ARTERIAL
PRESERVATION PROGRAM

Arterial Preservation Plan: Route 220 Corridor

VDOT Salem District

Prepared for:

VDOT

1401 East Broad Street, Richmond, VA 23219

Prepared by:

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April 2020 | Final Report

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List of Acronyms

APN - Arterial Preservation Network

APP - Arterial Preservation Program

AADT - Annual Average Daily Traffic

AASHTO - American Association of State Highway and Transportation Officials

CoSS - Corridor of Statewide Significance

EDTT - Extra Distance Travel Time

ETT - Experienced Travel Time

HCM - Highway Capacity Manual

LOS - Level of Service

MES - Mobility Enhancement Segment

MPS - Mobility Preservation Segment

MOE - Measure of Effectiveness

MUT - Median U-Turn

MUTCD - Manual of Uniform Traffic Control Devices

PDO - Property Damage Only

PHF - Peak Hour Factor

PSAP - Pedestrian Safety Action Plan

PSI - Potential for Safety Improvement

RCUT - Restricted Crossing U-Turn

RNS - Roadway Network System

SPS - Statewide Planning System

TIA - Traffic Impact Analysis

TMC - Turning Movement Count

TOSAM - Traffic Operations and Safety Analysis Manual

TRB - Transportation Research Board

TSN - Targeted Safety Need

v/c – Volume-to-Capacity Ratio

VDOT - Virginia Department of Transportation

VJuST - VDOT Junction Screening Tool

Table of Contents

1. Arterial Preservation Program Overview 4
1.1 Program Goals and Strategies 4
1.2 Arterial Preservation Network 4
2. Route 220 Corridor 5
2.1 Study Team 7
2.2 Public Outreach 7
2.3 Previous Studies 7
2.4 VTrans 8
2.4.1 Tier 1 Recommendations 8
2.4.2 Mid-term Needs 9
2.5 Park and Ride Locations 10
3. Existing and Future Land Use 11
4. Corridor Segmentation 11
4.1 Corridor Segmentation 11
4.2 Emerging Intersections 14
5. Data Collection and Inventory 16
6. Safety Analysis 16
6.1 Summary of Study Area Crashes 16
6.2 Potential for Safety Improvement 17
6.3 Roadway Departure Crashes 20
6.4 Emerging Intersection Crashes 22
6.5 Bicycle and Pedestrian Crashes 23
7. Access Management Spacing 23
8. Signal Justification Review 24
8.1 MUTCD Signal Warrant Results 25
8.2 Planning Level Signal Warrant Results 27
9. Traffic Analysis 28
9.1 Existing Conditions 28
9.1.1 Traffic Analysis Assumptions 28
9.1.2 Traffic Analysis Results 29
9.2 Traffic Forecasting 32
9.2.1 Traffic Growth Rate Development 32

9.3 No-Build Conditions 32
9.3.1 Traffic Analysis Assumptions 32
9.3.2 Traffic Analysis Results....32
10. Alternatives and Proposed Recommendations 35
11. Recommendations 37
11.1 Build Conditions....39
11.1.1 Traffic Analysis Assumptions 39
11.1.2 Traffic Analysis Results....39
11.2 Planning-Level Cost Ranges....42

List of Figures

Figure 1: Route 220 Study Corridor....6
Figure 2: Park and Ride Investment Strategy Locations Along the Route 220 Corridor 10
Figure 3: Route 220 Segmentation Map....12
Figure 4: Route 220 Emerging Intersections 16
Figure 5: Heat Map of Roadway Departure Crashes (2012-2016)....21
Figure 6: Traffic Growth Rates 33
Figure 7: Concept Development Considerations 36

List of Tables

Table 1: Previous Studies and Comprehensive Plans 8
Table 2: VTrans Mid-term Needs 9
Table 3: Park and Ride investment Strategy Locations along the Route 220 Corridor....10
Table 4: Route 220 Segmentation Limits....13
Table 5: 2012 – 2016 Route 220 Crashes by Year and Severity 17
Table 6: PSI Intersections 18
Table 7: PSI Segments 19
Table 8: TSN Intersections....20
Table 9: TSN Segments....20
Table 10: Roadway Departure Crashes by Year and Severity (2012-2016) 21
Table 11: Emerging Intersection Crashes By Severity (2012-2016) 22
Table 12: Emerging Intersection Crashes By Severity Continued (2012-2016) 23
Table 13: Minimum Spacing Standards For Commercial Entrances, Intersections, and Median Crossovers....24
Table 14: Signal Warrant Analysis Results....25
Table 15: Signal Warrant Analysis Results Continued....26
Table 16 : Planning Level Signal Warrant Analysis Results....27
Table 17 : Planning Level Signal Warrant Analysis Results Continued....28
Table 18: Level of Service Criteria 29

Table 19: Existing (2018) Unsignalized Delay and LOS 30
Table 20: Existing (2018) Signalized Delay and LOS 31
Table 21: Existing (2018) Lane Groups where 95th Percentile Volumes Exceed Capacity.....31
Table 22: No-Build (2040) Unsignalized Delay and LOS 34
Table 23: No-Build (2040) Signalized Delay and LOS 35
Table 24: No-Build (2040) Lane Groups where 95th Percentile Volumes Exceed Capacity.....35
Table 25: Emerging Intersection Alternatives 37
Table 26: Emerging Intersection Alternatives Continued 38
Table 27: ETT LOS Criteria.....39
Table 28: Build (2040) Unsignalized Delay and LOS.....41
Table 29: Build (2040) Signalized Delay and LOS.....42
Table 30: Build (2040) Lane Groups where 95th Percentile Volumes Exceed Capacity 42
Table 31: Planning Level Cost Ranges 43

Appendices

Appendix A – Existing and Future Land Use

Appendix B – Traffic Data

Appendix C – Safety Analysis

Appendix D – Traffic Signal Warrants

Appendix E – Existing Operational Analysis

Appendix F – No-Build Operational Analysis

Appendix G – Alternatives Evaluation

Appendix H – Corridor Recommendations and Intersection Alternative

Concepts Appendix I – Build Operational Analysis

1. Arterial Preservation Program Overview

1.1 Program Goals and Strategies

The Virginia Department of Transportation (VDOT) initiated the development of the **Arterial Preservation Program** in the spring of 2017. The purpose of the **Arterial Preservation Program** is to preserve and enhance the operational capacity and safety of the critical transportation highways included in the **Arterial Preservation Network**, while ensuring that:

- Mainline through traffic is served with priority
- Future land use and economic development is supported
- Access points and traffic control do not degrade travel speed and safety
- Safety is improved

The **Arterial Preservation Program** utilizes a toolbox of preservation and enhancement strategies to improve the current state of the corridor as well as progress future planning efforts. These strategies promote innovative transportation solutions to minimize delays for through traffic and improve safety while incorporating local economic development goals.

Arterial Preservation Plans are developed in partnership with localities for **Arterial Preservation Network** corridors to implement the following preservation and enhancement strategies:

- Integrate program priorities with local economic development goals
- Improve access management
- Educate community on the benefits of improved mobility
- Inspire comprehensive, transportation, and zoning planning efforts
- Eliminate unjustified traffic signals
- Implement innovative intersection configurations

1.2 Arterial Preservation Network

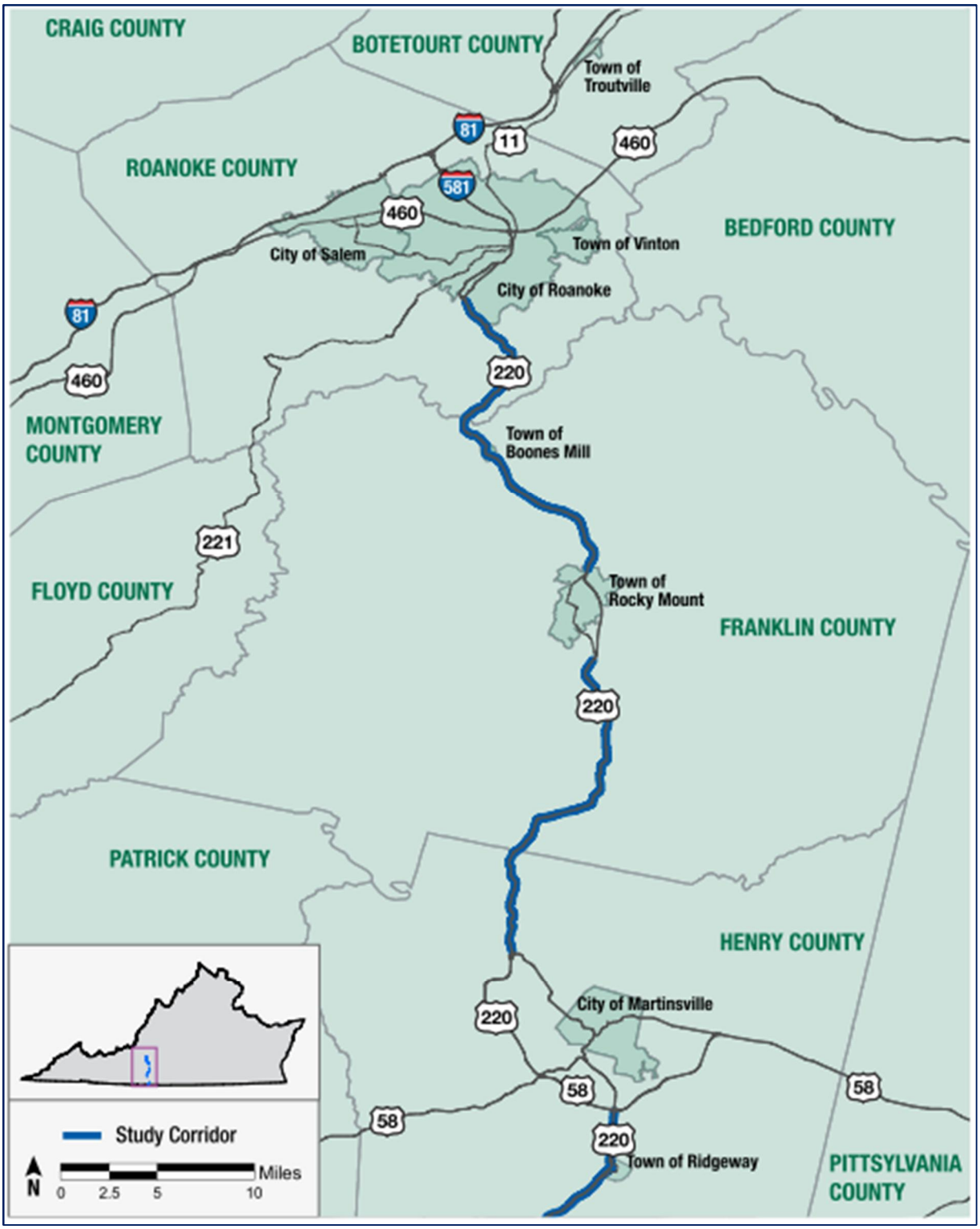
The **Arterial Preservation Network** is the state-maintained portion of the National Highway System in Virginia including some additional highways that facilitate connectivity. Over time, additional facilities may be added to further enhance connectivity should the need arise. More information on the **Arterial Preservation Program**, including an interactive map of the **Arterial Preservation Network**, can be found at http://www.virginiadot.org/programs/vdot_arterial_preservation_program.asp.

2. Route 220 Corridor

The purpose of the Route 220 Arterial Preservation Plan is to preserve and enhance the operational capacity of and improve safety along the corridor. The goal of this plan is to identify localized recommendations to preserve and enhance this key transportation corridor. These recommendations are primarily focused on shorter-term, lower cost improvements aimed at preserving capacity and improving safety, but do not necessarily address all current or future needs along the corridor.

The study corridor includes Route 220 from Southern Lane at the City of Roanoke limits to the North Carolina state line. The limited access portions of the corridor were not included (i.e., Town of Rocky Mount and City of Martinsville). The Route 220 corridor is a Corridor of Statewide Significance (CoSS) that connects major centers of activity and accommodates both inter-city travel and inter-state traffic. A map of the study corridor is shown in **Figure 1**.

FIGURE 1: ROUTE 220 STUDY CORRIDOR



2.1 Study Team

A Study Team was formed to provide local input and feedback to help guide the development of preferred alternatives during the APP planning process. The Study Team comprised of:

- VDOT District Land Use
- VDOT District Planning
- VDOT District Location and Design
- VDOT District Traffic Engineering
- VDOT Residency Offices
- VDOT Transportation and Mobility Planning Division
- Town of Boones Mill
- Roanoke County and City
- Franklin County
- Henry County
- Roanoke Valley – Alleghany Regional Commission
- West Piedmont Planning District Commission
- Kimley-Horn

2.2 Public Outreach

Four corridor-wide citizen information meetings were held during the study:

- Roanoke County
  - November 7, 2019 at the Clearbrook Elementary School
- Franklin County
  - July 19, 2018 at the Essig Recreation Center
  - November 13, 2019 at the Essig Recreation Center
- Henry County
  - November 14, 2019 at the Henry County Government Center

The purpose of the meetings was to receive comments on the preliminary recommendations along the study corridor. Members of the public were invited to provide comments on the preliminary recommendations of the corridor. Feedback received from the public was further reviewed with the stakeholders and revisions were made to the corridor recommendations where possible to address comments received.

2.3 Previous Studies

Relevant studies and plans completed in the study area were compiled and reviewed to identify previous recommendations along the study corridor. These studies and plans are listed in **Table 1**.

TABLE 1: PREVIOUS STUDIES AND COMPREHENSIVE PLANS

Previous Studies and Comprehensive Plans	Year
Previous Studies and Studies Currently Underway	
Roanoke County Department of Community Development Route 220 Corridor Study	2007
Roanoke Valley Alleghany Regional Commission Route 220 Corridor Review	2008
High Risk Rural Roads Study: Route 220 at Route 605	2009
High Risk Rural Roads Study: Route 220 at Route 739	2009
Virginia Statewide Multimodal Freight Study- Route 220 Multimodal Corridor	2010
West Piedmont Planning District Commission: Corridors of Statewide Significance North Carolina to West Virginia Corridor- Route 220	2013
VDOT's Park & Ride Investment Strategy	2014
Board of Supervisors of Franklin County Route 220-North Corridor Plan	2016
VTrans 2040 Multimodal Transportation Plan- North Carolina to West Virginia Corridor	2016
Martinsville Southern Connector Study	Underway
Comprehensive Plans	
County of Henry	1995
City of Roanoke	2001
Roanoke County	2005
Franklin County	2007
City of Martinsville	2009
Town of Rocky Mount	2015

2.4 VTrans

2.4.1 Tier 1 Recommendations

On January 10, 2010, the Commonwealth Transportation Board passed a resolution that funds from VDOT and the Department of Rail and Public Transit (DRPT) should be limited to needs identified in the Statewide Transportation Plan (VTrans) Tier 1 recommendations. VTrans Tier 1 recommendations focus on critical needs for Virginia's Corridors of Statewide Significance, Regional Networks, and Urban Development Areas for the years 2015-2025. The recommendations for the Route 220 study corridor were reviewed and incorporated into the final solution set for the corridor. The recommendations include:

- SA35 Route 220 Safety and Corridor Improvements in Franklin and Roanoke Counties, multi-jurisdictional
    - *Safety and Corridor Improvements on Route 220 in Franklin and Roanoke Counties (approximately 34 miles). Improve sweeping turns and narrow shoulders to accommodate truck traffic. Correct safety issues at/between Goose Dam Rd and Henry Rd, and between Iron Ridge Rd and Wooddale Dr in Franklin County. Review and improve or consolidate crossovers. Improve drainage in problematic areas.*

- SA36 Route 220 Access Management and Corridor Improvements Strategies in Henry, Franklin, and Roanoke Counties, multi-jurisdictional
    - *Develop and implement access management projects along Route 220 from the Roanoke City/ Roanoke County line to the Henry County/North Carolina line (approximately 47 miles). This is to improve safety and maintain the capacity and reliability of the corridor.*

2.4.2 Mid-term Needs

In addition to the Tier 1 recommendations, the Commonwealth Transportation Board passed resolution on the 2019 VTrans Mid-term needs that identified specific transportation needs that move Virginia towards achieving the long-term vision in January 2020. These Mid-term needs are location specific, data-driven, and linked to a distinct timeframe (0-10 years).

For intersections, the VTrans needs were categorized by the following: Need for Rail on-Time Performance, Need for Transit Access, Need for Safety Improvement, and Need for Improved Access to Industrial and Economic Development Area with Readiness Status 3 or higher. **Table 2** summarizes the study area intersections (detailed in **Section 4.2**) and their respective needs from the Mid-term needs analysis.

TABLE 2: VTRANS MID-TERM NEEDS

Intersection ID	Intersection	Mid-term Need
2	Route 220 at Matrimony Creek Road	Safety Improvement
3	Route 220 at Lee Ford Camp Road/Church Street	Safety Improvement
4	Route 220 at Morehead Avenue	Safety Improvement
10	Route 220 at Henry Road	Safety Improvement
11	Route 220 at Pleasant Hill Road	Safety Improvement
13	Route 220 at Bonbrook Mill Road	Safety Improvement
14	Route 220 at Iron Ridge Road	Safety Improvement
20	Route 220 at Grassy Hill Road	Safety Improvement
25	Route 220 at Naff Road	Safety Improvement
27	Route 220 at Webb Road	Safety Improvement
29	Route 220 at Davis Boone Road	Safety Improvement
31	Route 220 at Indian Grave Road/Clearbrook Village Lane	Safety Improvement

In addition to the intersections, several segments along Route 220 were identified in the Mid-term needs analysis. The needs for these Route 220 segments mainly consisted of the following:

- Capacity Preservation
- Transportation Demand Management
- Congestion Mitigation

Additional intersections and segments along Route 220 outside of the study area were identified for needs and can be found on the VTrans website: http://www.vtrans.org/mid-term-planning/mid-term-needs.

2.5 Park and Ride Locations

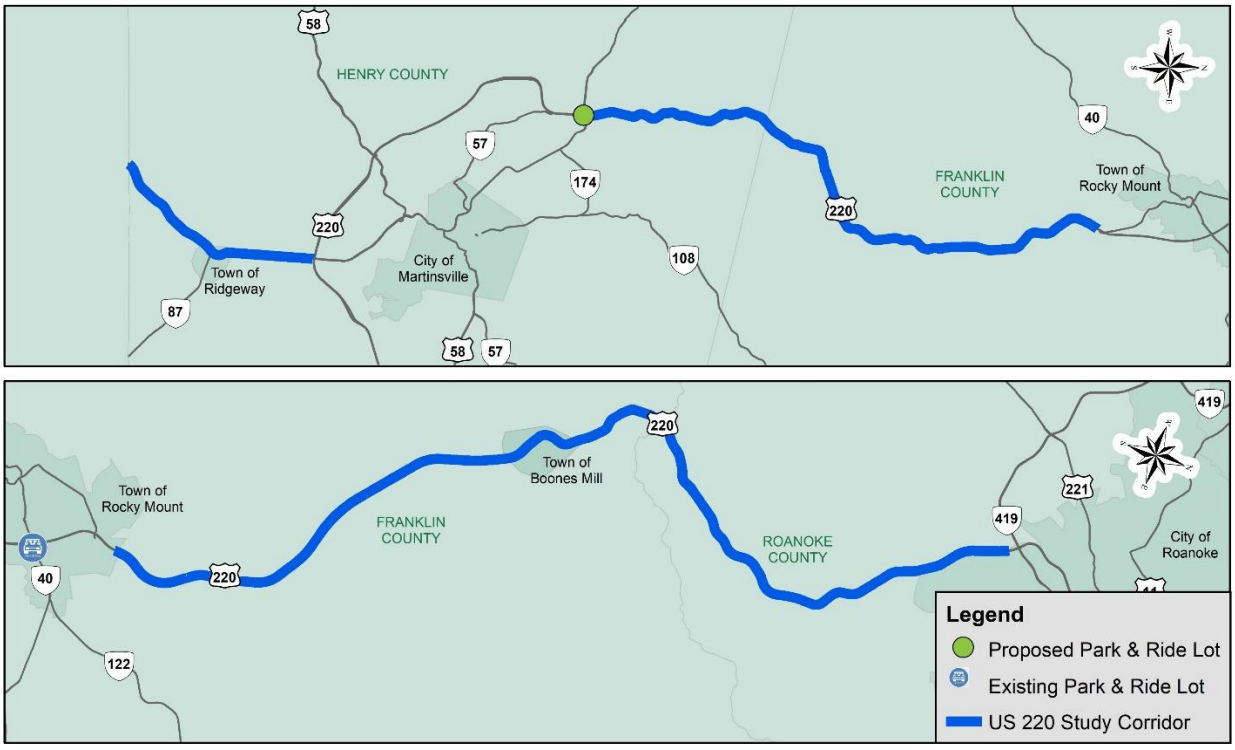
In 2014, VDOT completed a Park and Ride investment strategy study to determine where investments in Park and Ride lots are needed across the Commonwealth of Virginia. The recommendations include new Park and Ride lots, lot expansions, and safety improvements at existing Park and Ride lots. The Park and Ride lot investment strategy locations along the Route 220 corridor are summarized in **Table 3** and presented in **Figure 2**.

TABLE 3: PARK AND RIDE INVESTMENT STRATEGY LOCATIONS ALONG THE ROUTE 220 CORRIDOR

ID	Site	Jurisdiction	Description
A	SAL-9	Franklin County	Expand lot along Route 40 near Route 220
B	SAL-12	Henry County	Construct new lot along Route 220 at Route 57 (Fairystone Park Highway)

Source: VDOT Park & Ride Program Investment Strategy

FIGURE 2: PARK AND RIDE INVESTMENT STRATEGY LOCATIONS ALONG THE ROUTE 220 CORRIDOR



3. Existing and Future Land Use

The existing and future land use maps for Roanoke County, Franklin County, and Henry County are presented in **Appendix A**.

The Roanoke County Comprehensive Plan identifies a core and transition area parallel to Route 220. The core areas are areas where high intensity urban development is present and encouraged for the future. Core areas consist of larger scale highway-oriented retail uses and regionally based shopping facilities. Transition areas consist of areas where orderly development of highway frontage parcels is present and encouraged. These areas discourage intense retail and highway oriented commercial uses but encourage office, institutional, and small-scale, coordinated retail uses.

The *Franklin County Comprehensive Plan* identifies a majority of the land adjacent to Route 220 as Low Density Residential with several commercial highway corridors along Route 220 north and south of Rocky Mount as part of the future land use plan. These commercial highway corridors consist of linear commercial development along Route 220 intended to provide development opportunities extending behind the parcels that front Route 220. In addition, the Towns of Rocky Mount and Boones Mill are also designated as commercial centers for business, shopping and employment.

The *Henry County Comprehensive Plan* identifies a majority of the land paralleling the Route 220 corridor as “growth areas”. These areas are defined by available or planned transportation networks, utilities available for future service, and physical viability for development (without impacting environmentally sensitive areas).

4. Corridor Segmentation

4.1 Corridor Segmentation

The corridor was divided into segments to develop recommendation strategies for areas with similar safety, traffic operations, and land use characteristics. The segmentation was based on the existing and future land uses, previous studies, traffic data, crash data, LandTrack data, Land Use Permitting System (LUPS) data, and input from the VDOT Salem District. The LandTrack system is used to track VDOT’s review of traffic impact analysis (TIA) for proposed land development projects. LUPS is a VDOT database that houses all of the land use permits throughout the state. Corridor segments for Route 220 were categorized into the following segment types:

- **Developed Segments:** have an existing concentration of residential, commercial, manufacturing, and industrial land development. These segments have a higher density of existing access points and often include a series of signalized intersections. The goals for developed segments are to improve the efficiency and safety of the segment through a retrofit strategy by eliminating unwarranted traffic signals, improving access management spacing, and exploring innovative intersection configurations.
- **Emerging Segments:** are stretches of roadway that have active development or high potential for increased development within 10 years. These segments are often adjacent to developed segments or are adjacent to segments where limited access

designations terminate. The goals for emerging segments are to develop a corridor management strategy to maintain and protect the efficiency of the segment while promoting and facilitating local economic development goals.

- **Stable Segments:** may experience sporadic development but the land use is expected to remain consistent over the long term. These segments often traverse between developed and emerging segments. The goals for stable segments are to preserve the efficiency of the segment by promoting increased access management spacing and identifying spot intersection improvements.

The corridor was divided into 13 segments: one developed segment (0.9 total miles), six emerging segments (7.9 total miles), and six stable segments (33.5 total miles). The segments are shown in **Figure 3** and the limits are described in **Table 4**.

FIGURE 3: ROUTE 220 SEGMENTATION MAP

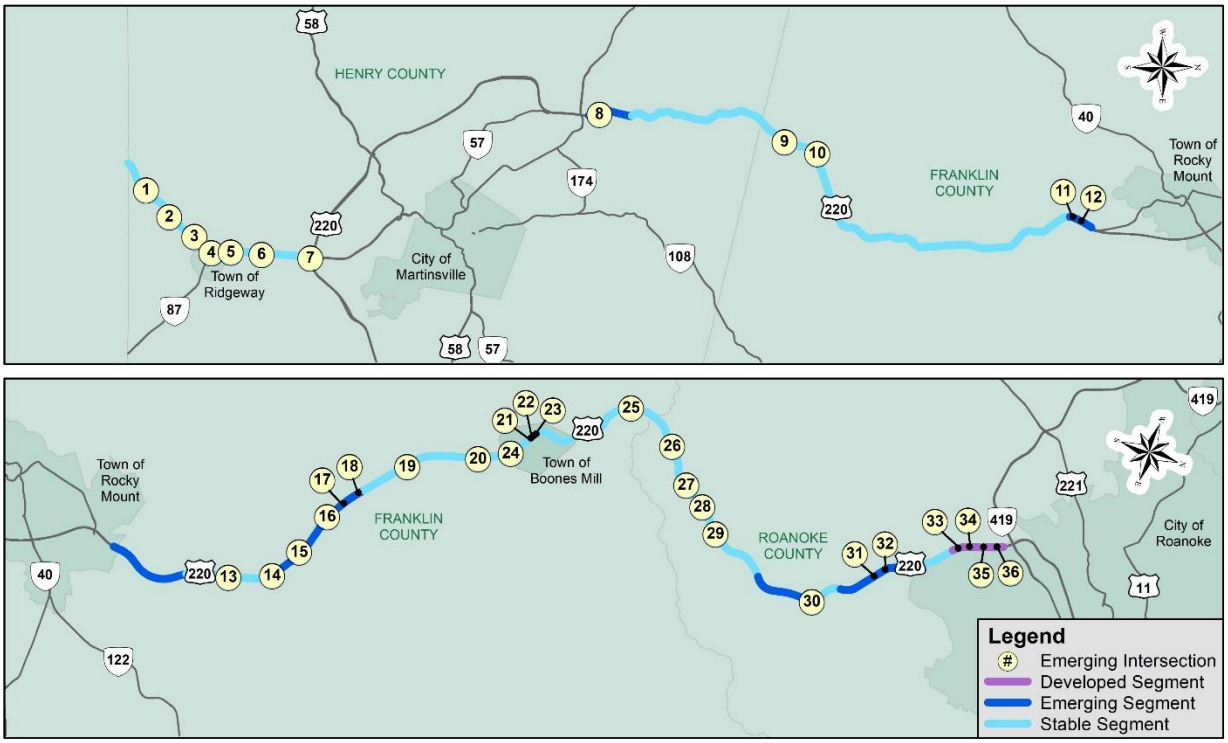


TABLE 4: ROUTE 220 SEGMENTATION LIMITS

Segment ID	Category	Route	Limits
1	Stable	Route 220	NC State Line to Route 58 Interchange
2	Emerging	Route 220	VA Route 57 Interchange to 250' north of White Tail Ln
3	Stable	Route 220	250' north of White Tail Lane to 400' south of Route 619 (Pleasant Hill Rd)
4	Emerging	Route 220	400' south of Route 619 (Pleasant Hill Rd) to Route 220 BUS Junction Ramps
5	Emerging	Route 220	Cornell Rd to Route 983 (Shady Ln)
6	Stable	Route 220	Route 983 (Shady Ln) to 600' south of Route 775 (Iron Ridge Rd)
7	Emerging	Route 220	600' south of Route 775 (Iron Ridge Rd) to 550' north of Ellwood Wray Dr
8	Stable	Route 220	550' north of Ellwood Wray Dr to Red Hill Rd
9	Emerging	Route 220	Red Hill Rd to 500' north of Route 668 (Yellow Mountain Rd)
10	Stable	Route 220	500' north of Route 688 (Yellow Mountain Rd) to 500' south of Suncrest Drive
11	Emerging	Route 220	500' south of Suncrest Drive to Junction with Blue Ridge Parkway
12	Stable	Route 220	Junction with Blue Ridge Parkway to 500' south of Route 789 (Old Rocky Mount Rd)
13	Developed	Route 220	500' south of Route 789 (Old Rocky Mount Rd) to VA Route 419/Route 220 BUS Junction

4.2 Emerging Intersections

Emerging intersections are existing intersections that experience safety, operational or congestion issues, or are expected to see an increase in demand due to planned or active development on the intersecting route. The goals for emerging intersections are to strategically target spot improvements and explore innovative intersection configurations to maintain or improve the safety and operations of the arterial. The following criteria were used to identify emerging intersections along the Route 220 corridor:

- Signalized intersections
- Potential for Safety Improvement (PSI) intersections
- Targeted Safety Need (TSN) intersections
- Junction of two primary routes
- Minor Street ADT ≥ 10% of major street ADT
- Crashes
- Intersections that will experience heavy increases in traffic due to future development
- Park & Ride investment strategy intersection
- District input

The preliminary list of emerging intersections was further narrowed based on the following criteria:

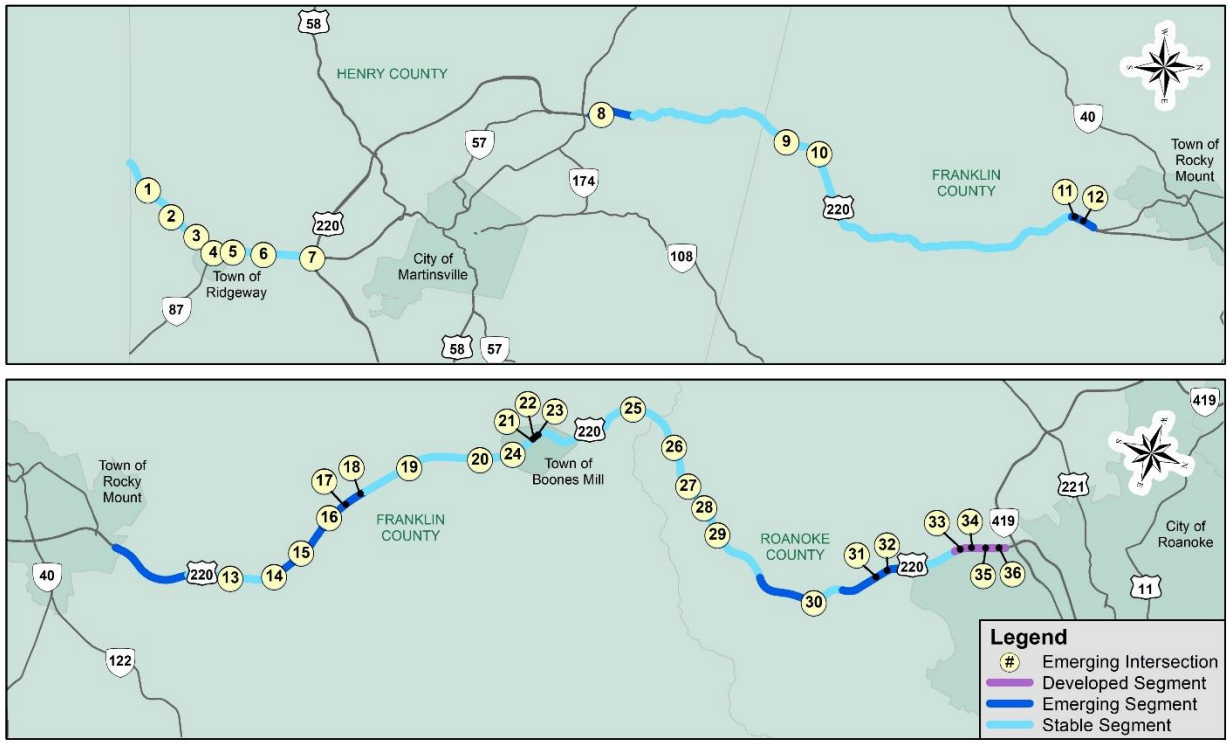
- Signalized intersection
- Targeted Safety Need (TSN) intersections
- PSI intersection rank ≤ 50
- Previous study recommendations
- Adjacent to future development

The emerging intersections identified along the Route 220 corridor are listed below and presented in **Figure 4**. The intersections shown in *italicized* text represent the intersections that have existing concepts previously developed or concepts are under development by VDOT to be included in this report.

1. Route 220 (Greensboro Road) at Route 689 (Reservoir Road)
2. Route 220 (Greensboro Road) at Route 734 (Matrimony Creek Road)
3. Route 220 (Greensboro Road) at Route 688 (Lee Ford Camp Road)/Route 220 BUS (Church Street)
4. Route 220 (Greensboro Road) at Route 87 (Morehead Avenue)
5. Route 220 (Greensboro Road) at Route 687 (Soapstone Road)/Route 220 BUS (Main Street)
6. Route 220 (Greensboro Road) at Route 1360 (Water Plant Road)
7. Route 220 (Greensboro Road) at Route 58 EB Ramps
8. *Route 220 (Virginia Avenue) at Route 1210 (Dyer Street)*
9. Route 220 (Virgil H Goode Highway) at Route 609 (Country Ridge Road)
10. Route 220 (Virgil H Goode Highway) at Route 605 (Henry Road)
11. Route 220 (Virgil H Goode Highway) at Route 619 (Pleasant Hill Road)
12. Route 220 (Virgil H Goode Highway) at Route 816 (Cassell Drive)/Route 619 (Sontag Road)

13. Route 220 (Virgil H Goode Highway) at Route 635 (Bonbrook Mill Road)
14. Route 220 (Virgil H Goode Highway) at Route 775 (Iron Ridge Road)
15. *Route 220 (Virgil H Goode Highway) at Route 697 (Wirtz Road)*
16. *Route 220 (Virgil H Goode Highway) at Route 1210 (Link Street)*
17. *Route 220 (Virgil H Goode Highway) at Route 697 (Brick Church Road)*
18. Route 220 (Virgil H Goode Highway) at Farm Road (Green Level Road)
19. Route 220 (Virgil H Goode Highway) at Route 691 (Taylors Rd)
20. Route 220 (Virgil H Goode Highway) at Route 919 (Grassy Hill Road)
21. *Route 220 (Virgil H Goode Highway) at Route 1605 (Whispering Creek Road)*
22. *Route 220 (Virgil H Goode Highway) at Route 684 (Church Hill Street)*
23. *Route 220 (Virgil H Goode Highway) at Route 739 (Bethlehem Road)*
24. *Route 220 (Virgil H Goode Highway) at Route 1602 (Boon Street)*
25. Route 220 (Virgil H Goode Highway) at Route 613 (Naff Road)
26. Route 220 (Franklin Road) at Route 667 (Spotswood Rd)/Route 677 (Willow Branch Road)
27. Route 220 (Franklin Road) at Route 615 (Webb Road)
28. Route 220 (Franklin Road) at Route 615 (Starlight Lane)/Shadow Hollow Lane
29. Route 220 (Franklin Road) at Route 770 (Davis Boone Road)
30. Route 220 (Franklin Road) at Route 668 (Yellow Mountain Road)
31. *Route 220 (Franklin Road) at Route 675 (Indian Grave Road/Clearbrook Village Lane)*
32. *Route 220 (Franklin Road) at Route 679 (Buck Mountain Road)/Route 766 (Stable Road)*
33. *Route 220 (Franklin Road) at Route 789 (Old Rocky Mount Road)*
34. *Route 220 (Franklin Road) at Crossbow Circle/Pheasant Ridge Road*
35. *Route 220 (Franklin Road) at Valley Avenue/Southern Hills Drive*
36. *Route 220 (Franklin Road) at Southern Lane SW*

FIGURE 4: ROUTE 220 EMERGING INTERSECTIONS



5. Data Collection and Inventory

A preliminary field review of the study area was conducted March 28-30, 2018 to observe existing geometric conditions, traffic control devices, peak hour traffic conditions, and driver behavior. Turning movement counts were performed on March 20, 2018. VDOT provided crash data, existing traffic signal timing plans, and traffic signal design plans. Traffic data is provided in **Appendix C**.

6. Safety Analysis

Crash data for the study area was used to evaluate corridor safety and identify crash patterns. VDOT Roadway Network System (RNS) crash data was obtained for the latest available five years of crash data (January 1, 2012 to December 31, 2016). The following sections provide a summary of the crashes that occurred within the project study area during the five-year crash analysis period.

6.1 Summary of Study Area Crashes

Over the 5-year crash analysis period, 2,193 crashes were reported in the study area. Of the reported crashes, there were 21 fatal crashes, 183 serious injury crashes, 427 minor/possible injury crashes, 129 no apparent injury crashes, and 1,433 crashes involving property damage only. A yearly summary of crashes, by crash severity, is shown in **Table 5**.

TABLE 5: 2012 – 2016 ROUTE 220 CRASHES BY YEAR AND SEVERITY

Year	Fatal Crashes	Serious Injury Crashes	Minor/ Possible Injury Crashes	No Apparent Injury Crashes	Property Damage Only Crashes	Total
2012	4	42	81	25	303	455
2013	3	36	95	20	306	460
2014	6	39	86	29	261	421
2015	2	33	79	26	292	432
2016	6	33	86	29	271	425
Total	**21**	**183**	**427**	**129**	**1,433**	**2,193**

6.2 Potential for Safety Improvement

Annually, all intersections and roadway segments within the Virginia Department of Transportation (VDOT) linear referencing system (LRS) are evaluated for the potential for safety improvement (PSI) based on the Highway Safety Manual (HSM) methodology by VDOT. The crash frequency, severity of crashes, volume, and length of segment are contributing factors in the predictive analysis. Crash predictions based on the safety performance function (SPF) crash data files are made for intersections and segments. Within the study area, there were 18 intersections and 11 segments on the Route 220 study corridor that were identified in VDOT Salem District's list for PSI. The intersections and segments are shown in **Table 6** and **Table 7**, respectively.

TABLE 6: PSI INTERSECTIONS

Intersection ID	Intersection	2016 PSI Rank (Salem District)	Intersection Studied?
3	Route 220 at Lee Ford Camp Road/Church Street	44	Yes – Emerging Intersection
4	Route 220 at Morehead Avenue	56	Yes – Emerging Intersection
8	Route 220 at Dyer Street	96	Yes – Emerging Intersection
11	Route 220 at Pleasant Hill Road	75	Yes – Emerging Intersection
12	Route 220 at Cassell Drive/Sontag Road	137	Yes – Emerging Intersection
13	Route 220 at Bonbrook Mill Road	46	Yes – Emerging Intersection
14	Route 220 at Iron Ridge Road	133	Yes – Emerging Intersection
17	Route 220 at Brick Church Road	148	Yes – Emerging Intersection; Part of Summit View Development
20	Route 220 at Grassy Hill Road	16	Yes – Emerging Intersection
22	Route 220 at Church Hill Street	104	Yes – Emerging Intersection; Existing Concept Developed
25	Route 220 at Naff Road	38	Yes – Emerging Intersection
26	Route 220 at Spotswood Drive/Willow Branch Road	97	Yes – Emerging Intersection
27	Route 220 at Webb Road	58	Yes – Emerging Intersection
28	Route 220 at Starlight Lane/Shadow Hollow Lane	90	Yes – Emerging Intersection
29	Route 220 at Davis Boone Road	153	Yes – Emerging Intersection
31	Route 220 at Indian Grave Road/Clearbrook Village Lane	67	Yes – Emerging Intersection; VDOT developing concept
NA	Route 220 at Stable Road/Blue Ridge Parkway Ramps	143	No
35	Route 220 at Valley Avenue/Southern Hills Drive	33	Yes – Emerging Intersection; VDOT developing concept

TABLE 7: PSI SEGMENTS

Location	2016 PSI Rank (Salem District)
Route 220 from Murry Hill Lane to Double Branch Road	389
Route 220 from Double Branch Road to Reed Creek Drive	164
Route 220 from Shady Lane to Bonbrook Mill Road	290
Route 220 from Spotswood Drive to Webb Road	312
Route 220 from Reed Hill Road to Crowell Gap Road	262
Route 220 from Yellow Mountain Road to Suncrest Drive	253
Route 220 from Clearbrook Lane to 1,000' North of Clearbrook Lane	325
Route 220 from 1,000' North of Clearbrook Lane to 1,100' South of Clearbrook Village Lane	248
Route 220 from 1,100' South of Clearbrook Village Lane to Clearbrook Village Lane	297
Route 220 from Buck Mountain Road to Stable Road	230
Route 220 from Hunting Hills Drive to Old Rocky Mount Road	228

VDOT also identified Targeted Safety Need (TSN) locations, which are intersections or segments where the actual number of crashes is greater than expected for three or more years during the 2012 – 2016 analysis period. Within the study area, there were 11 intersections and three segments on Route 220 that were identified as TSN locations. The intersections and segments are listed in **Table 8** and **Table 9**, respectively.

TABLE 8: TSN INTERSECTIONS

Intersection ID	Intersection	2016 PSI Rank (Salem District)	Intersection Studied?
3	Route 220 at Lee Ford Camp Road/Church Street	44	Yes – Emerging Intersection
4	Route 220 at Morehead Avenue	56	Yes – Emerging Intersection
11	Route 220 at Pleasant Hill Road	75	Yes – Emerging Intersection
13	Route 220 at Bonbrook Mill Road	46	Yes – Emerging Intersection
14	Route 220 at Iron Ridge Road	133	Yes – Emerging Intersection
20	Route 220 at Grassy Hill Road	16	Yes – Emerging Intersection
25	Route 220 at Naff Road	38	Yes – Emerging Intersection
26	Route 220 at Spotswood Drive/Willow Branch Road	97	Yes – Emerging Intersection
27	Route 220 at Webb Road	58	Yes – Emerging Intersection
29	Route 220 at Davis Boone Road	153	Yes – Emerging Intersection
NA	Route 220 at Stable Road/Blue Ridge Parkway Ramps	143	No

TABLE 9: TSN SEGMENTS

Location	2016 PSI Rank (Salem District)
Route 220 from Reed Hill Road to Crowell Gap Road	262
Route 220 from Clearbrook Lane to 1,000' North of Clearbrook Lane	325
Route 220 from 1,000' North of Clearbrook Lane to 1,100' South of Clearbrook Village Lane	248

6.3 Roadway Departure Crashes

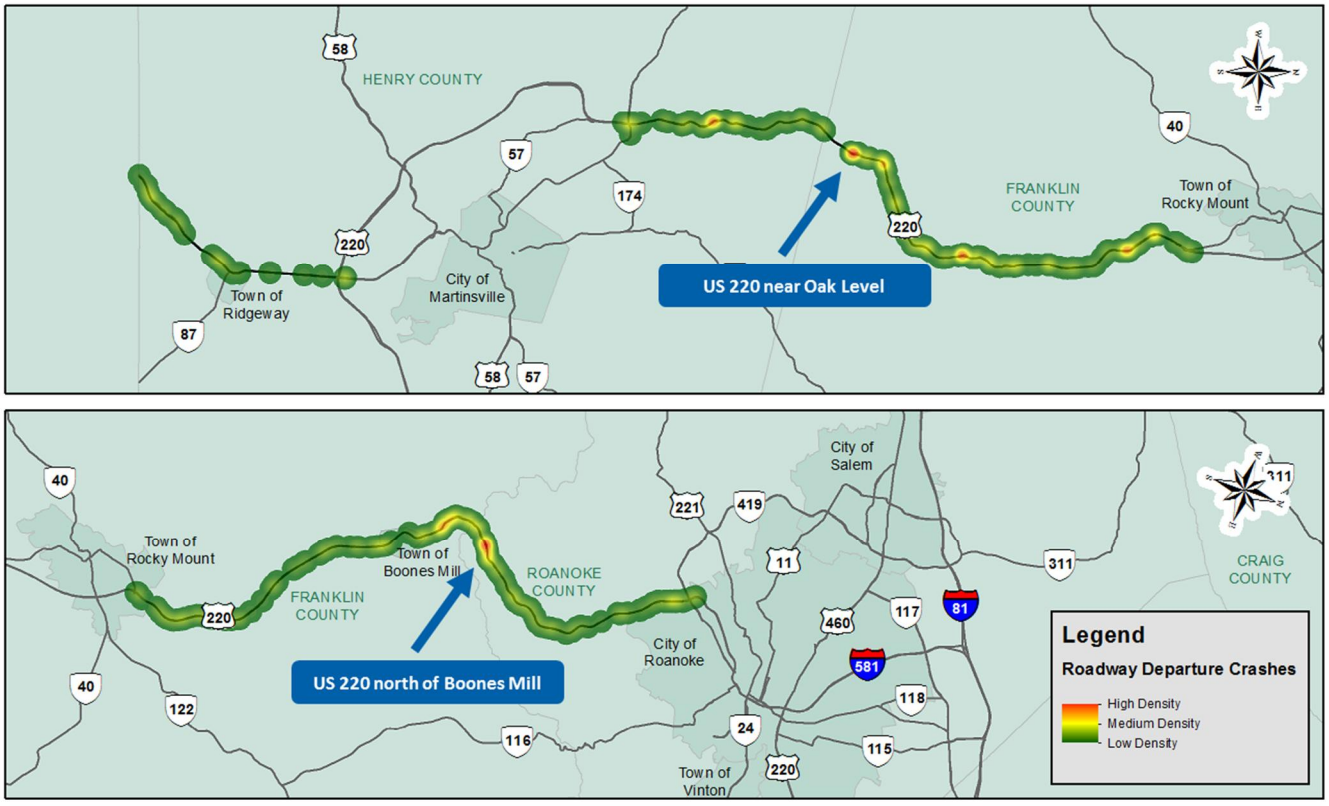
Roadway departure crashes are defined as when a vehicle which crosses the edge line, center line, or leaves the traveled way in another manner. The roadway departure crashes by year and severity are shown in **Table 10.** A density heat map, **Figure 5**, was created to identify the roadway departure hot spots along the corridor. The following locations were identified with the highest concentrations of roadway departure crashes:

- Route 220 near Oak Level
- Route 220 north of Boones Mill

TABLE 10: ROADWAY DEPARTURE CRASHES BY YEAR AND SEVERITY (2012-2016)

Year	Fatal Crashes	Serious Injury Crashes	Minor/ Possible Injury Crashes	No Apparent Injury Crashes	Property Damage Only Crashes	Total
2012	3	14	11	2	41	71
2013	1	10	18	3	40	72
2014	1	7	9	2	34	53
2015	0	8	15	3	37	63
2016	3	8	20	7	33	71
Total	**8**	**47**	**73**	**17**	**185**	**330**

FIGURE 5: HEAT MAP OF ROADWAY DEPARTURE CRASHES (2012-2016)



6.4 Emerging Intersection Crashes

Over the 2012 – 2016 analysis period, the crashes that occurred within the influence areas of the seven emerging intersections ranged from 0 at Route 220 at Reservoir Road to 42 at Route 220 at Indian Grave Road. The key crash statistics at each location are presented in **Appendix D**. **Table 11** and **Table 12** provide a summary of the emerging intersection crashes.

TABLE 11: EMERGING INTERSECTION CRASHES BY SEVERITY (2012-2016)

Intersection ID	Intersection	Fatal Crashes	Serious Injury Crashes	Minor/ Possible Injury Crashes	No Apparent Injury Crashes	Property Damage Only Crashes	Total
1	Route 220 at Reservoir Road	0	0	0	0	0	0
2	Route 220 at Matrimony Creek Road	0	0	0	0	0	0
3	Route 220 at Lee Ford Camp Rd/Church Street	0	1	7	2	15	25
4	Route 220 at Morehead Avenue	0	2	8	4	16	30
5	Route 220 at Soapstone Road/Main Street	0	2	2	1	9	14
6	Route 220 at Water Plant Road	0	2	3	0	8	13
7	Route 220 at Route 58 EB Ramps	1	3	7	2	11	24
8	Route 220 at Dyer Street	0	1	3	1	12	17
9	Route 220 at Country Ridge Road	1	2	0	0	3	6
10	Route 220 at Henry Road	0	2	4	0	8	14
11	Route 220 at Pleasant Hill	1	3	8	0	6	18
12	Route 220 at Cassell Road/Sontag Road	0	1	8	0	14	23
13	Route 220 at Bonbrook Mill Road	0	2	4	0	16	22
14	Route 220 at Iron Ridge Road	0	3	8	0	5	16
15	Route 220 at Wirtz Road	1	2	2	0	12	17
16	Route 220 at Link Street	0	0	0	0	0	0
17	Route 220 at Brick Church Road	0	2	3	0	5	10
18	Route 220 at Farm Road	0	0	0	0	1	1
19	Route 220 at Taylors Road	0	0	2	0	10	12
20	Route 220 at Grassy Hill Road	1	6	7	2	10	26
21	Route 220 at Whispering Creek Road	0	1	0	0	4	5
22	Route 220 at Church Hill Street	0	0	5	1	19	25
23	Route 220 at Bethlehem Rd	0	1	5	0	12	18

TABLE 12: EMERGING INTERSECTION CRASHES BY SEVERITY CONTINUED (2012-2016)

Intersection ID	Intersection	Fatal Crashes	Serious Injury Crashes	Minor/ Possible Injury Crashes	No Apparent Injury Crashes	Property Damage Only Crashes	Total
24	Route 220 at Boon Street	0	0	2	0	12	14
25	Route 220 at Naff Road	0	0	7	0	13	20
26	Route 220 at Spotswood Road/Willow Branch Rd	0	1	2	0	9	12
27	Route 220 at Webb Road	0	0	1	3	7	11
28	Route 220 at Starlight Lane/Shadow Hollow Lane	0	1	3	0	4	8
29	Route 220 at Davis Boone Road	0	1	2	3	4	10
30	Route 220 at Yellow Mountain Road	0	0	1	1	6	8
31	Route 220 at Indian Grave Road/Clearbrook Village Lane	0	0	6	8	28	42
32	Route 220 at Buck Mountain Road/Stable Road	0	0	7	3	22	32
33	Route 220 at Old Rocky Mount Rd	0	0	8	2	18	28
34	Route 220 at Crossbow Circle/ Pheasant Ridge Road	0	1	6	1	24	32
35	Route 220 at Valley Avenue/Southern Hills Drive	0	1	4	1	19	25
36	Route 220 at Southern Lane SW	0	2	5	1	30	38

6.5 Bicycle and Pedestrian Crashes

During the 2012 to 2016 analysis period, two bicycle crashes and eight pedestrian crashes were reported along the Route 220 study corridor. Of the eight pedestrian crashes, there were three fatal crashes, three serious injury crashes, and two minor injury crashes. Three of the pedestrian crashes occurred at an intersection.

In 2017, VDOT completed the *2012 – 2016 Pedestrian Crash Assessment* which led to the development of a Pedestrian Safety Action Plan (PSAP). The PSAP identifies locations with high pedestrian crash potential and recommends policies and countermeasures to improve pedestrian safety. There were no PSAP locations identified within the study area.

7. Access Management Spacing

The *VDOT Road Design Manual* provides access management design standards for entrances and intersections along roadways, which aim to provide access to land uses while preserving the flow of traffic. The standards are based on the functional classification and posted speed limit of the roadway. The Route 220 Corridor is classified as an “other principal arterial”, with speed limits ranging from 45 mph to 55 mph. The access management standards applicable to the roadway are listed in **Table 13**.

TABLE 13: MINIMUM SPACING STANDARDS FOR COMMERCIAL ENTRANCES, INTERSECTIONS, AND MEDIAN CROSSOVERS

Highway Functional Classification	Legal Speed Limit (mph)	Minimum Centerline to Centerline Spacing (Distance) in Feet			
		Spacing from Signalized Intersections to Other Signalized Intersections	Spacing from Unsignalized Intersections & Full Median Crossovers to Signalized or Unsignalized Intersections& Full Median Crossovers	Spacing from Full Access Entrances & Directional Median to Other Full Access Entrances and Any Intersection or Median Crossover	Spacing from Partial Access One or Two Way Entrances to Any Type of Entrance, Intersection or Median Crossover
Principal Arterial	≤ 30 mph 35 to 45 mph ≥ 50 mph	1,050 1,320 2,640	880 1,050 1,320	440 565 750	250 305 495

Source: VDOT Road Design Manual (Appendix F, Table 2-2)

One of the goals of the Arterial Preservation Program is to improve access management so access points and intersection control do not degrade travel speed and safety. The access point types and spacings were reviewed along the study corridor to evaluate if a different type of access point would improve operations and safety at locations and whether the spacing met the minimum VDOT standards

8. Signal Justification Review

An implementation strategy for the Arterial Preservation Program is to eliminate unjustified traffic signals. The purpose of the MUTCD and planning level warrant analyses was to identify the intersections that met the planning level warrants but also identify unsignalized improvements (e.g., innovative intersection configurations) to implement in place of installation of a signal. Improving traffic operations and safety at intersections without the installation of a signal supports the main goals of the Arterial Preservation Program in preserving and enhancing capacity and safety. It should be noted that prior to installation of a signal, a Signal Justification Report should be completed which consists of a detailed warrant analysis and provides justification of a signal based on volumes, crash patterns, and operational analysis.

Signal warrant analyses were conducted at the emerging intersections to determine if they meet the volume warrants from the 2009 Edition of the Manual of Uniform Traffic Control Devices (MUTCD). The MUTCD volume warrants specify that a signal may be justified if the volume of intersecting traffic crosses a certain threshold, or that the volume of mainline traffic is so high that the minor street traffic cannot find an acceptable gap to cross or merge with the mainline traffic. The thresholds look at the peak eight-hours, four-hours, and one-hour of a typical day.

8.1 MUTCD Signal Warrant Results

Table 14 and **Table 15** shows the results of the traffic signal warrant analysis for the existing traffic volumes at the 36 emerging intersections. The signal warrant analysis worksheets are provided in **Appendix D**.

TABLE 14: SIGNAL WARRANT ANALYSIS RESULTS

Intersection ID	Intersection	8-Hour Warrant Met?	4-Hour Warrant Met?	Peak Hour Warrant Met?	Result
1	Route 220 at Reservoir Road				Planning Analysis
2	Route 220 at Matrimony Creek Road	No	No	No	**Not Warranted**
3	Route 220 at Lee Ford Camp Rd/Church Street				Planning Analysis
4	Route 220 at Morehead Avenue				Planning Analysis
5	Route 220 at Soapstone Road/Main Street				Signalized
6	Route 220 at Water Plant Road				Signalized
7	Route 220 at Route 58 EB Ramps				Signalized
8	Route 220 at Dyer Street				Signalized
9	Route 220 at Country Ridge Road				Planning Analysis
10	Route 220 at Henry Road	No	Yes	No	**Warranted**
11	Route 220 at Pleasant Hill				Planning Analysis
12	Route 220 at Cassell Road/Sontag Road				Signalized
13	Route 220 at Bonbrook Mill Road	Yes	Yes	Yes	**Warranted**
14	Route 220 at Iron Ridge Road				Planning Analysis
15	Route 220 at Wirtz Road				Signalized
16	Route 220 at Link Street				VDOT Analysis
17	Route 220 at Brick Church Road				VDOT Analysis
18	Route 220 at Farm Road				Planning Analysis
19	Route 220 at Taylors Road	No	No	Yes	**Warranted**

TABLE 15: SIGNAL WARRANT ANALYSIS RESULTS CONTINUED

Intersection ID	Intersection	8-Hour Warrant Met?	4-Hour Warrant Met?	Peak Hour Warrant Met?	Result
20	Route 220 at Grassy Hill Road	No	Yes	Yes	**Warranted**
21	Route 220 at Whispering Creek Road				VDOT Analysis
22	Route 220 at Church Hill Street				VDOT Analysis
23	Route 220 at Bethlehem Road				VDOT Analysis
24	Route 220 at Boon Street				VDOT Analysis
25	Route 220 at Naff Road	No	No	Yes	**Warranted**
26	Route 220 at Spotswood Road/Willow Branch Rd				Planning Analysis
27	Route 220 at Webb Road				Planning Analysis
28	Route 220 at Starlight Lane/Shadow Hollow Lane				Planning Analysis
29	Route 220 at Davis Boone Road				Planning Analysis
30	Route 220 at Yellow Mountain Road	Yes	Yes	Yes	**Warranted**
31	Route 220 at Indian Grave Road/Clearbrook Village Lane				Signalized
32	Route 220 at Buck Mountain Road/Stable Road				Signalized
33	Route 220 at Old Rocky Mount Rd				Signalized
34	Route 220 at Crossbow Circle/ Pheasant Ridge Road				Signalized
35	Route 220 at Valley Avenue/Southern Hills Drive				Signalized
36	Route 220 at Southern Lane SW				Planning Analysis

8.2 Planning Level Signal Warrant Results

Planning level signal warrants were also conducted where 16-hour turning movement counts were not available. Four-hour turning movement counts and ADT projections were used to determine if the planning level signal warrants were met. **Table 16** and **Table 17** shows the results of the planning level traffic signal warrant analysis.

TABLE 16 : PLANNING LEVEL SIGNAL WARRANT ANALYSIS RESULTS

Intersection ID	Intersection	Condition A Minimum Vehicular Volume				Condition B Interruption of Continuous Traffic			
		A	B	C	D	A	B	C	D
1	Route 220 at Reservoir Road	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
3	Route 220 at Lee Ford Camp Rd/Church Street	**No**	**No**	**No**	Yes	**No**	**No**	Yes	Yes
4	Route 220 at Morehead Avenue	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5	Route 220 at Soapstone Road/Main Street	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6	Route 220 at Water Plant Road	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7	Route 220 at Route 58 EB Ramps	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
8	Route 220 at Dyer Street	**No**	**No**	**No**	**No**	**No**	**No**	**No**	Yes
9	Route 220 at Country Ridge Road	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
11	Route 220 at Pleasant Hill	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
12	Route 220 at Cassell Road/Sontag Road	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
14	Route 220 at Iron Ridge Road	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
18	220 at Farm Road	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
25	Route 220 at Naff Road	No	No	No	Yes	Yes	Yes	Yes	Yes
26	Route 220 at Spotswood Road/Willow Branch Rd	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
27	Route 220 at Webb Road	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**

TABLE 17 : PLANNING LEVEL SIGNAL WARRANT ANALYSIS RESULTS CONTINUED

Intersection ID	Intersection	Condition A Minimum Vehicular Volume				Condition B Interruption of Continuous Traffic			
		A	B	C	D	A	B	C	D
28	Route 220 at Starlight Lane/Shadow Hollow Lane	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
29	Route 220 at Davis Boone Road	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
31	Route 220 at Indian Grave Road/Clearbrook Village Lane	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
32	Route 220 at Buck Mountain Road/Stable Road	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
33	Route 220 at Old Rocky Mount Rd	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
34	Route 220 at Crossbow Circle/ Pheasant Ridge Road	**No**	Yes	Yes	Yes	Yes	Yes	Yes	Yes
35	Route 220 at Valley Avenue/Southern Hills Drive	**No**	Yes	Yes	Yes	Yes	Yes	Yes	Yes
36	Route 220 at Southern Lane SW	**No**	**No**	Yes	Yes	Yes	Yes	Yes	Yes

9. Traffic Analysis

9.1 Existing Conditions

9.1.1 Traffic Analysis Assumptions

The traffic analysis for the emerging intersections was completed using Synchro 9.0, a computer-based intersection operations model, which implements procedures presented in the Transportation Research Board's (TRB) *Highway Capacity Manual* (HCM) 2010. Synchro is designed to evaluate the performance of arterials, signalized intersections, and unsignalized intersections (two-way stop, all-way stop, and roundabouts). The intersection level of service (LOS) reported by Synchro reflects the total intersection delay and delay by turning movement.

Synchro inputs and analysis methodologies were consistent with the VDOT Traffic Operations and Safety Analysis Manual (TOSAM), Version 1.0. The signal timing and phasing plans for all signalized intersections were provided by VDOT.

9.1.2 Traffic Analysis Results

The existing conditions traffic analysis results for the emerging intersections are summarized in the following section. Two measures of effectiveness were selected to measure the quantitative performance of these intersections:

- Average vehicle delay by movement, approach, and intersection – measured in seconds per vehicle
- 95th percentile queue length by lane group – measured in feet

Delay and Level of Service

An intersection LOS is a qualitative measure of vehicular delay and considers several conditions related to intersection design and traffic volume, and the perception of those conditions by motorists. LOS ratings range from A to F, with LOS A indicating little or no average delay and LOS F indicating severe average delays, unstable traffic flow, and stop-and-go conditions. **Table 18** summarizes the LOS criteria as specified in the HCM.

TABLE 18: LEVEL OF SERVICE CRITERIA

LOS	Average Stopped Delay (seconds/vehicle)			Description of Traffic Conditions
	Signalized	Unsignalized	Roundabout	
A	≤ 10.0	≤ 10.0	≤ 10.0	Very low delay, progression is extremely favorable; most vehicles arrive during green phase.
B	> 10.0 to 20.0	> 10.0 to 15.0	> 10.0 to 15.0	Generally good progression, low delays, more vehicles must stop at intersection red phases.
C	> 20.0 to 35.0	> 15.0 to 25.0	> 15.0 to 25.0	Fair progression, increasing number of vehicles must stop; signal cycle fails to process all traffic.
D	> 35.0 to 55.0	> 25.0 to 35.0	> 25.0 to 35.0	Traffic congestion more noticeable, increasing cycle failures, unfavorable progression, and longer delays.
E	> 55.0 to 80.0	> 35.0 to 50.0	> 35.0 to 50.0	Poor progression, generally high v/c ratios, frequent cycle failures, intersection traffic approaching capacity.
F	≥ 80.0	≥ 50.0	≥ 50.0	Arrival flow exceeds intersection capacity, many cycle failures, poor progression, and high delays.

Source: 2000 Highway Capacity Manual (HCM)

LOS designation is reported differently for unsignalized and signalized intersections. Thus, the delay ranges differ slightly between unsignalized and signalized intersections due to driver expectations and behavior for each LOS. For unsignalized intersections, the LOS analysis assumes that the traffic on the mainline is not affected by traffic on the side street. For signalized intersections, LOS is defined in terms of delay, which is a measure of driver discomfort and frustration, and lost travel time. The LOS for each movement is calculated by determining the number of gaps that are available in the conflicting traffic stream.

HCM 2010 methodologies were used to analyze all unsignalized intersections and HCM 2000 methodologies were used to analyze all signalized intersections. Approach delay and LOS, by movement, for the unsignalized intersections is summarized in **Table 19**. The overall intersection delay and LOS for the signalized intersections in the study area is summarized in

Table 20. The delay and LOS for all locations, including individual movements, is included in **Appendix E.**

TABLE 19: EXISTING (2018) UNSIGNALIZED DELAY AND LOS

Intersection ID	Unsignalized Intersection	Stop Controlled Approach	AM Peak Hour		PM Peak Hour	
			Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
1	Route 220 at Reservoir Road	Eastbound	9.2	A	0.0	A
		Westbound	-	-	-	-
2	Route 220 at Matrimony Creek Road	Eastbound	-	-	-	-
		Westbound	9.9	A	9.6	A
3	Route 220 at Lee Ford Camp Road/Church Street	Eastbound	13.1	B	14.0	B
		Westbound	12.3	B	13.3	B
9	Route 220 at Country Ridge Road	Eastbound	-	-	-	-
		Westbound	12.8	B	12.8	B
10	Route 220 at Henry Road	Eastbound	12.4	B	14.0	B
		Westbound	-	-	-	-
11	Route 220 at Pleasant Hill Road	Eastbound	20.7	C	21.5	C
		Westbound	0.0	A	0.0	A
13	Route 220 at Bonbrook Mill Road	Eastbound	-	-	-	-
		Westbound	38.3	E	31.1	D
14	Route 220 at Iron Ridge Road	Eastbound	21.6	C	28.2	D
		Westbound	37.7	E	18.5	C
18	Route 220 at Farm Road	Eastbound	11.3	B	23.7	C
		Westbound	22.9	C	0.0	A
19	Route 220 at Taylors Road	Eastbound	10.8	B	24.1	C
		Westbound	36.5	E	24.2	C
20	Route 220 at Grassy Hill Road	Eastbound	281.8	F	359.9	F
		Westbound	42.5	E	0.0	A
25	Route 220 at Naff Rd	Eastbound	12.6	B	31.7	D
		Westbound	-	-	-	-
26	Route 220 at Spotswood Drive/Willow Branch Road	Eastbound	16.4	C	20.6	C
		Westbound	16.1	C	11.5	B
27	Route 220 at Webb Road	Eastbound	-	-	-	-
		Westbound	22.3	C	14.9	B
28	Route 220 at Starlight Lane/Shadow Hollow Lane	Eastbound	26.5	D	54.2	F
		Westbound	28.9	D	11.6	B
29	Route 220 at Davis Boone Road	Eastbound	-	-	-	-
		Westbound	17.2	C	11.8	B
30	Route 220 at Yellow Mountain Road	Eastbound	-	-	-	-
		Westbound	68.0	F	440.6	F

TABLE 20: EXISTING (2018) SIGNALIZED DELAY AND LOS

Intersection ID	Signalized Intersection	AM Peak Hour		PM Peak Hour	
		Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
4	Route 220 at Morehead Avenue	11.7	B	10.7	B
5	Route 220 at Soapstone Road/Main Street	26.5	C	26.3	C
6	Route 220 at Water Plant Road	15.9	B	18.0	B
7	Route 220 at Route 58 EB Ramps	15.9	B	15.2	B
8	Route 220 at Dyer Street	21.2	C	21.9	C
12	Route 220 at Cassell Road/Sontag Road	29.0	C	24.5	C

Queuing

The results of the existing AM and PM peak hour queuing analysis is summarized in **Appendix E.** The corresponding Synchro output sheets are provided in **Appendix E** for reference. A queue is the length of the line of cars that arrive at an intersection when the signal is red (or stop sign) combined with vehicles that did not clear the intersection during the previous green light, or able to be processed by a stop sign due to heavy cross street demand. The 95th percentile queue is the length, from the stop bar, that has only a 5-percent probability of being exceeded during the analysis period. Comparing the length of this line of vehicles to potential lane lengths available at each intersection provides another measure of 1) how efficiently an intersection processes traffic, and 2) how long turn lanes should be to accommodate queuing.

For movements without conflicting traffic volumes, no queue length was reported by Synchro. Movements where the 95th percentile volume exceeds capacity or where the volume for the 95th percentile queue is metered by an upstream signal were identified. The queuing results in **Table 21** display the movements where the 95th percentile volumes exceed capacity in the study area.

TABLE 21: EXISTING (2018) LANE GROUPS WHERE 95TH PERCENTILE VOLUMES EXCEED CAPACITY

Intersection ID	Intersection	Lane Group	Peak Hour
4	Route 220 at Morehead Avenue	Westbound Right	AM/PM
5	Route 220 at Soapstone Road/Main Street	Eastbound Through/Left	AM/PM
30	Route 220 at Yellow Mountain Road	Westbound Right	PM

9.2 Traffic Forecasting

To understand future traffic conditions for the emerging intersections in the study area and assess the long-term benefits of proposed improvements, traffic volumes were forecasted to 2040. The following sections describe the methodology for developing traffic growth rates and projecting future traffic volumes for the study area.

9.2.1 Traffic Growth Rate Development

The growth rate for the corridor was provided by VDOT Transportation and Mobility Division, using the Statewide Planning System (SPS) as a base, and verified with the VDOT Salem District. SPS provides guidance to planners relative to using a consistent system for traffic forecasting. The SPS data is generally derived through inspection of historical growth rates, and in areas that utilize a regional travel demand model, the SPS data considers the model output which corresponds to forecasted growth within the model area. The growth rates applied along the corridor are presented in **Figure 6**. Linear traffic growth rates were applied to existing (2018) turning movement traffic counts to develop future (2040) traffic projections for use in the analysis of future conditions at each emerging intersection.

9.3 No-Build Conditions

No-build traffic conditions were analyzed to evaluate the results of future (2040) traffic demand on the existing roadway network. The intent of the no-build conditions analysis is to provide a general understanding of the baseline future traffic conditions that may then be used to evaluate the effectiveness of potential future improvement strategies. Synchro modeling assumptions and analysis results for 2040 no-build conditions are described in the following sections.

9.3.1 Traffic Analysis Assumptions

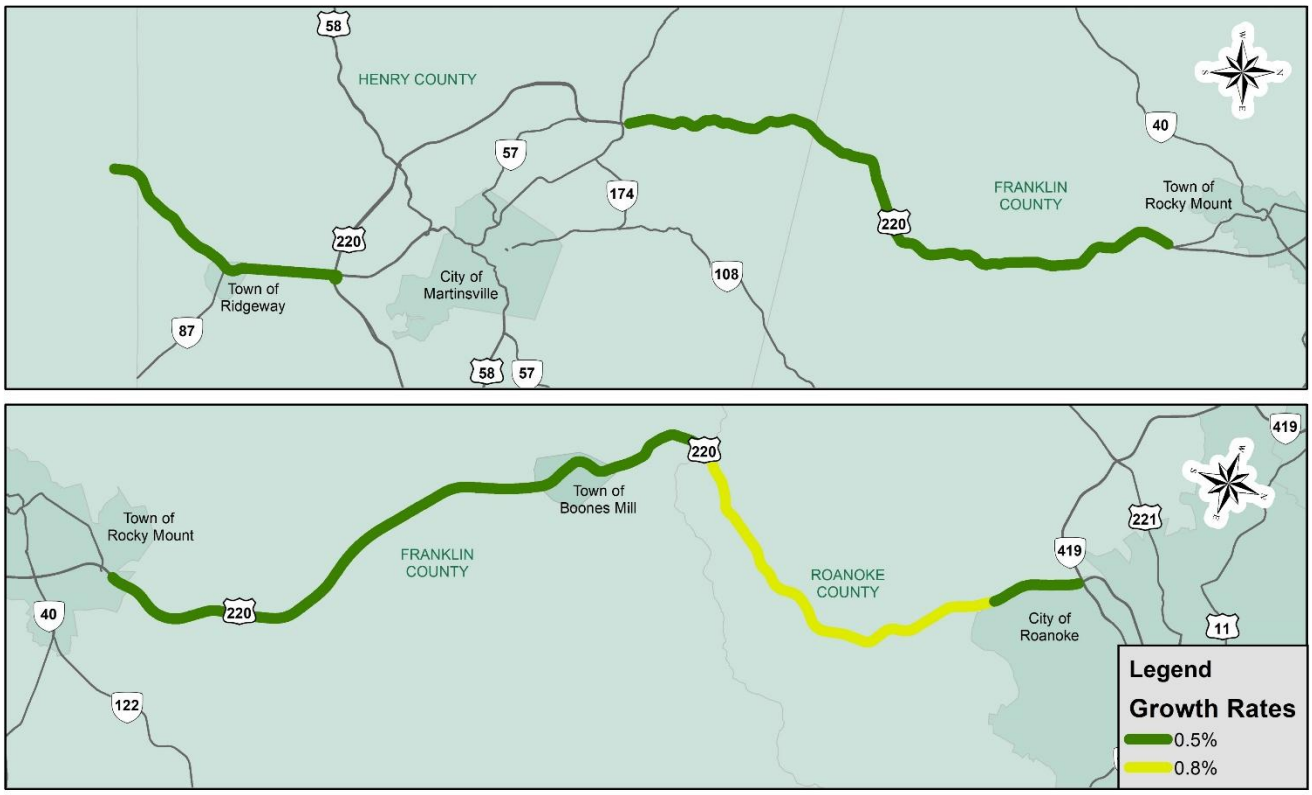
The existing conditions Synchro model was used as a basis to develop the no-build model. Because this is a future model, planned and approved projects identified through previous efforts that are anticipated along the corridor have been included. No other geometric or traffic signal timing changes were made to the existing Synchro model, but the model was updated with projected 2040 no-build traffic volumes.

9.3.2 Traffic Analysis Results

The same measures of effectiveness used to evaluate existing conditions were used to measure the quantitative performance of the no-build Synchro model:

- Average vehicle delay by movement, approach, and intersection – measured in seconds per vehicle
- 95th percentile queue length by lane group – measured in feet

FIGURE 6: TRAFFIC GROWTH RATES



Delay and Level of Service

Synchro was used to calculate the delay and associated LOS at each study area intersection under no-build conditions. The same methodologies used to analyze existing conditions were also used to analyze no-build conditions. HCM 2000 methodologies were used to analyze all signalized intersections and HCM 2010 methodologies were used to analyze all unsignalized intersections. Approach delay by movement and LOS for the unsignalized intersections is summarized in **Table 22.** The overall intersection delay and LOS for the signalized intersections in the study area is summarized in **Table 23.**

TABLE 22: NO-BUILD (2040) UNSIGNALIZED DELAY AND LOS

Intersection ID	Unsignalized Intersection	Stop Controlled Approach	AM Peak Hour		PM Peak Hour	
			Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
1	Route 220 at Reservoir Road	Eastbound	9.3	A	0.0	A
		Westbound	-	-	-	-
2	Route 220 at Matrimony Creek Road	Eastbound	-	-	-	-
		Westbound	10.1	B	9.8	A
3	Route 220 at Lee Ford Camp Rd/Church Street	Eastbound	13.9	B	14.9	B
		Westbound	12.8	B	14.1	B
9	Route 220 at Country Ridge Road	Eastbound	-	-	-	-
		Westbound	13.5	B	13.5	B
10	Route 220 at Henry Road	Eastbound	13.2	B	14.5	B
		Westbound	-	-	-	-
11	Route 220 at Pleasant Hill Road	Eastbound	24.9	C	25.3	D
		Westbound	0.0	A	0.0	A
13	Route 220 at Bonbrook Mill Road	Eastbound	-	-	-	-
		Westbound	58.0	F	42.0	E
14	Route 220 at Iron Ridge Road	Eastbound	25.9	D	35.9	E
		Westbound	50.8	F	21.2	C
18	Route 220 at Farm Road	Eastbound	11.6	B	26.6	D
		Westbound	25.7	D	0.0	A
19	Route 220 at Taylors Road	Eastbound	11.2	B	28.6	D
		Westbound	57.2	F	29.3	D
20	Route 220 at Grassy Hill Road	Eastbound	426.3	F	728.4	F
		Westbound	49.7	E	0.0	A
25	Route 220 at Naff Rd	Eastbound	14.0	B	45.3	E
		Westbound	-	-	-	-
26	Route 220 at Spotswood Drive/Willow Branch Road	Eastbound	18.9	C	25.8	D
		Westbound	18.5	C	12.4	B
27	Route 220 at Webb Road	Eastbound	-	-	-	-
		Westbound	25.4	D	15.8	C
28	Route 220 at Starlight Lane/Shadow Hollow Lane	Eastbound	31.5	D	89.8	F
		Westbound	35.4	E	12.4	B
29	Route 220 at Davis Boone Road	Eastbound	-	-	-	-
		Westbound	19.2	C	12.5	B
30	Route 220 at Yellow Mountain Road	Eastbound	-	-	-	-
		Westbound	141.7	F	**$**	F

$ notes V/C greater than 3.00

TABLE 23: NO-BUILD (2040) SIGNALIZED DELAY AND LOS

Intersection ID	Signalized Intersection (reference #)	AM Peak Hour		PM Peak Hour	
		Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
4	Route 220 at Morehead Avenue	11.9	B	11.5	B
5	Route 220 at Soapstone Road/Main Street	27.3	C	27.3	C
6	Route 220 at Water Plant Road	17.7	B	18.5	B
7	Route 220 at Route 58 EB Ramps	16.3	B	17.2	B
8	Route 220 at Dyer Street	23.1	C	22.1	C
12	Route 220 at Cassell Road/Sontag Road	33.7	C	27.6	C

Queuing

The results of the no-build AM and PM peak hour queuing analysis is summarized in **Appendix F**. The corresponding Synchro output sheets are provided in **Appendix F** for reference. For movements without conflicting traffic volumes, no queue length was reported by Synchro. Movements where the 95th percentile volume exceeds capacity or where the volume for the 95th percentile queue is metered by an upstream signal were identified. The queuing results in **Table 24** show the movements where the 95th percentile volumes exceed capacity in the study area.

TABLE 24: NO-BUILD (2040) LANE GROUPS WHERE 95TH PERCENTILE VOLUMES EXCEED CAPACITY

Intersection ID	Intersection	Lane Group	Peak Hour
4	Route 220 at Morehead Avenue	Westbound Right	AM & PM
5	Route 220 at Soapstone Road/Main Street	Eastbound Left/Through	AM & PM
30	Route 220 at Yellow Mountain Road	Westbound Right	AM & PM

10. Alternatives and Proposed Recommendations

Alternatives for each emerging intersection were developed to address safety, geometric, and operational deficiencies along the study corridor identified in the existing and no-build analyses, as well as during the field review. The alternatives for each emerging intersection consisted of traditional capacity improvements (such as additional turn lanes) and innovative intersection improvements.

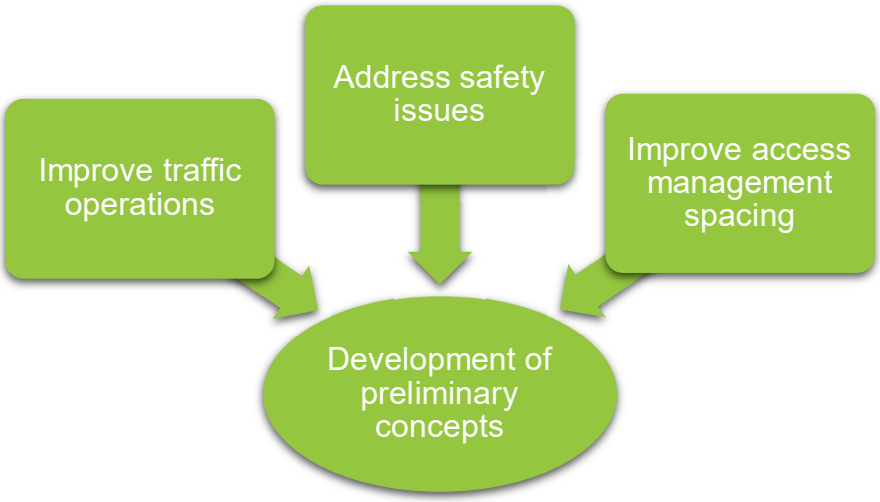
Innovative intersections modify the way vehicles, cyclists, and pedestrians navigate an intersection, compared to a traditional design, to improve traffic operations and safety. Examples of innovative intersections include roundabouts, Restricted Crossing U-Turns (RCUTs), Median

U-Turns (MUTs), and Continuous Green-T intersections (CGTs). Innovative intersection configurations are some of the strategies of the Arterial Preservation Program which can be used to achieve the goals of minimizing access points, reducing conflict points, and minimizing traffic stops and unnecessary delay that impede through movements along the corridor.

Initial alternative screening was performed at the analysis intersections using Synchro 9 and the VDOT Junction Screening Tool (VJuST). VJuST is a screening tool that helps transportation engineers and planners consider innovative intersection and interchange configurations that address mobility and safety issues. VJuST can help identify configurations to be evaluated with further study, analysis, and design.

Once the initial screening process was complete, the study team participated in an alternative's development workshop on April 16, 2018. During the workshop, the developed concepts were shared, and additional concepts were identified. The concepts discussed during the workshop focused on three key objectives: improve traffic operations, address safety issues, and improve access management spacing, as shown in **Figure 7**. The alternatives development workshop materials are provided in **Appendix G**. Additional conference calls were held following the initial alternatives development meeting to refine and select a preferred alternative at each intersection. Salem District initiated a separate study to analyze the traffic signals in the developed portion of Route 220. Given the tight spacing and signal coordination for this segment, a more detailed analysis and review was required.

FIGURE 7: CONCEPT DEVELOPMENT CONSIDERATIONS



11. Recommendations

The emerging intersection alternatives considered are presented in **Table 25** and **Table 26**, with the preferred alternative shown in bold text. Graphical displays of the preferred alternatives are provided in **Appendix H**. Preferred alternatives were reviewed, vetted, and agreed upon by the study team during the alternative's development workshop and subsequent conference calls.

In addition to intersection improvements, access management and selective roadway improvements were proposed along the 43-mile corridor. Recommendations were identified based on existing crash severity and frequency, roadway geometry (horizontal and vertical alignment, turn lane storage lengths, shoulder widths), and existing driveway and median opening spacing. Additional consideration was given to PSI segments and intersections. Recommendations include installing rumble strips, improving or installing curve warning signs and chevrons, converting full median openings to directional median openings, extending or constructing turn lanes, other general access management improvements, and curve straightening at select locations. The corridor recommendations are shown in **Appendix H**.

TABLE 25: EMERGING INTERSECTION ALTERNATIVES

Intersection ID	Description	Alternatives Considered
1	Route 220 at Reservoir Road	• **Lengthen SBR and EBR turn lanes (short term)**
		• Realign and lengthen SBR and EBR turn lanes (long term)
2	Route 220 at Matrimony Creek Road	• No Improvement
3	Route 220 at Lee Ford Camp Road/Church Street	• **Right-In/Right-Out for Church Street**
		• Unsignalized RCUT
4	Route 220 at Morehead Avenue	• **Signalized Continuous Green-T**
5	Route 220 at Soapstone Road/Main Street	• Unsignalized RCUT
		• Signalized RCUT
		• **Prohibit minor street through movements**
6	Route 220 at Water Plant Road	• Signalized Continuous Green-T with WB approach Closed
		• Signalized RCUT
		• Existing signalized configuration with WB approach closed
		• **Prohibit minor street through movements**
7	Route 220 at Route 58 EB Ramps	• Add enhanced signage + signal heads
8	Route 220 at Dyer Street	• **VDOT Concept: Prohibit minor street through movements**
9	Route 220 at Country Ridge Road	• Unsignalized Seagull
		• **Unsignalized RCUT**
10	Route 220 at Henry Road	• **Unsignalized Seagull**
		• Median Closure
		• Unsignalized RCUT
		• Curve Alignment
11	Route 220 at Pleasant Hill	• **Unsignalized RCUT**

TABLE 26: EMERGING INTERSECTION ALTERNATIVES CONTINUED

Intersection ID	Description	Alternatives Considered
12	Route 220 at Cassell Road/Sontag Road	• Signalized RCUT • Signalized intersection with added WBR turn lane • **Prohibit minor street through movements with added WBR**
13	Route 220 at Bonbrook Mill Road	• Unsignalized Seagull • Signalized Continuous Green-T • Unsignalized RCUT • **No Improvement**
14	Route 220 at Iron Ridge Road	• **Unsignalized RCUT** • Median Closure
15	Route 220 at Wirtz Road	• **VDOT Concept: Prohibit minor street through movements**
16	Route 220 at Link Street	• **Summit View Concept**
17	Route 220 at Brick Church Road	• **Summit View Concept**
18	Route 220 at Farm Road	• **Summit View Concept**
19	Route 220 at Taylors Road	• Unsignalized RCUT • **Improve turn lanes**
20	Route 220 at Grassy Hill Road	• **Unsignalized Seagull**
21	Route 220 at Church Hill Street	• *No improvement*
22	Route 220 at Bethlehem Road	• *No improvement*
23	Route 220 at Boon Street	• *No improvement*
24	Route 220 at Whispering Creek	• *No improvement*
25	Route 220 at Naff Road	• Unsignalized RCUT • **Unsignalized Seagull with added SBR turn lane** • Median Closure
26	Route 220 at Spotswood Road/Willow Branch Road	• **Add NBL and SBL turn lanes**
27	Route 220 at Webb Road	• **Right-In/Right-Out with added NBR turn lane**
28	Route 220 at Starlight Lane/Shadow Hollow Lane	• Right-in/right-out • Left-out/right-in/right-out • **Existing configuration with turn lane improvements**
29	Route 220 at Davis Boone Road	• Unsignalized Continuous Green-T • **No Improvement**
30	Route 220 at Yellow Mountain Road	• **Unsignalized Seagull**
31	Route 220 at Indian Grave Road/Clearbrook Village Lane	• **VDOT Concept: Prohibit minor street through movements**
32	Route 220 at Buck Mountain Road/Stable Road	• **VDOT Concept: Prohibit minor street through movement**
33	Route 220 at Old Rocky Mount Road	• *No improvement*
34	Route 220 at Crossbow Circle/ Pheasant Ridge Road	• **VDOT Concept: Prohibit minor street through movement**
35	Route 220 at Valley Avenue/Southern Hills Drive	• **VDOT Concept: Prohibit minor street through movement**
36	Route 220 at Southern Lane SW	• **No improvement**

Systemic Improvements

In addition to intersection improvements, systemic improvements were also proposed along the corridor. Similar to the emerging intersections, corridor-wide improvements addressed safety, geometric, and operational deficiencies along the study corridor.

The recommendations were based on existing geometry, crash severity and frequency (2011-2017), horizontal and vertical alignment, and driveway/median spacing. Additional consideration was given to PSI segments and intersections. Common recommendations included widening shoulders, installing rumble strips, and constructing curve warning signs.

11.1 Build Conditions

11.1.1 Traffic Analysis Assumptions

Build traffic conditions were analyzed to evaluate the results of future (2040) traffic demand under the preferred intersection alternative geometry. The intent of the 2040 build conditions analysis is to compare it to the 2040 no-build conditions analysis to determine the operational impacts. Synchro modeling assumptions and analysis results for 2040 build conditions are described in the following sections.

The no-build conditions Synchro model was used as a basis to develop the build model. The Synchro model was updated with the recommended intersection alternatives which involved geometric and traffic signal changes. Additionally, 2040 no-build traffic volumes were rerouted for innovative intersection concepts.

Since some improvement concepts involve innovative intersection designs that involve diverting some traffic movements, the experienced travel time (ETT) was calculated for movements that are diverted by the intersection design. ETT combines control delay from signalized and unsignalized intersections, crossovers, and the time for extra distance traveled. ETT was calculated using the methodologies provided by the *Highway Capacity Manual, 6th Edition.* The LOS criteria for ETT is defined in **Table 27**.

TABLE 27: ETT LOS CRITERIA

ETT LOS	ETT (seconds/vehicle)
A	≤ 10.0
B	> 10.0 to 20.0
C	> 20.0 to 35.0
D	> 35.0 to 55.0
E	> 55.0 to 80.0
F	≥ 80.0

Source: Highway Capacity Manual 6th Edition (HCM)

11.1.2 Traffic Analysis Results

The same measures of effectiveness used in existing and no-build conditions were used to measure the quantitative performance of the build Synchro model with the addition of ETT:

- Average vehicle delay by movement, approach, and intersection – measured in seconds per vehicle
- 95th percentile queue length by lane group – measured in feet
- ETT for innovative intersections – measured in seconds per vehicle

Delay and Level of Service

Synchro was used to calculate the delay and associated LOS at each study area intersection under build conditions. HCM 2000 methodologies were used to analyze all signalized intersections and HCM 2010 methodologies were used to analyze all unsignalized intersections. For intersections with proposed innovative intersection concepts, the delay results from Synchro were used to calculate the ETT. Approach delay by movement and LOS for the unsignalized intersections is summarized in **Table 28**. The overall intersection delay and LOS for the signalized intersections in the study area is summarized in **Table 29**. The delay and LOS for all locations, including individual movements, is included in **Appendix I**.

TABLE 28: BUILD (2040) UNSIGNALIZED DELAY AND LOS

Intersection ID	Unsignalized Intersection	Stop Controlled Approach	AM Peak Hour		PM Peak Hour	
			Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
1	Route 220 at Reservoir Road	Eastbound	9.3	A	0.0	A
		Westbound	-	-	-	-
2	Route 220 at Matrimony Creek Road	Eastbound	-	-	-	-
		Westbound	10.1	B	9.8	A
3	Route 220 at Lee Ford Camp Rd/Church Street	Eastbound	13.9	B	14.1	B
		Westbound	9.8	A	9.6	A
9	Route 220 at Country Ridge Road	Eastbound	-	-	-	-
		Westbound	10.8	B	11.1	B
10	Route 220 at Henry Road	Eastbound	14.3	B	17.2	C
		Westbound	-	-	-	-
11	Route 220 at Pleasant Hill Road	Eastbound	11.8	B	12.4	B
		Westbound	0.0	A	0.0	A
13	Route 220 at Bonbrook Mill Road	Eastbound	-	-	-	-
		Westbound	58.0	F	42.0	E
14	Route 220 at Iron Ridge Road	Eastbound	14.2	B	17.6	C
		Westbound	13.3	B	12.1	B
18	Route 220 at Farm Road	Eastbound	11.6	B	26.6	D
		Westbound	25.7	D	0.0	A
19	Route 220 at Taylors Road	Eastbound	11.2	B	28.6	D
		Westbound	57.2	F	29.3	D
20	Route 220 at Grassy Hill Road	Eastbound	338.9	F	894.7	F
		Westbound	14.0	B	0.0	A
25	Route 220 at Naff Rd	Eastbound	13.4	B	51.0	F
		Westbound	-	-	-	-
26	Route 220 at Spotswood Drive/Willow Branch Road	Eastbound	18.3	C	29.7	D
		Westbound	18.5	C	12.9	B
27	Route 220 at Webb Road	Eastbound	-	-	-	-
		Westbound	19.0	C	13.0	B
28	Route 220 at Starlight Lane/Shadow Hollow Lane	Eastbound	31.5	D	89.8	F
		Westbound	35.4	E	12.4	B
29	Route 220 at Davis Boone Road	Eastbound	-	-	-	-
		Westbound	19.2	C	12.5	B
30	Route 220 at Yellow Mountain Road	Eastbound	-	-	-	-
		Westbound	149.8	F	**$**	F

$ notes V/C greater than 3.00

TABLE 29: BUILD (2040) SIGNALIZED DELAY AND LOS

Intersection ID	Signalized Intersection (reference #)	AM Peak Hour		PM Peak Hour	
		Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
4	Route 220 at Morehead Avenue	11.4	B	11.3	B
5	Route 220 at Soapstone Road/Main Street	10.5	B	9.6	A
6	Route 220 at Water Plant Road	18.3	B	20.2	C
7	Route 220 at Route 58 EB Ramps	16.3	B	17.2	B
8	Route 220 at Dyer Street	23.1	C	23.4	C
12	Route 220 at Cassell Road/Sontag Road	25.7	C	25.1	C

Queuing

The results of the build AM and PM peak hour queuing analysis is summarized in **Appendix I**. The corresponding Synchro output sheets are provided in **Appendix I** for reference. For movements without conflicting traffic volumes, no queue length was reported by Synchro. Movements where the 95th percentile volume exceeds capacity or where the volume for the 95th percentile queue is metered by an upstream signal were identified. The queuing results in **Table 30** show the movements where the 95th percentile volumes exceed capacity in the study area.

TABLE 30: BUILD (2040) LANE GROUPS WHERE 95TH PERCENTILE VOLUMES EXCEED CAPACITY

Intersection ID	Intersection	Lane Group	Peak Hour
4	Route 220 at Morehead Avenue	Westbound Right	AM/PM
5	Route 220 at Soapstone Road/Main Street	Eastbound Through/Left	AM/PM
30	Route 220 at Yellow Mountain Road	Westbound Right	PM

11.2 Planning-Level Cost Ranges

Planning-level cost ranges were developed for the preferred alternatives for the emerging intersections identified as a priority by VDOT. Cost ranges were developed in context with the level of detail available in this study. Cost ranges were developed using quantities presented in 2019 dollars. A detailed, design-level cost estimate should be prepared once an improvement is advanced to the design phase. The planning-level cost ranges for each alternative is presented in **Table 31**.

TABLE 31: PLANNING LEVEL COST RANGES

Intersection ID	Intersection	Alternative	Cost Range (2019 Dollars)
4	Route 220 at Morehead Avenue	Signalized CGT	$5M - $10M
5	Route 220 at Soapstone Road/Main Street	Prohibit Minor Street Through Movements	$1M - $5M
6	Route 220 at Water Plant Road	Prohibit Minor Street Through Movements	≤ $1M
10	Route 220 at Henry Road	Unsignalized Seagull	$1M - $5M
11	Route 220 at Pleasant Hill	Unsignalized RCUT	$1M - $5M
12	Route 220 at Cassell Road/Sontag Road	Prohibit Minor Street Through Movements	$1M - $5M
14	Route 220 at Iron Ridge Road	Unsignalized RCUT	$5M - $10M
20	Route 220 at Grassy Hill Road	Unsignalized Seagull	$1M - $5M
25	Route 220 at Naff Road	Unsignalized Seagull	$5M - $10M
26	Route 220 at Willow Branch Road	Turn Lane Improvements	≤ $1M
27	Route 220 at Webb Road	Right-In/Right-Out Configuration	$1M - $5M
30	Route 220 at Yellow Mountain Road	Unsignalized Seagull	$5M - $10M