.4	B	18.7	B	35.4	D	60.4	E	E	D
Concept 1 2020																				
5 I-81 WB Ramp at State Route 75			-				I-81 WB Off-Ramp				State Route 75				State Route 75					
	Signal	Left	-	-	-	-	24.6	C	34.2	C	7.5	A	7.6	A	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-	9.2	A	4.2	A	15.7	B	13.1	B	18.9	14.8
		Right	-	-	-	-	44.1	D	44.5	D	-	-	-	-	13.3	B	8.7	A	LOS	LOS
		Approach	-	-	-	-	41.1	D	42.4	D	8.9	A	4.6	A	14.6	B	11.3	B	B	B
Concept 1 2040																				
5 I-81 WB Ramp at State Route 75			-				I-81 WB Off-Ramp				State Route 75				State Route 75					
	Signal	Left	-	-	-	-	18.7	B	27.9	C	16.5	B	16.6	B	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-	27.4	C	4.5	A	27.1	C	28.9	C	30.5	22.3
		Right	-	-	-	-	50.6	D	54.7	D	-	-	-	-	20.4	C	13.7	B	LOS	LOS
		Approach	-	-	-	-	45.9	D	49.1	D	25.6	C	6.0	A	24.0	C	22.5	C	C	C
Concept 2 2020																				
5 I-81 WB Ramp at State Route 75			-				I-81 WB Off-Ramp				State Route 75				State Route 75					
	Signal	Left	-	-	-	-	23.3	C	34.4	C	6.5	A	8.6	A	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-	14.3	B	4.4	A	18.1	B	12.8	B	22.2	14.9
		Right	-	-	-	-	48.8	D	45.7	D	-	-	-	-	14.8	B	8.5	A	LOS	LOS
		Approach	-	-	-	-	44.9	D	43.4	D	13.1	B	4.8	A	16.6	B	11.1	B	C	B
Concept 2 2040																				
5 I-81 WB Ramp at State Route 75			-				I-81 WB Off-Ramp				State Route 75				State Route 75					
	Signal	Left	-	-	-	-	19.1	B	27.5	C	12.0	B	19.1	B	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-	27.2	C	7.8	A	28.6	C	31.2	C	31.0	23.9
		Right	-	-	-	-	53.1	D	53.8	D	-	-	-	-	21.2	C	14.2	B	LOS	LOS
		Approach	-	-	-	-	48.1	D	48.2	D	24.5	C	9.3	A	25.2	C	24.1	C	C	C

Table 27: State Route 75 at I-81 Westbound Off/On-Ramps Future Queuing Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND			WESTBOUND			NORTHBOUND			SOUTHBOUND		
			Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)
2020 No Build														
5 I-81 WB Ramp at State Route 75			-			I-81 WB Off-Ramp			State Route 75			State Route 75		
	Signal	Left	-	-	-	250	142	142	85	109	108*	-	-	-
		Through	-	-	-	-	-	-	285	240	166	500	372	518*
		Right	-	-	-	650	317	213	-	-	-	500	311	453
2040 No Build														
5 I-81 WB Ramp at State Route 75			-			I-81 WB Off-Ramp			State Route 75			State Route 75		
	Signal	Left	-	-	-	250	323*	249	85	110*	109*	-	-	-
		Through	-	-	-	-	-	-	285	272	196	500	385	532*
		Right	-	-	-	650	559	378	-	-	-	500	361	534*
Concept 1 2020														
5 I-81 WB Ramp at State Route 75			-			I-81 WB Off-Ramp			State Route 75			State Route 75		
	Signal	Left	-	-	-	250	109	126	300	194	110	-	-	-
		Through	-	-	-	-	-	-	635	337	260	500	215	349
		Right	-	-	-	650	251	214	-	-	-	500	109	132
Concept 1 2040														
5 I-81 WB Ramp at State Route 75			-			I-81 WB Off-Ramp			State Route 75			State Route 75		
	Signal	Left	-	-	-	250	236	164	300	324*	191	-	-	-
		Through	-	-	-	-	-	-	635	619	285	500	293	481
		Right	-	-	-	650	407	302	-	-	-	500	129	337
Concept 2 2020														
5 I-81 WB Ramp at State Route 75			-			I-81 WB Off-Ramp			State Route 75			State Route 75		
	Signal	Left	-	-	-	250	138	117	325	246	102	-	-	-
		Through	-	-	-	-	-	-	630	519	246	500	208	334
		Right	-	-	-	650	276	228	-	-	-	500	101	153
Concept 2 2040														
5 I-81 WB Ramp at State Route 75			-			I-81 WB Off-Ramp			State Route 75			State Route 75		
	Signal	Left	-	-	-	250	205	138	325	329*	200	-	-	-
		Through	-	-	-	-	-	-	630	583	361	500	296	474
		Right	-	-	-	650	416	283	-	-	-	500	134	315

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State Route 75 at I-81 Eastbound Off/On-Ramps

Future LOS and queues results for the State Route 75 at I-81 Eastbound Off/On-Ramps signalized intersection are shown in Table 28 and Table 29. Based on the analysis of this intersection, the following operational issues are noted for each scenario:

No-Build

- The eastbound approach, which serves as the off-ramp from I-81 and is projected to operate at LOS E or worse under the following conditions:
  - 57 seconds of delay per vehicle (LOS E) during the PM peak hour under 2020 No-Build conditions
  - 83 seconds of delay per vehicle (LOS F) during the AM peak hour under 2040 No-Build conditions
  - 90 seconds of delay per vehicle (LOS F) during the PM peak hour under 2040 No-Build conditions
- The maximum projected queue lengths for the eastbound right-turn lane are expected to exceed the available amount of effective storage length for both peak hours under 2020 and 2040 conditions.
  - The adjacent eastbound left-turn lane queues are expected to be long (maximum queues range between 500 and 735 feet), which result in significant blockage to the right-turn lane:
    - 47% of the time during the AM peak hour (2020)
    - 46%, of the time during the PM peak hour (2040)
    - 65% of the time during the AM peak hour (2020)
    - 63% of the time during the PM peak hour (2040)
  - The extent of queueing associated with both turning movements at the off-ramp further complicates general traffic operations associated with the right-turn lane and the efficiency of the signalized intersection.
- The northbound through movement is expected to operate at LOS E or worse under the following conditions:
  - 56 seconds of delay per vehicle (LOS E) during the PM peak hour under 2020 No-Build conditions
  - 89 seconds of delay per vehicle (LOS F) during the AM peak hour under 2040 No-Build conditions
  - 83 seconds of delay per vehicle (LOS F during the PM peak hour under 2040 No-Build conditions
- Operational conditions for the northbound approach results in the queued vehicles impacting upstream intersection operations.
  - However, under No-Build conditions there is only approximately 60 feet available to the south before the next upstream intersection (Commerce Drive) is impacted by queuing vehicles.
  - Many of the upstream intersections are impacted by the bottleneck at this approach, resulting in long queues that can spill back as far as Gravel Lake Road to the south.
- Additionally, the southbound left-turn queues are projected to exceed the effective storage length of 160 feet for all No-Build scenarios.

Concept #1

- Year 2040 AM peak hour operations are expected to be significantly improved when compare to the 2040 No-Build conditions, improving from LOS E to LOS C for the overall intersection.
- All individual movements are expected to operate at LOS D or better
- The northbound right-turn lane maximum queues extend just past the effective storage length of 300 feet in the 2040 AM peak hour scenario. It should be noted that the 300 feet of storage represents approximately the maximum amount of storage that could be provided for this concept, given the location of the next upstream intersection. This queue is relatively minor and thus, there is no significant blocking expected to occur with the extended northbound left-turn lane or adjacent through lane.

Concept #2

- Year 2040 AM peak hour operations are expected to be significantly improved when compare to the 2040 No-Build conditions, improving from LOS E to LOS C for the overall intersection.
- Intersection operations are also slightly improved over Concept # 1 despite the introduction of a fourth leg/phase to the signal operations due to the removal of heavy southbound left-turn movement that is now accommodated with a channelized YIELD to the I-81 eastbound on-loop.
  - By removing this left-turn movement from the signal phasing, more green time can be allocated the I-81 eastbound off-ramp.
  - When using the same cycle length, the amount of time given to the eastbound approach increases from approximately 35 seconds during the AM peak and 36 seconds during the PM peak for Concept #1 to 40 seconds during the AM peak and 43 seconds during the PM peak for Concept #2.
- All individual movements are expected to operate at LOS D or better
- The only queue that exceeds the effective storage for Concept #2 occurs for the northbound left-turn lane during the 2040 AM peak hour
  - The queue is only forming due to adjacent through traffic blocking the adjacent turn lane, 11% of the time.
  - It should be noted that the 250 feet of storage represents approximately the maximum amount of storage that could be provided for this concept, given the location of the next upstream intersection and cannot be extended further.

For Build Concept #1, the I-81 Eastbound Off-Ramp left turning movement is projected to block the right turn lane 13% and 7% of the time during the AM and PM peak hours, respectively. When compared to Build Concept #2, almost all instances of blocking for this off-ramp have been mitigated (1% during the AM peak hour). Based on the future operational condition analysis, Build Concept #2 is generally projected to experience less delay and shorter queues when compared to Concept #1, and thus is anticipated to result in broader overarching benefits to I-81 eastbound off-ramp operations, on-loop operations, and the State Route 75 corridor.

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Table 28: State Route 75 at I-81 Eastbound Off/On-Ramps Future LOS Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND AM Delay	EASTBOUND AM LOS	EASTBOUND PM Delay	EASTBOUND PM LOS	WESTBOUND AM Delay	WESTBOUND AM LOS	WESTBOUND PM Delay	WESTBOUND PM LOS	NORTHBOUND AM Delay	NORTHBOUND AM LOS	NORTHBOUND PM Delay	NORTHBOUND PM LOS	SOUTHBOUND AM Delay	SOUTHBOUND AM LOS	SOUTHBOUND PM Delay	SOUTHBOUND PM LOS	Overall AM	Overall PM
2020 No Build																				
6 I-81 EB Ramp at State Route 75			I-81 EB Off-Ramp				-				State Route 75				State Route 75					
	Signal	Left	54.5	D	67.2	E	-	-	-	-	-	-	-	-	36.6	D	12.2	B	Delay	Delay
		Through	-	-	-	-	-	-	-	-	46.4	D	55.8	E	1.5	A	2.9	A	37.7	34.9
		Right	34.0	C	37.4	D	-	-	-	-	26.8	C	34.0	C	-	-	-	-	LOS	LOS
		Approach	49.8	D	57.1	E	-	-	-	-	42.2	D	50.9	D	16.8	B	6.8	A	D	C
2040 No Build																				
6 I-81 EB Ramp at State Route 75			I-81 EB Off-Ramp				-				State Route 75				State Route 75					
	Signal	Left	98.0	F	119.2	F	-	-	-	-	-	-	-	-	61.7	E	26.2	C	Delay	Delay
		Through	-	-	-	-	-	-	-	-	89.1	F	82.8	F	1.4	A	3.4	A	66.0	54.3
		Right	37.6	D	41.0	D	-	-	-	-	31.5	C	36.3	D	-	-	-	-	LOS	LOS
		Approach	83.4	F	90.8	F	-	-	-	-	75.7	E	71.6	E	28.8	C	13.0	B	E	D
Concept 1 2020																				
6 I-81 EB Ramp at State Route 75			I-81 EB Off-Ramp				-				State Route 75				State Route 75					
	Signal	Left	40.7	D	39.8	D	-	-	-	-	-	-	-	-	17.2	B	14.4	B	Delay	Delay
		Through	-	-	-	-	-	-	-	-	23.5	C	25.7	C	7.9	A	8.2	A	23.5	21.7
		Right	24.0	C	23.1	C	-	-	-	-	14.1	B	17.3	B	-	-	-	-	LOS	LOS
		Approach	36.9	D	34.2	C	-	-	-	-	21.5	B	23.8	C	11.9	B	10.8	B	C	C
Concept 1 2040																				
6 I-81 EB Ramp at State Route 75			I-81 EB Off-Ramp				-				State Route 75				State Route 75					
	Signal	Left	44.9	D	46.8	D	-	-	-	-	-	-	-	-	14.0	B	32.0	C	Delay	Delay
		Through	-	-	-	-	-	-	-	-	37.8	D	41.5	D	4.1	A	10.1	B	28.7	30.1
		Right	22.1	C	21.7	C	-	-	-	-	16.9	B	21.4	C	-	-	-	-	LOS	LOS
		Approach	39.4	D	37.7	D	-	-	-	-	33.0	C	36.6	C	8.3	A	19.4	B	C	C
Concept 2 2020																				
6 I-81 EB Ramp/Country Club Drive at State Route 75			I-81 EB Off-Ramp				-				State Route 75				State Route 75					
	Signal	Left	31.5	C	27.5	C	40.1	D	40.0	D	11.7	B	16.2	B	26.9	C	12.6	B	Delay	Delay
		Through	18.0	B	16.5	B					24.3	C	26.0	C	22.1	C	22.5	C	22.6	20.1
		Right									15.0	B	18.3	B	0.1	A	0.2	A	LOS	LOS
		Approach	28.4	C	23.8	C	40.1	D	40.0	D	21.6	C	23.8	C	13.0	B	12.3	B	C	C
Concept 2 2040																				
6 I-81 EB Ramp/Country Club Drive at State Route 75			I-81 EB Off-Ramp				-				State Route 75				State Route 75					
	Signal	Left	44.1	D	38.4	D	40.7	D	40.1	D	13.1	B	18.0	B	16.5	B	10.2	B	Delay	Delay
		Through	17.1	B	16.4	B					30.6	C	29.5	C	19.6	B	25.3	C	26.7	23.2
		Right									16.1	B	19.2	B	0.1	A	0.2	A	LOS	LOS
		Approach	37.6	D	30.4	C	40.7	D	40.1	D	26.4	C	26.4	C	10.4	B	13.2	B	C	C

Table 29: State Route 75 at I-81 Eastbound Off/On-Ramps Future Queuing Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND Effective Storage Length (ft)	EASTBOUND AM Max Queue (ft)	EASTBOUND PM Max Queue (ft)	WESTBOUND Effective Storage Length (ft)	WESTBOUND AM Max Queue (ft)	WESTBOUND PM Max Queue (ft)	NORTHBOUND Effective Storage Length (ft)	NORTHBOUND AM Max Queue (ft)	NORTHBOUND PM Max Queue (ft)	SOUTHBOUND Effective Storage Length (ft)	SOUTHBOUND AM Max Queue (ft)	SOUTHBOUND PM Max Queue (ft)
2020 No Build														
6 I-81 EB Ramp at State Route 75			I-81 EB Off-Ramp			-			State Route 75			State Route 75		
	Signal	Left	1,105	524	524	-	-	-	-	-	-	160	188*	184*
		Through	-	-	-	-	-	-	60	102*	106*	285	158	225
		Right	115	343*	332*	-	-	-	60	59	61*	-	-	-
2040 No Build														
6 I-81 EB Ramp at State Route 75			I-81 EB Off-Ramp			-			State Route 75			State Route 75		
	Signal	Left	1,105	682	715	-	-	-	-	-	-	160	193*	191*
		Through	-	-	-	-	-	-	60	99*	104*	285	251	240
		Right	115	352*	365*	-	-	-	60	59	59	-	-	-
Concept 1 2020														
6 I-81 EB Ramp at State Route 75			I-81 EB Off-Ramp			-			State Route 75			State Route 75		
	Signal	Left	1,200	311	347	-	-	-	-	-	-	310	177	302
		Through	-	-	-	-	-	-	410	381	350	635	162	305
		Right	325	132	191	-	-	-	300	248	224	-	-	-
Concept 1 2040														
6 I-81 EB Ramp at State Route 75			I-81 EB Off-Ramp			-			State Route 75			State Route 75		
	Signal	Left	1,200	532	385	-	-	-	-	-	-	310	239	324*
		Through	-	-	-	-	-	-	410	421	403	635	137	414
		Right	325	264	274	-	-	-	300	320*	320*	-	-	-
Concept 2 2020														
6 I-81 EB Ramp/Country Club Drive at State Route 75			I-81 EB Off-Ramp			Country Club Drive			State Route 75			State Route 75		
	Signal	Left	1,575	293	320	-	152	122	250	192	148	290	79	141
		Through	300	77	142				400	332	288	630	184	284
		Right							300	86	83	325	0	94
Concept 2 2040														
6 I-81 EB Ramp/Country Club Drive at State Route 75			I-81 EB Off-Ramp			Country Club Drive			State Route 75			State Route 75		
	Signal	Left	1,575	359	348	-	171	186	250	299*	165	290	78	170
		Through	300	153	166				400	376	289	630	177	343
		Right							300	138	80	325	0	128

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State Route 75 at Commerce Drive

The operations for this intersection are only applicable under No-Build conditions, since both build concepts result in the closure of Commerce Drive due to its proximity to the eastbound I-81 on/off-ramps and short distances to adjacent intersections. As shown in the operational summaries in Table 30 and Table 31, under its current configuration the intersection experiences significant queuing during the AM and PM peak hours. Simulated queues project spillback through the upstream intersection, largely caused by the bottleneck identified previously at the I-81 ramps. Because of this projected traffic on State Route 75, there are not sufficient gaps for vehicles to turn out from the unsignalized side streets, causing excessive queues for the vehicles at this approach to Route 75.

Table 30: State Route 75 at Commerce Drive Future LOS Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
2020 No Build																				
7 Commerce Drive at State Route 75			Commerce Drive				-				State Route 75				State Route 75					
	One-Way Stop	Left	19.6	C	20.8	C	-	-	-	-	0.1	A	0.1	A	-	-	-	-	Delay	Delay
		Through					-	-	-	-					0.0	A	0.0	A	0.7	0.8
		Right					-	-	-	-	-	-	-	-					LOS	LOS
		Approach	19.6	C	20.8	C	-	-	-	-	0.1	A	0.1	A	0.0	A	0.0	A	A	A
2040 No Build																				
7 Commerce Drive at State Route 75			Commerce Drive				-				State Route 75				State Route 75					
	One-Way Stop	Left	25.3	D	28.7	D	-	-	-	-	0.1	A	0.2	A	-	-	-	-	Delay	Delay
		Through					-	-	-	-					0.0	A	0.0	A	1.0	1.1
		Right					-	-	-	-	-	-	-	-					LOS	LOS
		Approach	25.3	D	28.7	D	-	-	-	-	0.1	A	0.2	A	0.0	A	0.0	A	A	A
Concept 1 - 2020																				
7 Commerce Drive at State Route 75			Commerce Drive				-				State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Right	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LOS	LOS
		Approach	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Concept 1 - 2040																				
7 Commerce Drive at State Route 75			Commerce Drive				-				State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Right	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LOS	LOS
		Approach	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Concept 2 - 2020																				
7 Commerce Drive at State Route 75			Commerce Drive				-				State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Right	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LOS	LOS
		Approach	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Concept 2 - 2040																				
7 Commerce Drive at State Route 75			Commerce Drive				-				State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Right	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LOS	LOS
		Approach	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 31: State Route 75 at Commerce Drive Future Queuing Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND			WESTBOUND			NORTHBOUND			SOUTHBOUND		
			Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)
2020 No Build														
7 Commerce Drive at State Route 75			Commerce Drive			-			State Route 75			State Route 75		
	One-Way Stop	Left	-	680	651	-	-	-	50	115*	104*	-	-	-
		Through	-	-	-	-	-	-				60	90*	80*
		Right	110	60	95	-	-	-	-	-	-			
2040 No Build														
7 Commerce Drive at State Route 75			Commerce Drive			-			State Route 75			State Route 75		
	One-Way Stop	Left	-	687	661	-	-	-	50	94*	100*	-	-	-
		Through	-	-	-	-	-	-				60	78*	90*
		Right	110	70	67	-	-	-	-	-	-			
Concept 1 2020														
7 Commerce Drive at State Route 75			Commerce Drive			-			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-	-	-	-	-	-	-	-	-	-
		Through	-	-	-	-	-	-	-	-	-	-	-	-
		Right	-	-	-	-	-	-	-	-	-	-	-	-
Concept 1 2040														
7 Commerce Drive at State Route 75			Commerce Drive			-			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-	-	-	-	-	-	-	-	-	-
		Through	-	-	-	-	-	-	-	-	-	-	-	-
		Right	-	-	-	-	-	-	-	-	-	-	-	-
Concept 2 2020														
7 Commerce Drive at State Route 75			Commerce Drive			-			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-	-	-	-	-	-	-	-	-	-
		Through	-	-	-	-	-	-	-	-	-	-	-	-
		Right	-	-	-	-	-	-	-	-	-	-	-	-
Concept 2 2040														
7 Commerce Drive at State Route 75			Commerce Drive			-			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-	-	-	-	-	-	-	-	-	-
		Through	-	-	-	-	-	-	-	-	-	-	-	-
		Right	-	-	-	-	-	-	-	-	-	-	-	-

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State Route 75 at Country Club Drive

The operations for this intersection are only applicable under No-Build and Concept #1 conditions, since the proposed ramp configurations of Concept #2 result in the realignment of Country Club Drive to become a part of the I-81 eastbound off-ramp/on-loop signalized intersection. Future LOS and queues results for the State Route 75 at Country Club Drive unsignalized intersection are shown in Table 32 and Table 33, respectively. For this intersection, it is projected that all movements will operate at LOS C or better during the future conditions. However, this intersection is expected to have significant queuing problems because of the spillback occurring at adjacent intersections along State Route 75 to the north and south. The intersection to the north (Commerce Drive) is located less than 100 feet away and it is easy for the volume of traffic to queue up and spill back to this point. Additionally, the northbound approach is expected to queue to the upstream intersection of Abingdon Place, which is approximately 500 feet away to the south. Because of these queues, the westbound approach does not have sufficient gaps for vehicles to turn out from the side streets, causing excessive queues as well. These queuing issues are expected to be mitigated with the proposed Concept #1 when compared to the No-Build conditions. Under Concept #1, maximum queues are projected to be contained within the available storage space and not impact adjacent intersections.

Table 32: State Route 75 at Country Club Drive Future LOS Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
2020 No Build																				
8 Country Club Drive at State Route 75			-				Country Club Drive				State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-	15.0	C	13.6	B	-	-	-	-	2.1	A	2.2	A	Delay	Delay
		Through	-	-	-	-					0.0	A	0.0	A					2.3	2.5
		Right	-	-	-	-									-	-	-	-	LOS	LOS
		Approach	-	-	-	-	15.0	C	13.6	B	0.0	A	0.0	A	2.1	A	2.2	A	A	A
2040 No Build																				
8 Country Club Drive at State Route 75			-				Country Club Drive				State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-	17.9	C	16.0	C	-	-	-	-	2.3	A	2.7	A	Delay	Delay
		Through	-	-	-	-					0.0	A	0.0	A					2.7	2.9
		Right	-	-	-	-									-	-	-	-	LOS	LOS
		Approach	-	-	-	-	17.9	C	16.0	C	0.0	A	0.0	A	2.3	A	2.7	A	A	A
Concept 1 2020																				
8 Realigned Country Club Drive at State Route 75			-				Country Club Drive				State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-	17.3	C	15.2	C	-	-	-	-	3.2	A	2.4	A	Delay	Delay
		Through	-	-	-	-					0.0	A	0.0	A					3.0	3.2
		Right	-	-	-	-									-	-	-	-	LOS	LOS
		Approach	-	-	-	-	17.3	C	15.2	C	0.0	A	0.0	A	3.2	A	2.4	A	A	A
Concept 1 2040																				
8 Realigned Country Club Drive at State Route 75			-				Country Club Drive				State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-	23.0	C	21.5	C	-	-	-	-	3.7	A	2.9	A	Delay	Delay
		Through	-	-	-	-					0.0	A	0.0	A					3.7	4.3
		Right	-	-	-	-									-	-	-	-	LOS	LOS
		Approach	-	-	-	-	23.0	C	21.5	C	0.0	A	0.0	A	3.7	A	2.9	A	A	A
Concept 2 2020																				
8 Realigned Country Club Drive at State Route 75			-				Country Club Drive				State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Right	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LOS	LOS
		Approach	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Concept 2 2040																				
8 Realigned Country Club Drive at State Route 75			-				Country Club Drive				State Route 75				State Route 75					
	One-Way Stop	Left	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Right	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LOS	LOS
		Approach	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 33: State Route 75 at Country Club Drive Future Queuing Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND			WESTBOUND			NORTHBOUND			SOUTHBOUND		
			Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)
2020 No Build														
8 Country Club Drive at State Route 75			-			Country Club Drive			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-	-	914	913	-	-	-	50	84*	65*
		Through	-	-	-	-	-	-	510	515*	511*			
		Right	-	-	-	120	170*	170*				-	-	-
2040 No Build														
8 Country Club Drive at State Route 75			-			Country Club Drive			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-	-	919	916	-	-	-	50	60*	82*
		Through	-	-	-	-	-	-	510	526*	527*			
		Right	-	-	-	120	170*	170*				-	-	-
Concept 1 2020														
8 Realigned Country Club Drive at State Route 75			-			Country Club Drive			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-	-	87	109	-	-	-	410	164	197
		Through	-	-	-				525	45	12			
		Right	-	-	-							-	-	-
Concept 1 2040														
8 Realigned Country Club Drive at State Route 75			-			Country Club Drive			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-	-	230	164	-	-	-	410	215	240
		Through	-	-	-				525	253	59			
		Right	-	-	-							-	-	-
Concept 2 2020														
8 Realigned Country Club Drive at State Route 75			-			Country Club Drive			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-	-	-	-	-	-	-	-	-	-
		Through	-	-	-	-	-	-	-	-	-	-	-	-
		Right	-	-	-	-	-	-	-	-	-	-	-	-
Concept 2 2040														
8 Realigned Country Club Drive at State Route 75			-			Country Club Drive			State Route 75			State Route 75		
	One-Way Stop	Left	-	-	-	-	-	-	-	-	-	-	-	-
		Through	-	-	-	-	-	-	-	-	-	-	-	-
		Right	-	-	-	-	-	-	-	-	-	-	-	-

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State Route 75 at Abingdon Place

The operations for this intersection are only applicable under No-Build and Concept #2 conditions, since the proposed ramp configurations of Concept #1 result in the closure of Abingdon Place. Future LOS and queues results for the State Route 75 at Abingdon Place unsignalized intersection are shown in Table 34 and Table 35, respectively. For this intersection, it is projected that all movements will operate at LOS D or better during the future conditions. However, this intersection is expected to have significant queuing problems for the northbound approach during the AM peak hour, because of the previously mentioned spillback occurring at downstream intersections. As a result of these queues, the westbound approach does not have sufficient gaps for vehicles to turn out from the side streets during the 2040 No-Build PM peak hour, causing excessive queues as well.

These queuing issues are expected to be mitigated with the proposed Concept #2 when compared to the No-Build conditions. Under Concept #2, maximum queues are projected to be contained within the available storage space and not impact adjacent intersections.

Table 34: State Route 75 at Abingdon Place Future LOS Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
2020 No Build																				
9 Abingdon Place at State Route 75			Driveway				Abingdon Place				State Route 75				State Route 75					
	Two-Way Stop	Left																	Delay	Delay
		Through	16.8	C	20.5	C	12.0	B	11.0	B	0.0	A	0.0	A	1.3	A	0.3	A	0.6	0.9
		Right																	LOS	LOS
		Approach	16.8	C	20.5	C	12.0	B	11.0	B	0.0	A	0.0	A	1.3	A	0.3	A	0.6	A
2040 No Build																				
9 Abingdon Place at State Route 75			Driveway				Abingdon Place				State Route 75				State Route 75					
	Two-Way Stop	Left																	Delay	Delay
		Through	25.8	D	27.1	D	13.0	B	12.9	B	0.0	A	0.0	A	1.5	A	0.4	A	0.7	1.2
		Right																	LOS	LOS
		Approach	25.8	D	27.1	D	13.0	B	12.9	B	0.0	A	0.0	A	1.5	A	0.4	A	A	A
Concept 1 2020																				
9 Abingdon Place at State Route 75			Driveway				Abingdon Place				State Route 75				State Route 75					
	Two-Way Stop	Left	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Right	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LOS	LOS
		Approach	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Concept 1 2040																				
9 Abingdon Place at State Route 75			Driveway				Abingdon Place				State Route 75				State Route 75					
	Two-Way Stop	Left	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Delay	Delay
		Through	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Right	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LOS	LOS
		Approach	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Concept 2 2020																				
9 Abingdon Place at State Route 75			Driveway				Abingdon Place				State Route 75				State Route 75					
	Two-Way Stop	Left									0.0	A	0.0	A	8.8	A	8.0	A	Delay	Delay
		Through	17.7	C	21.5	C	12.2	B	11.2	B	0.0	A	0.0	A	0.0	A	0.0	A	0.4	0.8
		Right																	LOS	LOS
		Approach	17.7	C	21.5	C	12.2	B	11.2	B	0.0	A	0.0	A	0.9	A	0.2	A	A	A
Concept 2 2040																				
9 Abingdon Place at State Route 75			Driveway				Abingdon Place				State Route 75				State Route 75					
	Two-Way Stop	Left									0.0	A	0.0	A	9.2	A	8.2	A	Delay	Delay
		Through	28.5	D	29.4	D	13.4	B	13.3	B	0.0	A	0.0	A	0.0	A	0.0	A	0.5	1.1
		Right																	LOS	LOS
		Approach	28.5	D	29.4	D	13.4	B	13.3	B	0.0	A	0.0	A	1.0	A	0.2	A	A	A

Table 35: State Route 75 at Abingdon Place Future Queuing Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND			WESTBOUND			NORTHBOUND			SOUTHBOUND		
			Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)	Effective Storage Length (ft)	AM Max Queue (ft)	PM Max Queue (ft)
2020 No Build														
9 Abingdon Place at State Route 75			Driveway			Abingdon Place			State Route 75			State Route 75		
	Two-Way Stop	Left												
		Through	-	38	32	-	30	57	510	480	119	510	111	61
		Right												
2040 No Build														
9 Abingdon Place at State Route 75			Driveway			Abingdon Place			State Route 75			State Route 75		
	Two-Way Stop	Left												
		Through	-	45	73	-	46	244	510	528*	416	510	150	101
		Right												
Concept 1 2020														
9 Abingdon Place at State Route 75			Driveway			Abingdon Place			State Route 75			State Route 75		
	Two-Way Stop	Left	-	-	-	-	-	-	-	-	-	-	-	-
		Through	-	-	-	-	-	-	-	-	-	-	-	-
		Right	-	-	-	-	-	-	-	-	-	-	-	-
Concept 1 2040														
9 Abingdon Place at State Route 75			Driveway			Abingdon Place			State Route 75			State Route 75		
	Two-Way Stop	Left	-	-	-	-	-	-	-	-	-	-	-	-
		Through	-	-	-	-	-	-	-	-	-	-	-	-
		Right	-	-	-	-	-	-	-	-	-	-	-	-
Concept 2 2020														
9 Abingdon Place at State Route 75			Driveway			Abingdon Place			State Route 75			State Route 75		
	Two-Way Stop	Left										200	42	31
		Through	-	31	30	-	31	47	510	18	3	400	0	0
		Right										-	-	-
Concept 2 2040														
9 Abingdon Place at State Route 75			Driveway			Abingdon Place			State Route 75			State Route 75		
	Two-Way Stop	Left										200	58	34
		Through	-	34	38	-	31	55	510	36	0	400	0	0
		Right										-	-	-

This space intentionally left blank.

State Route 75 at Birdie Drive

Future LOS and queues results for the State Route 75 at Birdie Drive unsignalized intersection are shown in Table 36 and Table 37, respectively. For this intersection, it is projected that all movements will operate at LOS D or better during the future conditions. Like with many of the intersections south of the I-81 interchange, significant queuing problems are expected for the northbound approach during the AM peak hour, because of the excessive queues projected to occur at downstream intersections. Due to these queue lengths, the westbound approach does not have sufficient gaps for vehicles to turn out from the side streets during the 2040 No-Build AM peak hour, causing excessive queues.

These queuing issues are expected to be mitigated with the proposed Concept #2 when compared to the No-Build conditions. Under Concept #2, maximum queues are projected to be contained within the available storage space and not impact adjacent intersections.

Table 36: State Route 75 at Birdie Drive Future LOS Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND AM Delay	EASTBOUND AM LOS	EASTBOUND PM Delay	EASTBOUND PM LOS	WESTBOUND AM Delay	WESTBOUND AM LOS	WESTBOUND PM Delay	WESTBOUND PM LOS	NORTHBOUND AM Delay	NORTHBOUND AM LOS	NORTHBOUND PM Delay	NORTHBOUND PM LOS	SOUTHBOUND AM Delay	SOUTHBOUND AM LOS	SOUTHBOUND PM Delay	SOUTHBOUND PM LOS	Overall AM	Overall PM
2020 No Build																				
10 Birdie Drive at State Route 75			Driveway				Birdie Drive				State Route 75				State Route 75					
	Two-Way Stop	Left																	Delay	Delay
		Through	9.7	A	20.0	C	13.9	B	11.0	B	0.1	A	0.0	A	0.9	A	1.4	A	1.4	1.4
		Right																	LOS	LOS
		Approach	9.7	A	20.0	C	13.9	B	11.0	B	0.1	A	0.0	A	0.9	A	1.4	A	A	A
2040 No Build																				
10 Birdie Drive at State Route 75			Driveway				Birdie Drive				State Route 75				State Route 75					
	Two-Way Stop	Left																	Delay	Delay
		Through	10.0	B	26.0	D	16.5	C	11.2	B	0.1	A	0.0	A	1.0	A	1.6	A	1.7	1.7
		Right																	LOS	LOS
		Approach	10.0	B	26.0	D	16.5	C	11.2	B	0.1	A	0.0	A	1.0	A	1.6	A	A	A
Concept 1 2020																				
10 Birdie Drive at State Route 75			Driveway				Birdie Drive				State Route 75				State Route 75					
	Two-Way Stop	Left																	Delay	Delay
		Through	9.9	A	20.9	C	14.4	B	11.0	B	0.1	A	0.0	A	0.8	A	1.4	A	1.4	1.4
		Right																	LOS	LOS
		Approach	9.9	A	20.9	C	14.4	B	11.0	B	0.1	A	0.0	A	0.8	A	1.4	A	A	A
Concept 1 2040																				
10 Birdie Drive at State Route 75			Driveway				Birdie Drive				State Route 75				State Route 75					
	Two-Way Stop	Left																	Delay	Delay
		Through	10.2	B	28.5	D	17.4	C	11.2	B	0.1	A	0.0	A	1.0	A	1.6	A	1.7	1.7
		Right																	LOS	LOS
		Approach	10.2	B	28.5	D	17.4	C	11.2	B	0.1	A	0.0	A	1.0	A	1.6	A	A	A
Concept 2 2020																				
10 Birdie Drive at State Route 75			Driveway				Birdie Drive				State Route 75				State Route 75					
	Two-Way Stop	Left																	Delay	Delay
		Through	9.8	A	21.0	C	14.4	B	11.2	B	0.1	A	0.0	A	0.8	A	1.4	A	1.4	1.4
		Right																	LOS	LOS
		Approach	9.8	A	21.0	C	14.4	B	11.2	B	0.1	A	0.0	A	0.8	A	1.4	A	A	A
Concept 2 2040																				
10 Birdie Drive at State Route 75			Driveway				Birdie Drive				State Route 75				State Route 75					
	Two-Way Stop	Left																	Delay	Delay
		Through	10.1	B	29.5	D	17.4	C	11.4	B	0.1	A	0.0	A	1.0	A	1.6	A	1.7	1.8
		Right																	LOS	LOS
		Approach	10.1	B	29.5	D	17.4	C	11.4	B	0.1	A	0.0	A	1.0	A	1.6	A	A	A

Table 37: State Route 75 at Birdie Drive Future Queuing Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND Effective Storage Length (ft)	EASTBOUND AM Max Queue (ft)	EASTBOUND PM Max Queue (ft)	WESTBOUND Effective Storage Length (ft)	WESTBOUND AM Max Queue (ft)	WESTBOUND PM Max Queue (ft)	NORTHBOUND Effective Storage Length (ft)	NORTHBOUND AM Max Queue (ft)	NORTHBOUND PM Max Queue (ft)	SOUTHBOUND Effective Storage Length (ft)	SOUTHBOUND AM Max Queue (ft)	SOUTHBOUND PM Max Queue (ft)
2020 No Build														
10 Birdie Drive at State Route 75			Driveway			Birdie Drive			State Route 75			State Route 75		
	Two-Way Stop	Left												
		Through	-	31	33	-	221	54	890	539	0	510	86	81
		Right												
2040 No Build														
10 Birdie Drive at State Route 75			Driveway			Birdie Drive			State Route 75			State Route 75		
	Two-Way Stop	Left												
		Through	-	28	43	-	547	80	890	902*	97	510	117	107
		Right												
Concept 1 2020														
10 Birdie Drive at State Route 75			Driveway			Birdie Drive			State Route 75			State Route 75		
	Two-Way Stop	Left												
		Through	-	30	37	-	62	38	1,560	31	0	510	94	90
		Right												
Concept 1 2040														
10 Birdie Drive at State Route 75			Driveway			Birdie Drive			State Route 75			State Route 75		
	Two-Way Stop	Left												
		Through	-	30	41	-	79	45	1,560	63	0	510	126	106
		Right												
Concept 2 2020														
10 Birdie Drive at State Route 75			Driveway			Birdie Drive			State Route 75			State Route 75		
	Two-Way Stop	Left												
		Through	-	31	38	-	58	59	1,560	17	0	510	94	103
		Right												
Concept 2 2040														
10 Birdie Drive at State Route 75			Driveway			Birdie Drive			State Route 75			State Route 75		
	Two-Way Stop	Left												
		Through	-	31	48	-	78	57	1,560	35	2	510	117	118
		Right												

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State Route 75 at Gravel Lake Road

The State Route 75 at Gravel Lake Road intersection operations are different between the No-Build and Build conditions, since this intersection is modified as a part of Concept #1 and #2. Gravel Lake Road will be relocated to the south and become the fourth leg of the State Route 75 at Fairway Drive intersection. This new intersection was analyzed as two-way stop controlled. The future LOS and queue results for this intersection are shown in Table 38 and Table 39, respectively. It is projected that all movements will operate at LOS D or better during the future conditions.

Table 38: State Route 75 at Gravel Lake Road Future LOS Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND AM Delay	EASTBOUND AM LOS	EASTBOUND PM Delay	EASTBOUND PM LOS	WESTBOUND AM Delay	WESTBOUND AM LOS	WESTBOUND PM Delay	WESTBOUND PM LOS	NORTHBOUND AM Delay	NORTHBOUND AM LOS	NORTHBOUND PM Delay	NORTHBOUND PM LOS	SOUTHBOUND AM Delay	SOUTHBOUND AM LOS	SOUTHBOUND PM Delay	SOUTHBOUND PM LOS	Overall AM	Overall PM
2020 No Build																				
11 Gravel Lake Road at State Route 75			Gravel Lake Road				-				State Route 75				State Route 75					
	One-Way Stop	Left					-	-	-	-	0.1	A	0.3	A	-	-	-	-	Delay	Delay
		Through	19.3	C	15.2	C	-	-	-	-					0.0	A	0.0	A	0.7	0.7
		Right					-	-	-	-	-	-	-	-					LOS	LOS
		Approach	19.3	C	15.2	C	-	-	-	-	0.1	A	0.3	A	0.0	A	0.0	A	A	A
2040 No Build																				
11 Gravel Lake Road at State Route 75			Gravel Lake Road				-				State Route 75				State Route 75					
	One-Way Stop	Left					-	-	-	-	0.1	A	0.5	A	-	-	-	-	Delay	Delay
		Through	24.0	C	18.3	C	-	-	-	-					0.0	A	0.0	A	0.8	0.9
		Right					-	-	-	-	-	-	-	-					LOS	LOS
		Approach	24.0	C	18.3	C	-	-	-	-	0.1	A	0.5	A	0.0	A	0.0	A	A	A
Concept 1 2020																				
11 Realigned Gravel Lake Road/Fairway Drive at State Route 75			Gravel Lake Road				Fairway Drive				State Route 75				State Route 75					
	Two-Way Stop	Left									8.2	A	9.0	A	8.4	A	7.9	A	Delay	Delay
		Through	19.6	C	17.1	C	13.7	B	10.5	B	0.0	A	0.0	A	0.0	A	0.0	A	2.4	2.3
		Right	0.0	A	0.0	A									0.0	A	0.0	A	LOS	LOS
		Approach	19.6	C	17.1	C	13.7	B	10.5	B	0.1	A	0.3	A	0.3	A	0.4	A	A	A
Concept 1 2040																				
11 Realigned Gravel Lake Road/Fairway Drive at State Route 75			Gravel Lake Road				Fairway Drive				State Route 75				State Route 75					
	Two-Way Stop	Left									8.3	A	9.5	A	8.7	A	8.1	A	Delay	Delay
		Through	27.2	D	22.5	C	16.6	C	10.5	B	0.0	A	0.0	A	0.0	A	0.0	A	3.3	2.8
		Right	0.0	A	0.0	A									0.0	A	0.0	A	LOS	LOS
		Approach	27.2	D	22.5	C	16.6	C	10.5	B	0.2	A	0.4	A	0.4	A	0.4	A	A	A
Concept 2 2020																				
11 Realigned Gravel Lake Road/ Fairway Drive at State Route 75			Gravel Lake Road				Fairway Drive				State Route 75				State Route 75					
	Two-Way Stop	Left									8.5	A	9.0	A	8.4	A	7.9	A	Delay	Delay
		Through	19.6	C	17.1	C	13.8	B	10.5	B	0.0	A	0.0	A	0.0	A	0.0	A	2.4	2.3
		Right	0.0	A	0.0	A									0.0	A	0.0	A	LOS	LOS
		Approach	19.6	C	17.1	C	13.8	B	10.5	B	0.2	A	0.3	A	0.3	A	0.4	A	A	A
Concept 2 2040																				
11 Realigned Gravel Lake Road/ Fairway Drive at State Route 75			Gravel Lake Road				Fairway Drive				State Route 75				State Route 75					
	Two-Way Stop	Left									8.7	A	9.5	A	8.7	A	8.1	A	Delay	Delay
		Through	27.3	D	22.5	C	16.7	C	10.5	B	0.0	A	0.0	A	0.0	A	0.0	A	3.3	2.8
		Right	0.0	A	0.0	A									0.0	A	0.0	A	LOS	LOS
		Approach	27.3	D	22.5	C	16.7	C	10.5	B	0.2	A	0.4	A	0.4	A	0.4	A	A	A

Table 39: State Route 75 at Gravel Lake Road Future Queuing Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND Effective Storage Length (ft)	EASTBOUND AM Max Queue (ft)	EASTBOUND PM Max Queue (ft)	WESTBOUND Effective Storage Length (ft)	WESTBOUND AM Max Queue (ft)	WESTBOUND PM Max Queue (ft)	NORTHBOUND Effective Storage Length (ft)	NORTHBOUND AM Max Queue (ft)	NORTHBOUND PM Max Queue (ft)	SOUTHBOUND Effective Storage Length (ft)	SOUTHBOUND AM Max Queue (ft)	SOUTHBOUND PM Max Queue (ft)
2020 No Build														
11 Gravel Lake Road at State Route 75			Gravel Lake Road			-			State Route 75			State Route 75		
	One-Way Stop	Left				-	-	-				-	-	-
		Through	-	156	66	-	-	-	415	138	56			
		Right				-	-	-	-	-	-	890	8	4
2040 No Build														
11 Gravel Lake Road at State Route 75			Gravel Lake Road			-			State Route 75			State Route 75		
	One-Way Stop	Left				-	-	-				-	-	-
		Through	-	569	92	-	-	-	415	429*	86			
		Right				-	-	-	-	-	-	890	2	10
Concept 1 2020														
11 Realigned Gravel Lake Road/Fairway Drive at State Route 75			Gravel Lake Road			Fairway Drive			State Route 75			State Route 75		
	Two-Way Stop	Left							250	32	48	250	35	36
		Through	-	61	55	-	58	42	400	0	0	1,560	0	0
		Right	200	23	56							250	0	0
Concept 1 2040														
11 Realigned Gravel Lake Road/Fairway Drive at State Route 75			Gravel Lake Road			Fairway Drive			State Route 75			State Route 75		
	Two-Way Stop	Left							250	37	61	250	33	33
		Through	-	74	59	-	66	37	400	0	0	1,560	2	2
		Right	250	27	48							250	11	4
Concept 2 2020														
11 Realigned Gravel Lake Road/ Fairway Drive at State Route 75			Gravel Lake Road			Fairway Drive			State Route 75			State Route 75		
	Two-Way Stop	Left							250	30	59	250	31	33
		Through	-	68	62	-	65	46	400	0	0	1,620	0	0
		Right	250	21	45							250	8	2
Concept 2 2040														
11 Realigned Gravel Lake Road/ Fairway Drive at State Route 75			Gravel Lake Road			Fairway Drive			State Route 75			State Route 75		
	Two-Way Stop	Left							250	61	54	250	33	33
		Through	-	81	68	-	80	39	400	0	0	1,620	0	4
		Right	250	23	55							250	6	4

The previous northbound queuing issues identified under the No-Build conditions, because of the spillback occurring at downstream intersections, mostly disperses at this intersection under Build conditions. The maximum queue for the northbound approach only impacts the next upstream intersection under 2040 No-Build conditions during the AM peak hour. Because of this queue under the No-Build scenario, the eastbound Gravel Lake Road approach does not get sufficient gaps for vehicles to turn out on to State Route 75 during this time, causing excessive side street queuing. These queuing issues are expected to be mitigated with the proposed build concepts when compared to the No-Build conditions. Under the two build conditions, maximum queues are projected to be contained within the available storage space and will not impact adjacent intersections.

It should be noted that as future traffic volumes change and new development occurs along the realigned section of Gravel Lake Road, traffic signal warrants should be continually monitored to determine if signalization of this intersection is warranted.

State Route 75 at Vances Mill Road

The State Route 75 at Vances Mill Road intersection operations are different between the No-Build and Build scenarios, since this intersection is proposed to be modified as part of the Concept #1 and #2 improvements. This intersection will be relocated to the south to accommodate the modifications occurring at the Gravel Lake Road/State Route 75/Fairway Drive intersection to the north. The future LOS and queues results for this unsignalized intersection are shown in Table 40 and Table 41, respectively. For this intersection, it is projected that all movements will operate at LOS D or better during the future conditions. The previously mentioned northbound queuing issue identified for 2040 No-Build conditions during the AM peak hour is still expected to extend through this intersection, resulting in a significant queue. Because of this queue, the eastbound Vances Mill Road approach does not have sufficient gaps for vehicles to turn out on to State Route 75 during this time, resulting in excessive side street queuing.

These queuing issues are expected to be mitigated with the proposed build concepts when compared to the No-Build conditions and the signalization of this intersection. Under the two build conditions, maximum queues are projected to be contained within the available storage space and not impact adjacent intersections.

Table 40: State Route 75 at Vances Mill Road Future LOS Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND AM Delay	EASTBOUND AM LOS	EASTBOUND PM Delay	EASTBOUND PM LOS	WESTBOUND AM Delay	WESTBOUND AM LOS	WESTBOUND PM Delay	WESTBOUND PM LOS	NORTHBOUND AM Delay	NORTHBOUND AM LOS	NORTHBOUND PM Delay	NORTHBOUND PM LOS	SOUTHBOUND AM Delay	SOUTHBOUND AM LOS	SOUTHBOUND PM Delay	SOUTHBOUND PM LOS	Overall AM	Overall PM
2020 No Build																				
12 Vances Mill Road/Fairway Drive at State Route 75			Vances Mill Road				Fairway Drive				State Route 75				State Route 75					
	Two-Way Stop	Left																	Delay	Delay
		Through	21.1	C	18.2	C	14.2	B	10.1	B	1.9	A	0.7	A	0.5	A	0.7	A	4.5	3.8
		Right													0.0	A	0.0	A	LOS	LOS
		Approach	21.1	C	18.2	C	14.2	B	10.1	B	1.9	A	0.7	A	0.4	A	0.6	A	A	A
2040 No Build																				
12 Vances Mill Road/Fairway Drive at State Route 75			Vances Mill Road				Fairway Drive				State Route 75				State Route 75					
	Two-Way Stop	Left																	Delay	Delay
		Through	34.0	D	28.1	D	18.0	C	10.0	B	2.1	A	0.8	A	0.7	A	0.8	A	6.6	5.3
		Right													0.0	A	0.0	A	LOS	LOS
		Approach	34.0	D	28.1	D	18.0	C	10.0	B	2.1	A	0.8	A	0.6	A	0.7	A	A	A
Concept 1 2020																				
12 Realigned Vances Mill Road at State Route 75			Vances Mill Road				-				State Route 75				State Route 75					
	Two-Way Stop	Left					-	-	-	-	7.9	A	8.4	A	-	-	-	-	Delay	Delay
		Through	15.9	C	14.4	B	-	-	-	-	0.0	A	0.0	A	0.0	A	0.0	A	2.8	2.6
		Right					-	-	-	-	-	-	-	-	0.0	A	0.0	A	LOS	LOS
		Approach	15.9	C	14.4	B	-	-	-	-	1.3	A	0.6	A	0.0	A	0.0	A	A	A
Concept 1 2040																				
12 Realigned Vances Mill Road at State Route 75			Vances Mill Road				-				State Route 75				State Route 75					
	Two-Way Stop	Left					-	-	-	-	8.1	A	8.8	A	-	-	-	-	Delay	Delay
		Through	20.2	C	18.4	C	-	-	-	-	0.0	A	0.0	A	0.0	A	0.0	A	3.4	3.1
		Right					-	-	-	-	-	-	-	-	0.0	A	0.0	A	LOS	LOS
		Approach	20.2	C	18.4	C	-	-	-	-	1.3	A	0.6	A	0.0	A	0.0	A	A	A
Concept 2 2020																				
12 Realigned Vances Mill Road at State Route 75			Vances Mill Road				-				State Route 75				State Route 75					
	Two-Way Stop	Left					-	-	-	-	7.9	A	8.3	A	-	-	-	-	Delay	Delay
		Through	15.9	C	14.5	B	-	-	-	-	0.0	A	0.0	A	0.0	A	0.0	A	2.8	2.6
		Right					-	-	-	-	-	-	-	-	0.0	A	0.0	A	LOS	LOS
		Approach	15.9	C	14.5	B	-	-	-	-	1.3	A	0.5	A	0.0	A	0.0	A	A	A
Concept 2 2040																				
12 Realigned Vances Mill Road at State Route 75			Vances Mill Road				-				State Route 75				State Route 75					
	Two-Way Stop	Left					-	-	-	-	8.1	A	8.7	A	-	-	-	-	Delay	Delay
		Through	20.2	C	18.7	C	-	-	-	-	0.0	A	0.0	A	0.0	A	0.0	A	3.4	3.1
		Right					-	-	-	-	-	-	-	-	0.0	A	0.0	A	LOS	LOS
		Approach	20.2	C	18.7	C	-	-	-	-	1.3	A	0.6	A	0.0	A	0.0	A	A	A

Table 41: State Route 75 at Vances Mill Road Future Queuing Results

Intersection Number and Description	Type of Control	Lane Group	EASTBOUND Effective Storage Length (ft)	EASTBOUND AM Max Queue (ft)	EASTBOUND PM Max Queue (ft)	WESTBOUND Effective Storage Length (ft)	WESTBOUND AM Max Queue (ft)	WESTBOUND PM Max Queue (ft)	NORTHBOUND Effective Storage Length (ft)	NORTHBOUND AM Max Queue (ft)	NORTHBOUND PM Max Queue (ft)	SOUTHBOUND Effective Storage Length (ft)	SOUTHBOUND AM Max Queue (ft)	SOUTHBOUND PM Max Queue (ft)
2020 No Build														
12 Vances Mill Road/Fairway Drive at State Route 75			Vances Mill Road			Fairway Drive			State Route 75			State Route 75		
	Two-Way Stop	Left										415	37	44
		Through	-	101	102	-	48	30	-	63	35			
		Right										150	3	0
2040 No Build														
12 Vances Mill Road/Fairway Drive at State Route 75			Vances Mill Road			Fairway Drive			State Route 75			State Route 75		
	Two-Way Stop	Left										415	66	60
		Through	-	740	127	-	266	50	-	737	53			
		Right										150	12	4
Concept 1 2020														
12 Realigned Vances Mill Road at State Route 75			Vances Mill Road						State Route 75			State Route 75		
	Two-Way Stop	Left				-	-	-	-	39	33	-	-	-
		Through	-	86	87	-	-	-	-	0	0	400	0	0
		Right				-	-	-	-	-	-	150	4	4
Concept 1 2040														
12 Realigned Vances Mill Road at State Route 75			Vances Mill Road						State Route 75			State Route 75		
	Two-Way Stop	Left				-	-	-	-	52	33	-	-	-
		Through	-	101	97	-	-	-	-	0	0	400	2	0
		Right				-	-	-	-	-	-	150	6	6
Concept 2 2020														
12 Realigned Vances Mill Road at State Route 75			Vances Mill Road						State Route 75			State Route 75		
	Two-Way Stop	Left				-	-	-	150	42	28	-	-	-
		Through	-	96	86	-	-	-	-	0	0	400	0	0
		Right				-	-	-	-	-	-	150	4	6
Concept 2 2040														
12 Realigned Vances Mill Road at State Route 75			Vances Mill Road						State Route 75			State Route 75		
	Two-Way Stop	Left				-	-	-	150	53	33	-	-	-
		Through	-	110	105	-	-	-	-	0	0	400	0	0
		Right				-	-	-	-	-	-	150	10	2

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6.3. Summary of Analysis

Sections 6.2.1 through 6.2.3 summarize the analysis results of the traffic operations for 2020 and 2040 No-Build and Build conditions. Each of the build concepts improve operations at the Exit 17 interchange and at adjacent study area intersections when compared to the No-Build conditions. Under No-Build conditions, significant vehicle delays and queues are expected to occur due to the current interchange configuration. By providing more space between the I-81 ramp termini, creating additional left turn-lane storage capacity, and better traffic signal optimization, improved traffic operations are anticipated at the I-81 Off/On-Ramp signalized intersections as well as along the State Route 75 corridor under both build concepts. The lengthening of the eastbound off-ramp allows for more cars to queue without potentially impacting interstate mainline operations. The extended left-turn lanes provide more storage for vehicles to queue on State Route 75 under the I-81 overpass, limiting impacts to through traffic flow. Additionally, the proposed access management strategies introduced with each of the build concepts reduces the number of driveways and intersections in the immediate vicinity of the interstate ramp termini, which helps improve traffic operations and reduce the number of potential conflict points.

However, Concept #2 – Partial Cloverleaf Southwest Quadrant is projected to operate with less delay and shorter to almost negligible queue lengths when compared to Concept #1, since what was once a heavy southbound left-turn movement to access I-81 eastbound now becomes a channelized YIELD right-turn movement with the on-loop ramp configuration. The operational benefits associated with removing the southbound left-turn movement to access I-81 eastbound on-ramp are further reflected in the reduction of the anticipated queue lengths for the I-81 eastbound off-ramp approach to State Route 75. Removal of the heavy left-turn movement (i.e., 2040 projections of 225 during the AM and 390 during the PM peaks) that was replaced with a relatively low-volume left-turn movement (i.e., 2040 projections of 50 during the AM and 90 during the PM) accessing Country Club Drive, allowed for more green time to reallocated from the southbound left to the eastbound off-ramp.

Additionally, whereas the I-81 eastbound off/on-ramp signalized intersection metered or restricted southbound left-turning traffic from accessing the I-81 on-ramp and the I-81 mainline, the I-81 eastbound on-loop associated with Concept #2 is able to more efficiently process this traffic as a right-turn movement, which allows more traffic to flow unimpeded to access eastbound I-81, and with the extension of the acceleration lane do so without any adverse impacts to merge operations along the mainline.

Concept #2 – Partial Cloverleaf Southwest Quadrant will also provide an inherent level of improvements to safety when compared to the exiting/No-Build conditions. Within the study area, the number of potential conflict points along State Route 75 is only expected to increase by three (3) (i.e., 171 to 174) with the proposed interchange modification and the changes to adjacent intersections. However, the primary safety benefit will be achieved in terms of removing several existing access points and driveways in the vicinity of the new I-81 Eastbound Off-ramp termini location. Currently, State Route 75 within the study area has an approximate access density of 59 driveways per mile. As part of the proposed Concept #2 modifications, eight (8) existing driveways/access points will be eliminated along State Route 75, resulting in an access density of 49 driveways per mile. Additionally, as part of this concept, VDOT is prepared to implement limited access lines/fencing that extends south from the new I-81 eastbound off/on-ramp termini location 200 feet on the west and 300 feet on the east sides of State Route 75. This will prevent any future developments from having access along State Route 75 in the immediate vicinity of the ramp termini, preserving the safety benefits stated here. As such, it is anticipated that the construction of Concept #2 will not negatively impact overall safety conditions within the study area along State Route 75.

Conditions along I-81 are also not expected to experience any deterioration in regards to safety conditions with the proposed eastbound ramp modifications. As stated previously, the extension of I-81 eastbound on-loop acceleration lane from 1,050 feet to 2,150 feet provides vehicles with a longer distance at which to achieve an operational travel speed (i.e., 60 to 70 mph) that is consistent with eastbound I-81, prior to merging into the mainline travel lane. This will also be further controlled through the installation of flexible post delineators located between the improved acceleration lane and adjacent interstate lanes, so vehicles will be prohibited from merging too soon. This will create the opportunity for VDOT to proactively enhance the operational and safety condition of the on-loop acceleration lane as vehicles merge into the I-81 eastbound mainline travel lane.

Therefore, based on the broader overarching benefits to the I-81 eastbound off-ramp operations to include the new signalized intersection, on-loop operations, and operational benefits to the State Route 75 corridor, the preferred concept for this IMR is Concept #2 – Partial Cloverleaf Southwest Quadrant.

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7. Land Use and Demographics

7.1. Land Use

Existing and future land uses for both the Town of Abingdon and Washington County were considered as a part of preparing the IMR. Figure 24 and Figure 25 illustrate the existing land use plans near the Exit 17 study area, based on their respective Comprehensive Plans. From the Town of Abingdon plan, the land uses in the immediate vicinity of the proposed interchange and adjacent to State Route 75 consist primarily of office/commercial, agricultural, medium-density residential, and low-density residential uses. For Washington County, land use within the study area consist of commercial, agricultural, and residential uses as well. These land uses also coincide with the existing zoning for the study area, as discussed in Section 2.2 – Existing Land Use and Zoning.

Future land use plans for the Town of Abingdon and Washington County are illustrated in Figure 26 and Figure 27, respectively. Based on the Town of Abingdon's Comprehensive Plan Update, the only changes to the existing land use plan and the future land use plan is the reclassification of office/commercial to "gateway" office/commercial. As stated in the Town's Comprehensive plan, this land use category applies to the gateway entrances into Abingdon and are intended to serve as a mixture of commercial uses. By denoting this area as a gateway, future developments should encourage economic prosperity while preserving the unique and attractive nature of Abingdon. Typical land uses would consist of: retail commercial, restaurants, offices, and planned shopping centers. New development should have substantial landscaping; coordinated access points, minimal signage and lighting, and be complimentary to adjacent development.

For Washington County, the changes between the existing and future land use plan for the Exit 17 study area pertain to its agricultural uses. Under the future land use plan, agriculture uses are delineated into two types: "Limited" and "General". Limited agricultural land uses do not permit any commercial or industrial developments. However, general agricultural land uses would allow for transition to non-farm uses. It should be noted that these agricultural uses fall under the "Open Space" classification in the county's land use map (Figure 27).

7.2. Socio-Economic Demographics

The 2014 socio-economic profile for the study area, which includes portions of Washington County and the Town of Abingdon, are shown in Table 42.

Table 42: 2014 Socio-Economic Data

	Washington County	Town of Abingdon
Population	54,833	8,176
Households	25,694	4,274
Population that is Employed	24,403	3,630

Source: 2014 American Community Survey (ACS), 5-Year Data

The Town of Abingdon and portions of Washington County were also recently added into the Bristol Metropolitan Planning Organization (MPO) boundary. The Exit 17 study area is currently in the process of being incorporated into an expanded Regional Travel Demand Model (TDM) in support of updating the Bristol Tennessee/Virginia Urban Area MPO Long Range Transportation Plan (LRTP) Year 2040.

Future projections from the TDM for socio-economic data for the region is expected to continually increase between 2010 and 2040, as shown in Table 43 and Table 44. This is also illustrated for the region by households and employment in Figure 28 and Figure 29, respectively.

Table 43: Future Year Population and Total Number of Households

Year	Population	No. of Households	% Growth (from 2010)
2010	106,297	45,043	-
2015	107,742	45,616	1.3%
2020	109,167	46,243	2.7%
2030	112,034	47,506	5.5%
2040	114,904	48,762	8.3%

Source: Bristol MPO Travel Demand Model Update, Technical Memorandum #5, (2015).

Table 44: Future Year Total Employment

Year	Total Employment	% Growth (from 2010)
2010	54,269	-
2015	58,763	8.3%

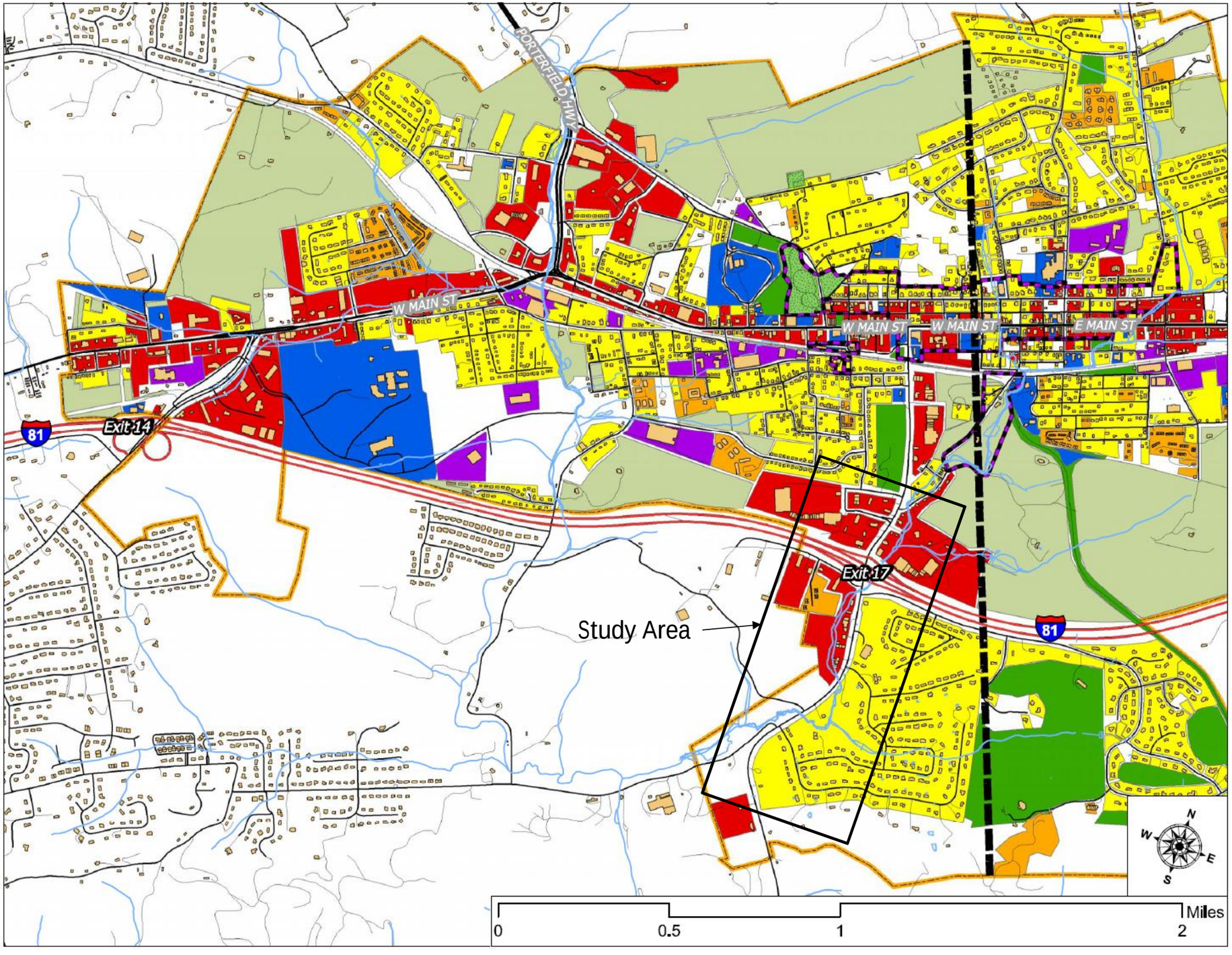
Source: Bristol MPO Travel Demand Model Update, Technical Memorandum #5, (2015).

7.3. Future Planned Development

The Meadows development is a mixed-use development with a 131,000 square-foot shopping center that contains a 60,000 square-foot grocery store, a 10-pump fuel service center, 42,500 square feet of retail shops, four high-turnover sit-down restaurants totaling 26,000 square feet, and two hotels with a total of 200 rooms. This shopping center is planned for construction on the northeast quadrant of State Route 75 at Cook Street/Realigned Green Spring Road intersection. A separate traffic impact study was prepared for this development and its portions of its findings were incorporated into this report. Aside from the referenced Meadows development, no other major developments have been identified for consideration near the Exit 17 study area.

7.4. Regional Planning Support

At the regional level, the I-81 Exit 17 project has the documented support of the Bristol MPO, Town of Abingdon, and Washington County. The interchange improvement project is identified and referenced in the Bristol Tennessee/Virginia Urban Area MPO LRTP Year 2040, the Mount Rogers Planning District Commission 2035 LRTP, as well as a needed improvement in both the Washington County Comprehensive Plan (2014) and the Town of Abingdon Comprehensive Plan (2013). The I-81 Exit 17 project is listed in the Bristol Tennessee/Virginia Urban Area MPO FY17-20 Transportation Improvement Program (TIP), as well as the VDOT FFY2015-2018 State Transportation Improvement Program (STIP). In response to the documented support and identified need, VDOT has obligated the financial resources necessary to fully fund the anticipated costs associated with design, right-of-way, and construction of the Exit 17 improvement project.



Town of Abingdon,
Washington County, Virginia
Comprehensive Plan Update
August 2013

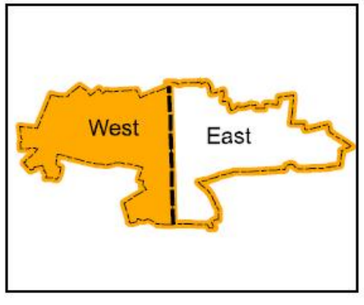
Legend

- Corporate Limits
- Historic District
- Match Line

Existing Land Use

- Agricultural/ Forest
- Low-Density Residential
- Medium-Density Residential
- High-Density Residential
- Office/ Commercial
- Business/ Tech./ Industrial
- Public/ Institutional
- Recreation
- Cemetery

Map 15- West
Existing Land Use



Source: Town of Abingdon, 2013 Comprehensive Plan Update

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Interstate 81 - Exit 17
Interchange Modification Report

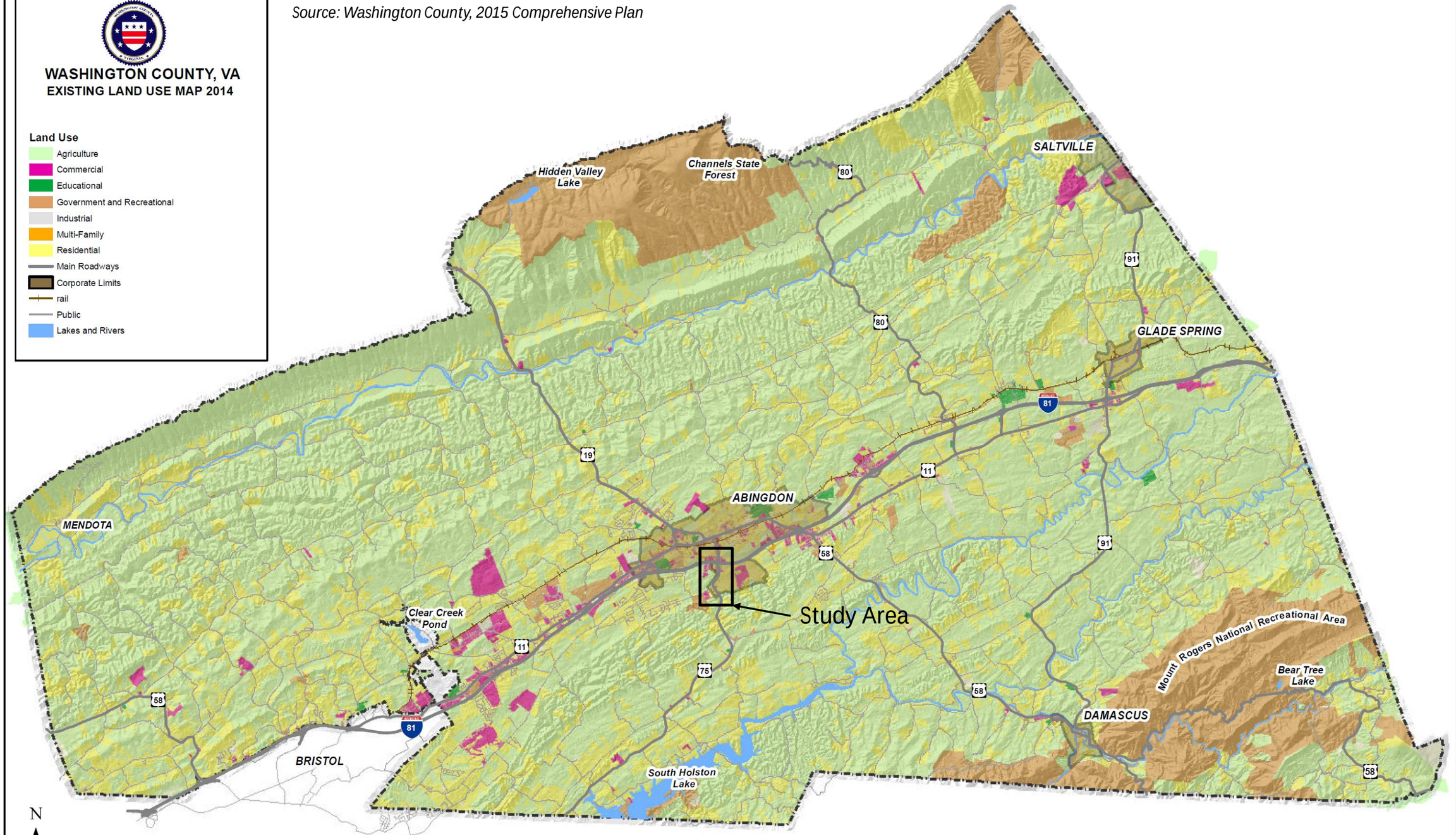
Town of Abingdon
Existing Land Use

FIGURE
24

Source: Washington County, 2015 Comprehensive Plan

WASHINGTON COUNTY, VA
EXISTING LAND USE MAP 2014

Land Use
- Agriculture
- Commercial
- Educational
- Government and Recreational
- Industrial
- Multi-Family
- Residential
- Main Roadways
- Corporate Limits
- rail
- Public
- Lakes and Rivers



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MAP PRODUCED BY THE WASHINGTON COUNTY GIS DEPARTMENT JULY 2014

0 0.5 1 2 3 4 Miles

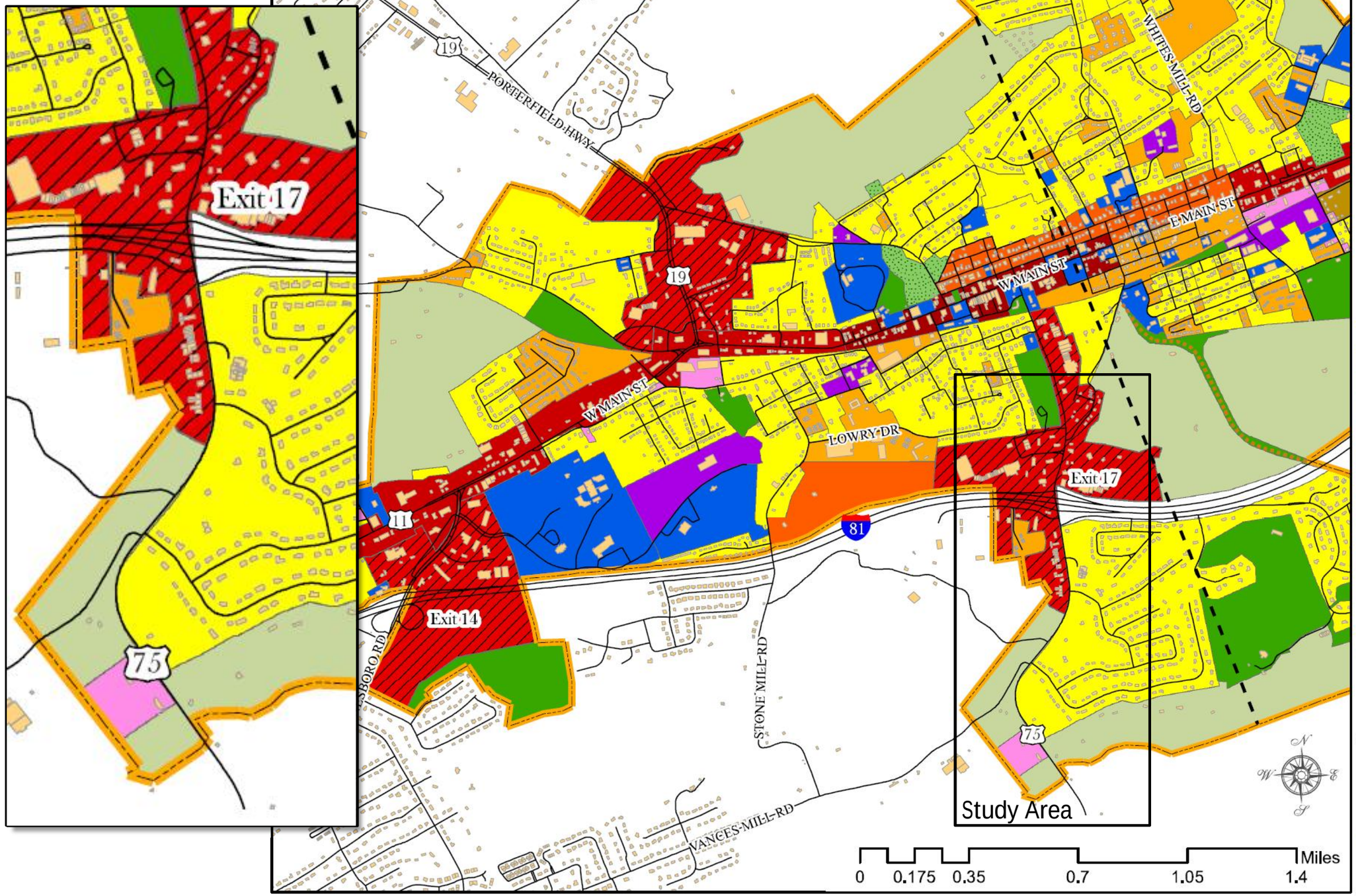
STARS VDOT

Interstate 81 - Exit 17
Interchange Modification Report

Washington County
Existing Land Use

FIGURE
25

Study Area

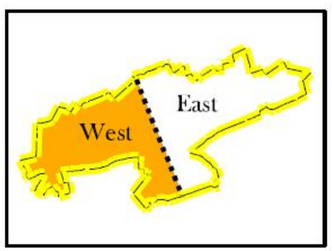


Town of Abingdon,
Washington County, Virginia
Comprehensive Plan Update
August 2013

Future Land Use

- Agricultural/ Consvtn. Res.
- Low-Density Residential
- Medium-Density Residential
- High-Density Residential
- Mixed-Use Residential/ Comm.
- Central Business District
- Gateway Office/ Commercial
- Corridor Office/ Commercial
- Office/ Commercial
- Business/ Technology/ Ind.
- Public/ Institutional
- Recreation/ Open Space
- Cemetery
- Street Centerlines
- Corporate Limits
- Virginia Creeper Trail

Map 11-West
Public Facilities



Source: Town of Abingdon, 2013 Comprehensive Plan Update

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Interstate 81 - Exit 17
Interchange Modification Report

Town of Abingdon
Future Land Use Plan

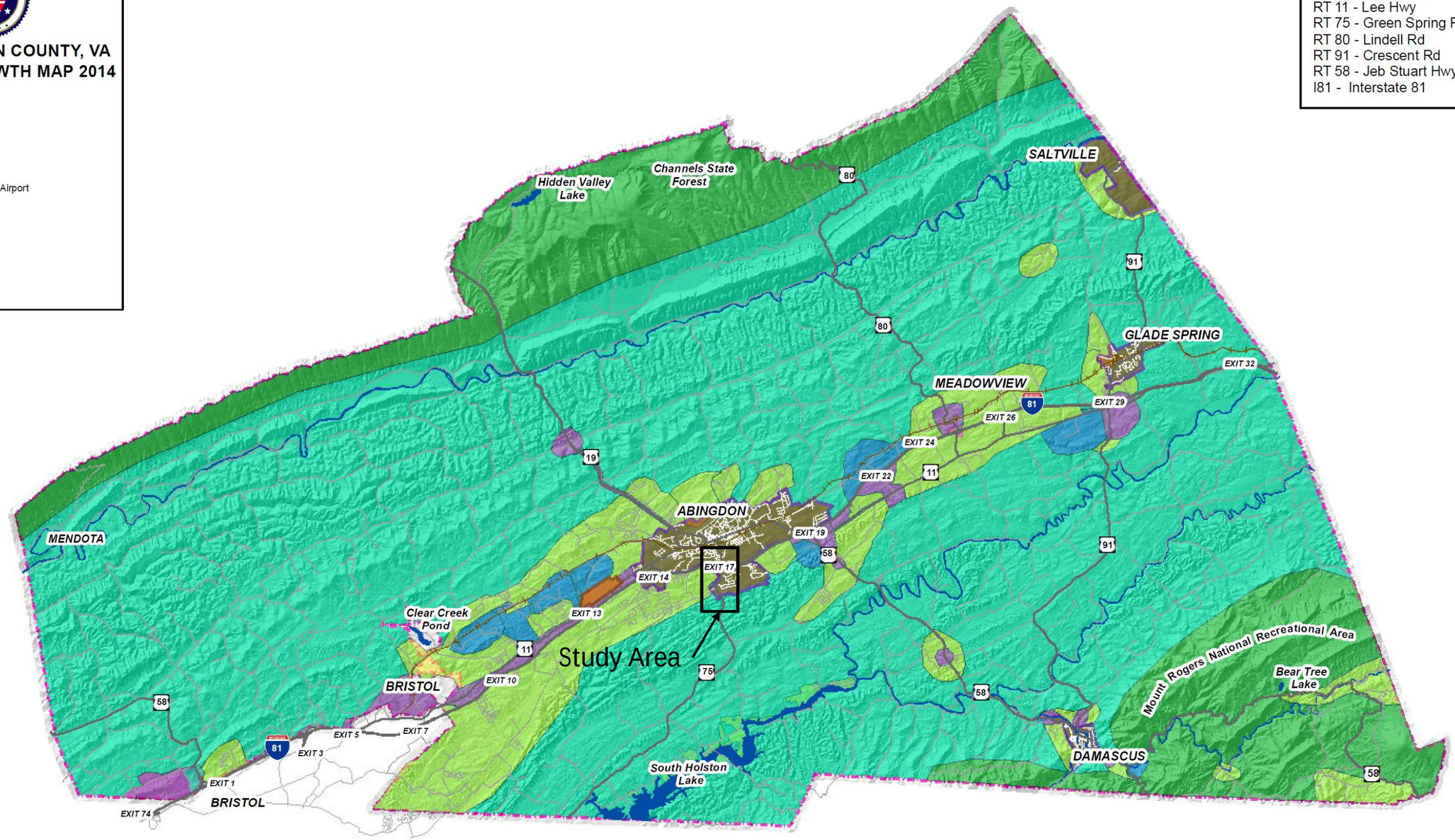
FIGURE
26

Source: Washington County, 2015 Comprehensive Plan

WASHINGTON COUNTY, VA
FUTURE GROWTH MAP 2014

- Commercial
- Industry
- Open Space
- Highlands
- Residential
- Virginia Highlands Airport
- rail
- Main Roadways
- Town
- Public
- Lakes and Rivers
- Corporate Limits

RT 58 - Gate City Hwy
RT 19 - Porterfield Hwy
RT 11 - Lee Hwy
RT 75 - Green Spring Rd
RT 80 - Lindell Rd
RT 91 - Crescent Rd
RT 58 - Jeb Stuart Hwy
I81 - Interstate 81



N

0 0.5 1 2 3 4 Miles

MAP PRODUCED BY THE WASHINGTON COUNTY GIS DEPARTMENT JULY 2014

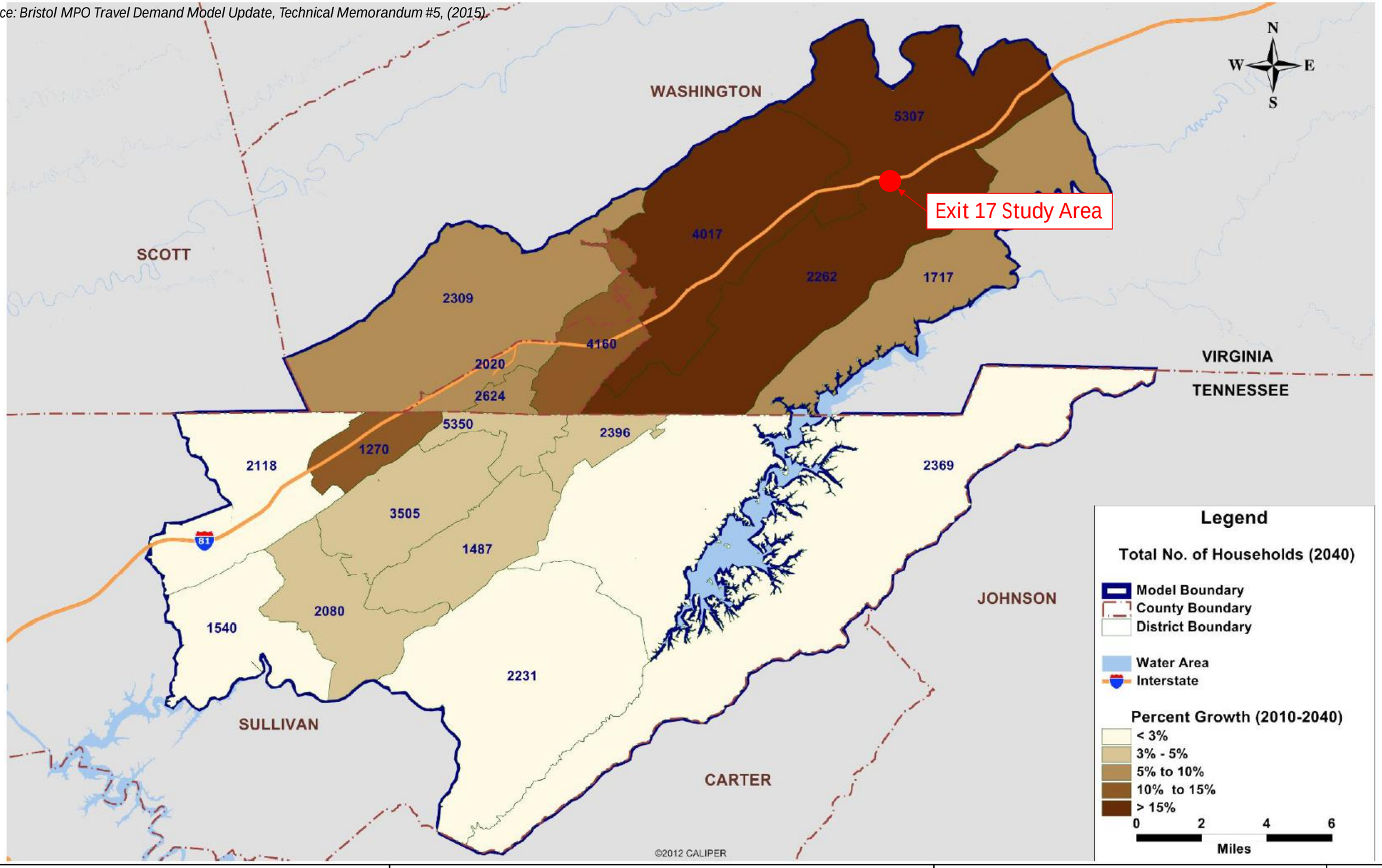
STARS VDOT

Interstate 81 - Exit 17
Interchange Modification Report

Washington County
Future Land Use

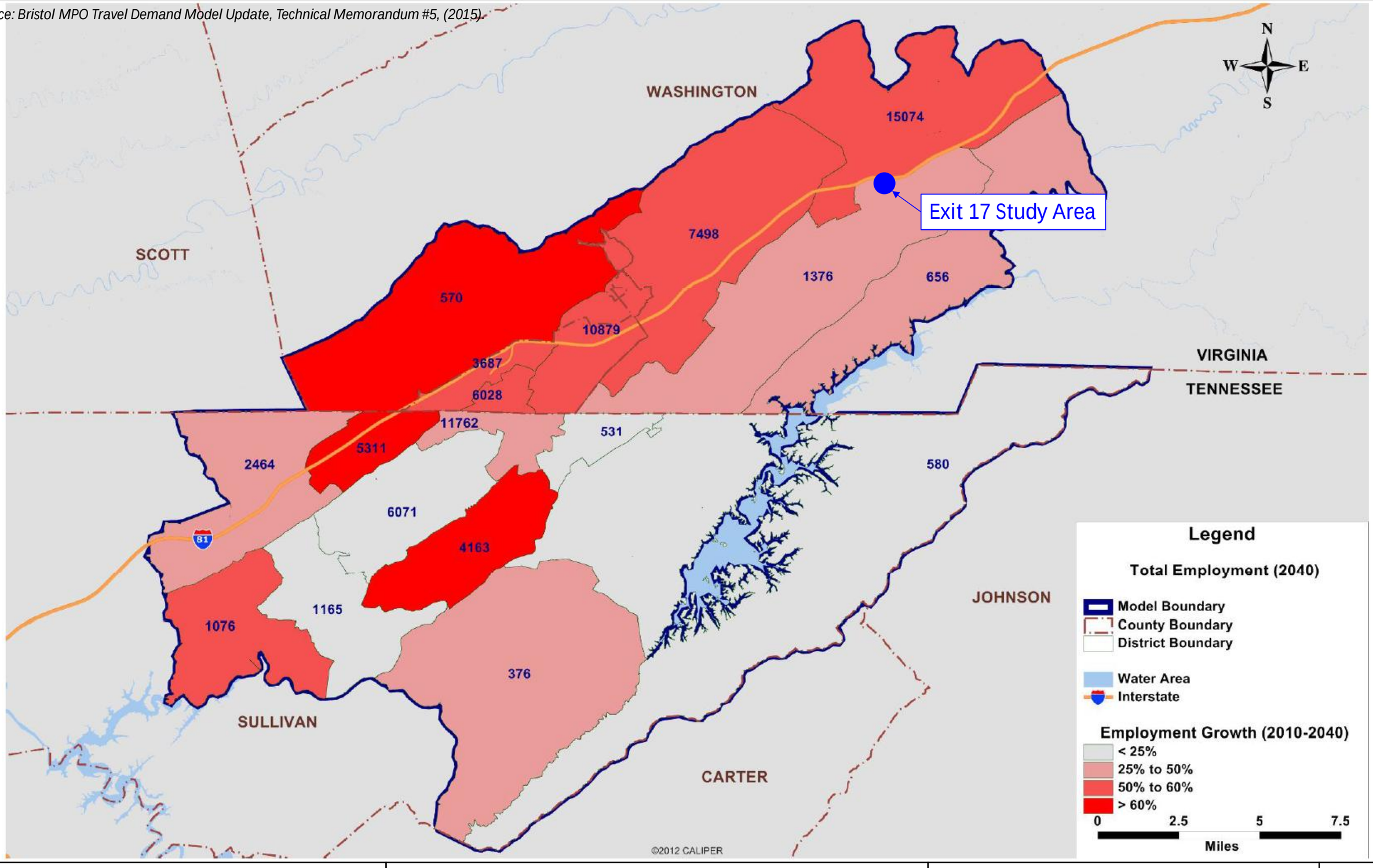
FIGURE
27

Source: Bristol MPO Travel Demand Model Update, Technical Memorandum #5, (2015).



STARS VDOT	Interstate 81 - Exit 17 Interchange Modification Report	Bristol MPO Travel Demand Model 2040 Projected Household Growth	FIGURE **28**

Source: Bristol MPO Travel Demand Model Update, Technical Memorandum #5, (2015).



STARS VDOT	Interstate 81 - Exit 17 Interchange Modification Report	Bristol MPO Travel Demand Model 2040 Projected Employment Growth	FIGURE **29**

8. Environmental Compliance

In accordance with FHWA policy, this IMR was completed to evaluate the feasibility of the proposed interchange improvements and modifications. At this time, no National Environmental Policy Act (NEPA) or Virginia State Environmental Review Process (SERP) documents are being prepared for this project. Acceptance of this IMR alone does not constitute approval for construction and the required NEPA and/or SERP documents must be completed prior to final approval for construction.

A review using NEPA process criterion was conducted for this project to determine if any sensitive sites may be present or potentially impacted by the construction of the proposed improvements at the Exit 17 interchange. This section assesses the potential for significant impacts to the human or natural environment. Based on the comprehensive review of various standard environmental data sources, the proposed project may pose potential impacts to natural and historic resources located within or adjacent to the project limits.

The following areas were reviewed to identify potential significant impacts to parcels within the study area, shown in Figure 9-1:

- Socio-Economic Impacts
  - Environmental Justice
  - Community Facilities
  - Parks and Recreation
- Cultural and Historic Resource Impacts
- Natural Resources Impacts
  - Floodplain
  - Wetlands and Surface Waters
  - Wildlife and Habitat
- Farmland Impacts
- Air Quality Impacts
- Hazardous Materials Impacts

The following areas will need to be reviewed for the required NEPA and/or SERP document once this IMR has been approved:

- Noise
- Right-of-way and relocations
- Cumulative and indirect impacts
- Public involvement
- Coordination with state environmental and natural resource agencies to provide comments on any significant environmental impacts of the project and avoid or minimize those impacts.

8.1. Socio-Economic Impacts

A review of the potential socio-economic impacts associated with modifying the Exit 17 interchange, consisted of data searches for information related to environmental justice, community and parks and recreation facilities. This information is discussed below.

8.1.1. Environmental Justice

U.S. Census Bureau data from 2014 Five-Year American Community Survey were reviewed to determine both the percentage of the population that is considered minority (non-white) and that is below the poverty level. The percentages for the Census Tracts within the study area (Figure 30) were compared to the population data for Washington County, where the Census Tracts are located. The proposed interchange modifications will not significantly or disproportionately impact the populations in these Census Tracts.

		Population*	Minority Population (non-white)	Population below poverty level
Washington County	Total	54,833	1,864	4,058
	Percent	100%	3.4%	7.4%
Census Tract 104.01	Total	2,103	137	93
	Percent	3.8%	2.2%	4.4%
Census Tract 105.02	Total	3,709	411	959
	Percent	6.8%	9.4%	25.9%
Census Tract 106.01	Total	4,312	262	562
	Percent	7.9%	6.1%	13.0%

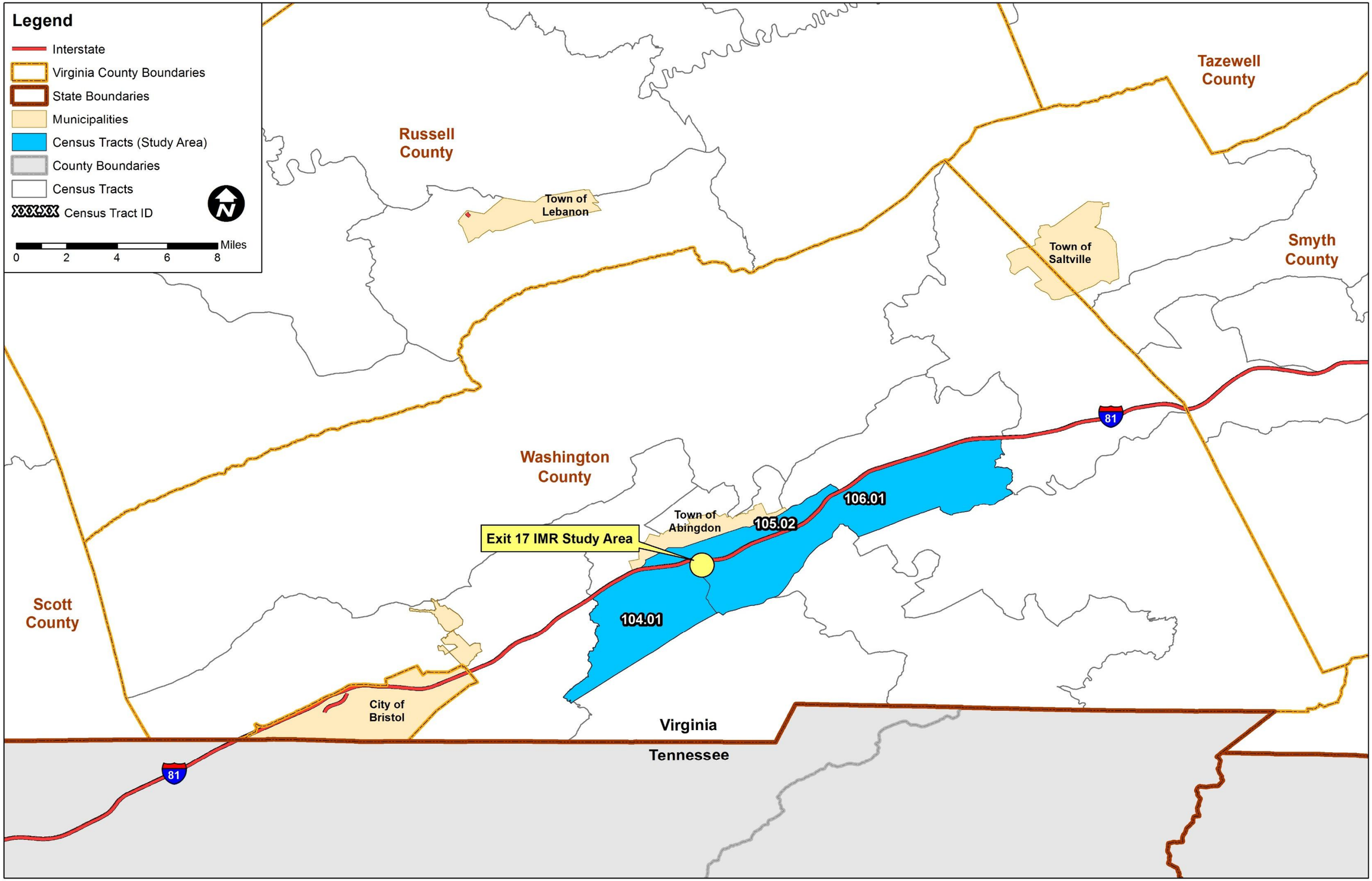
*Notes: * Census Tract percent population is the percentage of the County population in that census tract. Census Tract percentages greater than the County they are located in are highlighted in red.*

8.1.2. Community Facilities

Community facilities such as school zones, fire departments, rescue squads, and libraries were identified to determine their proximity to the study area using GIS data provided by Washington County. The community facilities identified are shown on Figure 31 and include the following:

- Schools
  - Abingdon Elementary
  - Abingdon High School
  - Highlands Community College
- Fire Department/Rescue squad
  - Abingdon Fire Department
  - Washington County LSG
- Hospital
  - Johnston Memorial Hospital
- Library
  - Washington County Public Library

The proposed modifications to the Exit 17 interchange will not impact these facilities.

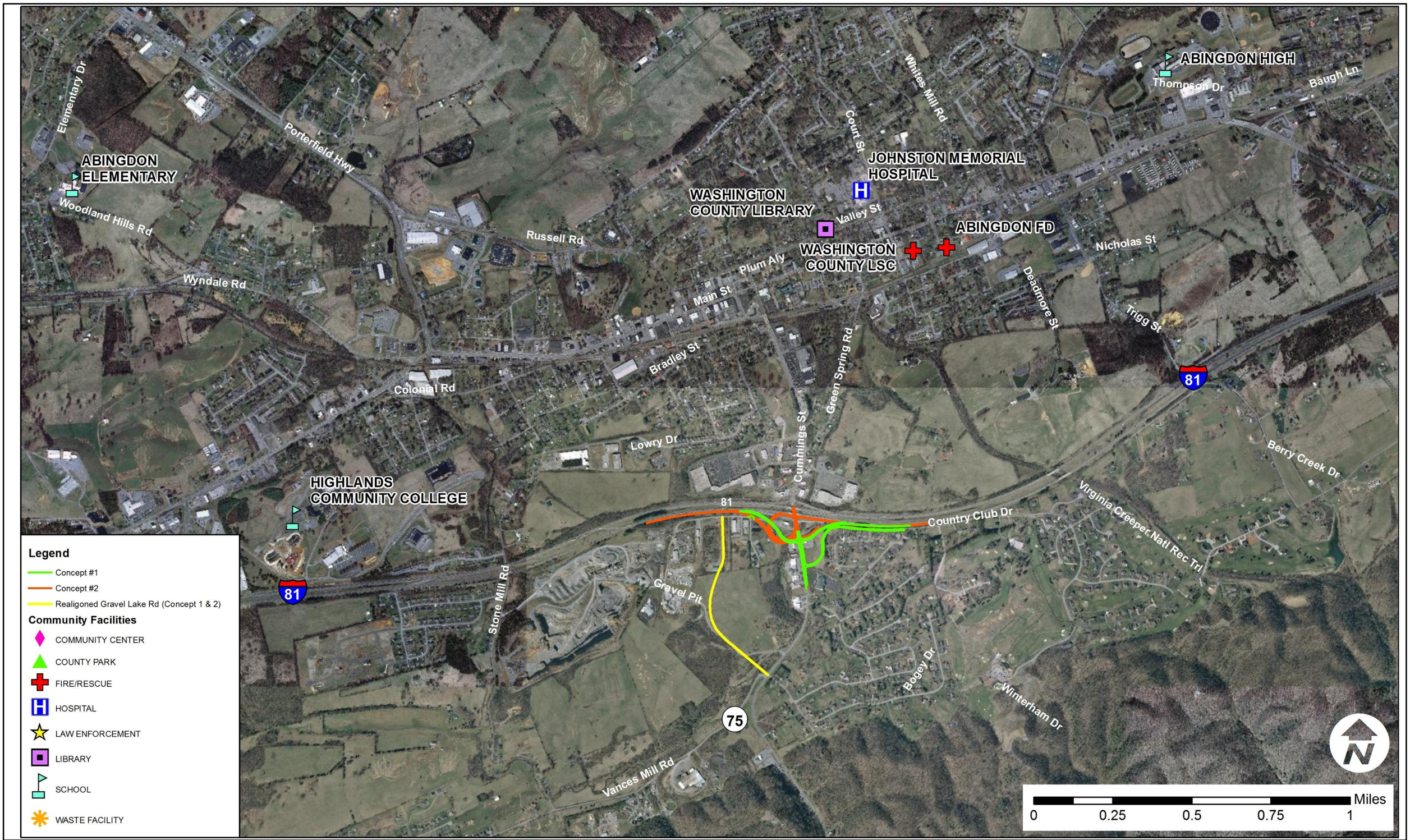


STARS VDOT

Interstate 81 - Exit 17
Interchange Modification Report

Study Area Census Tracts

FIGURE
30



STARS VDOT

Interstate 81 - Exit 17
Interchange Modification Report

Community Facilities

FIGURE
31

8.1.3. Parks and Recreation/Section 4(f)

The following sources were reviewed to identify park and recreational facilities within the study area:

- Washington County GIS data
- Virginia Department of Game and Inland Fisheries (DGIF) GIS data
- Virginia Department of Conservation and Recreation (DCR) GIS data

No national, state, county or city parks, recreation centers were identified within or near the study area. The Virginia Creeper Trail is located just north of the study area. This trail is a converted railroad bed and stretches 34 miles from Abingdon, Virginia down to Damascus, Virginia. The proposed modifications to the Exit 17 interchange will not impact this facility

8.2. Cultural and Historic Resources

The Virginia Department of Historic Resources (DHR) Virginia Cultural Resource Information System (VCRIS) (http://www.dhr.virginia.gov) was used to identify potentially eligible archeological and architectural sites located within or near the study area, as shown in Figure 32. To be eligible for listing in the National Register of Historic Places, sites must meet the National Register Criteria for Evaluation, which involves examining the age, integrity, and significance of the site.

Six archeological sites were identified during the review and two architectural sites were identified, all with a status of 'not evaluated'. The following archaeological and architectural resources were identified within the project area, DHR ID: #44WG0116, #44WG0027, #44WG0166, #095-0011, #44WG0115, #44WG0037, and #44WG0012, and are detailed in Table 45. The VDHR Identified Sites highlighted in red are located within the proposed study area of Concept #1 and Concept #2. There are many archaeological and architectural resources in and around the Exit 17 interchange. Coordination with VDHR will be needed if the sites may or will be impacted while modifying the interchange. Additional information on the archaeological and architectural sites is located in Appendix J.

Table 45: VDHR Identified Sites

VDHR ID #	Site Description	Status
44WG0116	Native American camp with various artifacts found.	Not Evaluated
44WG0027	Native American Hamlet with various artifacts found.	Not Evaluated
44WG0166	Native American camp and fire site with various artifacts found.	Not Evaluated
095-0011	Green Hill, identified as a single, two and a half story dwelling.	Not Evaluated
44WG 0115	Native American camp with various artifacts; unknown portion of the site has been destroyed.	Not Evaluated
44WG0037	Kelly or White Site, identified as a Native American grave or burial. Based on the archaeological survey completed in 1975 and provided by the Commonwealth of Virginia, Virginia State Library, the site may tie in with the Sullins Site, located southwest of the listed site record. However, mapping of burial locations was not provided in this survey. The current uses of the site include residential property and cultivated farmland.	Not Evaluated
44WG0012	Sullins or Abingdon Site, identified as a Native American grave, burial, and Palisaded settlement. According to the survey, local collectors previously excavated the site which contained evidence for seven house patterns, storage pits, burials, and hearths.	Not Evaluated
095-0217	Identified as an Indian burial or funerary site.	Not Evaluated

8.3. Natural Resources

Natural resources data were also reviewed to identify potential environmental constraints for the interchange. Information about water resources – floodplain, streams, and wetlands – as well as wildlife and habitat areas in and near the study area are described below. Additional information about these resources can be found in Appendix J.

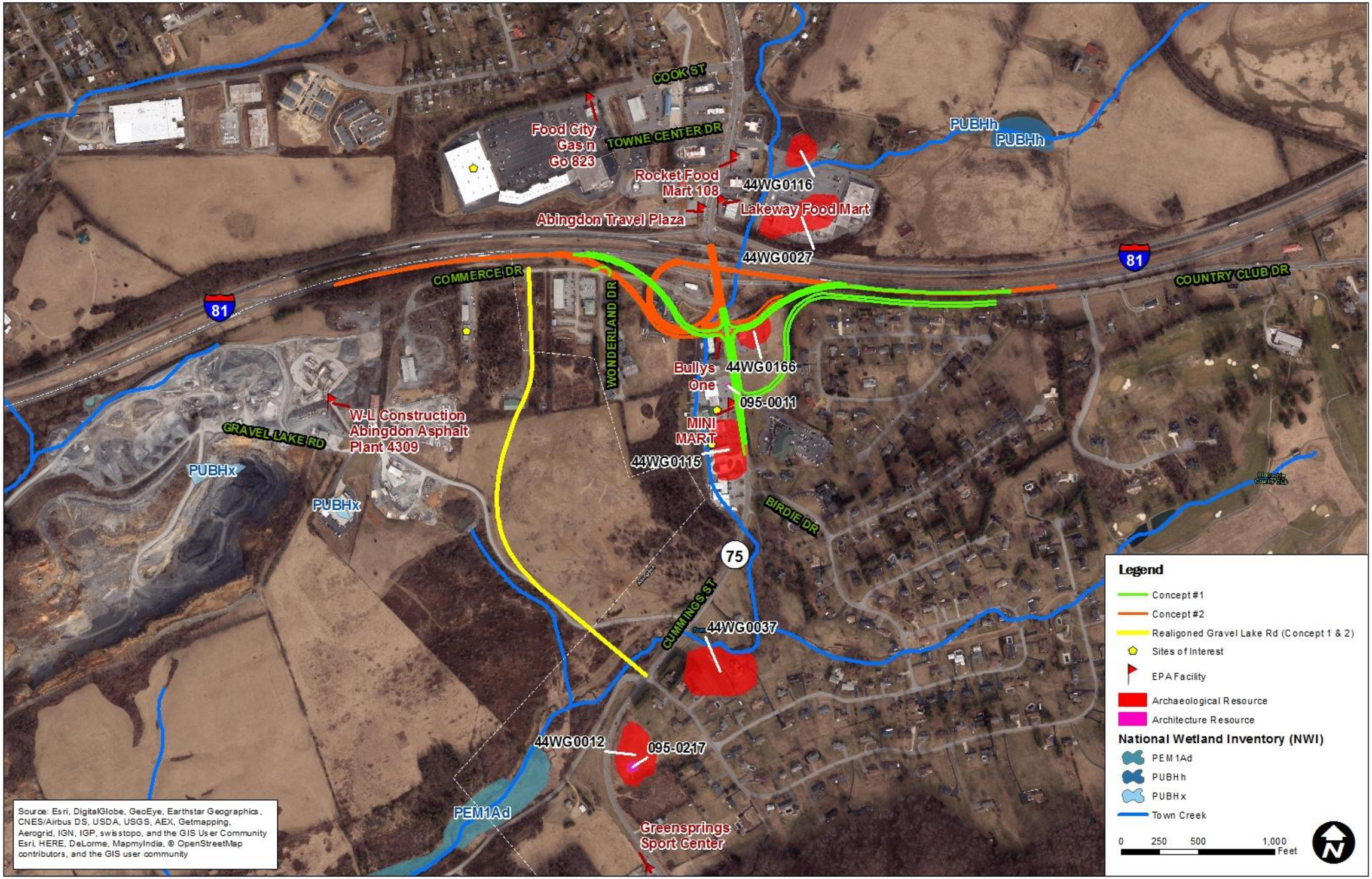
8.3.1. Floodplain

The Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) panels for Washington County were reviewed to identify any floodplains within the study area. The Panel/ Map Number containing the study area is 51191C0280C, with an effective date of September 29, 2010. A copy of the FIRM Map can be found in Appendix J. The portion of the project area located in the vicinity of Town Creek is within the regulated floodway. A narrow portion around the regulated floodway is located within shaded Zone X (areas corresponding to the 500-year floodplain and/or 100-year floodplain with average depths of less than 1-foot with drainage areas less than 1 square mile). Areas east of Cummings Street and west of Town Creek are located within unshaded Zone X, which are areas determined to be outside the 500-year floodplain.

8.3.2. Wetlands and Surface Waters

Topographic and National Wetland Inventory (NWI) mapping, aerial photography, and U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) soil survey data were reviewed to identify potential wetland and stream areas. The United State Geological Survey (USGS) Abingdon, Virginia 7.5 Minute Quadrangle topographic maps show the subject property as ranging in elevation between approximately 2,000 to 2,100 feet above the National Geodetic Vertical Datum of 1929. The Abingdon, VA, 1:24,000 scale topographic map and the National Hydrology Dataset from the USGS were reviewed to identify surface waters within and near the study area. The topographic mapping shows Town Creek, a perennial stream, running north to south through the center of the project boundary (Figure 33). According to the NWI mapping, palustrine emergent persistent wetlands with a water regime of temporarily flooded and partially drained/ditched (PEM1Ad) are shown on the southwestern portion of the project area adjacent to Vances Mill Road. The drainage feature and signatures of saturated soil are evident in the 1994 USGS Digital Orthophoto Quarter Quadrangles (DOQQ) (Figure 34).

Kimley-Horn conducted a site visit on September 13, 2014. A drainage feature was observed within the extent of the study area, extending from north of I-81 to the southern-most boundary, and is determined to be Town Creek. A tributary of the perennial stream can be observed south of Gravel Lake Road, flowing southeast to northwest and terminating at what appears to be an impoundment potentially associated with the neighboring land uses. Wetlands were observed in the south western portion of the project area along Gravel Lake Road and Vances Mill Road. Figure 31 also depict the build concepts, the NWI mapped wetlands, waters observed during the site visit, and survey provided locations of wetlands.



STARS VDOT

Interstate 81 - Exit 17

Interchange Modification Report

Environmental Features

FIGURE

32

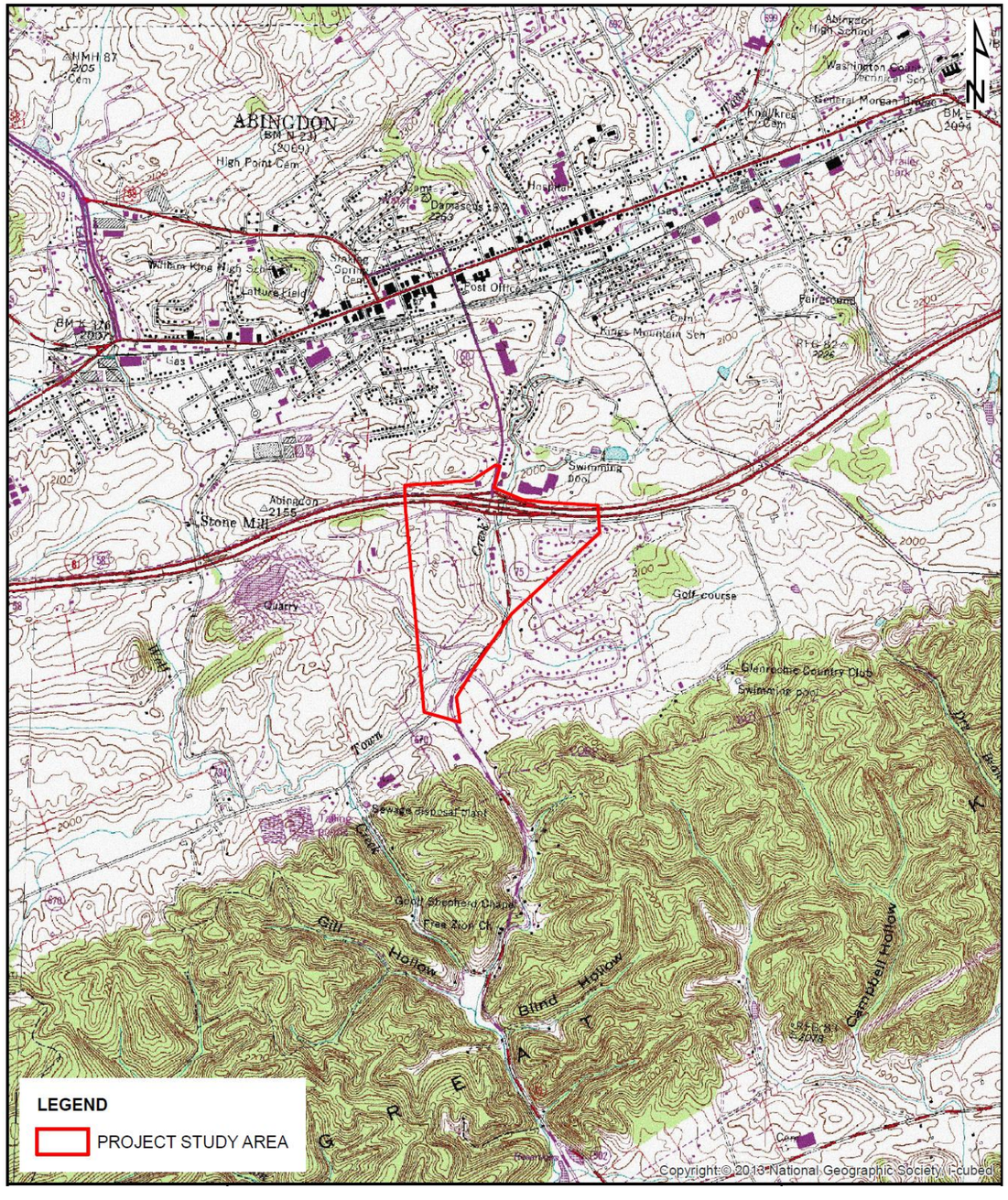


Figure 33: Topographic Vicinity

Figure 34: 1994 USGS Digital Orthophoto Quarter Quadrangles

8.3.3. Wildlife and Habitat

The Virginia Department of Game and Inland Fisheries' (DGIF) Virginia Fish and Wildlife Information Service (VaFWIS), Department of Conservation and Recreation's (DCR) Natural Heritage Data Explorer, U.S. Fish and Wildlife Service's (USFWS) Information, Planning, and Conservation system (IPaC), and the Center for Conservation Biology's (CCB) Eagle Nest Locator were reviewed to determine whether known federal or state threatened or endangered (T&E) species, wildlife or plant resources have been documented within the project area property limits or a two-mile radius of the project area.

The DGIF VaFWIS Project Review Report, dated October 10, 2014, did not reveal documentation of threatened or endangered species within the project area. However, portions of the project area including Town Creek and it's adjacent tributary are identified as potential habitats for the state endangered Tennessee Dace (Chrosomus tennesseensis) and Loggerhead Shrike (Lanius ludovicianus).

The DCR's Division of Natural Heritage (DHR) searched its Biotics Data System for occurrences of natural heritage resources within the project area. Based on the search, this project is situated on karst-forming carbonate rock and can be characterized by sinkholes, caves, disappearing streams, and large springs. If the project involves filling or "improvement" of sinkholes or cave openings, please coordinate with Wil Orndorff at DCR (wil.orndorff@dcr.virginia.gov) to document and minimize adverse impacts.

The CCB's Eagle Nest Locator did not depict bald eagle nests within 750 feet of the project area.

According to the Official Species List from the USFWS, dated October 10, 2014, there are 14 threatened or endangered species that may occur within the boundary of the project area. The following species were identified:

- Spruce-Fir Moss spider (Microhexura montivaga)- The spruce-fir moss spider is one of the smallest members of the spider suborder "tarantulas," and lives on the highest mountain peaks in the Southern Appalachian Mountains.
- Fluted kidneyshell (Ptychobranchus subtentum)- The fluted kidneyshell is a large freshwater mussel and can be found in portions of the Cumberland and Tennessee River systems.
- Littlewing pearlymussel (Pegias fabula)- The littlewing pearlymussel is a small mussel that can be found in the Cumberland River system and the Tennessee River system.
- Shiny pigtoe (Fusconaia cor)- The shiny pigtoe is found in shoals and riffles of small to medium sized rivers and is typically burrowed in sand and cobble substrates.
- Slabside Pearlymussel (Pleuronaia dolabelloides)- The slabside pearlymussel is a moderately sized mussel that can be found in portions of the Cumberland and Tennessee River systems.
- Tan riffleshell (Epioblasma florentina)- The tan riffleshell is a medium-size freshwater mussel that can be found in portions of the Tennessee River.
- Spotfin Chub (Erimonax monachus)- The spotfin chub is a small, slender fish that can be found in river systems of Tennessee and Virginia.
- Smooth coneflower (Echinacea laevigata)- The smooth coneflow is a herbaceous perennial that can be found in Virginia, North Carolina, South Carolina, and Georgia.
- Virginia spiraea (Spiraea virginiana)- The Virginia spiraea is a perennial shrub with many branches, and is a Southern Appalachian species with isolated populations found in the mountain regions of Virginia and surrounding states.
- Carolina Northern Flying squirrel (Glaucomys sabrinus coloratus)- The Carolina Northern Flying squirrel has bright cinnamon brown colored fur and is found across Canada and the northern United States. The Carolina subspecies is distributed in western North Carolina, east Tennessee, and southwest Virginia.
- Gray Bat (Myotis grisescens)- The gray bat is distinguished from other bats by the unicolored gray fur on its back. The gray bat occupies a limited geographic range in limestone karst areas of Alabama, Tennessee, western Virginia, and western North Carolina.
- Indiana Bat (Myotis sodalis)- The Indiana bat is a small and very social species that can be found in cave systems of the north central and east coast of the United States.
- Northern Long-eared Bat (Myotis septentrionalis)- The northern long-eared bat is a medium-sized bat, and as its name suggest, can be distinguished by its long ears. The range of the northern long-eared bat includes much of the eastern and north central United States.
- Virginia Big-eared Bat (Corynorhinus plecotus)- The Virginia big-eared bat is of medium size with huge ears joined across the forehead. It is one of two Virginia bat species that is cave dwelling, and exclusively in limestone caves.

A copy of the documentation relating to the database research is contained in Appendix J.

A letter from the Virginia DCR dated November 6, 2014, included in Appendix J, states that the proposed interchange build concepts will not adversely impact any documented state-listed plants or insects, and there are no State Natural Area Preserves under DCR's jurisdiction in the project vicinity. However, the project is situated on karst-forming carbonate rock and can be characterized by sinkholes, caves, disappearing streams, and large springs. If such features are encountered during the project, proper coordination with DCR will be required to document and minimized adverse impacts.

8.4. Hazardous Materials

A field review of the project corridor was conducted from public thoroughfares to assess the potential for encountering hazardous materials, petroleum impacted soil, or groundwater during construction of the proposed improvements. Environmental Data Resources Inc. (EDR) was engaged to perform an environmental database search of state and federal regulatory agency records concerning the release of petroleum products or hazardous materials for the area located within the vicinity of the proposed project. A Freedom of Information Act (FOIA) request was submitted on November 4, 2014 for additional information associated with suspect areas identified in the EDR. In addition, the Virginia Department of Environmental Quality's (DEQ) Virginia Environmental Geographic Information Systems (VEGIS) website was reviewed (accessed November 18, 2014) for petroleum releases and Voluntary Remediation Program (VRP) sites identified within the project corridor. The findings and recommendations are presented in Figure 31 and described below.

The project area is located within a mixed use area of Abingdon consisting of residential, commercial, and industrial uses. The following sites within the vicinity of the project corridors were identified as Recognized Environmental Concerns (RECs).

- 598 Cummings Street, Rocket Food Mart 108 – this site is identified in the EDR report as being located along the eastern side of State Route 75 just south of the intersection with Towne Centre Drive. 598 Cummings Street is listed on the Underground Storage Tanks (UST), Leaking Underground Storage Tanks (LUST), and Leaking Tanks (LTANKS) databases.

Reported for three (3) 10,000-gal USTs containing gasoline that have been removed from the ground and two 1,000-gal USTs containing diesel that have been removed from the ground. This site is associated with Pollution Complaint (PC) #2001-1015 which was closed March 5, 2003. According to the DEQ VEGIS website the facility is a confirmed petroleum release site that has been closed as of November 2, 2014.

- 604 Cummings Street, Exxon Lakeway Food Mart – this site is identified in the EDR report as being located along the eastern side State Route 75 just north of I-81. 604 Cummings Street is listed on the UST and Financial Assurance databases. Reportedly, one 10,000-gal UST containing gasoline is currently in use, two 8,000-gal USTs containing gasoline are currently in use, five 6,000-gal USTs containing gasoline that have been removed from the ground, and one 550-gal UST containing used oil that has been removed from the ground. The site is identified as Facility ID #1-018784 which was closed on May 11, 1994.
- 611 Cummings Street, Abingdon Travel Plaza, Chevron-Dad's Express Stop, Stucky's BP, C&M of Abingdon – this site is identified in the EDR report as being located along the western side of State Route 75 just north of I-81. 611 Cummings Street is listed on the UST, LUST, LTANKS, and Financial Assurance databases. Reportedly, one 8,000-gal UST containing gasoline has been removed from the ground, five 4,000-gal USTs containing gasoline have been removed from the ground, and one 2,000-gal UST containing diesel has been removed from the ground. This site is associated with PC #2014-1020 and FAC ID #1-015332, which were closed February 28, 2014, and PC #2002-1074 which was closed on May 13, 2002. According to the DEQ VEGIS website the facility is a confirmed petroleum release site that has been closed as of November 2, 2014.
- 713 and 715 Cummings Street Cherokee Convenience Store, Bully's 1, and Exit 17 Valero – this site is identified in the EDR report as being located along the western side of State Route 75 south of the intersection with Commerce Drive. The former Bully's 1 at 713 Cummings Street is listed on the UST and Financial Assurance Databases. Reportedly, three 8,000-gal USTs containing gasoline have been removed from the ground. According to the DEQ FOIA documentation and the DEQ VEGIS website, the facility has one Aboveground Storage Tank (AST) of unknown size and material, registered on December 2, 2013. According to the DEQ FOIA documentation and the DEQ VEGIS website, the former Cherokee Convenience Store #15 had a documented petroleum release under PC #99-0323. This PC is now closed, dated January 30, 2002. The former Exit 17 Valero is listed on the LUST database under PC #2008-1011 that is currently open according to the DEQ VEGIS website as of November 2, 2014.
- 1151 Cummings Street Marathon Jimbo's General Store and Lakeway Speed Mart – this site is identified in the EDR report as being located along the western side of State Route 75 south of the intersection with Vances Mill Road. Jimbo's General Store is listed on the UST and Financial Assurance databases. Reportedly, three 6,000-gal USTs containing gasoline are currently in use and one 550-gal UST containing kerosene is closed in the ground. This site is associated with FAC ID #1-018287. The 550-gal UST was closed in September of 2000.

A copy of the documentation relating to the database research is contained in Appendix J.