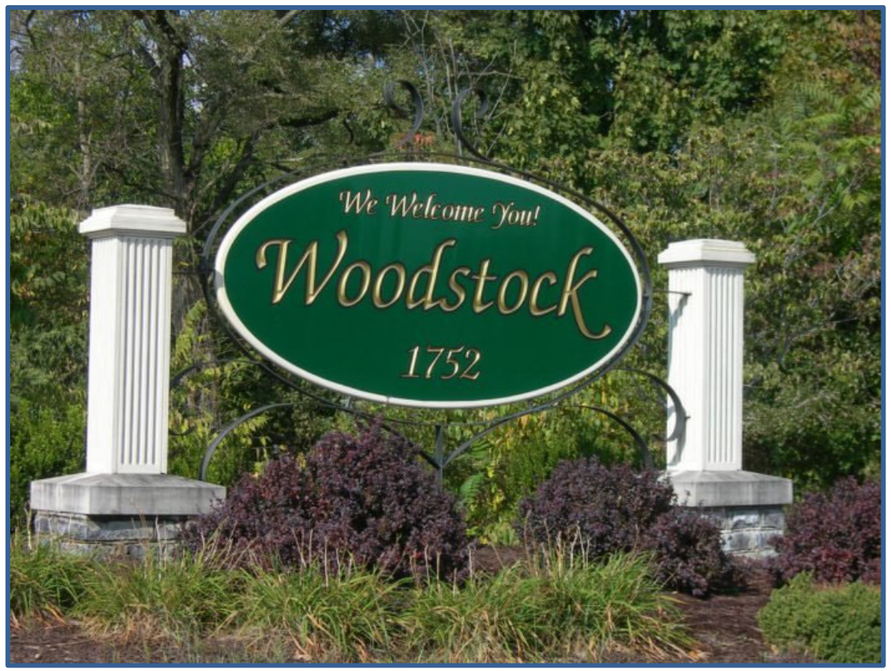

ROUTE 42 CORRIDOR IMPROVEMENT STUDY TOWN OF WOODSTOCK

Draft Final Report – January 2020

VDOT Staunton District Planning

Disclaimer

This study has been prepared in cooperation with the Virginia Department of Transportation and the Town of Woodstock. The contents of this study reflect informational input from Town officials, staff, and the general public and analysis and recommendations prepared by the Staunton District Planning Office of the Virginia Department of Transportation. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration, Federal Transit Administration, the Virginia Department of Transportation, or the Virginia Department of Rail and Public Transportation. This study is not a legal document, and does not constitute a standard, specification, or regulation. Although much care was taken to ensure the accuracy of information presented in this document, the Virginia Department of Transportation Staunton District Planning Office does not guarantee the accuracy of this information.

Acceptance of this document as evidence of fulfillment of the objectives of this planning study does not constitute endorsement / approval of the need for any recommended improvements, nor does it constitute approval of their location and design or a commitment to fund any such improvements. Additional project level environmental impact assessments and/or studies of alternatives may be necessary.

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Additional copies of this document may be obtained by contacting:

Virginia Department of Transportation
Staunton District Planning
811 Commerce Road
Staunton, VA 24401
(540)332-9067

List of Acronyms

ADT – Average Daily Traffic
AADT – Annual Average Daily Traffic
CTB – Commonwealth Transportation Board
CMF – Crash Modification Factor
HCM – Highway Capacity Manual
LOS – Level of Service
MOE – Measure of Effectiveness
PDO – Property Damage Only
PSI – Potential for Safety Improvement
TMC – Turning Movement Count
TMPD – Transportation and Mobility Planning Division
TOSAM – Traffic Operations and Safety Analysis Manual
STARS – Strategically Targeted Affordable Roadway Solutions
SYIP – Six-Year Improvement Plan
VDOT – Virginia Department of Transportation
VJuST – VDOT Junction Screening Tool

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1. Introduction

1.1. Background and Study Initiation

The Virginia Department of Transportation (VDOT) office of Transportation and Mobility Planning Division (TMPD) manages an annual study program to develop corridor improvement recommendations that are intended to be competitive in state funding opportunities, supporting programming of the Six-Year Improvement Plan (SYIP). The Strategically Targeted Affordable Roadway Solutions (STARS) program focuses on corridors with safety and congestions needs. STARS utilizes a data-driven process to identify candidate corridors with critical traffic and safety challenges. During the 2017 round of STARS candidate consideration, the Route 42 corridor in Woodstock, VA was identified with high safety needs based on 2012 – 2016 crash history. Given the scale of the corridor, VDOT Staunton District Planning determined that the location would be ideal for developing an in-house study following the STARS process. District Planning coordinated with the VDOT Edinburg Residency and the Town of Woodstock to discuss the corridor and determined to move forward with the study with the support of both the town and residency.

The Route 42 corridor ranks highly within the VDOT Staunton Construction District with several significant crash locations. The STARS program seeks to develop comprehensive, innovative transportation solutions to resolve the existing safety issues and improve traffic operations. The goals of the STARS program include:

- Development of innovative, cost –effective solutions
- Evaluate potential solutions in greater detail
- Identify potential project risks, costs and schedule
- Build stakeholder consensus
- Improve readiness for project funding application

This study is titled the Route 42 Corridor Improvement Study and will be referred to as the Study in this report. Route 42 is considered to run east/west and other roads are considered to run north/south for the purpose of the study.

1.2. Purpose of Study

The purpose of the study is to evaluate existing operational and safety deficiencies within the identified study area and to develop targeted improvement recommendations to address the identified corridor needs. With the development of study recommendations, consideration is given to the likelihood that recommended improvements would perform favorably in the SMART SCALE project prioritization process or other funding opportunities to support programming of the state SYIP. In addition to the goals if the STARS process stated above, VDOT District Planning worked with Woodstock town staff to identify the following specific study goals related to the Route 42 corridor:

- A collaborative and supported effort between town representatives, corridor stakeholders and VDOT.
- Develop a corridor plan that identifies future improvement recommendations that address operational, safety and gateway treatment needs.
- Improvement recommendations will consider and address all users of the corridor, including pedestrians and cyclists.
- Supporting study analysis and data will be available for town utilization in the development and submission of future transportation funding applications for recommendation implementation.

1.3. Study Working Group

The study working group included a collaborative effort in the development of study scope, analysis methodologies, future assumptions, public input, and the review of corridor needs and recommendations. The study working group consisted of the following parties:

- VDOT Staunton District Planning
- Town of Woodstock staff
- Town of Woodstock Street Committee
- VDOT Edinburg Residency
- VDOT Staunton District Traffic Engineering
- VDOT Staunton District Location and Design
- Public Input

1.4. Study Area

The extents of the corridor study consist of the full, 1.0-mile section of Route 42 within the Woodstock town limits and includes eight study intersections:

1. Hisey Avenue – Signalized
2. Henry Ford / Woodstock Commons Drive – Signalized
3. I-81, Exit 283 Southbound Ramps – Signalized
4. I-81, Exit 283 Northbound Ramps - Signalized
5. Motel Drive – Unsignalized (full access)
6. Ox Road – Signalized
7. Susan Avenue – Unsignalized (northbound left turns prohibited)
8. Main Street / US 11 – Signalized

Land uses along Route 42 consist primarily of interstate services (fast food, hotels, service stations) and regional commercial destinations (Lowes, Wal-Mart). The intersecting side streets serve residential areas. The Shenandoah County Fairgrounds are accessed from Route 42 via Ox Road and the Woodstock / Shenandoah County public school complex is located south of the corridor along Susan Avenue. Refer to ***Figure 1*** for the full study area limits.

Figure 1: Study Location Exhibit

1.5. Summary of Study Process and Recommendations

Utilizing the 2017 STARS operational and safety data, VDOT District Planning developed a presentation illustrating the higher-level needs and deficiencies of the corridor, along with the stated purpose and goals of the study. This information was presented to the Woodstock Street Committee in the fall of 2017 to advocate for town support of advancing the study. With endorsement from the Street Committee, a study kickoff meeting between town staff and VDOT was held in the winter of 2018 to finalize study limits and methodologies. Given the timeline to the opening of SMART SCALE Round 3 application development (March 2018), an accelerated schedule was agreed upon to collect traffic data and develop a corridor wide improvement scenario for the town's consideration for advancement in the SMART SCALE program. In order to validate town support for the study and gain public input early in the process to assist in recommendation development, it was agreed that a public meeting would be held to present existing corridor needs and solicit public input to define the future vision of the corridor. A Public Information Meeting was held at the Woodstock Town Hall in March of 2018 and received general support for the consideration of corridor improvements.

Following the public meeting, traffic data was collected in April 2018 and a corridor wide concept focusing on the reduction of vehicular conflict points was developed and submitted as two SMART SCALE pre-applications by the end of the May 2018 deadline. One pre-application included the entire study corridor and the other included only the section of Route 42 between I-81 and US 11 (Main Street). The SMART SCALE final application development window (June - July 2018) was utilized to refine the corridor improvement plan that consisted of roadway medians, innovative intersections, signal operation enhancements, and non-motorized network improvements. The final corridor plan was presented to Town Council in the summer of 2018 and the two SMART SCALE applications were submitted by the town with a resolution of support in August 2018. Unfortunately, following the release of project scoring and a recommended funding scenario by VDOT in January 2019, both applications failed to secure project funding. While the applications addressed the safety needs of the corridor, scoring high marks in SMART SCALE safety scoring, the final score could not overcome the improvement costs to result in a competitive application.

Following the unsuccessful outcome of SMART SCALE Round 3, VDOT District Planning engaged town staff in a modified study approach to improve future application competitiveness by focusing on specifically targeting improvements at the study intersection level, as opposed to corridor wide improvements. Individual intersections would be evaluated with location specific recommendations developed to meet the overall intent of the previous corridor wide plan. The intersection recommendations would have the ability to stand on their own or be clustered as multiple intersection improvements to enhance future application flexibility and cost competitiveness. A draft of the intersection evaluations were presented to the Woodstock Street Committee in June 2019. Based on feedback from that meeting, intersection recommendations were finalized and prioritized. Additionally, other improvements concepts were discussed and agreed upon for evaluation, including a future northwest connector roadway to the west of the interstate to improve overall regional accessibility. This new alignment concept evaluation included a supporting origin and destination analysis to estimate future vehicle volumes on the facility. The revised, prioritized intersection improvement recommendations were presented to the Woodstock Street Committee in the fall of 2019. The study recommendations and process have been compiled into this draft final report document and will be submitted for town review in January 2020. The final study report is anticipated to be available for town utilization in the consideration of SMART SCALE Round 4 application development in March 2020.

Abbreviated Study Timeline:

- Presentation of Corridor Needs to Woodstock Street Committee – Fall 2017
- Study Kickoff – Winter 2017/18
- Public Information Meeting – March 2018
- Traffic Data Collection – April 2018
- Smart Scale Pre-Application Development – April 2018
- Corridor Improvement Plan Development – May / June 2018
- Town Council Resolutions of Support – July 2018
- Smart Scale Application Submittal – August 2018
- Smart Scale Scores Released – January 2019
- Modification of Study Approach – Spring 2019
- Presentation of Intersection Recommendations to Woodstock Street Committee – June 2019
- Presentation of Prioritized Recommendations to Woodstock Street Committee – October 2019
- Submit Draft Final Study Report for Town Review – December 2019

Summary of Corridor Recommendations:

- Traffic signal improvements including installation of flashing yellow arrow left turn phasing where appropriate and signal coordination to improve operations and progression along the corridor.
- Corridor wide median improvements to reduce conflict points, enhance pedestrian crossings and provide opportunities for aesthetic improvements.
- Utilization of Innovative Intersections at key study intersections to enhance corridor operations and safety, while maintaining corridor access to adjacent properties.
- Improve pedestrian and bicycle facilities along the corridor in a manner that supports the adopted Woodstock Bicycle and Pedestrian Master Plan.
- Long-term recommendations consist of interchange / ramp intersection improvements when warranted based on condition of the existing interstate bridge and a new roadway connecting Route 42 (via Hisey Avenue) to Spring Street to provide an alternative route for downtown trips to the west.

2. Existing Conditions

2.1. Roadway Characteristics

Route 42 (West Reservoir Road) in the Town of Woodstock is a State Primary roadway, connecting Interstate 81 to US 11 (Main Street). The facility serves as the principle entrance for the town from the I-81, Exit 283 interchange and as an important interstate / regional commercial corridor. The existing geometry of Route 42 generally consists of a 2-lane roadway with left turn lanes (some segments containing separate, opposing left turn lanes). The corridor widens to a 4-lane roadway with left turn lanes east of the intersection with Ox Road to the intersection with US 11. The roadway transitions from 45 mph posted speed to 35 mph posted speed as you enter the town limits from Shenandoah County to the west. Designated with a Major Collector Functional Classification, Route 42 is intended to balance vehicle throughput and accessibility. Collector facilities distribute traffic between roadways with higher functional classification (interstates and arterials) and the local street network. However, due to the number of full access commercial entrances and signalized intersections along the corridor, the function of the facility has been degraded in terms of both vehicular delay and safety.

2.2. Signal Operations

Six of the eight study intersections along the corridor are signalized. However, with the exception of the traffic signals at the interstate ramps, the remaining signals along the corridor are not operating in coordination. Signal coordination consists of communications between properly spaced intersections that synchronize primary movements to improve progression and throughput on the mainline. Coordination plans can also include detailed time of day plan to adjust the signals to accommodate the peak periods of higher volume demand. Other than the ramps, the remaining signals on the study corridor are operating independently, which results in random arrivals of vehicles as they progress along the corridor, leading to lower average speeds, longer travel times, and high risks of certain crash types such as rear ends. VDOT Staunton District Traffic Engineering has historically had available annual funding to upgrade existing signal corridors to coordination. While unavailable in recent years and with the future of this funding currently unknown, the Route 42 corridor in Woodstock is a priority location for the VDOT Traffic Engineering section to coordinate in the future. Additionally, during the study period, VDOT Staunton District Traffic Engineering upgraded the existing 5-section signal heads for left turn protected / permissive signal operations with flashing yellow arrow signal heads. This conversion to flashing yellow arrow for left turn movements provides additional flexibility in programming signal efficiency.

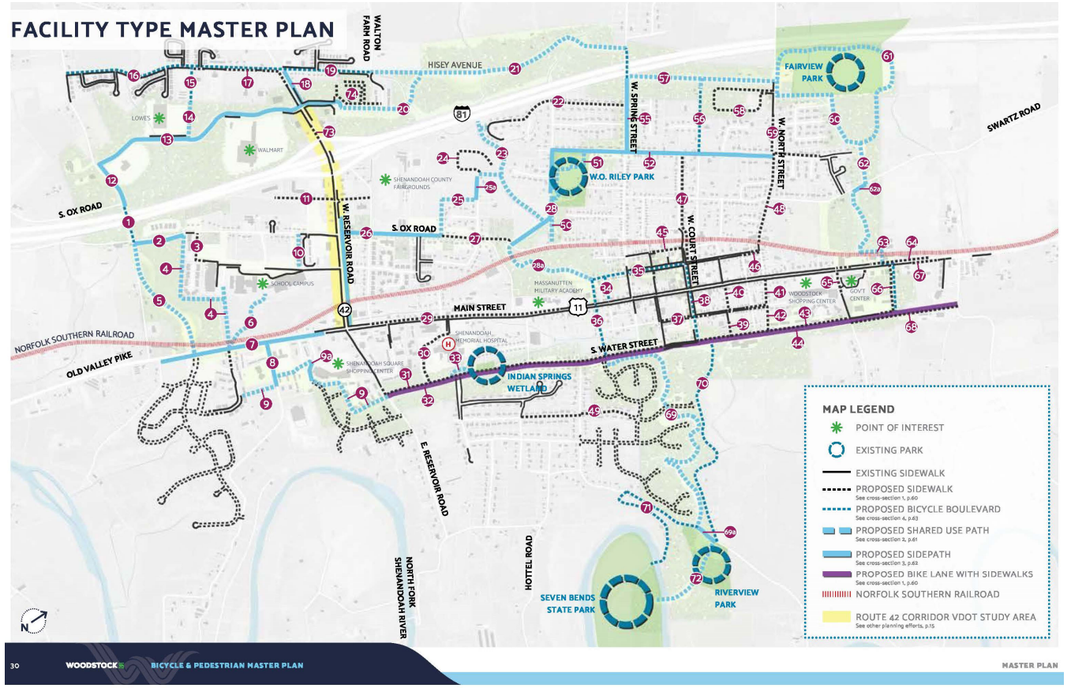
2.3. Interchange Conditions

Given the current condition of the Exit 283 interchange bridge (24-month inspection cycle with a sufficiency rating of 77.9, Deck Rating = 7, Superstructure Rating = 7, Substructure Rating = 6), geometrical improvements to the interchange are not proposed with this study. With these current condition ratings, a planning-level estimate of the remaining lifecycle of the bridge would exceed 30 years. Additionally, existing traffic operations at the interchange ramps are generally acceptable. Without a significant operational issue, funding to improve the interchange would not be available until the bridge condition reaches an unacceptable level. Based on these limitations, any significant improvements to the ramp intersections would consist of long-term recommendations based on future traffic conditions.

2.4. Non-Motorized Facilities

The study corridor contains an extensive network of existing sidewalk segments along the north and south side of Route 42, in addition to sidewalk on adjacent side streets. However, many of the existing sidewalk segments are older construction that do not meet current design standards in terms of width, separation from the roadway and accessibility. The condition of these sidewalks, in addition to significant gaps in the existing network, lack of pedestrian crossing facilities at intersections, and density of commercial entrances results in a lower user comfort level. The gaps in the Route 42 sidewalk network exist on the north side of the corridor between Hisey Avenue and Henry Ford Drive, through the interchange, and between Ox Road and Main Street. The south side of the corridor has a continuous sidewalk along the study limits except for a small gap at the I-81 southbound on-ramp. The study corridor also lacks accommodations for bicyclists. The town recently adopted a Bicycle and Pedestrian Master Plan. This study will evaluate non-motorized needs to develop pedestrian and bicycle recommendations that are consistent with the recommendations of the town plan.

https://www.townofwoodstockva.com/517/Bicycle-Pedestrian-Trail-Master-Plan



2.5. Traffic Data Collection

Mid-week, 12-hour turning movement counts were collected at the eight study intersections in April 2018. The count data was used to determine AM and PM peak-hour traffic volumes, heavy vehicle percentages and pedestrian volumes along Route 42 to support traffic analysis of existing conditions and in the development of improvement recommendations. In addition to the turning movement counts, historical Annual Average Daily Traffic (AADT) volumes collected through the VDOT count program were reviewed for determining previous and forecasted traffic growth rates along Route 42. ***Figure 2*** identifies existing peak-hour and AADT traffic volumes along the study corridor. ***Table 1*** identifies historical AADT volumes along Route 42 and adjacent facilities.

Table 1: Historical Traffic Volumes

Roadway Segment	Annual Average Daily Traffic (AADT) Volumes			% change 2005-2017	% change 2014-2017
	2005	2014	2017		
Route 42 west of Hisey Avenue	7,700	7,100	6,800	-11.7 %	-4.2 %
Route 42 between Motel Drive and Ox Road	15,300	13,500	13,000	-15.0 %	-3.7 %
Route 42 east of Susan Avenue	15,700	15,000	14,000	-10.8 %	-6.7 %
US 11 north of Route 42	14,200	12,300	11,000	-22.5 %	-10.6 %
US 11 south of Route 42	10,400	8,600	8,700	-16.3 %	1.2 %

The significant decrease in traffic along the corridor between 2005 and 2014 can be attributed to both the 2007 - 2009 recession and improvements to the town's transportation network with the connection of Henry Ford Drive to Route 42 and improvements to Hisey Avenue, providing alternative options for east-west connectivity. The comparison of historical AADT volumes also indicate that overall traffic volumes along the corridor have been steady to slightly declining over the past 10-15 years. See ***Appendix A*** for full count data.

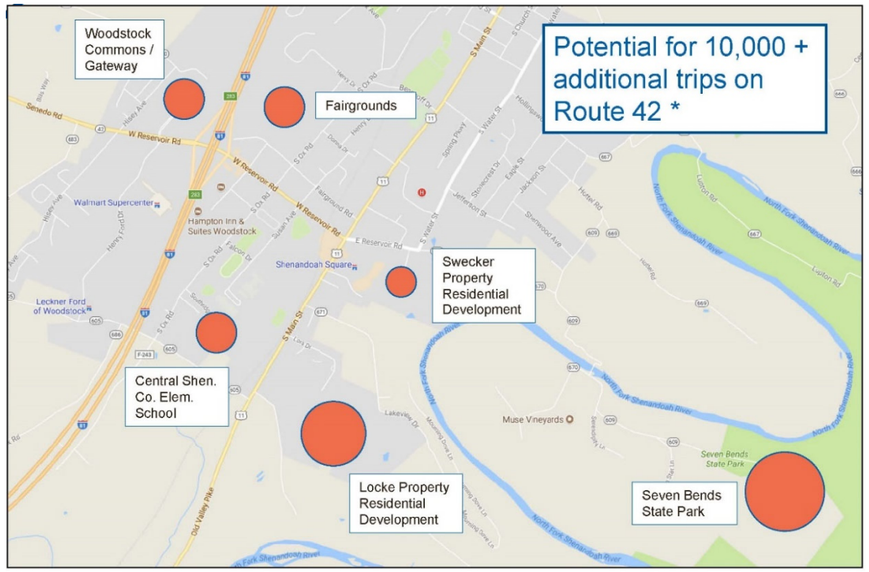
2.6. Existing Land Use and Future Developments

The existing study corridor is composed of mostly commercial land uses that serve local, regional, and interstate needs. Existing development is a mixture of individual pad sites to the east of the interstate (fast food and fueling stations) and larger shopping centers to the west (Lowes and Wal-Mart). Residential areas are located along the entire corridor immediately behind the commercial uses. The Shenandoah County / Woodstock public schools campus to the southeast of the study corridor via Susan Avenue is a primary traffic generator along Route 42. Additionally, the Shenandoah County Fairgrounds located immediately north of the corridor can generate significant event traffic along Route 42 with varying degrees of operational impacts. In discussions with town staff, the current owners of the fairgrounds have indicated an intent to increase the number of events hosted by the facility.

While the Route 42 corridor is generally built-out along the study limits, prior to the 2007 - 2009 recession, there were a number of land development projects under various stages of progress within the town that would have a traffic impact on the study corridor. While, some of the site below have advanced to construction since that time, the majority have not. The list of land development sites below provides a current status of the individual projects, with these being considered in determining traffic growth rates for future-year analysis scenarios.

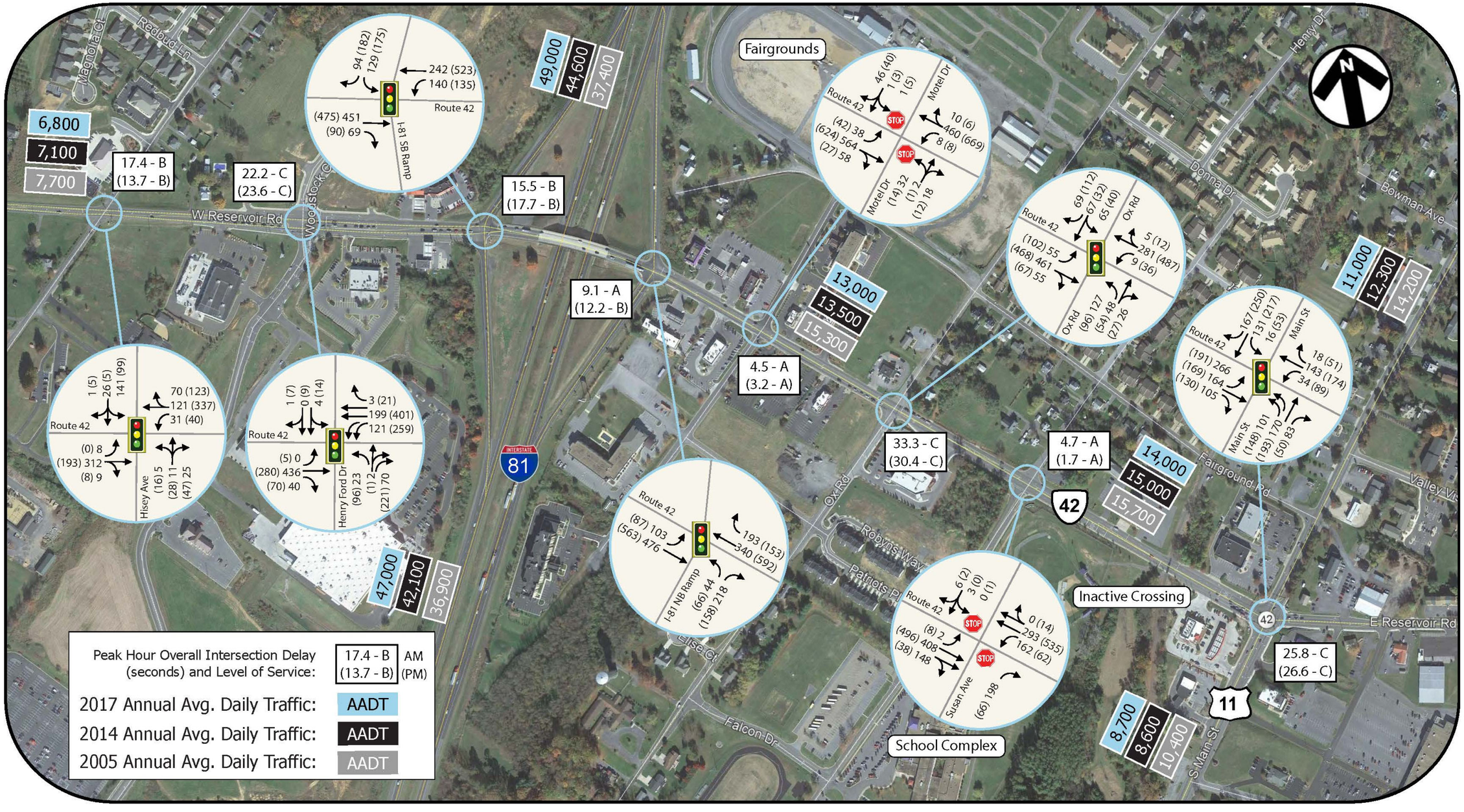
- 2005 Woodstock Commons / Gateway Development TIA: Residential and Commercial Mixed Use / 5,100 ADT (portions of the development has advanced to construction)
- 2005 Locke Property TIA: Residential and Commercial Mixed Use / 9,200 ADT (development has not advanced)
- 2005 Swecker Property TIA: Residential / 980 ADT (development has not advanced)
- 2009 Shenandoah County Central Campus Elementary School: 700 students / 900 ADT (development has not advanced)

Additionally, Seven Bends State Park officially opened in 2019. The park is located along the north fork of the Shenandoah River, just to the east of the Town of Woodstock. During the initial phases, the park is planned to be more informal in nature, focusing on passive recreation with minimal facilities for public use. Vehicular access to the park is currently limited by two single-lane, low water bridges. While the study corridor serves as the primary route to access the park from Interstate 81, significant visitation to Seven Bends State Park is most likely connected to future access improvements over the river. However, the state's newest park is certainly an important asset to consider in the future planning of the town's transportation system. At the same time, vehicular operations, throughput, and safety along Route 42 will be an important factor in the success and growth of the park. Additionally, visitors typically attracted to this type of destination would more than likely share the multimodal values of pedestrian and bicycle access along the corridor as stated in the goals of the study, with future potential connections into the park.



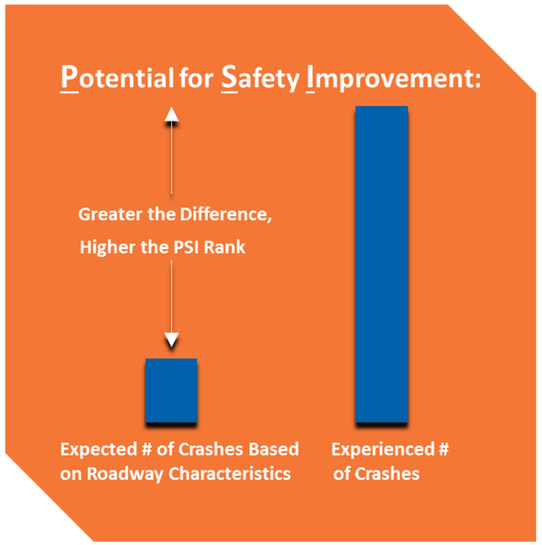
* Based on ITE Trip Generation Rates and assumptions from previously submitted TIA studies

Figure 2: Existing Traffic Data Exhibit



2.7. Safety Analysis

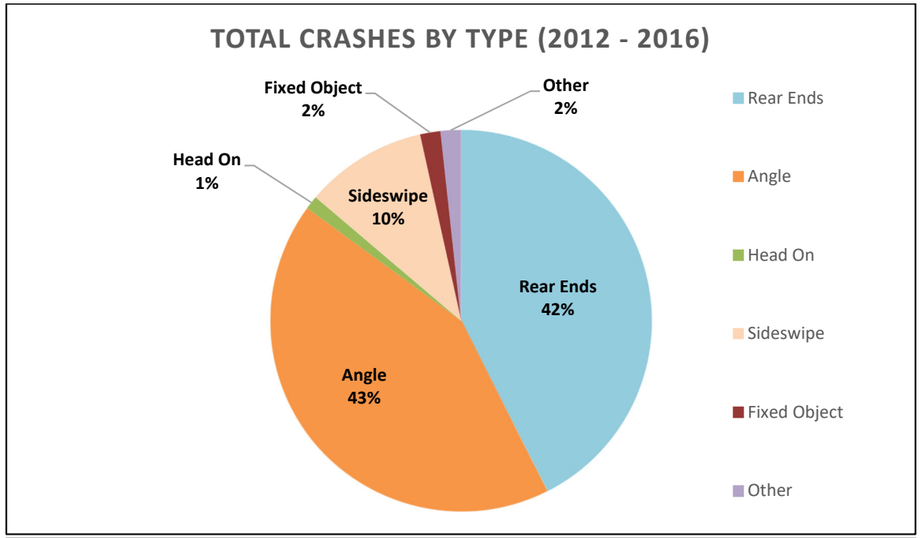
Crash data collected and compiled by VDOT TMPD for the annual STARS program, identifies several intersections and roadway segments along Route 42 as possessing PSI (Potential for Safety Improvement) rankings. PSI is a system utilized for prioritizing locations for safety improvements based on a comparison of experienced crashes over a 5-year period to expected crashes given specific roadway or intersection characteristics. ***Table 2*** below identifies the PSI rankings along the corridor as a result of 2012 – 2016 crash data available at the time of the planning-level safety analysis conducted with the study. The 2016 STARS data identified three study intersection having a PSI ranking within the Top 100 intersection in the VDOT Staunton Construction District, with the Route 42 / Ox Road intersection having the third highest district intersection PSI. Updated 2017 and 2018 PSI rankings are also shown for comparison. The PSI rankings illustrate that the highest safety needs along the study corridor focus on three primary intersections: the I-81, Exit 283 southbound off-ramp, Ox Road, and US 11 (Main Street). Looking at the PSI trend over the three-year period indicates that the Ox Road intersection is consistently the top safety need of the corridor. However, the safety needs of the US 11 intersection have increased each year to the same level as Ox Road. Additionally, the Susan Avenue intersection has entered the Top 100 PSI ranking in 2018.



The pie charts on this page provide a snapshot of crash details along the corridor for the 2012 – 2016 data. During these 5 years, there were 204 total crashes within the study area. The crash type along the corridor is predominately an equal split between angel and rear end crashes (85% of all crashes). The abundance of these crash types is indicative of the high density of full access points and lack of signal coordination. While the number of overall crashes is high, the number of injuries related to these crashes is relatively low with 83% resulting in property damage only (PDO). This can be attributed to the lower speeds of the corridor.

Table 2: Potential for Safety Improvement (PSI) Rankings

Roadway Segment or Intersection	2016 PSI	2017 PSI	2018 PSI
Segment of Route 42 west of I-81 Exit 283 SB Ramp	-	95	-
Intersection of Route 42 and I-81 Exit 283 SB Ramp	45	39	53
Intersection of Route 42 and Ox Road	3	2	6
Intersection of Route 42 and Susan Avenue	-	-	90
Intersection of Route 42 and Main Street (US 11)	27	8	7



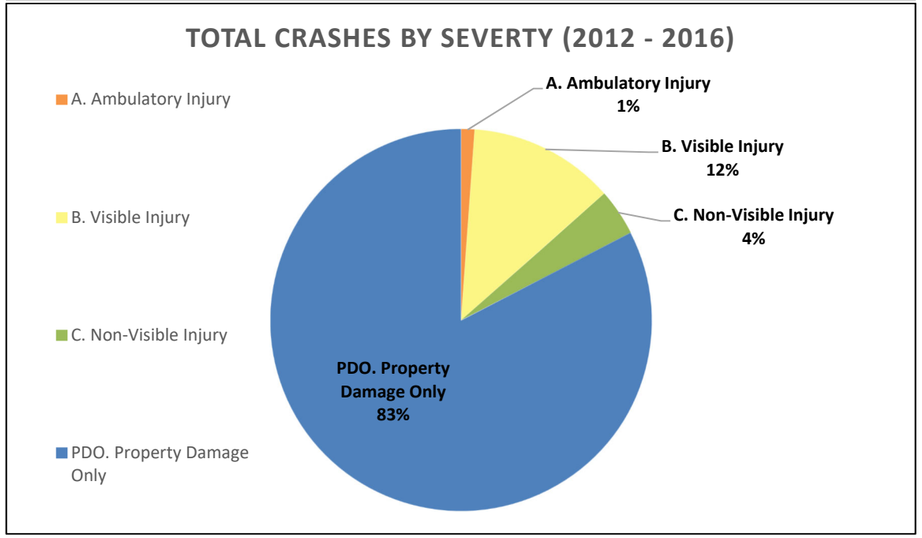


Figure 3 and ***Figure 4*** on the following pages identify total crashes along the study corridor by intersection and roadway segment over the 2012 – 2016 period and individual crash locations by crash type and severity as summarized in the pie charts above.

Figure 3: Crash Diagram (2012 – 2016)

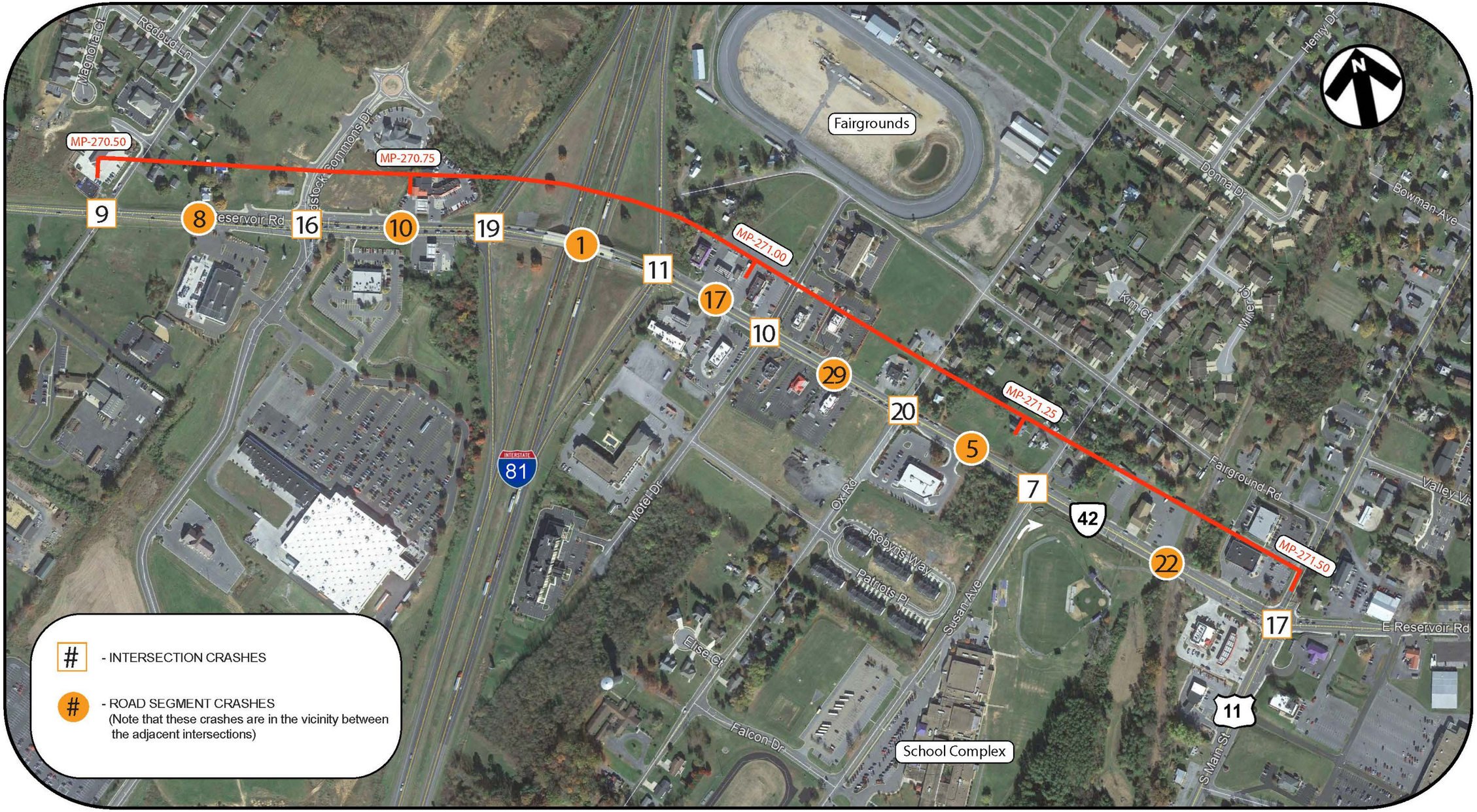
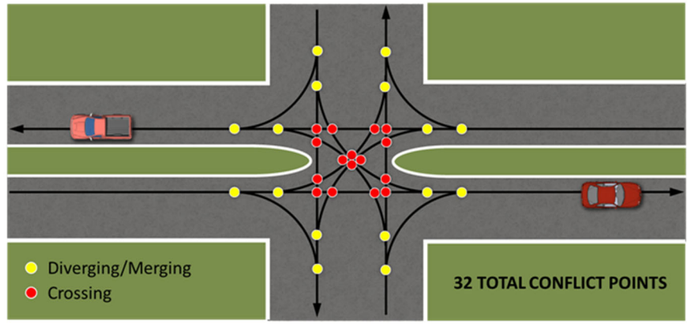


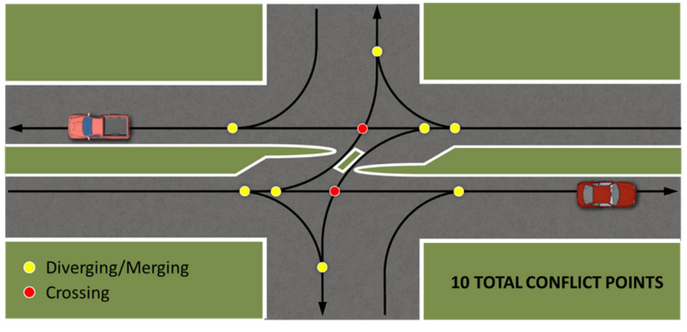
Figure 4: Crash Location and Type Exhibit (2012 – 2016)

2.8. Access Management

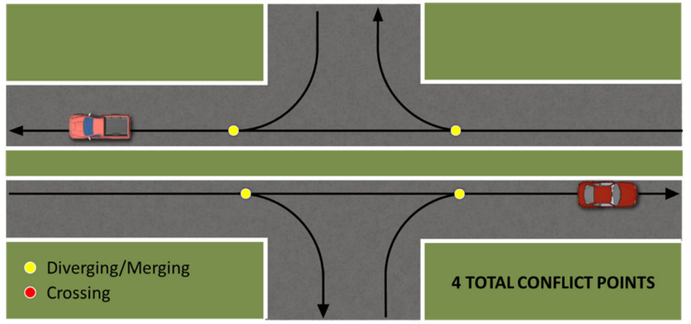
The high number of crashes along the corridor can be directly attributed to the number and density of full access points within the 1-mile study area. Access Management is a term that refers to the coordinated planning and design of access between roadways and land development to preserve the safety and efficiency of travel. With a designation of a Major Collector Functional Classification, the intent of Route 42 is to provide a balance between access to the adjacent roadway network and properties and corridor mobility or throughput. As additional points of access are established along a corridor, vehicular conflict point increase, resulting in a reduction of mobility and an increased risk of crashes. Ideal Access Management can result from good land planning practices, including shared entrances, partial entrances, interparcel connections, and a supporting parallel road network. However, for developed corridors such as Route 42, retrofitting these practices can be problematic from the standpoint of cost and property owner support. Therefore, more practical Access Management solutions can be achieved through roadway improvements within existing right-of-way. The introduction of a raised median along an undivided corridor results in a significant reduction of conflict points, as entrances are converted to right-in / right-out only. While property access is reduced, properly placed full and partial access points (directional median openings for example) can maintain adequate access through the utilization of U-turns and side streets, while enhancing corridor safety and throughput.



Each full access entrance and crossover contain 32 conflict points, of which 16 are higher risk crossing conflicts



Introduction of a median with directional left turns reduces conflict points by 68%



A full median, converting entrances to Right-In / Right-Out only reduces conflict points by 88%

Based on VDOT standards and national best practices, a 1-mile segment of a Major Collector facility similar to Route 42 would typically contain a maximum of 14 total intersections / entrances, consisting of a combination of four to eight signalized intersections and six to ten full access entrances. The study limits along Route 42 currently contains 32 total intersection / entrance locations. A standard 4-leg full access intersection or entrance contains 32 conflict points (16 crossing, 8 diverging, and 8 merging). A 3-leg full access intersection or entrance contains 9 conflict points (3 crossing, 3 diverging, and 3 merging). ***Table 3*** below identifies a comparison of the number of existing conflict points along the study corridor to the number of conflict points included in the 2018 SMART SCALE Corridor Concept. The reduction of conflict points by more than 59 % along the corridor has the potential to substantially lower crash occurrences and enhance safety for all users of Route 42.

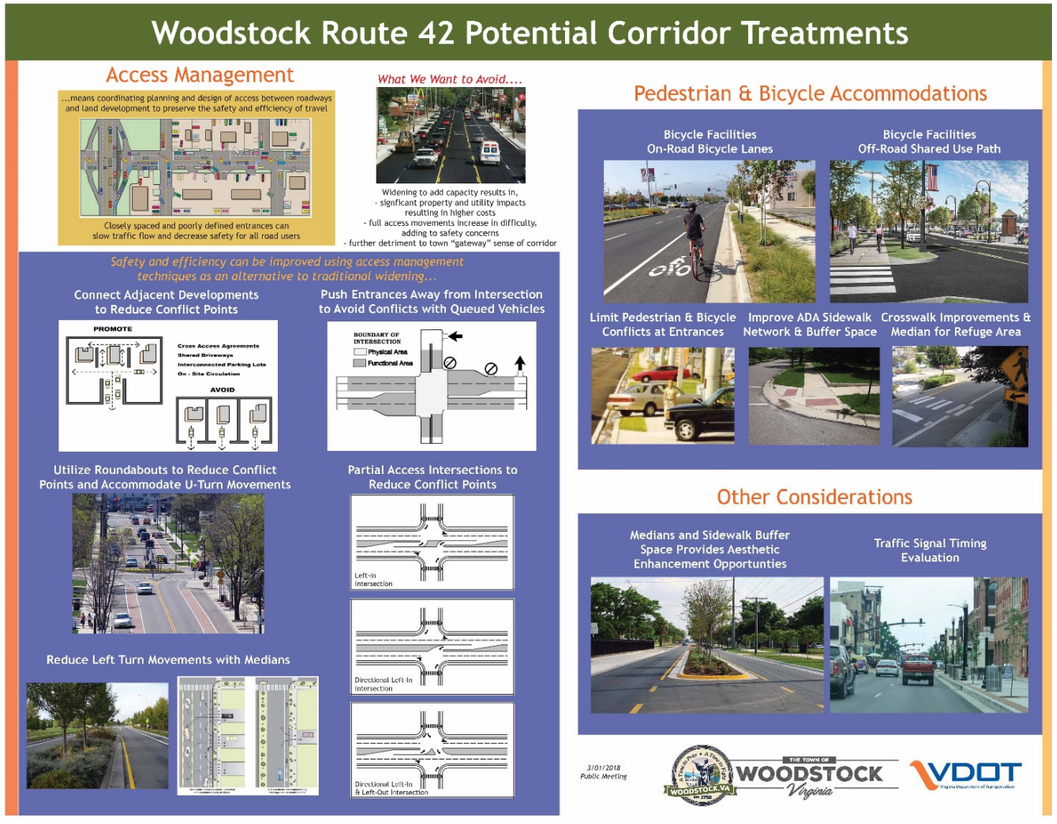
Table 3: Summary of Vehicular Conflict Points

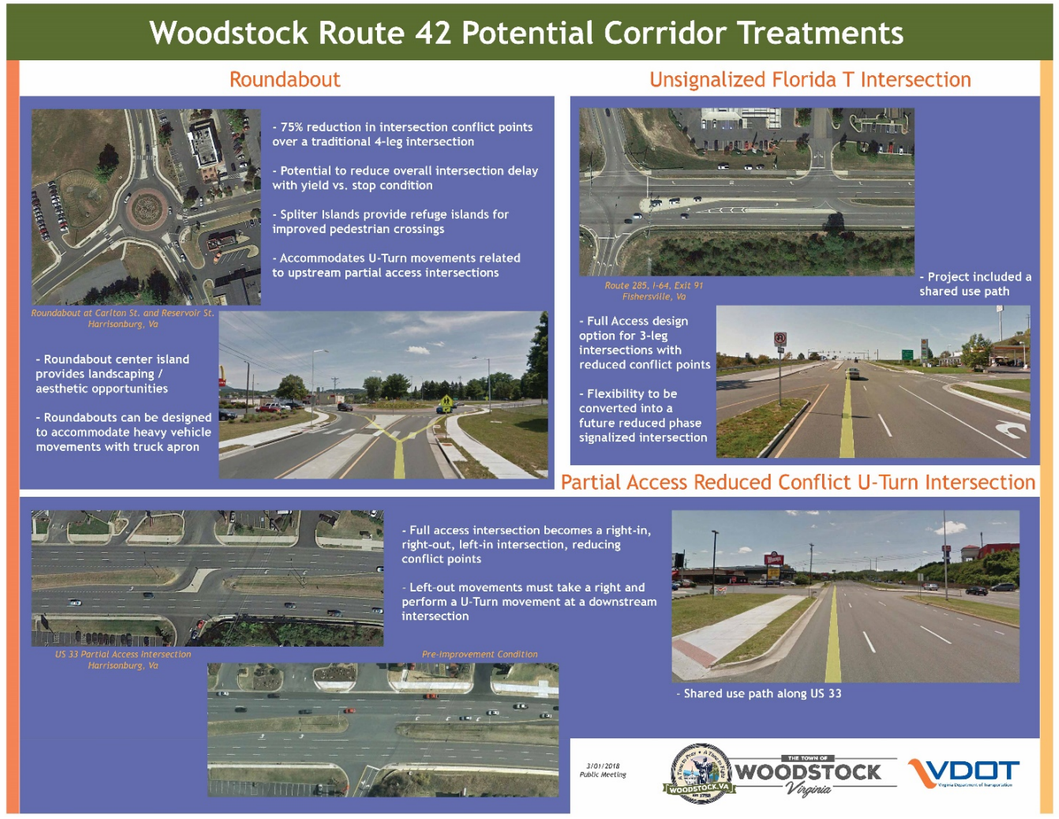
Intersection Type	Existing and No Build		2018 SMART SCALE Concept		% Reduction in Conflict Points
	Number of Locations	Conflict Points	Number of Locations	Conflict Points	
Study Intersection (4-leg)	5	160	3	74	-54 %
Study Intersection (roundabout)	-	-	2	16	-
Study Intersection (Susan Avenue)	1	22	1	11	-50 %
Study Intersection (3-leg)	2	18	2	18	-
Full Access Commercial Entrance	23	207	0	-	-100 %
Partial Access Entrance	2	6	25	49	-
Total	**33**	**413**	**33**	**168**	**-59 %**

3. Public Involvement

3.1. Public Information Meeting Summary

In order to present the findings of the existing corridor conditions analysis and seek public input to validate the study process and identified needs, VDOT and town staff hosted a Public Information Meeting at the town offices on March 1, 2018. The meeting consisted of a formal presentation that provided the purpose and need of the study, existing safety and operational analysis results, a review of access management and planning best practices, and a discussion of example improvement alternatives that could be considered along the corridor. Following the presentation, those in attendance moved around the room to review and discuss the presented information in smaller groups, while providing feedback through a visual preference survey of indicating the treatments that they would support along the corridor, as presented on the two display boards included on this page.





The meeting was well attended by the public and business owners along the corridor. While there were concerns voiced by business owners regarding access management improvements that may affect direct access (raised center medians), the presented improvement treatments were generally well received and supported. There was a consensus among the attendees that the existing safety and operational issues identified by the available data were actual needs of the corridor experienced by daily user and that improvements to address these needs were necessary. Feedback received from the meeting and visual preference survey indicated strong support for improving bicycle and pedestrian facilities along Route 42, while also enhancing the corridor aesthetically through gateway treatments.

Following the development of the corridor wide plan and supporting SMART SCALE applications, the town also held a public hearing during a normally scheduled Town Council meeting in the summer of 2018 to consider and adopt a resolution of support for advancing the application for funding consideration. See ***Appendix B*** for a summary of received public comments.

4. Traffic Analysis Scenarios

4.1. Existing Traffic Conditions

Utilizing the existing morning and afternoon peak-hour traffic volumes collected along the study corridor, traffic models were developed and analyzed in Synchro 10.0 for existing year 2018 conditions. Current traffic signal phasing and timings were also programmed in the traffic models, with only the ramp intersections being modeled as running in coordination, to match existing conditions. Measures of Effectiveness (MOE) are model outputs that can be utilized to determine operational characteristics of the corridor, serving as a baseline for the comparison of future improvement alternatives in determining existing operational needs and how improvement alternatives mitigate those needs. Average delay per vehicle is the primary MOE utilized in the analysis of the traffic model scenarios. Delay per vehicle can be used to assess individual intersection movements, approaches and overall intersection performance. In order to effectively communicate the significance of delay, the MOE is typically expressed as a qualitative scale know of Level of Service (LOS). ***Table 4*** and the graphic on this page shows the range of average vehicle delay in seconds and operational characteristics associated with the assigned LOS of each range of delay.

Table 4: Level of Service

Level of Service (LOS)	Signalized Intersection	Unsignalized Intersection
A	≤ 10 seconds	≤ 10 seconds
B	> 10 – 20 seconds	> 10 – 15 seconds
C	> 20 – 35 seconds	> 15 – 25 seconds
D	> 35 – 55 seconds	> 25 – 35 seconds
E	> 55 – 80 seconds	> 35 – 50 seconds
F	> 80 seconds	> 50 seconds

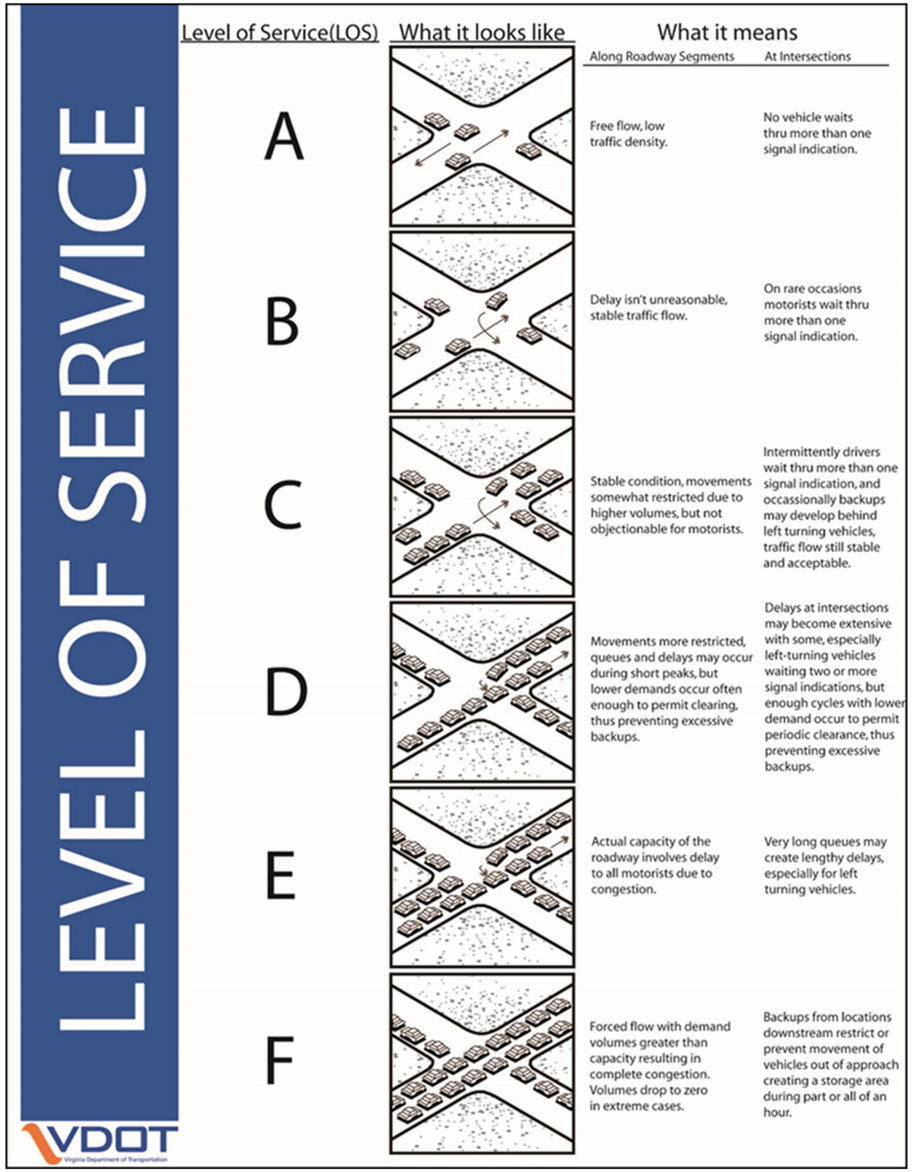
In addition to delay per vehicle, other MOEs that were utilized in the corridor analysis consist of the following:

- **Volume over Capacity (V/C) –** A ratio comparison of total roadway capacity to existing volume. Congestion issues typically begin at a V/C above 0.8, with roadways reaching over-capacity conditions with significant operational issues at and above 1.0.

- **Travel Time –** Average travel time represents the average time in seconds in which vehicles travel the modeled corridor over the analysis period (1-hour).

- **Speed –** Average speed represents the average miles per hour in which vehicles travel the modeled corridor over the analysis period (1-hour).

- **95th Percentile Queue Length** – The vehicle queue length in feet that has only a 5% probability of being exceeded in the analysis period (1-hour). This distance is utilized to confirm adequate storage lengths for turn lanes and potential impacts to upstream intersections due to spill back.



The existing conditions analysis identified overall acceptable operational conditions during morning and afternoon peak periods. Overall intersection LOS and V/C for the eight-study intersections for the peak periods are presented in ***Table 5A*** and ***5B*** below and on ***Figure 2***. The study intersections that indicate developing levels of congested conditions include Henry Ford Drive in the AM period, the southbound I-81 ramp in the PM period and Ox Road and Main Street during both periods, with the Ox Road intersection beginning to approach capacity conditions.

Table 5A: Existing 2018 Peak-Hour Overall Intersection Analysis Results (Delay in seconds / vehicle, level of service, and volume / capacity)

Study Intersection	AM Peak-Hour	PM Peak-Hour
Route 42 / Hisey Avenue	17.1 (B), 0.74 V/C	13.7 (B), 0.65 V/C
Route 42 / Henry Ford Drive	22.2 (C), 0.84 V/C	23.6 (C), 0.74 V/C
Route 42 / I-81 Southbound Ramps	15.5 (B), 0.73 V/C	17.7 (B), 0.87 V/C
Route 42 / I-81 Northbound Ramps	9.1 (A), 0.55 V/C	12.2 (B), 0.65 V/C
Route 42 / Motel Drive	4.5 (A), 0.56 V/C	3.2 (A), 0.40 V/C
Route 42 / Ox Road	33.3 (C), 0.91 V/C	30.4 (C), 0.89 V/C
Route 42 / Susan Avenue	4.7 (A), 0.47 V/C	1.7 (A), 0.15 V/C
Route 42 / Main Street	25.8 (C), 0.86 V/C	26.6 (C), 0.82 V/C

Table 5B: Existing 2018 Peak-Hour Travel Time Analysis Results

Measure of Effectiveness	Eastbound		Westbound	
	AM	PM	AM	PM
Average Travel Time (sec.)	275.1	283.7	193.8	209.7
Average Speed (mph)	14.0	13.6	18.2	16.8

Field and user observations of the study corridor indicate stop and go mainline conditions during peak periods and excessive westbound approach queues at the Ox Road intersection that may extend back to Main Street during the afternoon peak period. While the traffic modeling did not replicate this observed queueing condition, the analysis results of the Ox Road intersection would indicate that this location is the most likely to experience significant operational issues on a daily basis. The low average speeds reported along the corridor confirm the observed poor progression due to lack of existing signal coordination.

Event traffic related to the Shenandoah Fairgrounds can also have a significant impact on Route 42 operations, even resulting in spillbacks on the ramps, creating problematic conditions on mainline I-81. However, roadway improvements are typically analyzed in the mitigation of normal daily traffic conditions. This approach ensures that roadways are not overdesigned to accommodate extreme conditions with limited transportation funding. As a result, event traffic conditions are not included in the analysis. Typically, known traffic events can be successfully mitigated with a transportation plan developed in coordination with the appropriate parties, consisting of lower cost measures including event signal timings, routing plans and signage, and directing of traffic by law enforcement.

4.2. Future Year Traffic Growth Rate

Following discussions with town staff and the consideration of historical corridor counts with known and speculative future development within the town, it was agreed that the future-year traffic analysis would assume a conservative 1.0% linear annual growth rate to the 2040 design-year of the study. While traffic counts on the corridor have slightly declined over the past decade, the minimal growth rate would allow sensitivity testing of identified improvements to verify acceptable operating conditions in the design-year, should local development occur. The utilized growth rate results in an overall corridor traffic increase of 22% in the 2040 design-year. Additionally, the study assumes the build-out of the Woodstock Commons development, with trip generation and distribution of traffic following the assumptions utilized in the supporting 2005 TIA (Traffic Impact Analysis).

4.3. No Build Scenario Analysis (2040)

Building upon the existing conditions analysis, the future growth rate was applied globally to the 2018 turning movement counts to forecast 2040 design-year turning movement volumes and AADT as identified on ***Figure 5***. Since identified as a priority corridor for Staunton District Traffic Engineering, all future-year analysis scenarios, including the No-Build, assume that the corridor traffic signals are coordinated. In order to establish a baseline for corridor operations in evaluating improvement alternatives, a future scenario was analyzed without improvements to the corridor (other than signal coordination and optimization). The analysis results are presented in the tables below. Overall, the delay and V/C ratios increase at all study intersections during both peak periods because of the future traffic growth. This results in the Henry Ford Drive and Motel Drive intersections reaching over-capacity conditions in both peak periods and the Main Street intersection during the morning peak-hour. A V/C ratio over 1.0 indicates operational breakdowns resulting in excessive delay and/or unserved vehicles at an intersection due to long queues. Interestingly, while the operations of individual intersections degrade in the future No-Build scenario, the corridor travel times and speeds improve in both directions in both peak periods as a result of signal coordination. ***Tables 6A*** and ***6B*** and ***Figure 5*** illustrates overall intersection delay associated with the 2040 No-Build analysis.

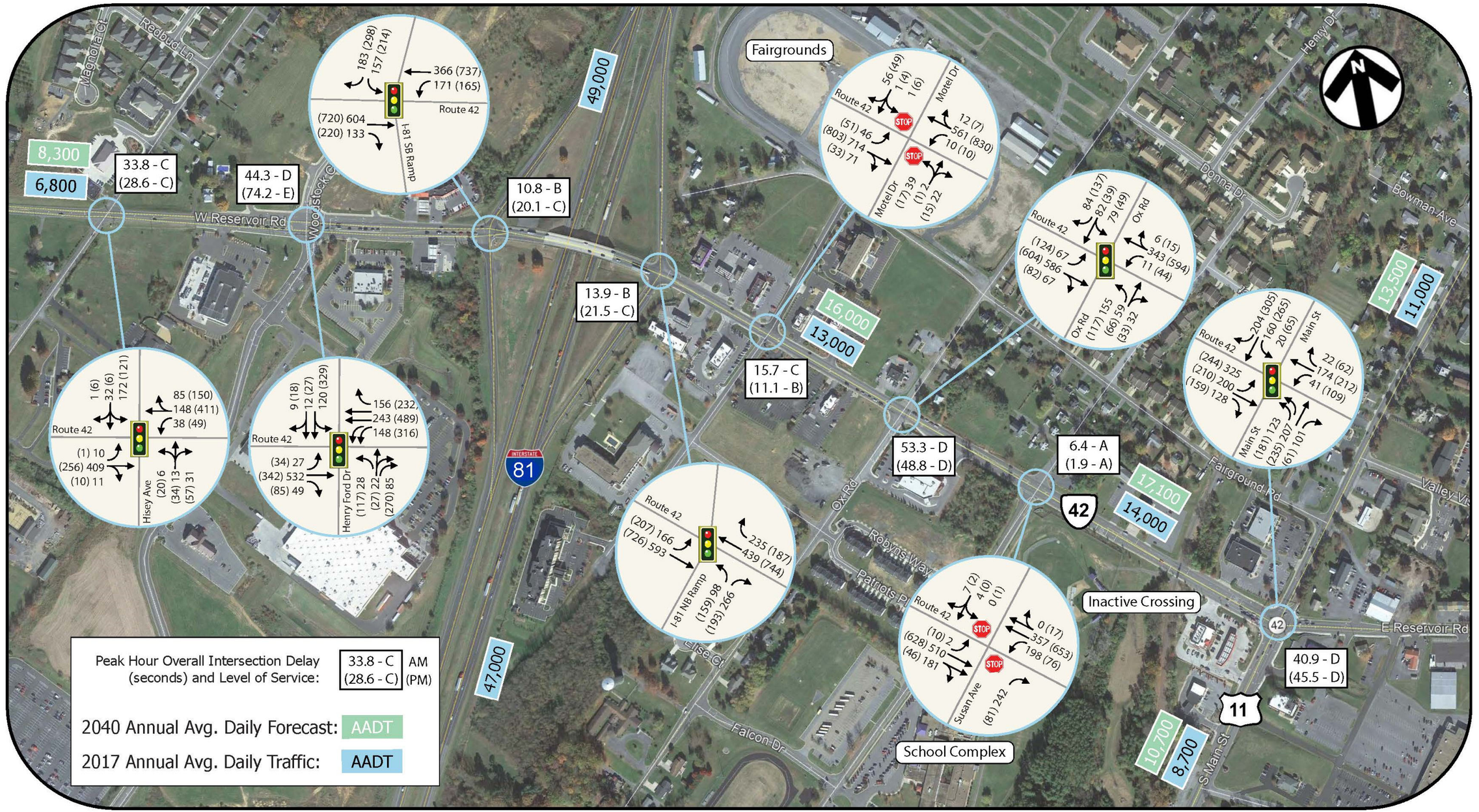
Table 6A: No-Build 2040 Peak-Hour Overall Intersection Analysis Results (Delay in seconds / vehicle, level of service, and volume / capacity)

Study Intersection	AM Peak-Hour	PM Peak-Hour
Route 42 / Hisey Avenue	33.8 (C), 0.88 V/C	28.6 (C), 0.84 V/C
Route 42 / Henry Ford Drive	44.3 (D), 1.08 V/C	74.4 (E), 1.33 V/C
Route 42 / I-81 Southbound Ramps	10.8 (B), 0.75 V/C	20.1 (C), 0.87 V/C
Route 42 / I-81 Northbound Ramps	13.9 (B), 0.69 V/C	21.5 (C), 0.91 V/C
Route 42 / Motel Drive	15.7 (C), 1.27 V/C	11.1 (B), 1.11 V/C
Route 42 / Ox Road	53.3 (D), 0.95 V/C	48.8 (D), 0.81 V/C
Route 42 / Susan Avenue	6.4 (A), 0.64 V/C	1.9 (A), 0.21 V/C
Route 42 / Main Street	40.9 (D), 1.00 V/C	45.5 (D), 0.95 V/C

Table 6B: No-Build 2040 Peak-Hour Travel Time Analysis Results

Measure of Effectiveness	Eastbound		Westbound	
	AM	PM	AM	PM
Average Travel Time (sec.)	244.4	249.3	168.4	194.4
Average Speed (mph)	15.8	15.8	20.9	18.1

Figure 5: Future Traffic Data Exhibit – 2040 No Build Scenario



4.4. SMART SCALE Corridor Concept Scenario Development and Analysis (2040)

Following the 2040 No-Build Scenario traffic analysis, a corridor improvement plan was developed to address the identified needs of the facility, utilizing input from the town and public feedback. Given the SMART SCALE Round 3 application schedule, the development of the corridor improvements was an expedited process, focusing on the reduction of vehicular conflict points along the corridor and enhancing pedestrian and bicycle accommodations. A hybrid roundabout (2-lanes serving Route 42 with a single lane serving the side streets) was proposed at the Ox Road intersection to address the high crash location. Center raised medians are recommended along the majority of the corridor, utilizing directional median openings and the roundabout at Ox Road (via U-turns) to accommodate left turn movements and provide reasonable levels of access to adjacent properties. Re-introducing the northbound left turn at Susan Avenue will provide more balanced vehicle loading along Route 42, while increasing routing options. Extensions of the existing non-motorized network and pedestrian crossing improvements are consistent with the town Pedestrian and Bicycle Master Plan. Similar to the No-Build scenario, the improved scenario assumes signal coordination and optimization of signal timings along the corridor. Recommended signal operation improvements in the improved scenario also consider the implementation of protected / permissive left turn phasing with Flashing Yellow Arrows where appropriate. ***Figures 6a – 6d*** provide a conceptual rendering of the SMART SCALE Corridor Concept developed for the 2018 SMART SCALE application period.

Utilizing the forecasted 2040 design-year peak-hour traffic volumes, adjustments to vehicle distribution to reflect the limitation of left turn movements were made in the traffic models. To be consistent with VDOT traffic analysis guidance, Sidra Intersection 8.0 software was utilized to evaluate the roundabout concepts for all future improvement scenarios. Results of the 2040 design-year SMART SCALE Corridor Concept traffic analysis compared to the Existing and No-Build scenario results are illustrated in ***Tables 7A – 7B*** below. All study intersections improve in overall intersection delay over the No-Build scenario, with acceptable operational conditions along the entire corridor during the peak periods. Speeds and travel times along the corridor improve dramatically over both the existing conditions and future No-Build scenarios. As a result, the developed corridor improvement plan significantly enhances roadway safety with the reduction of conflict points, while also improving traffic operations at all study intersection. 2040 traffic volumes associated with the SMART SCALE Corridor Concept and overall intersection delay is identified on ***Figure 7.***

Table 7A: AM Peak-Hour Overall Intersection Analysis Results
(Delay in seconds / vehicle, level of service, and volume / capacity)

Study Intersection	Traffic Analysis Scenario		
	2018 Existing	2040 No Build	2040 Improved
Route 42 / Hisey Avenue	17.1 (B), 0.74 V/C	33.8 (C), 0.88 V/C	8.0 (A), 0.53 V/C
Route 42 / Henry Ford Drive	22.2 (C), 0.84 V/C	44.3 (D), 1.08 V/C	30.6 (C), 0.73 V/C
Route 42 / I-81 Southbound Ramps	15.5 (B), 0.73 V/C	10.8 (B), 0.75 V/C	12.8 (B), 0.75 V/C
Route 42 / I-81 Northbound Ramps	9.1 (A), 0.55 V/C	13.9 (B), 0.69 V/C	11.5 (B), 0.68 V/C
Route 42 / Motel Drive	4.5 (A), 0.56 V/C	15.7 (C), 1.27 V/C	1.6 (A), 0.21 V/C
Route 42 / Ox Road	33.3 (C), 0.91 V/C	53.3 (D), 0.95 V/C	9.6 (A), 0.53 V/C
Route 42 / Susan Avenue	4.7 (A), 0.47 V/C	6.4 (A), 0.64 V/C	7.4 (A), 0.64 V/C
Route 42 / Main Street	25.8 (C), 0.86 V/C	40.9 (D), 1.00 V/C	28.6 (C), 0.78 V/C

Table 7B: PM Peak-Hour Overall Intersection Analysis Results
(Delay in seconds / vehicle, level of service, and volume / capacity)

Study Intersection	Traffic Analysis Scenario		
	2018 Existing	2040 No Build	2040 Improved
Route 42 / Hisey Avenue	13.7 (B), 0.65 V/C	28.6 (C), 0.84 V/C	9.1 (A), 0.61 V/C
Route 42 / Henry Ford Drive	23.6 (C), 0.74 V/C	74.4 (E), 1.33 V/C	41.0 (D), 0.84 V/C
Route 42 / I-81 Southbound Ramps	17.7 (B), 0.87 V/C	20.1 (C), 0.87 V/C	22.4 (C), 0.86 V/C
Route 42 / I-81 Northbound Ramps	12.2 (B), 0.65 V/C	21.5 (C), 0.91 V/C	21.9 (C), 0.83 V/C
Route 42 / Motel Drive	3.2 (A), 0.40 V/C	11.1 (B), 1.11 V/C	1.4 (A), 0.25 V/C
Route 42 / Ox Road	30.4 (C), 0.89 V/C	48.8 (D), 0.81 V/C	16.8 (B), 0.86 V/C
Route 42 / Susan Avenue	1.7 (A), 0.15 V/C	1.9 (A), 0.21 V/C	2.4 (A), 0.24 V/C
Route 42 / Main Street	26.6 (C), 0.82 V/C	45.5 (D), 0.95 V/C	31.6 (C), 0.81 V/C

Table 7C: AM Peak-Hour Travel Time Analysis Results

Measure of Effectiveness	Eastbound			Westbound		
	2018 Existing	2040 No Build	2040 Improved	2018 Existing	2040 No Build	2040 Improved
Average Travel Time (sec.)	275.1	244.4	177.5	193.8	168.4	142.4
Average Speed (mph)	14.0	15.8	22.0	18.2	20.9	25.0

Table 7D: PM Peak-Hour Travel Time Analysis Results

MOE	Eastbound			Westbound		
	2018 Existing	2040 No Build	2040 Improved	2018 Existing	2040 No Build	2040 Improved
Average Travel Time (sec.)	283.7	249.3	204.3	209.7	194.4	189.4
Average Speed (mph)	13.6	15.8	19.0	16.8	18.1	19.1

SMART SCALE Corridor Concept Benefit Snapshot

- Significant Corridor Reduction of Conflict Points: **59%**
  Roundabout Planning-Level Crash Modification Factor (CMF) = **0.40**
  Non-Freeway Access Management Planning-Level Crash Modification Factor (CMF) = **0.75**
- 2040 AM Peak-Hour Corridor Travel Time Improvement over existing conditions (1 mile segment):
  Eastbound = **97** seconds
  Westbound = **51** seconds
- 2040 PM Peak-Hour Corridor Travel Time Improvement over existing conditions (1 mile segment):
  Eastbound = **79** seconds
  Westbound = **20** seconds
- Pedestrian crossing and signal improvements
- Shared use paths fill in existing gaps in sidewalk network
- Proposed median provides landscaping / aesthetic opportunities for “town gateway”

Table 7E: AM Peak-Hour Improved Scenario Analysis Results by Movement (Delay in seconds / vehicle and 95th Percentile Queue)

Intersection	NB Left	NB Thru	NB Right	SB Left	SB Thru	SB Right	EB Left	EB Thru	EB Right	WB Left	WB Thru	WB Right
Hisey Ave	6.8 (A)	6.8 (A)	6.8 (A)	5.9 (A)	5.9 (A)	5.9 (A)	10.8 (B)	10.9 (B)	10.5 (B)	5.2 (A)	5.2 (A)	5.2 (A)
95th % Queue	13′	13′	13′	34′	34′	34′	104′	104′	104′	42′	42′	42′
Storage	300′	300′	300′	250′	250′	250′	500′	500′	500′	650′	650′	650′
Henry Ford Dr	46.7 (D)	62.2 (E)	2.5 (A)	57.4 (E)	53.3 (D)	53.3 (D)	8.4 (A)	19.9 (B)	0.1 (A)	59.3 (E)	12.1 (B)	7.9 (A)
95th % Queue	36′	30′	0′	81′	35′	35′	23′	536′	0′	97′	207′	51′
Storage	270′	270′	270′	340′	340′	340′	200′	650′	250′	380′	600′	250′
I-81 SB Ramp	-	-	-	66.7 (E)	-	1.9 (A)	-	9.6 (A)	0.8 (A)	12.7 (B)	6.8 (A)	-
95th % Queue	-	-	-	196′	-	0′	-	46′	0′	70′	131′	-
Storage	-	-	-	800′	-	300′	-	600′	600′	290′	600′	-
I-81 NB Ramp	62.4 (E)	-	14.6 (B)	-	-	-	2.0 (A)	1.6 (A)	-	-	15.8 (A)	2.4 (A)
95th % Queue	116′	-	104′	-	-	-	6′	32′	-	-	323′	41′
Storage	300′	-	800′	-	-	-	270′	600′	-	-	450′	260′
Motel Dr	-	-	16.1 (C)	-	-	15.2 (C)	9.4 (A)	0.8 (A)	0.8 (A)	10.2 (B)	0.3 (A)	0.3 (A)
95th % Queue	-	-	25′	-	-	25′	25′	0′	0′	25′	0′	0′
Storage	-	-	180′	-	-	180′	150′	450′	450′	150′	540′	540′
Ox Road	13.2 (B)	12.8 (B)	13.7 (B)	12.2 (B)	12.2 (B	12.2 (B	7.0 (A)	6.9 (A)	6.6 (A)	10.9 (B)	10.9 (B)	11.4 (B)
95th % Queue	57′	57′	57′	81′	81′	81′	72′	74′	74′	108′	108′	108′
Storage	220′	220′	220′	220′	220′	220′	540′	540′	540′	560′	560′	560′
Susan Ave	42.1 (E)	-	21.7 (C)	-	-	10.9 (B)	-	0.0 (A)	0.0 (A)	12.3 (B)	5.0 (A)	5.0 (A)
95th % Queue	60′	-	147′	-	-	25′	-	0′	0′	55′	0′	0′
Storage	150′	-	350′	-	-	150′	-	560′	560′	320′	600′	600′
Main St	41.9 (D)	47.1 (D)	37.3 (D)	41.2 (D)	44.3 (D)	27.4 (C)	19.5 (B)	19.8 (B)	4.6 (A)	20.1 (C)	28.0 (C)	5.5 (A)
95th % Queue	117′	224′	5′	24′	171′	29′	201′	159′	13′	29′	177′	0′
Storage	250′	280′	180′	350′	360′	360′	360′	360′	300′	280′	380′	280′

Table 7F: PM Peak-Hour Improved Scenario Analysis Results by Movement (Delay in seconds / vehicle and 95th Percentile Queue)

Intersection	NB Left	NB Thru	NB Right	SB Left	SB Thru	SB Right	EB Left	EB Thru	EB Right	WB Left	WB Thru	WB Right
Hisey Ave	6.1 (A)	6.1 (A)	6.1 (A)	7.4 (A)	7.4 (A)	7.4 (A)	6.9 (A)	7.0 (A)	6.7 (A)	10.8 (B)	11.2 (B)	10.8 (B)
95th % Queue	22′	22′	22′	32′	32′	32′	52′	52′	52′	162′	162′	162′
Storage	300′	300′	300′	250′	250′	250′	500′	500′	500′	650′	650′	650′
Henry Ford Dr	42.3 (D)	63.4 (E)	13.8 (B)	59.8 (E)	48.2 (D)	48.2 (D)	17.1 (B)	25.0 (C)	0.5 (A)	62.0 (E)	27.3 (C)	10.0 (A)
95th % Queue	108′	34′	81′	188′	55′	55′	27′	382′	0′	186′	516′	25′
Storage	270′	270′	270′	340′	340′	340′	200′	650′	250′	380′	600′	250′
I-81 SB Ramp	-	-	-	70.4 (E)	-	32.0 (C)	-	20.9 (C)	1.5 (A)	22.8 (C)	10.4 (B)	-
95th % Queue	-	-	-	247′	-	230′	-	510′	25′	66′	235′	-
Storage	-	-	-	800′	-	300′	-	600′	600′	290′	600′	-
I-81 NB Ramp	76.6 (E)	-	4.7 (A)	-	-	-	34.8 (C)	1.6 (A)	-	-	32.1 (C)	4.3 (A)
95th % Queue	203′	-	21′	-	-	-	131′	6′	-	-	740′	53′
Storage	300′	-	800′	-	-	-	270′	600′	-	-	450′	260′
Motel Dr	-	-	16.3 (C)	-	-	20.4 (C)	10.0 (B)	0.7 (A)	0.7 (A)	10.0 (B)	0.1 (A)	0.1 (A)
95th % Queue	-	-	25′	-	-	25′	25′	0′	0′	25′	0′	0′
Storage	-	-	180′	-	-	180′	150′	450′	450′	150′	540′	540′
Ox Road	11.8 (B)	11.3 (B)	12.3 (B)	26.5 (C)	26.5 (C)	26.5 (C)	7.1 (A)	7.0 (A)	6.7 (A)	27.1 (C)	27.1 (C)	27.6 (C)
95th % Queue	43′	43′	43′	158′	158′	158′	79′	80′	80′	410′	410′	410′
Storage	220′	220′	220′	220′	220′	220′	540′	540′	540′	560′	560′	560′
Susan Ave	25.9 (D)	-	12.2 (B)	-	-	13.4 (B)	-	0.0 (A)	0.0 (A)	9.9 (A)	1.4 (A)	1.4 (A)
95th % Queue	25′	-	25′	-	-	25′	-	0′	0′	25′	0′	0′
Storage	150′	-	350′	-	-	150′	-	560′	560′	320′	600′	600′
Main St	42.9 (D)	34.7 (C)	25.8 (C)	27.8 (C)	47.6 (D)	30.5 (C)	23.7 (C)	26.4 (C)	18.2 (B)	20.5 (C)	34.4 (C)	26.1 (C)
95th % Queue	155′	240′	0′	64′	285′	83′	196′	197′	18′	87′	237′	0′
Storage	250′	280′	180′	350′	360′	360′	360′	360′	300′	280′	380′	280′

Tables 7E and ***7F*** above provides a more detailed evaluation of the analysis results by individual intersection movements for the SMART SCALE Corridor Concept during the morning peak period. With all intersections operating at a LOS C or better, the individual movement analysis also reflects generally acceptable conditions of LOS D or better. The only individual movements with a LOS E in the morning period are the northbound thru, southbound left, and westbound left movements at Henry Ford Drive, the southbound and northbound lefts at the interstate off-ramps, and the proposed northbound left (sign controlled) at Susan Avenue. All 95th percentile queue lengths are accommodated by available storage lengths in the AM period.

During the PM period, all study intersections operate at an acceptable LOS D or better. Overall, individual movements are also generally acceptable, with only the northbound thru, southbound left and westbound left movements at Henry Ford Drive and left turns from the interstate off-ramps having an LOS E. All 95th percentile queue lengths are accommodated by available storage lengths in the PM period. The most significant queue experienced along the corridor during both peak periods is the westbound afternoon queue at the proposed Ox Road roundabout at 410′. The length of this queue is a result of the single westbound lane through the roundabout. However, this queue does not impact the upstream intersection at Susan Avenue (560′ separation) and is an improvement over existing conditions.

Figure 6a: 2018 SMART SCALE Corridor Concept (1 of 4)

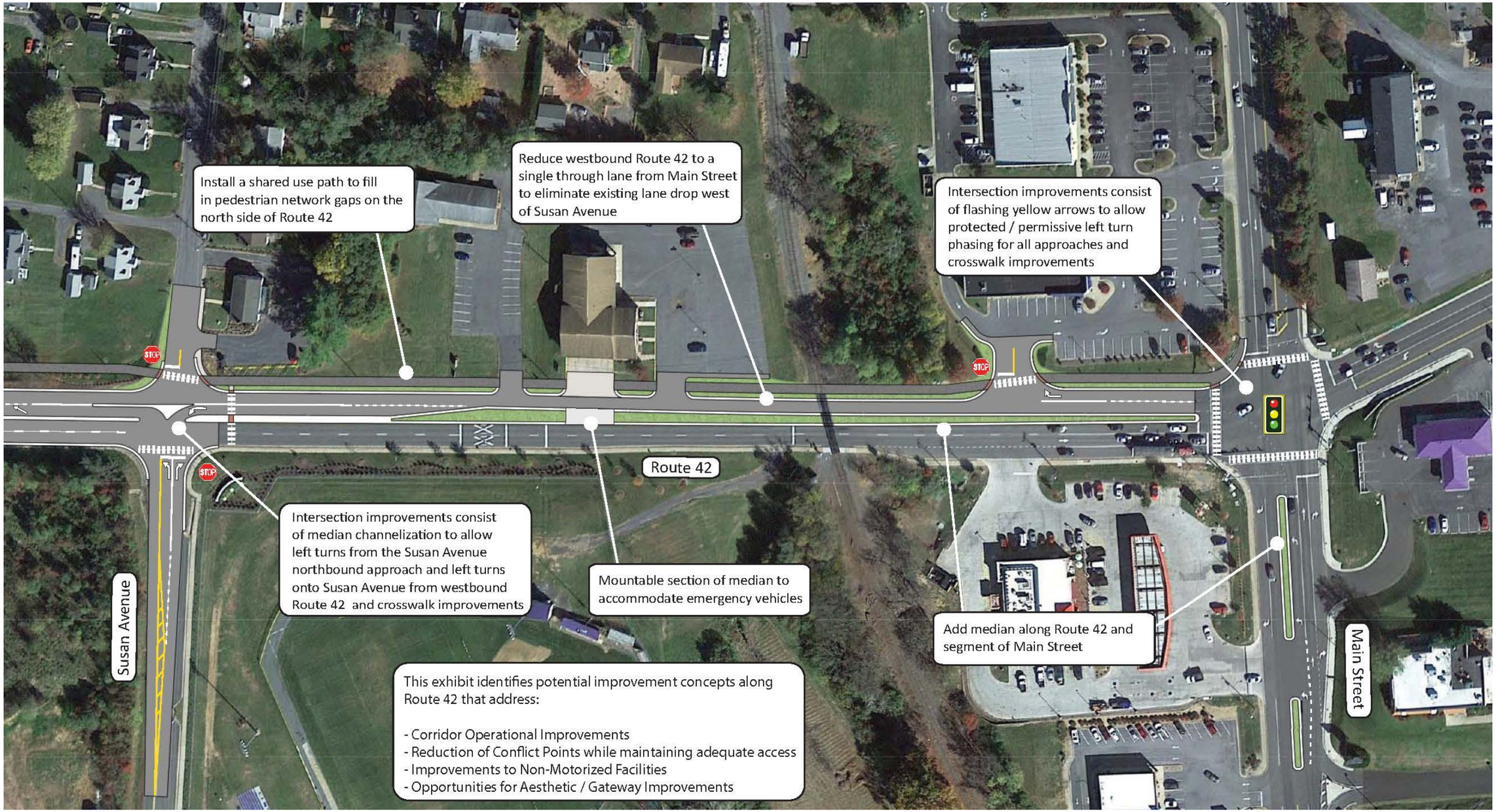


Figure 6b: 2018 SMART SCALE Corridor Concept (2 of 4)

Figure 6c: 2018 SMART SCALE Corridor Concept (3 of 4)

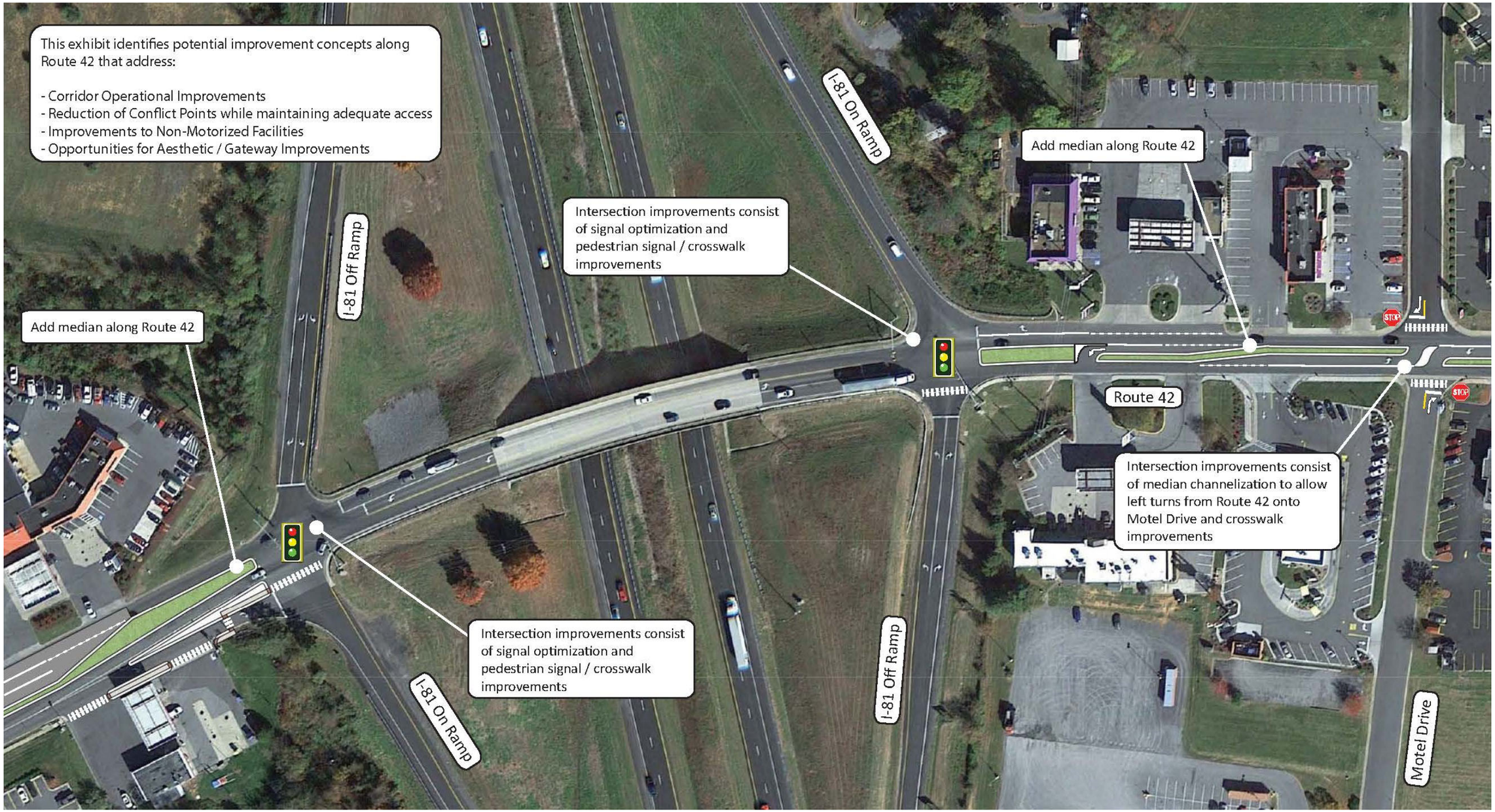


Figure 6d: 2018 SMART SCALE Corridor Concept (4 of 4)

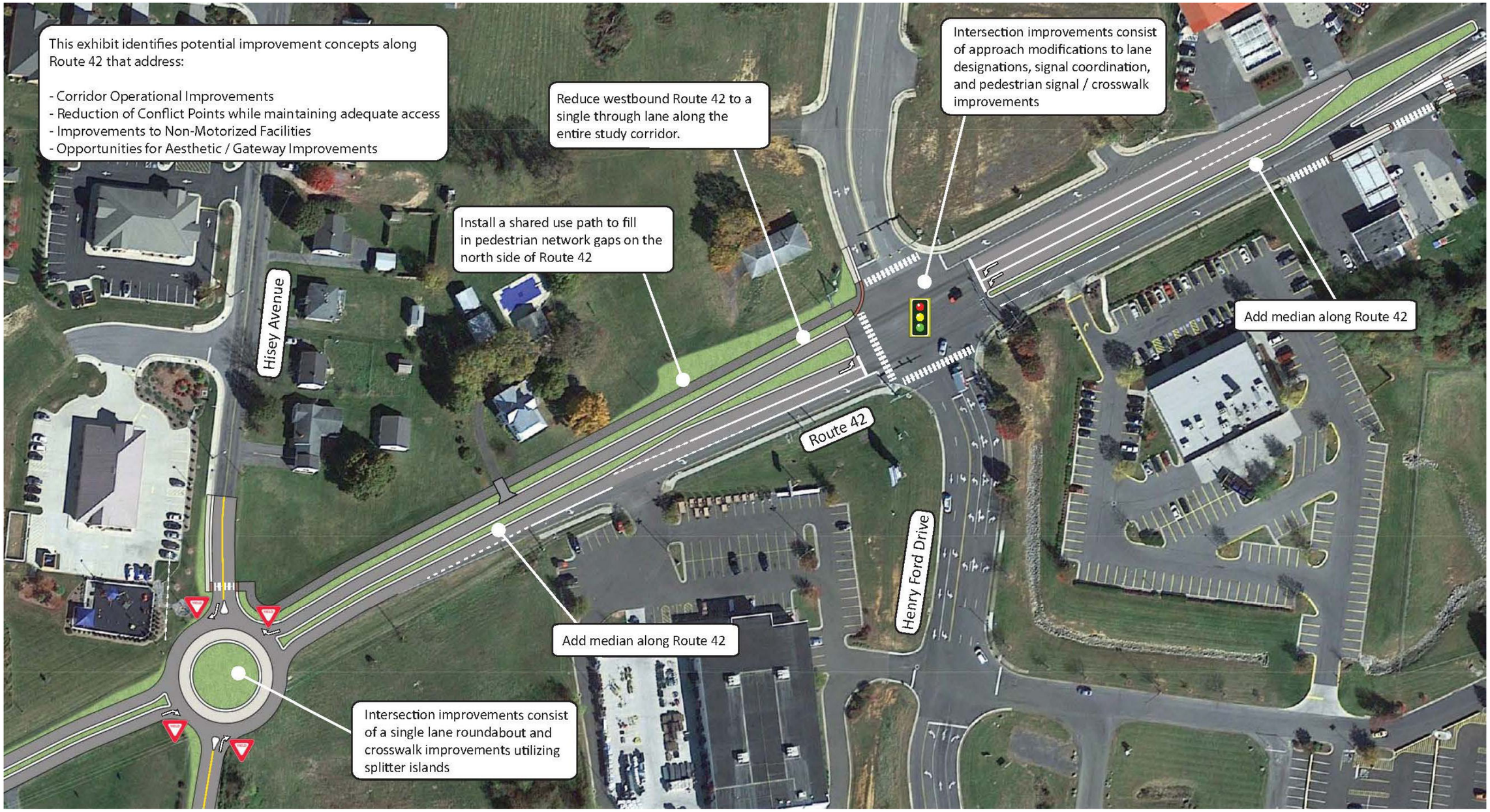
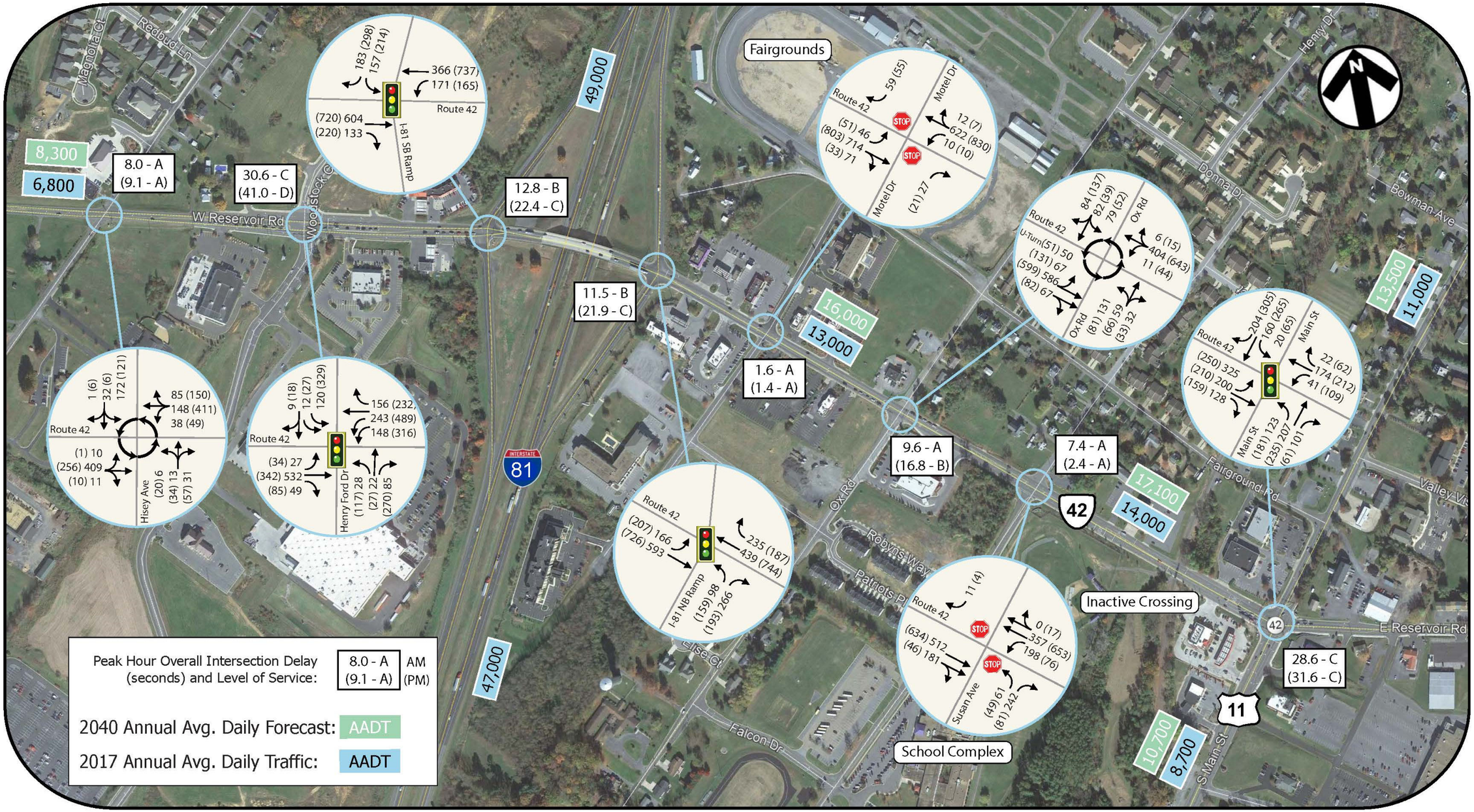


Figure 7: Future Traffic Data Exhibit – SMART SCALE Corridor Concept (2040 design-year)



5. Intersection Improvement Concepts

Following the state scoring of SMART SCALE Round 3 applications, a draft funding scenario was released for Commonwealth Transportation Board (CTB) consideration in January 2019 that served as the initial starting point for the development and approval of the Fiscal Year 2020 SYIP. Unfortunately, the ultimate cost of both Route 42 corridor applications ($10-15 million in SMART SCALE request) prevented the projects from being competitive for funding consideration. See ***Appendix C*** for the 2018 SMART SCALE Route 42 applications and scorecards. As a result, VDOT and the town agreed upon a revised approach to the Route 42 study to evaluate intersection specific improvements that maintain the overall intent of the 2018 SMART SCALE Corridor Concept. These targeted improvement concepts result in lower cost recommendations that will increase the competitiveness of future funding applications. The concepts were developed in a complementary manner to allow for phased implementation over time as funding becomes available until the ultimate vision for the corridor is realized.

5.1. VDOT Junction Screening Tool (VJuST) Analysis:

VJuST Analysis Results:

Type	Max V/C	Ped. Benefit	Conflict Points
Conventional Signal	0.48		48
Mini Roundabout	0.66		8
Roundabout	0.49		8
Two-Way Stop	0.63	-	48

VJuST is a planning-level intersection analysis tool that utilizes peak-hour turning movements and approach geometry to evaluate Innovative Intersections alternatives based on operations (volume / capacity), safety (conflict points), and pedestrian accessibility. The primary benefits of Innovative Intersections are a reduction of signal phases (turning movements) to increase intersection efficiency by providing more green time to higher movement demands and reducing overall conflict points within the intersection. The results of the analysis are presented in a tabular, comparative format as shown on the left, with a conventional traffic signal serving as the baseline. Users of the tool can select the types of Innovative Intersections to be considered based on the characteristics of the intersection. A description of the considered intersection types and performance measures utilized in the VJuST analysis is presented in the following sections below.

5.2. Description of Analyzed Intersection Types:

Conventional Signal – Represents a signalized intersection based on the approach lane geometry and number of phases associated with the signal cycle.

Bowtie – Utilizes roundabouts on the side streets to divert left turns from the primary intersection (reducing the number of signal phases). Left turns are converted to right turns with a downstream roundabout U-Turn that then proceed with a through movement at the primary intersection. Can be partial, removing a pair of left turns or full, removing all left turns from the intersection.

Continuous Green-T – Improvement for 3-leg intersections. The mainline and side street left turns are channelized / separated from the advancing mainline through volumes (top side of intersection), essentially removing this direction of mainline traffic from the intersection. Side street lefts merge into the unopposed mainline volume downstream of the intersection.

Displaced Left Turn – Left turn movements "crossover" opposing through movements upstream of the primary intersection with a new two-phase signal. This allows the opposing left turns and through movements to run concurrently at the primary intersection. The concept increases the number of signals, but the reduced number of signal phases can create a more efficient intersection. This Innovative Intersection was not considered along Route 42 due to limited intersection spacing to accommodate additional signals and significant R/W impacts associated with Displaced Left Turns.

Median U-Turn (MUT) – Utilizes downstream U-Turn movements to remove left turns from the primary intersection (reducing signal phases). Lefts are converted to through movements with a downstream U-Turn that then proceed with a right turn at the primary intersection. Can be partial (PMUT), removing a pair of left turns or full, removing all left turns from the intersection.

Restricted Crossing U-Turn (RCUT) – An RCUT is similar to the Median U-Turn, but the side street left and through movements are converted to a right turn and the U-Turn is accommodated downstream on the mainline roadway. The mainline left turns onto the side streets are maintained at the primary intersection.

Roundabout – Traditional roundabouts can consist of single-lane, dual-lane, or hybrid designs that can accommodate two lanes of travel on only certain approaches.

Mini Roundabout – These roundabouts utilize a smaller inscribed diameter that generally fit within existing intersection footprints, limiting R/W impacts, but have a lower capacity than traditional roundabouts. Operates the same as a traditional roundabout, except the center and splitter islands are traversable to accommodate heavy vehicle turning movements.

Two-way Stop Controlled – Considers a traditional side street stop sign controlled intersection with free flowing mainline traffic.

5.3. Performance Consideration:

Max V/C - V/C is a comparison of peak-hour intersection traffic volumes to intersection capacity. The provided V/C represents the worst of all intersection approaches. Generally, congestion beings to occur at a V/C of 0.80 or higher. At a 0.90 V/C, the intersection is approaching saturated conditions and congestion begins to become unacceptable. Once an intersection reached over-capacity at 1.00 V/C, intersection operations begin to fail with demand not being served, resulting in excessive delay and queues.

Pedestrian Benefit - Compares the potential of each intersection concept to accommodate pedestrians based on safety, wayfinding, and delay. Potential is qualitatively defined as better (+), similar (blank cell), or worse (-) than a conventional intersection.

Conflict Points - Represents the total weighted conflict points associated with each intersection concept (Crossing + Merging + Diverging). The higher risk Crossing conflicts receive a 2 X weighting. Reduced conflict points enhances intersection safety.

Crash Modification Factor - Concept benefits are also summarized, including an anticipated reduction of crashes resulting from the improvement based on a Crash Modification Factor (CMF) assigned to each

improvement type. The CMF is applied to the 5-year crash total (2012 - 2016) associated with the intersection or road segment to determine a forecasted annual reduction in crashes. The utilized CMFs are based on those used in Smart Scale scoring. More information on these CMFs can be found here: http://vasmartscale.org/documents/ss_planning_level_cmfs_092116.pdf

5.4.Analysis Assumptions and Results:

Forecasted 2040 PM peak-hour traffic volumes were utilized for the VJuST analysis based on the agreed upon growth rates associated with the study. If an intersection concept restricted an existing movement or introduced a new movement (addition of a left turn at the Susan Avenue northbound approach for example), traffic diversions to adjust the turning movement volumes were considered. The VJuST analysis results were then utilized to develop intersection specific improvement concept summary sheets. The summary sheets provide a graphical diagram of the improvement including associated movement diversions and a description narrative. The VJuST analysis table comparing the operation and safety results for the considered alternatives is also included on each summery sheet, as well as, a planning-level cost estimate associated with each improvement concept including a breakdown by project phase with an estimated schedule.

Since VJuST is a planning-level analysis tool, intersection concepts that are considered for advancement in funding consideration will required additionally analysis to finalize the recommendation. The more detailed traffic analysis will validate the VJuST results, confirm acceptable operations in the AM peak-hour, and assist in refining the intersection improvement. VDOT Staunton District Planning is available to assist the town with this additional traffic analysis at such time of consideration by the town to advance a recommendation for funding consideration.

5.5.Improvement Prioritization

The Intersection Improvement Concept Summary Sheets were provided to town staff for review and comment in late spring of 2019. VDOT presented the analysis results and concepts to the town Street Committee in June, while also providing an overview of the Smart Scale Round 3 results to frame the intent of this updated study approach. Each intersection improvement concept was discussed among the group to identify benefit and potential concerns. Following the Street Committee Meeting, several alternatives were determined not suitable for advancement, while some additional concepts were discussed for consideration. The town directed VDOT to revise the intersection improvement concepts based on the received feedback and develop a prioritized list of corridor recommendations based on which improvement concepts addressed the most critical needs along the corridor and cost related to competitiveness in funding consideration. VDOT developed nine final Intersection Improvement Concepts with six short-term improvement recommendations and three long-term improvement recommendations. The final concepts are presented in ***Figures 8a – 8i***. Intersection concepts that were evaluated and considered, but ultimately not advanced can be reviewed in ***Appendix D***.

Figure 8a: Intersection Improvement Concept – Main Street (US 11)

Route 42 / Main Street Intersection Needs:

- High crash frequency location (#57 PSI)
- Access Management issues at intersection
- Town gateway / entrance

VJuST Analysis Results:

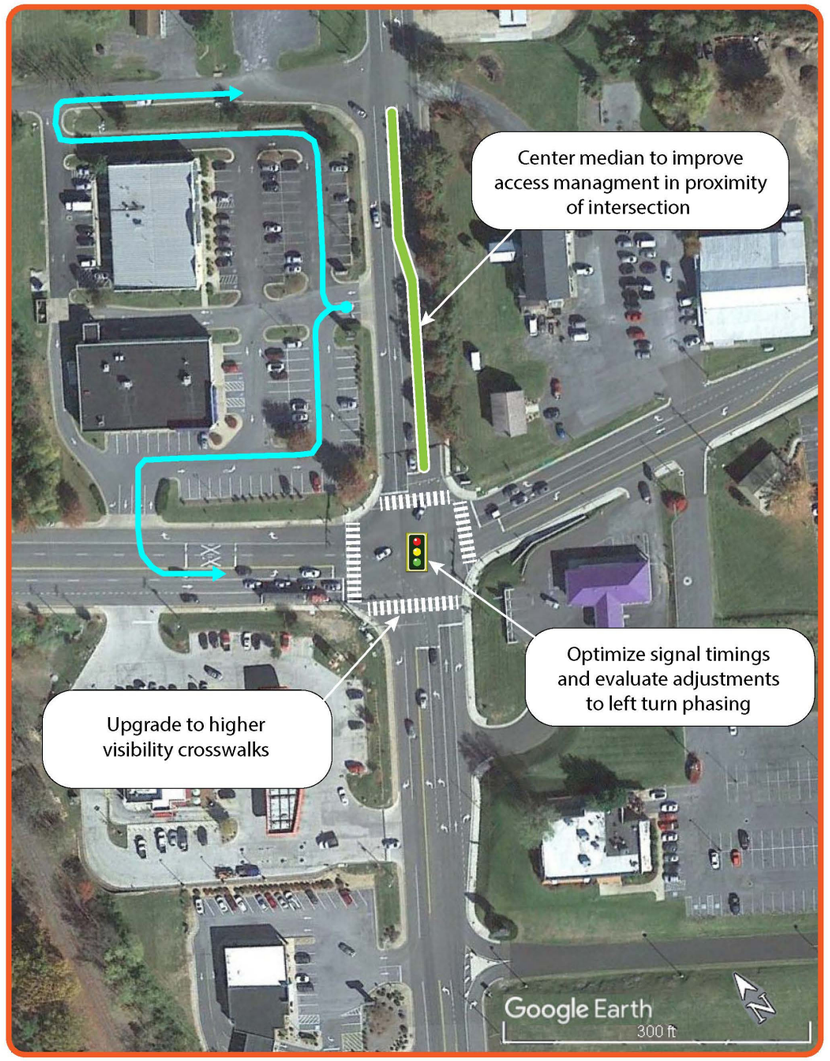
Type	Max V/C	Ped. Benefit	Conflict Points
Conventional Signal	0.54		48
Partial Median U	0.57	+	28
RCUT	0.73		20
Roundabout	0.57		8

Planning Level Cost Estimate:

PE:	$100,000	18 months
RW:	N/A	N/A
CN:	$1,000,000	12 months
Total:	$1,100,000	30 months
Notes:	Estimate is 2019 dollars. Anticipates no R/W or utility impacts.	

Improvement Concept Description:

Based on the VJuST analysis results, the existing signalized intersection provides the best results from a congestion standpoint. However, the intersection is identified as a Top 100 Potential for Safety Improvement location based on crash history. A roundabout could be considered at this location as a higher cost, long-term solution, but topography and approach grades to the east could be challenging, in addition to R/W impacts. The concept proposes intersection enhancements including a center median on the southbound approach on Main Street, higher visibility crosswalks, and signal timing optimization. A conversion to protected / permissive, flashing yellow arrow left turn phasing is recommended for evaluation on all approaches except for the northbound dual lefts. The Main Street median will reduce conflicting turning movements, consolidating them at the side street intersection and provide opportunities for aesthetic enhancements approaching the historic downtown.



Improvement Concept Benefits:

Safety	CMF	Crashes (5-year)	Expected Reduction
Center Median	0.80	11	0.4 per year
Signal Optimization	0.92	17	0.3 per year

Improves signal operations (delay / queuing) by optimizing the existing signal and evaluating adjustments to the left turn phasing.
Provides opportunities for “gateway” enhancements.

Figure 8b: Intersection Improvement Concept – Susan Avenue

Route 42 / Susan Avenue Intersection Needs:

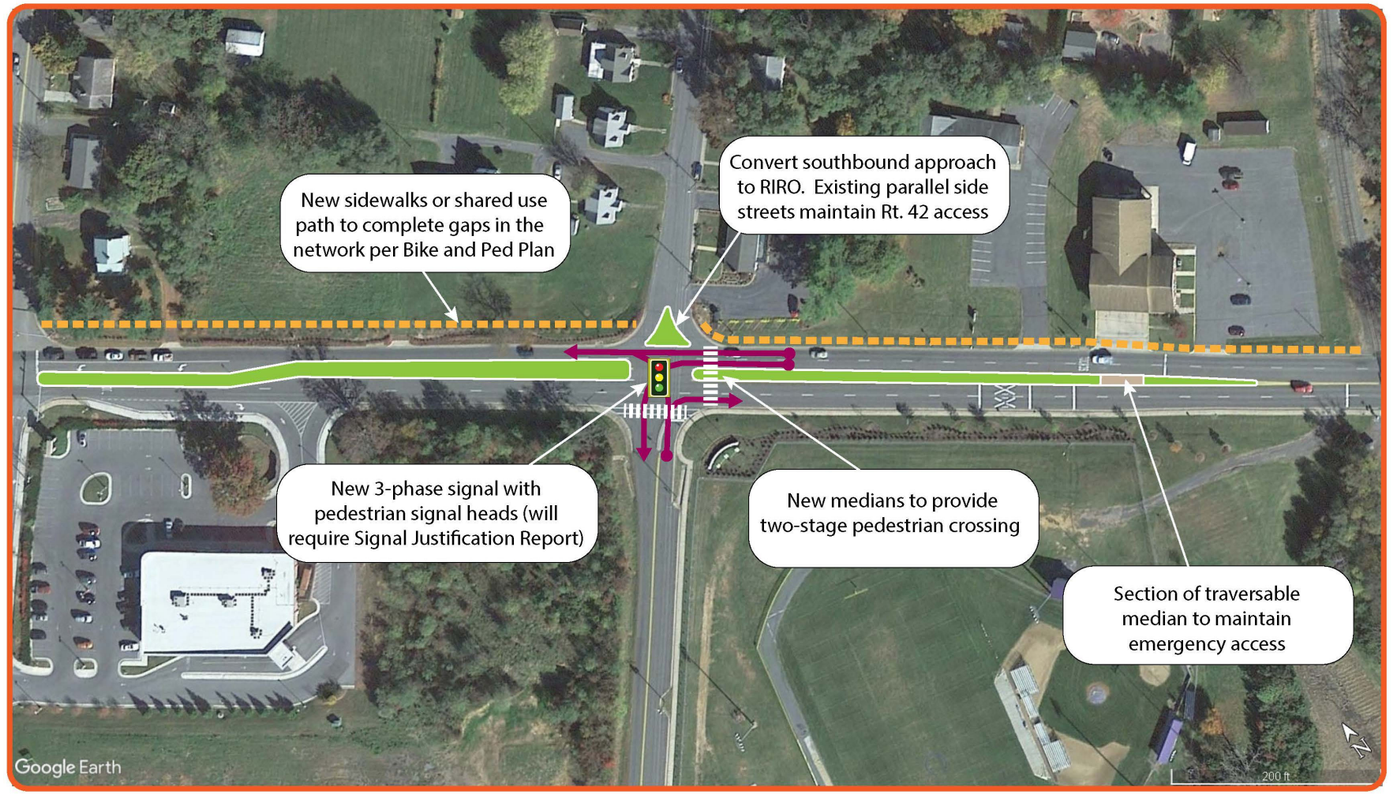
- Lack of pedestrian crossing facilities (school access)
- Reduced vehicular accessibility (northbound lefts)
- Town gateway / entrance

VJuST Analysis Results:

Type	Max V/C	Ped. Benefit	Conflict Points
Conventional Signal	0.37		14
RCUT	0.36	-	20
Roundabout	0.31		8
Two-Way Stop	0.46		28

Improvement Concept Description:

Based on the VJuST analysis results, congestion is not an issue at the Susan Avenue intersection. However, existing characteristics of the intersection do not support pedestrian accessibility to the adjacent school facility. The concept of a new signal at this location, along with center medians will enhance pedestrian access and safety. The operations and safety of a new signal would benefit from modifying the low volume southbound approach to a right-in / right-out, with the parallel network utilized to maintain vehicular accessibility. This would allow more green time to Route 42 and reduce weighted conflict points by 50%. The addition of a northbound left would have a positive effect on the corridor by balancing side street volumes and increasing access. New pedestrian facilities are proposed along the north side of Route 42.



Improvement Concept Benefits:

Safety	CMF	Crashes (5-year)	Expected Reduction
New Signal	0.65	7	0.5 per year
Center Median	0.80	16	0.6 per year

Completes gaps in existing sidewalk network based on Bike and Pedestrian Plan recommendations. Median allows for two-stage pedestrian crossings, enhancing non-motorized accessibility and safety.

Provides opportunities for “gateway” enhancements.

Planning Level Cost Estimate:

PE:	$250,000	18 months
RW:	$750,000	12 months
CN:	$2,500,000	18 months
Total:	$3,500,000	48 months

Notes:
Estimate is 2019 dollars. Anticipates moderate R/W and utility impacts (related to pedestrian facilities).

Short-Term Recommendation **Town of Woodstock - Route 42 Study**

Figure 8c: Intersection Improvement Concept – (Ox Road)

Route 42 / Ox Road Intersection Needs:

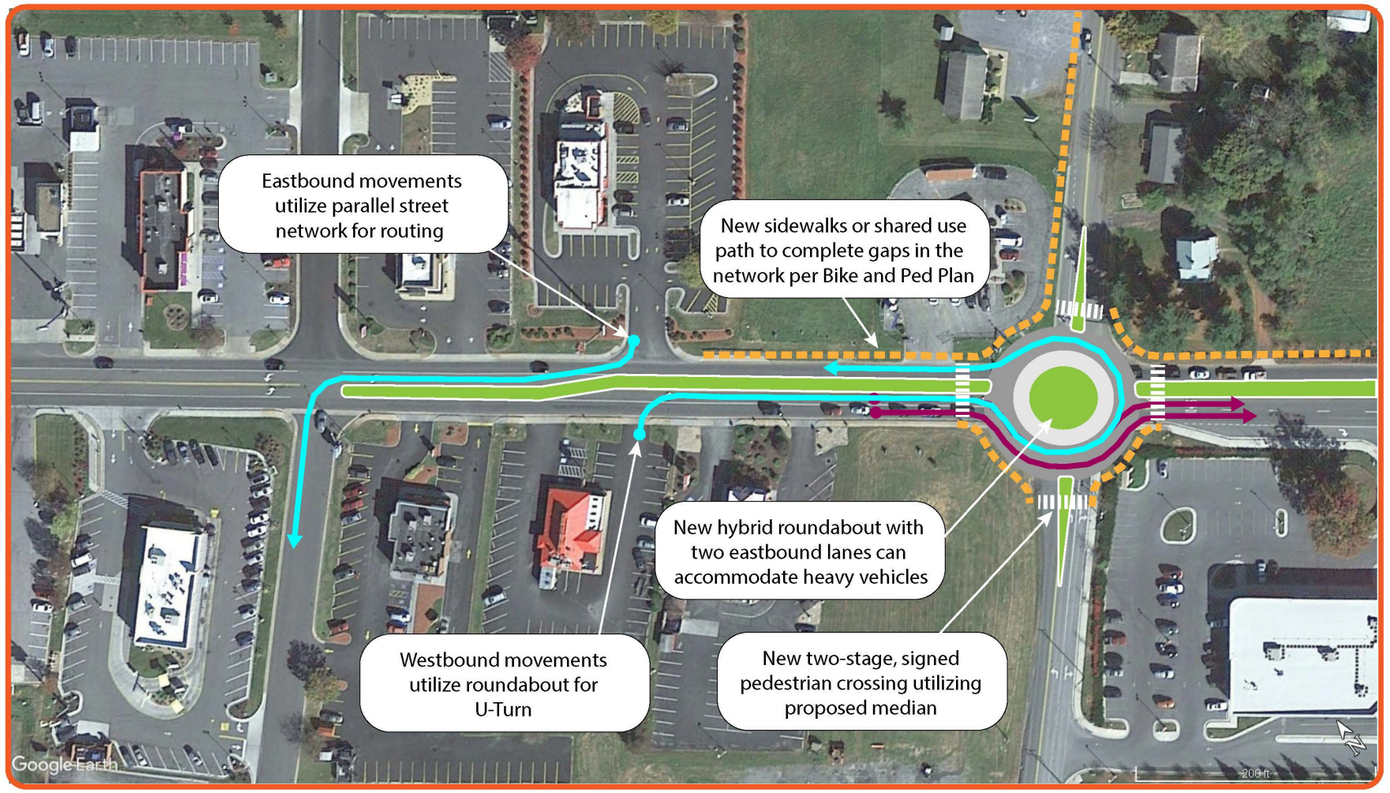
- High crash frequency location (#2 PSI)
- Peak hour delay / progression / queuing issues
- Lack of pedestrian crossing facilities

VJuST Analysis Results:

Type	Max V/C	Ped. Benefit	Conflict Points
Conventional Signal	0.62		48
Partial Bowtie	0.60	+	24
Continuous Green-T	0.56	-	16
Roundabout	0.68		8

Improvement Concept Description:

Based on the VJuST analysis results, a roundabout is the recommended improvement at the Ox Road and Route 42 intersection. A hybrid roundabout would provide two eastbound lanes on Route 42 with all remaining approaches being single lane. The splitter island of the eastbound approach could be extended as a center median along Route 42 to the upstream intersection with Motel Drive. This would significantly reduce vehicle conflict points, enhancing safety. The roundabout would accommodate heavy vehicle U-turn movements to maintain corridor accessibility. The roundabout would also maintain continous, lower speeds on the Route 42 corridor, improving travel time consistency and reducing intersection queuing. The splitter islands and median could be utilized to improve pedestrian crossings.



Improvement Concept Benefits:

Safety	CMF	5-Year Crashes	Expected Reduction
Roundabout	0.40	20	2.4 per year
Center Median	0.80	29	1.2 per year

Completes gaps in existing sidewalk network based on Bike and Pedestrian Plan recommendations. Median and splitter islands allow for two-stage pedestrian crossings, enhancing non-motorized accessibility and safety.

Provides opportunities for “gateway” enhancements

Planning Level Cost Estimate:

PE:	$500,000	24 months
RW:	$2,000,000	18 months
CN:	$4,000,000	18 months
Total:	$6,500,000	60 months

Notes:
Estimate is 2019 dollars. Anticipates moderate R/W and utility impacts. Utilize vacant southwest parcel to minimize impacts.

Figure 8d: Intersection Improvement Concept – I-81, Exit 283 Southbound Ramp

Route 42 / I-81 SB Ramp Intersection Needs:

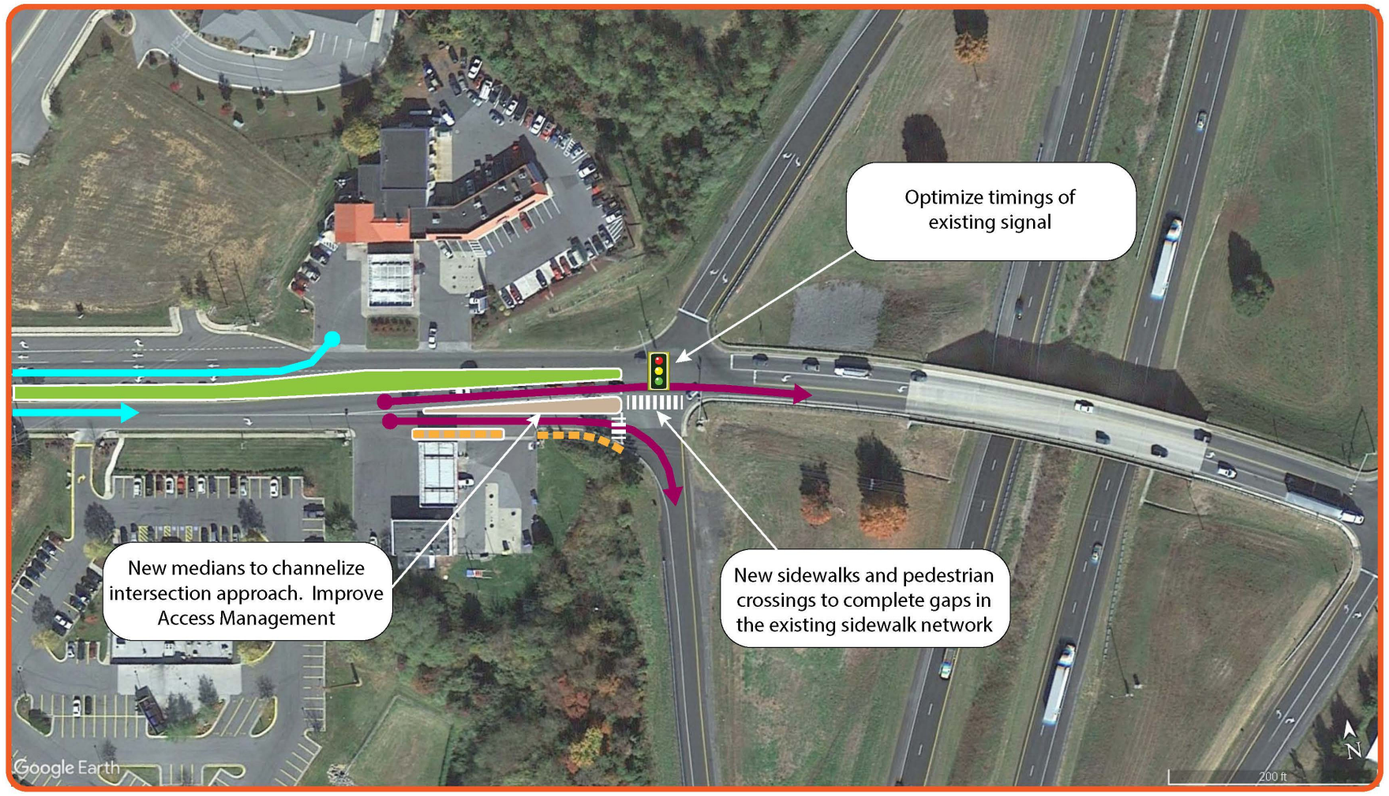
- High crash frequency location (#63 PSI)
- Access Management (ramp and entrance spacing)
- Lack of pedestrian crossing facilities

VJuST Analysis Results:

Type	Max V/C	Ped. Benefit	Conflict Points
Conventional Signal	0.81		18
Partial Median U	0.82	-	14
RCUT	0.88		8
Roundabout	0.76		6

Improvement Concept Description:

Based on the VJuST analysis results and intersection characteristics, there is not a preferred concept at the Exit 283 southbound ramp intersection. While a roundabout shows the most benefit from a congestion and safety standpoint, a roundabout at this location may be problematic due to R/W and utility impacts, ramp approach angle, intersection geometry and spacing between ramp and commercial entrances (less than 100'). The improvement concept improves access management and better define movement geometry with the introduction of medians. The medians also improve pedestrian accessibility through the intersection, enhancing safety and completing a connection to the existing sidewalk on the interstate bridge.



Improvement Concept Benefits:

Safety	CMF	Crashes (5-year)	Expected Reduction
Center Median	0.80	10	0.4 per year
Signal Optimization	0.92	19	0.3 per year

Completes gaps in existing sidewalk network based on Bike and Pedestrian Plan recommendations. Median allows for two-stage pedestrian crossings, enhancing non-motorized accessibility and safety.

Provides opportunities for "gateway" enhancements.

Planning Level Cost Estimate:

PE:	$200,000	18 months
RW:	$250,000	12 months
CN:	$1,700,000	12 months
Total:	$2,150,000	42 months

Notes:
Estimate is 2019 dollars. Anticipates minimal R/W and utility impacts.

Short-Term Recommendation **Town of Woodstock - Route 42 Study** VDOT

Figure 8e: Intersection Improvement Concept – Henry Ford Drive

Route 42 / Henry Ford Dr. Intersection Needs:

- Peak hour queuing issues due to ramp proximity
- Lacks pedestrian crossing facilities
- Potential for significant traffic growth at intersection

VJuST Analysis Results:

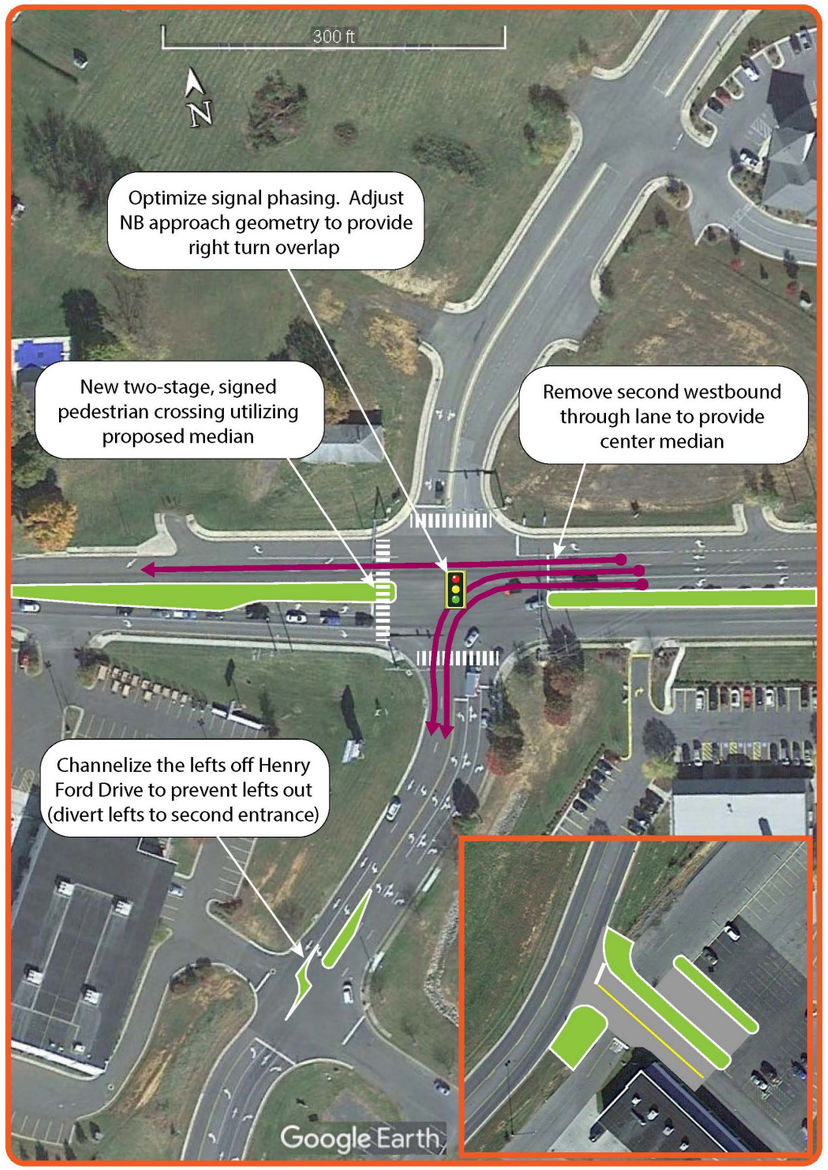
Type	Max V/C	Ped. Benefit	Conflict Points
Conventional Signal	0.65		48
Partial Median U	0.66	+	28
RCUT	0.65		20
Roundabout	0.52		8

Planning Level Cost Estimate:

PE:	$250,000	18 months
RW:	$250,000	6 months
CN:	$1,700,000	12 months
Total:	$2,200,000	36 months
Notes:	Estimate is 2019 dollars. Anticipates minimal R/W and utility impacts.	

Improvement Concept Description:

The short-term recommendations for the Henry Ford Drive intersection consist of median improvements along Route 42 and pedestrian crossing enhancements with pedestrian signal heads and crosswalks. The proposed medians would benefit the new pedestrian crossings (connecting the sidewalk network) by taking advantage of two stage crossings. The medians also provide aesthetic enhancement opportunities. The existing signal phasing and lane approach geometry should be evaluated for introducing a right turn overlap for the northbound approach. This concept also proposes improvements to the existing Wal-Mart entrance. By providing a secondary entrance to accommodate Henry Ford Drive southbound left turns, the current entrance could be improved by channelized left turns from Henry Ford Drive, while preventing left turns out of Wal-Mart (diverting movements to the secondary entrance), reducing conflict points at the primary entrance.



Improvement Concept Benefits:

Safety	CMF	Crashes (5-year)	Expected Reduction
Center Median	0.80	10	0.4 per year

Improves signal operations (delay / queuing) by optimizing signal phasing and approach geometry.
Provides pedestrian crossings to connect the existing sidewalk network.
Provides opportunities for “gateway” enhancements.

Figure 8f: Intersection Improvement Concept – Hisey Avenue

Route 42 / Hisey Ave. Intersection Needs:

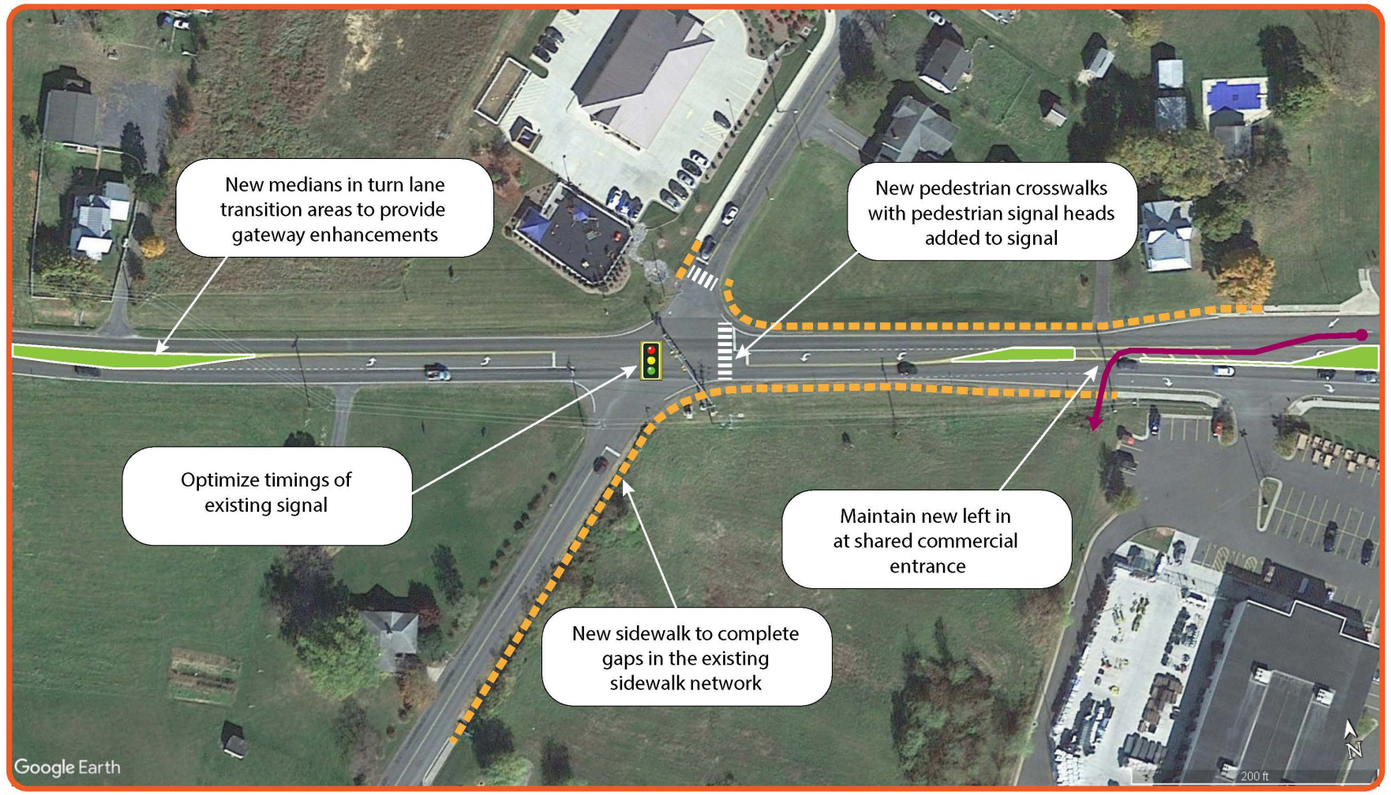
- Fatal crash location (no PSI)
- Town gateway / entrance
- Lack of pedestrian crossing facilities

VJuST Analysis Results:

Type	Max V/C	Ped. Benefit	Conflict Points
Conventional Signal	0.48		48
Mini Roundabout	0.66		8
Roundabout	0.49		8
Two-Way Stop	0.63	-	48

Improvement Concept Description:

Based on the VJuST analysis results, there are no congestion related issues at the Hisey Avenue intersection and there is minimal difference in intersection operations in comparing improvement types. This improvement concept maintains the existing signal (with optimization of timings) while extending the adjacent existing sidewalks to the intersection. New crosswalks and pedestrian signal heads would be added to the intersection to improve pedestrian crossings, completing gaps in the existing pedestrian network of the Route 42 corridor. To provide minimal "gateway" enhancement opportunities, existing turn lane transition areas could be converted to medians.



Improvement Concept Benefits:

Safety	CMF	Crashes (5-year)	Expected Reduction
Signal Optimization	0.92	9	0.1 per year

Completes gaps in existing sidewalk network based on Bike and Pedestrian Plan recommendations. Provide crosswalks and pedestrian signal heads at the existing signalized intersection to improve pedestrian accessibility.

Provides minimal opportunities for "gateway" enhancements.

Planning Level Cost Estimate:

PE:	$100,000	12 months
RW:	$500,000	12 months
CN:	$1,000,000	18 months
Total:	$1,600,000	48 months

Notes:
Estimate is 2019 dollars. Anticipates minimal R/W and utility impacts.

Short-Term Recommendation **Town of Woodstock - Route 42 Study**

Figure 8g: Intersection Improvement Concept – I-81, Exit 283 Northbound Ramp (Long-Term)

Route 42 / I-81 NB Ramp Intersection Needs:

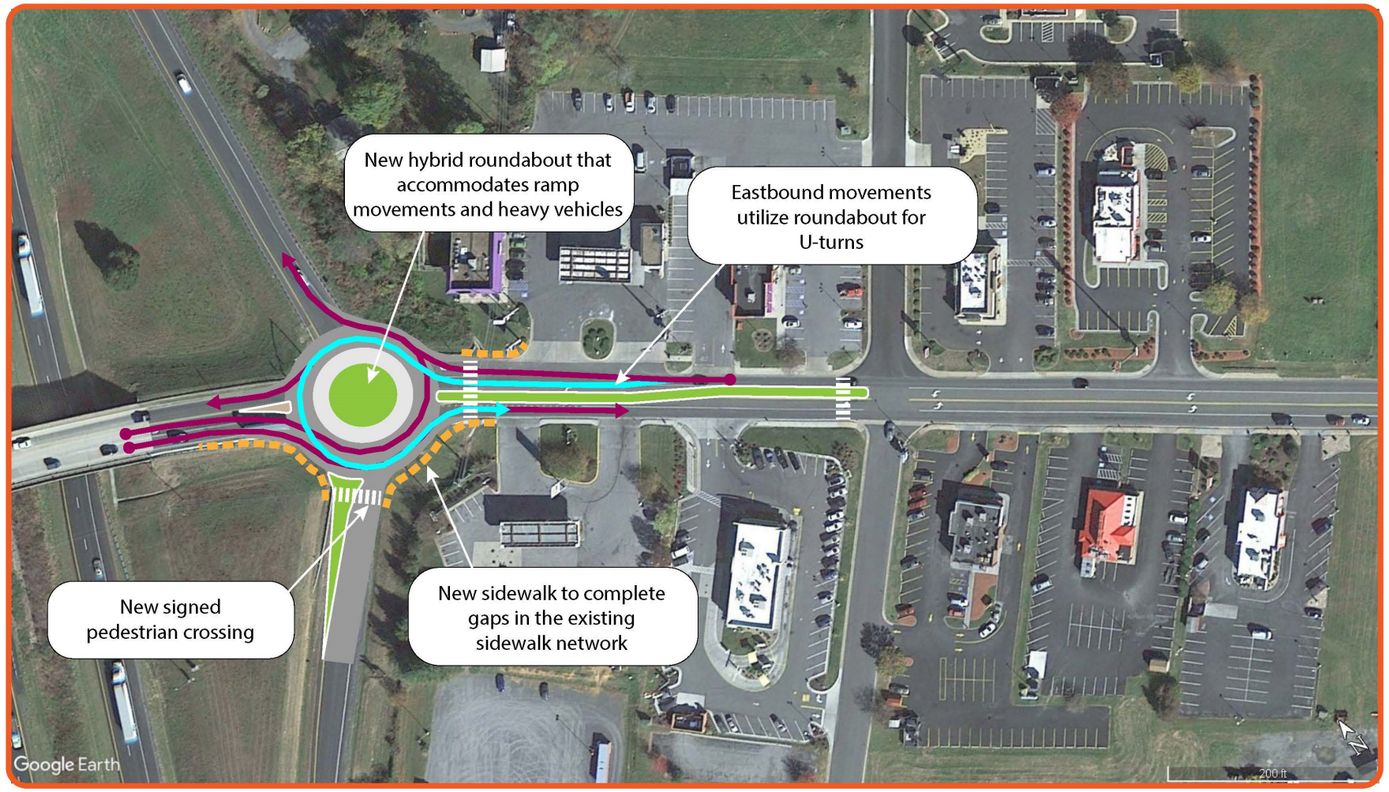
- Access Management (ramp and entrance spacing)
- Lack of pedestrian crossing facilities
- Town gateway / entrance

VJuST Analysis Results:

Type	Max V/C	Ped. Benefit	Conflict Points
Conventional Signal	0.77		18
Partial Median U	0.77	-	14
RCUT	0.75		8
Roundabout	0.77		6

Improvement Concept Description:

Based on the VJuST analysis results, there is not a preferred concept from a congestion standpoint at the Exit 283 nouthbound ramp intersection. However, a roundabout shows similar operations as a conventional signal while reducing conflict points by 66%, significantly enhancing safety. The northbound ramp intersection geometry and available right-of-way seems to generally support the implementation of a hybrid roundabout concept. The eastbound and westbound approaches of the roundabout would consist of two lanes to accommodate the individual on-ramp movements. Along with center median, the intersection concept improves access management and reduces conflict points while utilizing U-turns to maintain accessibility. Medians improve pedestrian access and safer crossings along the corridor.



Improvement Concept Benefits:

Safety	CMF	Crashes (5-year)	Expected Reduction
Roundabout	0.40	11	1.3 per year
Center Median	0.80	17	0.7 per year

Completes gaps in existing sidewalk network based on Bike and Pedestrian Plan recommendations. Median and splitter islands allows for two-stage pedestrian crossings, enhancing non-motorized accessibility and safety.

Provides opportunities for “gateway” enhancements.

Planning Level Cost Estimate:

PE:	$400,000	24 months
RW:	$1,000,000	18 months
CN:	$3,500,000	18 months
Total:	$4,900,000	60 months

Notes:
Estimate is 2019 dollars. Anticipates minimal to moderate R/W and utility impacts.

Figure 8h: Intersection Improvement Concept – I-81, Exit 283 Southbound Ramp (Long-Term)

Route 42 / I-81 SB Ramp Intersection Needs:

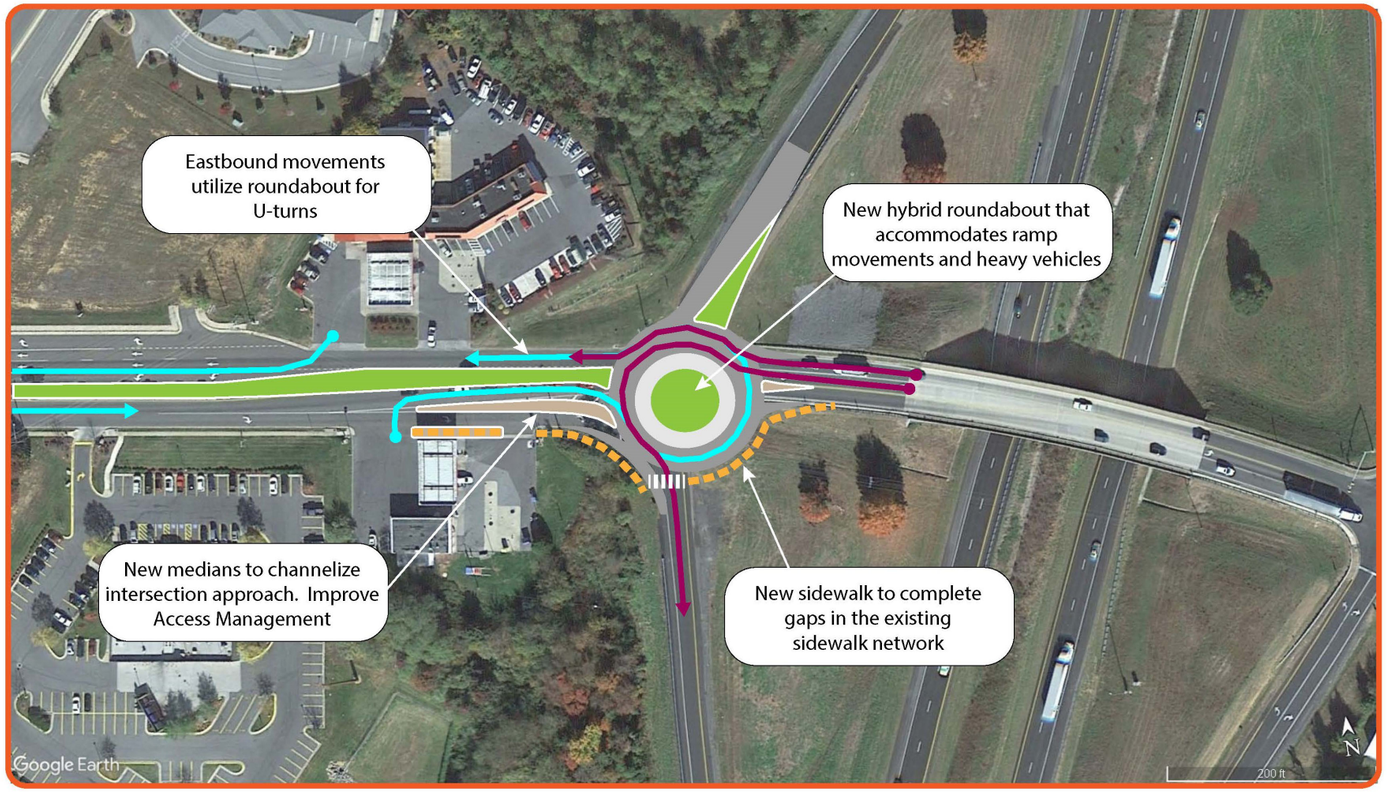
- High crash frequency location (#63 PSI)
- Access Management (ramp and entrance spacing)
- Lack of pedestrian crossing facilities

VJuST Analysis Results:

Type	Max V/C	Ped. Benefit	Conflict Points
Conventional Signal	0.81		18
Partial Median U	0.82	-	14
RCUT	0.88		8
Roundabout	0.76		6

Improvement Concept Description:

Based on the VJuST analysis results and intersection characteristics, there is not a preferred concept at the Exit 283 southbound ramp intersection. While a roundabout shows the most benefit from a congestion and safety standpoint, a roundabout at this location may be problematic due to R/W and utility impacts, ramp approach angle, intersection geometry and spacing between ramp and commercial entrances (less than 100'). The roundabout concept would also significantly reduce intersetion conflict points and provide the ability to maintain commercial access by utilizing U-turn movements. New sidewalk and pedestrian crossing would enhancing safety and complete a connection to the existing sidewalk on the interstate bridge.



Improvement Concept Benefits:

Safety	CMF	Crashes (5-year)	Expected Reduction
Roundabout	0.40	19	2.3 per year
Center Median	0.80	10	0.4 per year

Completes gaps in existing sidewalk network based on Bike and Pedestrian Plan recommendations.

Provides opportunities for "gateway" enhancements.

Planning Level Cost Estimate:

PE:	$500,000	24 months
RW:	$1,250,000	18 months
CN:	$4,500,000	18 months
Total:	$6,250,000	60 months

Notes:
Estimate is 2019 dollars. Anticipates moderate R/W and utility impacts.

Long-Term Recommendation **Town of Woodstock - Route 42 Study**

Figure 8i: Intersection Improvement Concept – Henry Ford Drive (Long-Term)

Route 42 / Henry Ford Dr. Intersection Needs:

- Peak hour queuing issues due to ramp proximity
- Lacks pedestrian crossing facilities
- Potential for significant traffic growth at intersection

VJuST Analysis Results:

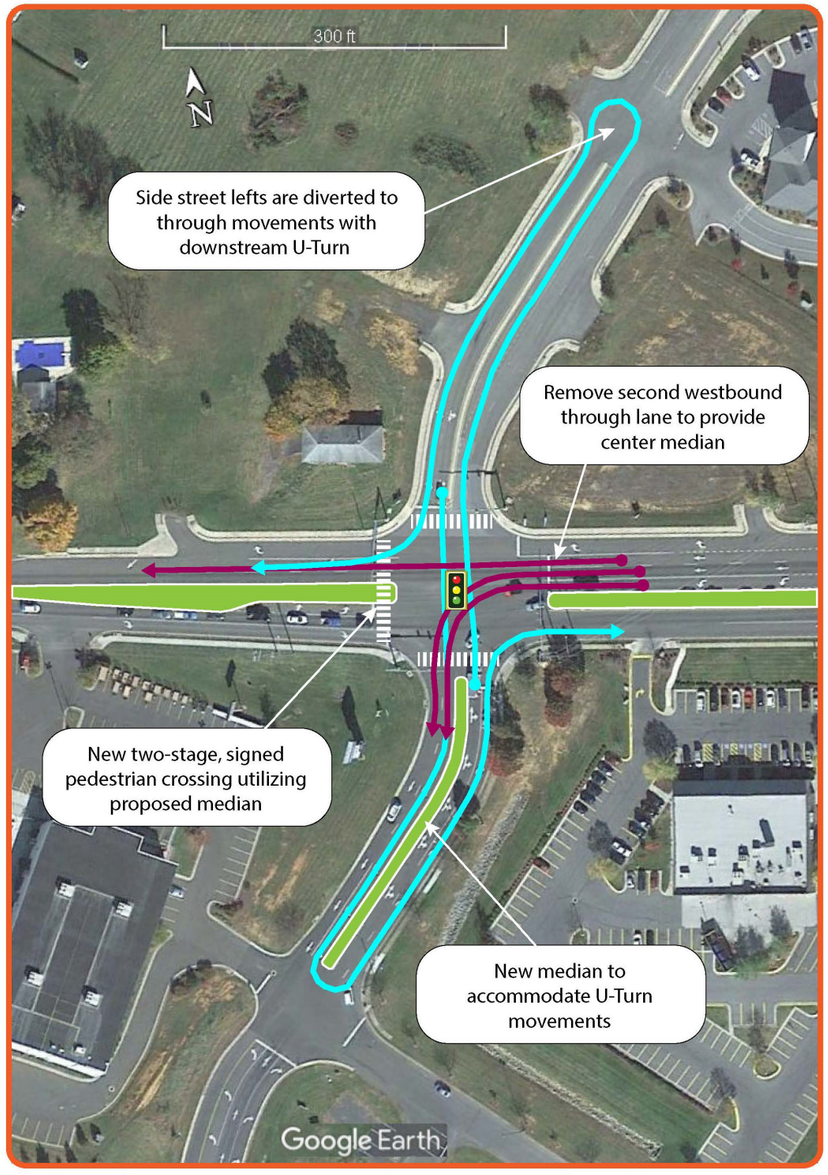
Type	Max V/C	Ped. Benefit	Conflict Points
Conventional Signal	0.65		48
Partial Median U	0.66	+	28
RCUT	0.65		20
Roundabout	0.52		8

Planning Level Cost Estimate:

PE:	$200,000	18 months
RW:	$200,000	6 months
CN:	$1,500,000	12 months
Total:	$1,900,000	36 months
Notes:	Estimate is 2019 dollars. Anticipates minimal R/W and utility impacts.	

Improvement Concept Description:

Based on the VJuST analysis results, there are several improvement alternatives that could be considered at the Henry Ford Drive intersection from a performance and safety standpoint. A Partial Median U-Turn is the recommended concept because of the ability to implement with the existing roadway network. A RCUT intersection would require U-Turn movements at the southbound I-81 ramp, while a roundabout of this scale would have a significant scope and cost with concerns of queues impacting ramp operations. The Partial Median U-Turn would divert side street left turns to a through movement with a downstream U-Turn to right turn onto Route 42. This reduces intersection conflict points and signal phases, resulting in enhanced safety and operations. Proposed medians would also benefit new pedestrian crossings (connecting the sidewalk network) by taking advantage of two stage crossings. The medians also provide aesthetic enhancement opportunities.



Improvement Concept Benefits:

Safety	CMF	Crashes (5-year)	Expected Reduction
Partial Median U-Turn	0.65	16	1.1 per year
Center Median	0.80	10	0.4 per year

Improves signal operations (delay / queuing) by reducing the number of signal phases (more green time).
Provides pedestrian crossings to connect the existing sidewalk network.
Provides opportunities for “gateway” enhancements.

Long-Term Recommendation **Town of Woodstock - Route 42 Study**

6. Final Corridor Recommendations

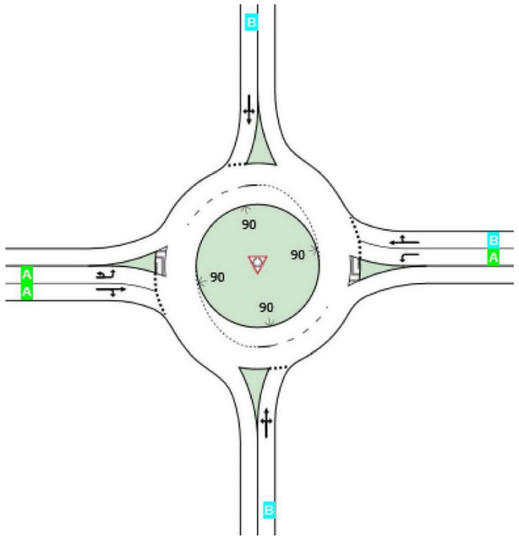
Following coordination with town staff and the Street Committee meetings in the summer and fall of 2019 to review, adjust, and prioritize the Intersection Improvement Concepts, a final set of corridor short-term and long-term recommendations have been developed for the town's consideration moving forward. The preferred intersection improvement recommendations provide targeted, cost competitive projects that address the identified needs of the study and can be implemented in a phased approach as funding becomes available, while maintaining the town's future vision for the Route 42 corridor. The final corridor recommendations can be found in ***Table 8***. The final set of recommendations achieve the overall intent of the previously developed 2018 SMART SCALE Corridor Concept, with the following noted variations:

Corridor Wide Improvements: The evaluated improvement that provides the most significant immediate corridor operational benefit, at the lowest cost is the coordination of the existing traffic signals along the corridor. This improvement reduces vehicle stops for east – west movement along Route 42, lowering travel time and increasing average vehicle speeds, while lowering the risk for rear end crashes. The corridor remains a top priority of the VDOT Traffic Engineering Northwest Regional Operation for signal coordination when funding becomes available.

Bicycle and Pedestrian Facilities: Bicycle and Pedestrian recommendations along Route 42 are included where appropriate in the individual Intersection Improvement Concepts. The bicycle and pedestrian recommendations correspond to the overall facilities master plan from the recently adopted Town of Woodstock Bicycle and Pedestrian Master Plan.
https://www.townofwoodstockva.com/517/Bicycle-Pedestrian-Trail-Master-Plan

US 11 (Main Street) Intersection: Following discussions with the VDOT Edinburg Residency, the previous recommendation to reduce the northbound dual lefts to a single left turn lane was removed to preserve intersection capacity to accommodate potential future development on US 11 to the south of town. The revised recommendation for the Main Street intersection consist of enhancements to the existing pedestrian crossings and crosswalks, improvement to signal operations including the evaluation of implementing protected / permissive left turn phasing, and the introduction of a raised median along the southbound approach of Main Street.

Susan Avenue Intersection: Re-introducing the northbound left turn from Susan Avenue was maintained, but the recommendation to facilitate this movement was revised to a reduced phase signal. The signal will provide an opportunity to implement a two-staged pedestrian crossing with the proposed median to the public school complex. The crossing would incorporate actuated pedestrian signal heads and a crosswalk. A shared use path is proposed along the north side of Route 42 from the intersection with Main Street to Ox Road.



Ox Road Intersection: A hybrid roundabout continues to be the preferred recommendation. However, during additional analysis to support the Intersection Improvement Concepts, a more operationally efficient roundabout geometry was developed. Previously, the proposed roundabout maintained two east bound through lanes on Route 42. However, maintaining a separate through and left turn lane in both directions on Route 42 results in a better overall intersection LOS as illustrated below (PM peak-hour delay per vehicle in seconds and 95th percentile queue length in feet shown).

Approach	2018 Smart Scale Geometry		2019 Revised Geometry	
	Delay	Queue	Delay	Queue
Rt. 42 Eastbound	6.8 (A)	80'	8.9 (A)	145'
Rt. 42 Westbound	29.6 (C)	410'	11.6 (B)	215'
Ox Rd. Northbound	12.1 (B)	43'	12.8 (B)	54'
Ox Rd. Southbound	24.6 (C)	158'	16.9 (B)	94'
Overall	17.4 (B)		11.1 (B)	

Raised medians are proposed on both Route 42 approaches to the roundabout. Pedestrian crossings can be implemented at all approaches of the roundabout, utilizing the medians / splitter island to accommodate two-stage crossings. The proposed shared use path on the eastern leg of the intersection is planned to extend north along Ox Road.

Motel Drive Intersection: While the final recommendations do not include the Motel Drive intersection, the raised median improvements associated with the Ox Road roundabout could be extended to include the direction left turn channelization as previously proposed at Motel Drive. Lack of property owner support for improvements at this section of the corridor and less options to maintain adequate level of property access resulted in this intersection not being included in the final recommendations.

Henry Ford Drive Intersection: The intersection improvement recommendation is consistent with the 2018 SMART SCALE Corridor Concept, but the recommended reconstruction of curb on the north side of Route 42 to re-purpose previous roadway widening was removed to lower cost. Additionally, the improvement recommendation is extended to the south to include adjustment of the existing Woodstock Square Shopping Center (Wal-Mart) access to provide a secondary entrance to accommodate left turns onto southbound Henry Ford Drive. The long-term recommendation at this location is dependent on corridor traffic growth and land development in the future. Should future traffic conditions at Henry Ford Drive result in Route 42 queues that impact operations at the I-81 southbound ramps, Innovative Intersections to reduce the number of signal phases should be considered to improve overall intersection operations. A partial median U-turn

concept that converts the side street left turn into through movements with downstream U-turns was evaluated in the VJuST analysis and was identified as providing an operational and safety benefit.

Hisey Avenue Intersection: The roundabout recommended from the SMART SCALE Corridor Concept primarily focused on providing a "gateway" feature at the western town limits. While the roundabout performs well operationally and results in a significant reduction of conflict points, the VJuST analysis shows that the existing signal performs slightly better than the roundabout. This combined with a lower number of crashes at this location on the corridor results in the risk of potential benefit associated with the roundabout not being realized due to cost. Therefore, the recommended improvement at the Hisey Avenue intersection is to maintain the conventional signal while adding pedestrian crossings and converting the existing pavement markings for the left turn lane transition areas to raised medians to provide minimal landscaping / gateway opportunities.

Interchange Ramps: The short-term recommendations at the I-81 ramps is to maintain the improvements included in the SMART SCALE Corridor Concept. This consists of traffic signal timing and pedestrian crossing improvements at both intersections and lane channelization / access management improvements at the southbound ramps. As stated earlier in the report, the adequate condition of the Route 42 bridge over the interstate limits a significant transportation improvement at the interchange. Roundabouts at both ramps may be suitable as a potential long-term recommendation to enhance interchange operations and safety. Once the bridge condition reaches a point where a replacement project is being considered by VDOT, a full operational evaluation of the interchange will be required at that time to identify a preferred alternative.

Northwest Connector: During the review with town staff and the Street Committee on the Intersection Improvement Concepts, the idea of a new connector roadway from Hisey Avenue to Spring Street on the west side of Interstate 81 was discussed. This northwest connector would provide an additional routing option for people who travel between the downtown area and Interstate 81 and points west. As a result, the attractiveness of this alternative route would divert traffic off Route 42, similar to the effect that the opening of Henry Ford Drive had on reducing daily vehicular volumes on Route 42. This traffic diversion would help offset operational impacts along Route 42 related to future traffic growth along the corridor. While a portion of the area containing the potential connector roadway currently resides in Shenandoah County, the proximity to the Exit 283 interchange would also generate new land for future economic development interest and growth for the town and surrounding region. The Northwest Connector Concept is identified on ***Figure 9***.

In order to determine the potential operational benefit of the Northwest Connector concept, an Origin and Destination Analysis was completed using StreetLight data. Streetlight is an online analysis platform that utilizes location based services data (cell phone data) to perform analysis of travel patterns for the town and immediately adjacent areas. To facilitate the origin and destination analysis, the town and surrounding region were divided into travel zones based on geography, similar land uses, and significant traffic generators such as downtown, the commercial area along Henry Ford Drive, public school campus, and the hospital complex. A sample of location based service data is then utilized by Streetlight to forecast travel patterns based on time of day between the establish zones. As identified on ***Figure 10***, the analysis indicates that opening day traffic volumes on the Northwest Connector concept is anticipated to be 1,200 – 1,450 ADT. This projected volume represents a significant portion of the assumed traffic growth along Route 42 utilized in the future-year analysis scenarios. As a result, this potential traffic diversion would benefit the operational characteristics of Route 42 by extending the life of available corridor capacity related to future growth. Additional travel trends identified in the StreetLight analysis include:

- Interstate 81 only serves 15 - 25% of local trips in the morning and afternoon peak-periods.
- Local trips rely on US 11 at the same level of Interstate 81 for access to and from the immediate Woodstock area.
- Ox Road serves as a significant "cut-through" / alternative route for traffic traveling between downtown Woodstock and Intestate 81.
- The commercial area along Henry Ford Drive and the County Government Center to the north of downtown are the most significant daily traffic generators.
- The commercial uses along Route 42 account for 32% of all daily trips within the immediate Woodstock region, while the downtown area generated 9% of all daily trips.

A full set of all Origin and Destination Analysis Exhibits can be found in ***Appendix E***.

2019 Intersection Improvement Recommendations Benefit Snapshot

- While not as aggressive as the 2018 SMART SCALE Corridor Concept in reducing conflict points, the individual intersection improvement recommendations reduce conflict points at most of the study intersections. At such time that all six short-term recommendations have been implemented, corridor wide conflict points will have been reduced by 40 - 50%
- 2040 PM Peak-Hour Corridor Travel Time Improvement over existing conditions (1 mile segment):
  Eastbound = 70 seconds
  Westbound = 14 seconds
- Pedestrian crossing and signal improvements
- Shared use paths and new sidewalk fill in existing gaps in the sidewalk network
- Proposed median provides landscaping / aesthetic opportunities for "town gateway"
- Intersection Improvement Recommendations provide a flexible and more competitive path for implementing transportation improvements along the Route 42 corridor.

Figure 9: Northwest Connector Concept (Long-Term)

Town / Regional Network Needs:

- Expand transportation network to improve east - west accessibility (increase desirable travel routes)
- Route 42 redundancy (congestion relief)
- Access for future development

Planning Level Cost Estimate:

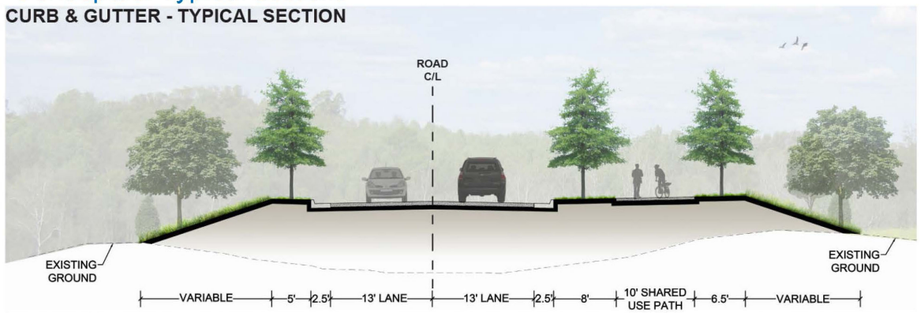
PE:	$650,000	24 months
RW:	$1,930,000	24 months
CN:	$6,430,000	24 months
Total:	$9,010,000	72 months
Notes:	Estimate is 2019 dollars. Assumes curb & gutter typical section with shared use path.	

Improvement Concept Description:

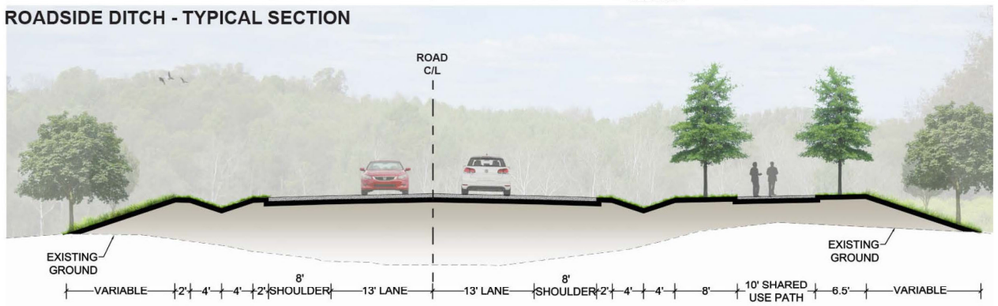
A new northwest connector linking Hisey Avenue to Spring Street (Rt. 816) would enhance east - west mobility and accessibility for the town and region. The concept consists of a 2-lane new roadway (approx. 1.0 mile length) with a shared use path on one side. The new connection would provide reduncancy for Route 42, reducing impacts of future traffic growth, while providing opportunities for new development access. While safety benefits of new facilities are difficult to quantify, a reduction of crashes along Route 42 would be anticipated due to lowering daily corridor volumes as a result of trip diversion to the new facility.

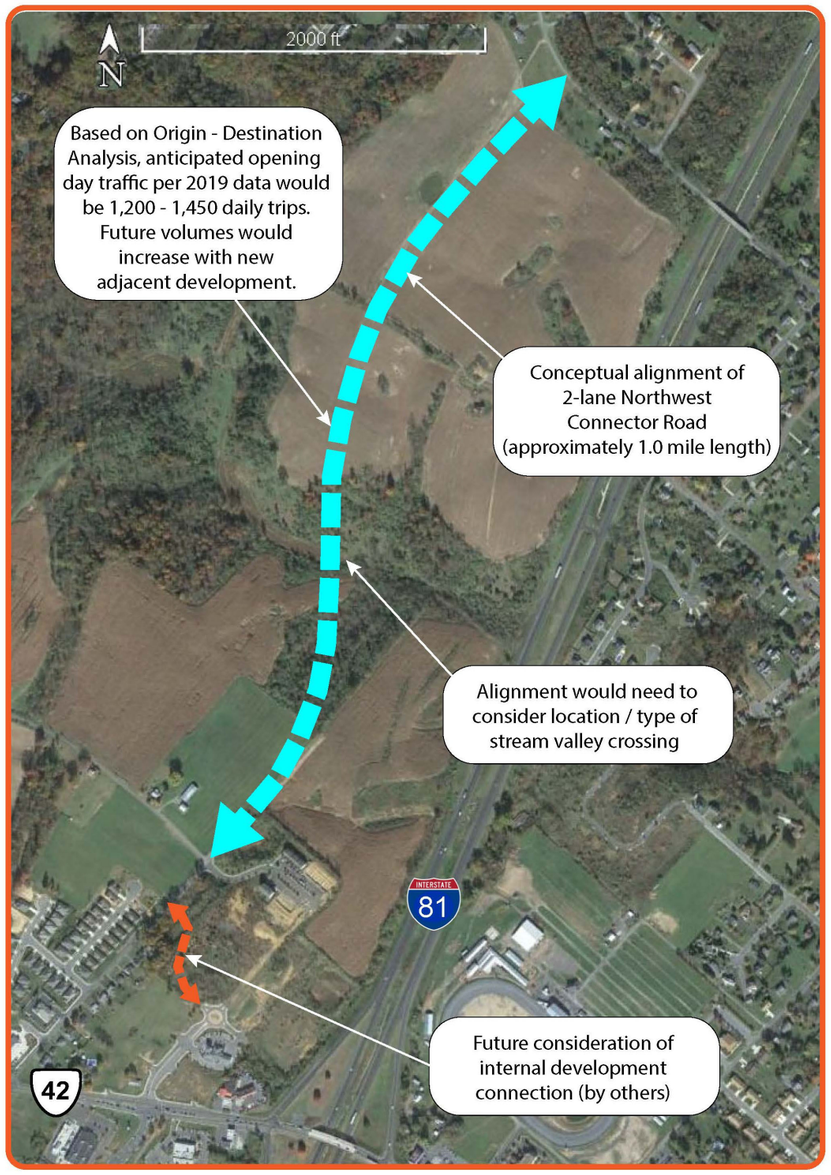
Conceptual Typical Sections

CURB & GUTTER - TYPICAL SECTION



ROADSIDE DITCH - TYPICAL SECTION

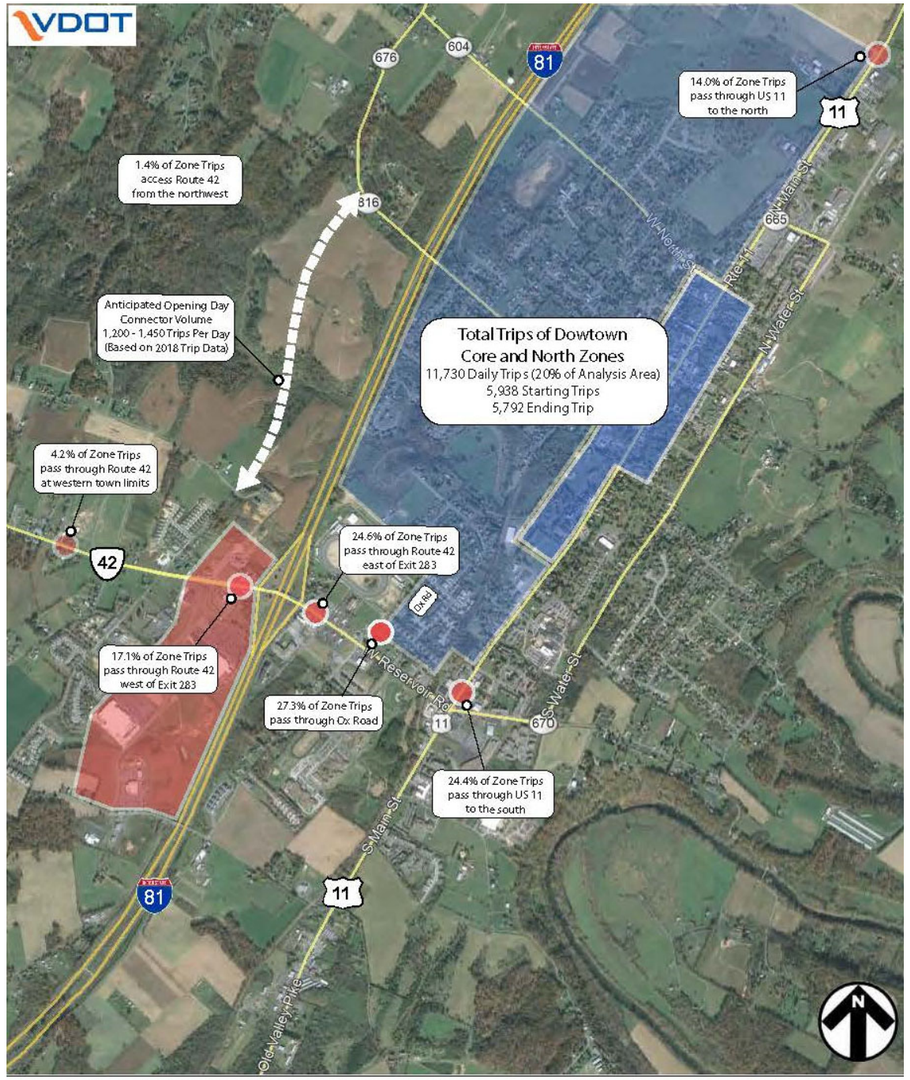




Long-Term Recommendation

Town of Woodstock - Route 42 Study

Figure 10: Origin and Destination Analysis Exhibit to Support the Western Connector Concept



Estimate Weekday Trips From Downtown Core and North Zones based on Trip Distributions:

- 880 Trips to I-81 via Route 42
- 1,210 Trip to Route 42 West Zone via Route 42
- 490 Trip to the west of Town Limits via Route 42
- 160 Trips to Route 42 west of Exit 283 via northern routes

Anticipated Diversion to Future Northwest Connector:

20-30% of Trips to I-81
50-60% of Trips to Route 42 West Zone
50-60% of Trips to Points West of Town
80-90% of Trips from northern routes

1,200 - 1,450 Total Diverted Trips

Table 8: Final Corridor Recommendations

Study Intersection	Improvement	Priority	Planning-Level Cost Estimate (2019 Dollars)
Corridor Wide	Add signal coordination to existing traffic signals along study limits.	Short-Term	$200,000
Route 42 / Main Street	Improve Pedestrian Crossing with enhanced Crosswalks; Improve signal operations; Add raised median on southbound Main Street approach.	Short-Term	$1,100,000
Route 42 / Susan Avenue	Signalize Intersection with Right-In / Right-Out for southbound Susan Avenue approach; Add Pedestrian Crossing with Actuated Pedestrian Signals and Crosswalk; Add shared use path to complete gaps in existing network; Add raised medians.	Short-Term	$3,500,000
Route 42 / Ox Road	Hybrid Roundabout; Improve Pedestrian Crossings with crosswalks utilizing roundabout splitter islands; Add raised medians; shared use path from the east on Route 42 to continue north of Ox Road.	Short-Term	$6,500,000
Route 42 / Northbound Ramps	Hybrid Roundabout (at time of interchange bridge replacement, consider a single point roundabout interchange)	Long-Term	$4,900,000
Route 42 / Southbound Ramps	Channelization of eastbound Route 42 approach to improve Access Management; Add Pedestrian Crossing with Actuated Pedestrian Signals and Crosswalk; Improve signal operations; Add sidewalk to complete gaps in existing network (shared use path on north side of Route 42)	Short-Term	$2,200,000
Route 42 / Southbound Ramps	Hybrid Roundabout (at time of interchange bridge replacement, consider a single point roundabout interchange)	Long-Term	$6,300,000
Route 42 / Henry Ford Drive	Improve Pedestrian Crossing with Actuated Pedestrian Signals and Crosswalk; Add sidewalk to complete gaps in existing network; Improve signal operations; Replace striped islands with raised medians; Create second entrance to Woodstock Square Shopping Center to improve operations at existing entrance on Henry Ford Drive.	Short-Term	$2,200,000
Route 42 / Henry Ford Drive	Evaluate Partial Median U-Turn Innovative Intersection as warranted by future intersection operations to preserve interstate ramp operations.	Long -Term	$1,900,000
Route 42 / Hisey Avenue	Improve Pedestrian Crossing with Actuated Pedestrian Signals and Crosswalk; Add sidewalk to complete gaps in existing network (shared use path on north side of Route 42); Improve signal operations; Replace striped islands with raised medians.	Short-Term	$1,600,000
Northwest Connector	New location 2-lane roadway connecting Hisey Avenue to Spring Street (approx. 1-mile) with curb and gutter and shared use path on one side.	Long-Term	$9,000,000