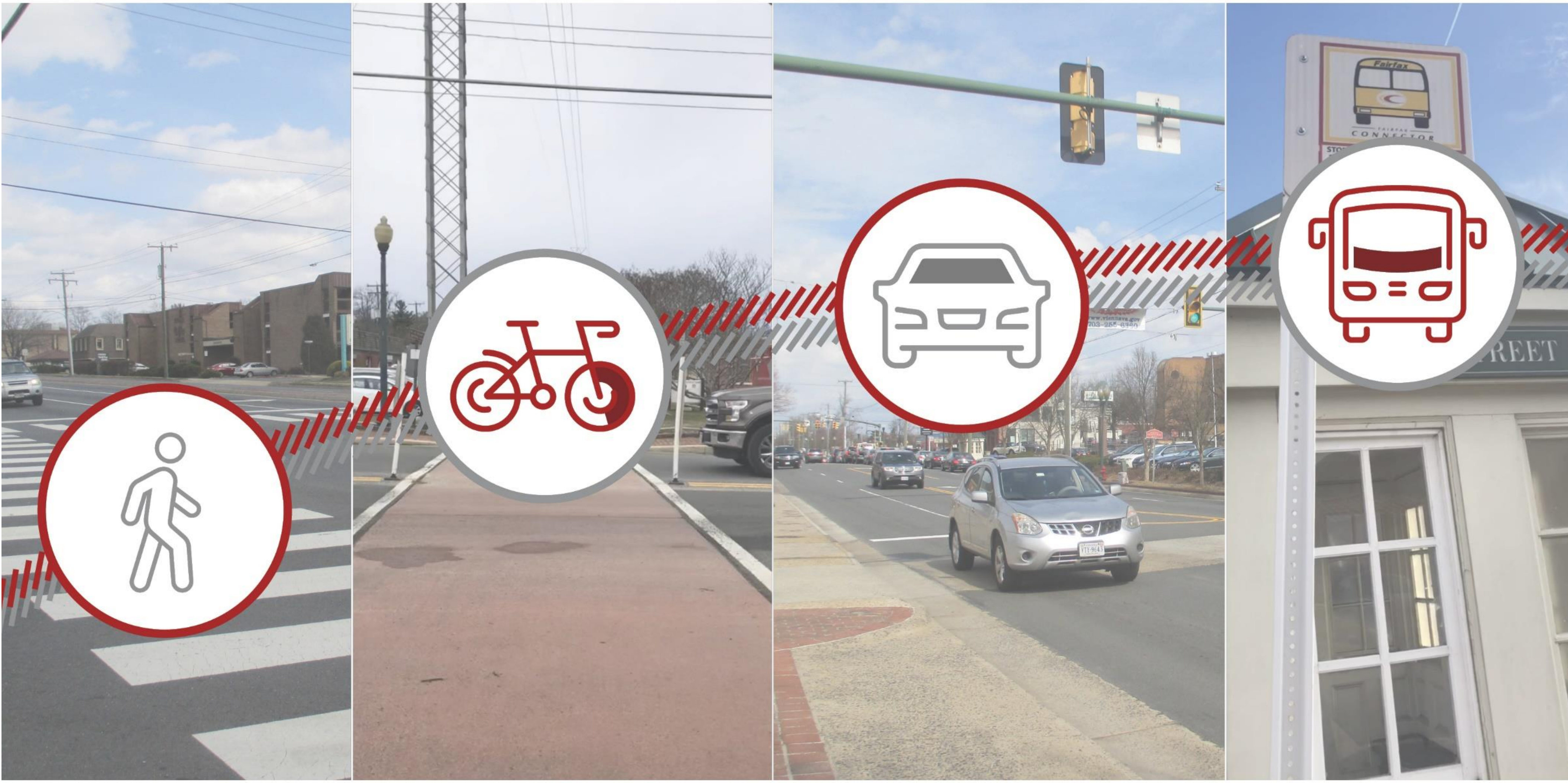
Maple Avenue Corridor

Multimodal Transportation and Land Use Study



Kimley»Horn

TOWN OF
VIENNA
Virginia

Maple Avenue Corridor

Multimodal Transportation and Land Use Study

Final Report

July 10, 2020

Prepared for:

Town of Vienna

Prepared by:

Kimley»Horn

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Executive Summary

Study Overview

This Multimodal Transportation and Land Use Study of the Maple Avenue corridor was developed to assist the Town of Vienna in identifying recommendations that leverage the existing strengths of the Maple Avenue corridor; in addressing current and future mobility challenges; in understanding and developing a plan for the potential impacts related to changes in adjacent land use and density; and, in setting the stage for a Maple Avenue corridor that works within the context of the Town of Vienna's broader economic, mobility, and livability goals.

The core purpose of the Maple Avenue Corridor Multimodal Transportation and Land Use Study was to develop near- and mid-term recommendations that will help to enhance mobility and the travel experience along the corridor as well as help to enhance safety and access for *all modes of transportation*.

Study Approach

The study was conducted across three phases:

1. **Evaluation of Existing Transportation Conditions:** Information about the existing conditions of the Town's transportation system was summarized, with a focus on the Maple Avenue corridor — strengths, challenges, opportunities, and ongoing projects. ***Simply, what is the current state of mobility in Vienna and what are the ways in which residents, visitors, and through travelers/commuters interact with the major travel corridor?*** Data gathered consisted of traffic counts; crash history; and the presence and condition of pedestrian, bicycle, and transit facilities and services. Current land use and development conditions along the corridor were also reviewed.

2. **Evaluation of Future Transportation Conditions:** A future scenario was studied that consisted of planned and potential development along the Maple Avenue corridor, under a more dense, mixed-used zoning scenario; projects contained in Vienna's Capital Improvement Program (CIP); and regional transportation and land use projects that could reasonably be expected to occur within the next 10-years. ***What are tomorrow's transportation challenges and how resilient is the corridor to future mobility demands?***

3. **Identification and Evaluation of Potential Strategies:** An initial set of recommendations was developed to respond to near- and mid-term mobility challenges as well as address community-identified transportation priorities. Recommendations were vetted through a public process and ***prioritized to identify what Vienna can do today and what Vienna can prepare to do in the near future to create a Maple Avenue corridor that works for all modes and that speaks to the needs, goals, and vision of Vienna mobility.***

Study Timeline

1	**Evaluation of Existing Transportation Conditions**

March 2019
- Study Kick-Off
- Study Area Walking Tour

April 2019
- Town Council Work Session #1
- Public Workshop #1

2	**Evaluation of Future Transportation Conditions**

June 2019
- Town Council Work Session #2
- Public Workshop #2

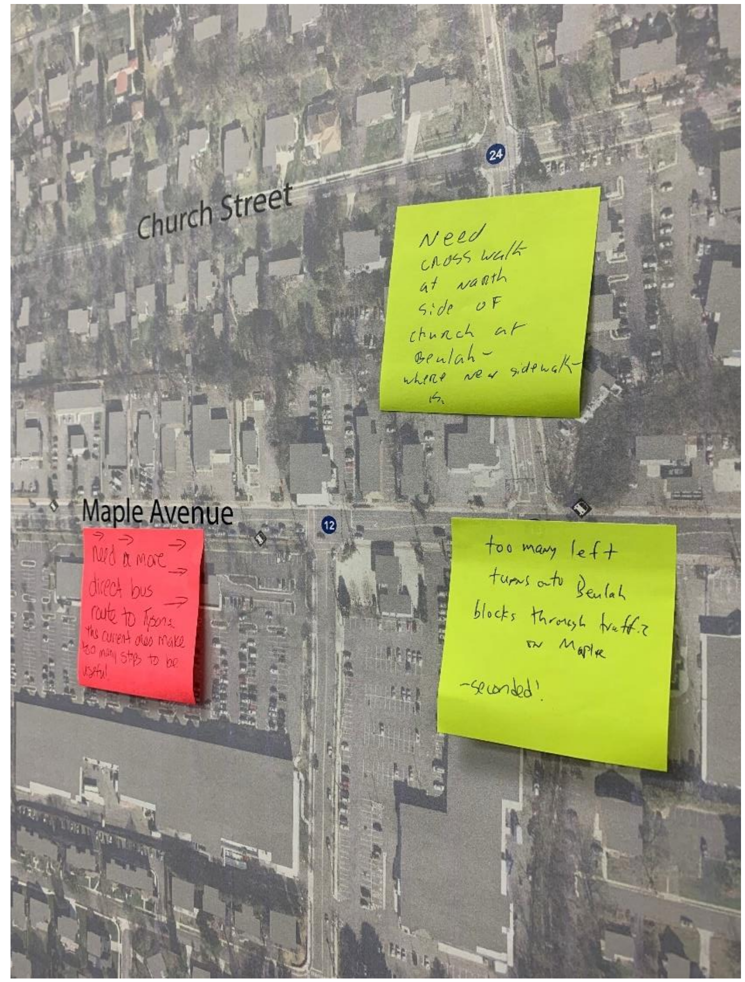
3	**Identification and Evaluation of Potential Strategies**

August 2019
- Town Council Work Session #3

September 2019
- Public Workshop #3
- Preliminary Recommendations

November 2019
- Town Council Work Session #4
- Final Recommendations

December 2019
- Draft Final Report



Location specific comments from a community workshop

Community Engagement Summary

Several Town leadership briefings and community engagement opportunities were built into the study process. These engagement opportunities consisted of a walking tour to better understand, feel, and experience the corridor; joint work sessions with the Town Council and the Transportation Safety Commission; and presentations and hands-on workshops with the community. These engagements were strategically timed to coincide with key study phases or critical decision points in the study.

The community engagement process was oriented to foster collaboration with the Vienna community to understand, contextualize, and prioritize the key challenges and potential improvements for mobility within the Maple Avenue corridor. High-level community priorities that were identified at the beginning of the study and that were then reinforced throughout the community engagement process are provided below.

Top-Ranked Community Priorities

Traffic Calming

Driveway Management

On-Street Bicycle Facilities

Fill Existing Sidewalk Gaps

Improve/ Enhance Street Crossings

Local Circulator Service

Public Parking (On- or Off-Street)

Other Community Priorities

- ***Improve Signal Timing***
- ***Trail Enhancements***
- ***Bikeshare Stations***
- ***Faster and More Reliable Bus Service***
- ***More Frequent Bus Service***
- ***Curbspace Management***

Transportation investment activity

Existing Condition Summary

Hourly and Daily Traffic Patterns

Maple Avenue (VA Route 123) experiences significant traffic volumes on typical weekdays given its local and regional prominence within the Northern Virginia transportation network. The corridor has a "dual identity;" it functions as a local "main street" providing access to commercial, retail, and entertainment uses that front Maple Avenue. It also functions as a primary arterial, connecting suburban Fairfax County and parts south and west to Tysons, and the greater Northern Virginia and Washington DC region to the north and east. This duality creates notable travel characteristics:

Peak direction backups along Maple Avenue

- Maple Avenue operates directionally in the peak periods, dominated by eastbound movements in the morning and westbound movements in the afternoon/evening
- There is a slight midday drop in traffic between morning and afternoon peak periods – though traffic generally remains at consistent levels throughout the day. This is likely due to Maple Avenue's function as a key local commercial corridor that serves the community all day, the fact that Vienna is a destination and a place where people want to be throughout the day, as well as the fact that Maple Avenue serves as a key connection to regional entertainment and activity centers outside of Vienna
- Weekend traffic is as high or higher than weekday traffic during specific periods, again speaking to Vienna's attraction to visitors and the viability of Maple Avenue as a regional corridor and weekend activity at commercial entrances

Despite the regular cadence of peak period commuter traffic, the average daily vehicle traffic has reduced from a high of just under 36,000 vehicles per day (vpd) in 2011 to just under 30,000 vpd in 2018. Considering just weekday traffic, a similar reduction is seen, from under 39,000 vpd in 2011 to under 33,000 vpd in 2018. The values are derived from annual average daily traffic reports prepared by the Virginia Department of Transportation (VDOT). While there are no comparable reports for peak period/hour travel, it can be assumed that at least moderate reductions in peak period/hour travel are occurring to support this daily reduction.

These downward trends are the result of many factors; changes in car ownership, evolving attitudes towards transit, modified regional commuting patterns, transportation demand management, and capacity enhancements along major parallel routes that influence travel through and around Vienna.

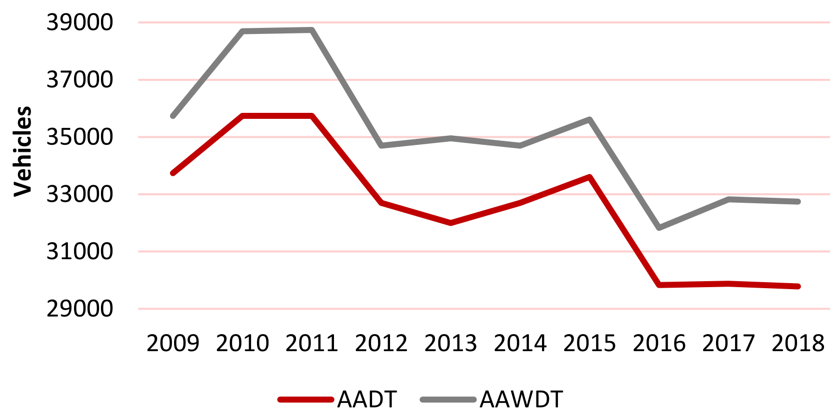
Based on a State Smart Transportation Initiative Study (SSTI) performed for the Town in June 2017[1]:

- Approximately 47 percent of trips along Maple Avenue are less than 5 miles
- Approximately 11 percent of trips along Maple Avenue are "local," starting and ending entirely within Vienna

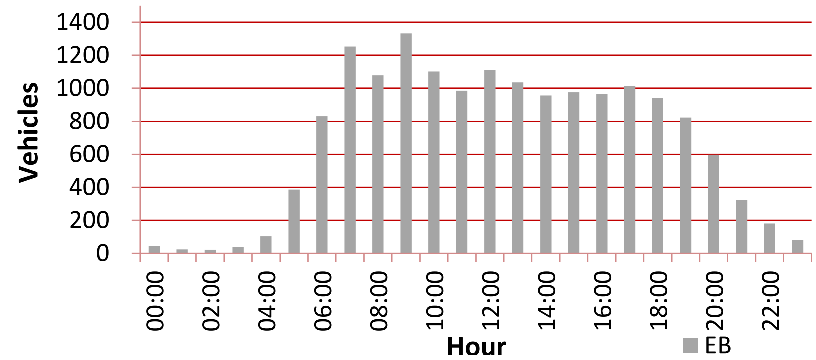
[1] Data and Analysis for Vienna Transportation Process. SSTI. June 12, 2017.

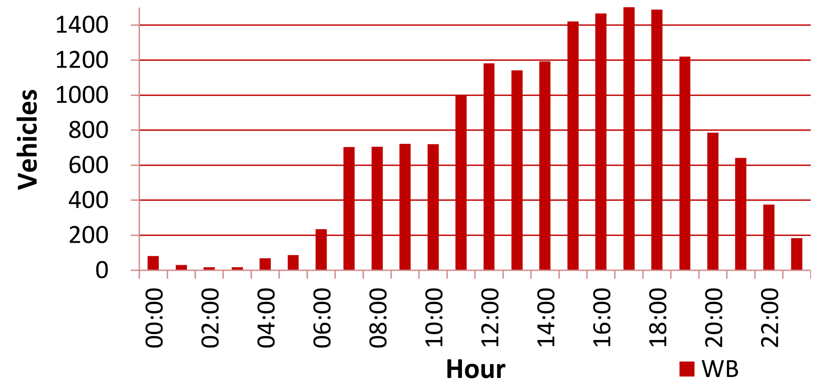
- Approximately 52 percent of trips along Maple Avenue are "internal-external," meaning the trips start or stop in Vienna, or have an interim destination within Vienna that accounts for more than a 5-minute delay
- Approximately 37 percent of trips along Maple Avenue are "pass-through," meaning these trips travel through but never stop in the Town of Vienna

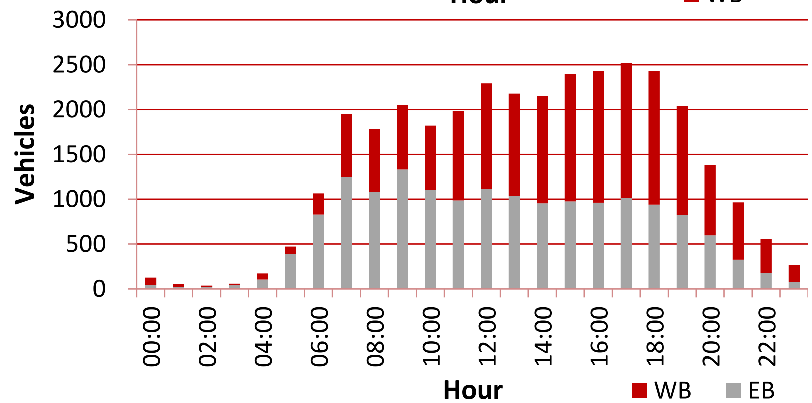
Average Daily Weekday Traffic Along Maple Avenue based on VDOT AADT Reports



Hourly Traffic Along Maple Avenue based on Traffic Counts conducted February 2019







Vehicle Operations

Vehicle operations are described using level of service (LOS), which is defined in the Highway Capacity Manual (HCM) as a quantitative stratification of a specific performance measure representing **quality of service or how well a transportation facility operates from a traveler's perspective**. LOS is graded A (best) to F (worst) and is a typical measure that describes roadway operations, reflects travelers' perspectives, and is used by roadway operating agencies to identifying areas of concern.

Different factors influence the perception and reality of a facility's quality. With respect to vehicular travel, some of these factors include: travel time, speed, delay, number of stops, maneuverability, comfort, convenience, safety, user costs, and accessibility.

For the purposes of this study, the primary performance measures used to indicate vehicular quality of service along the Maple Avenue corridor consisted of vehicle delay at signalized and unsignalized intersections and travel speeds along the arterial. Additional measures such as queuing and crash history provide context for how well the road is performing at specific times or at specific locations. While the Town of Vienna does not maintain a LOS standard, overall intersection LOS D during the peak hour of traffic is a typical target for most suburban/urban areas in Northern Virginia. LOS D, by industry standards, indicates that roads and intersections are functioning within quality and service that is tolerable to most users during peak times and that roads are not overbuilt such that they are providing capacity in excess of what may be needed during off-peak times.

LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
• Free flow • Desired speeds • Low traffic • High maneuverability • Exceptional progression • No delay • Volume-to-Capacity Ratio (v/c) < 1.0	• Stable flow • Reasonable speeds • Low to moderate traffic • Favorable progression • Minimal delay • v/c <1.0	• Stable flow • Reasonable speeds • Restricted maneuverability • Moderate traffic • Moderate progression • Some stops at intersections • Some delays • v/c <1.0	• Occasionally less than stable flow • Reduced speeds • Restricted maneuverability • Moderate to high traffic • Reduced progression • More stops at intersections • Moderate delays • v/c < 1.0	• Unstable flow • Reduced speeds • Low maneuverability • High to Significant traffic • Unfavorable progression • Frequent stops at intersections and queuing that fails to clear cycle • Significant delays • v/c < 1.0	• Unstable flow • Low speeds • High congestion • Very low maneuverability • Siginficant traffic • Poor progression • Intolerable delays • Significant queuing that fails to clear cycle • v/c > 1.0; Over capacity

During the commuter peak hour, most signalized intersections are operating at overall LOS D or better during the AM and PM peak hours. Maple Avenue is congested but intersections are operating with a tolerable level of delay given the volume of traffic, required pedestrian crossing times, and number of travel lanes. Left turn movements at certain intersections operate with LOS E or F due to significant left turn volumes and a heavy opposing traffic flow that makes finding a gap in traffic difficult. This results in queuing and congestion that may spill beyond the available storage length of turn lanes during the peak hour.

Quality of service at unsignalized intersections is indicated by how easy or difficult it is to turn into and out of the side street. Not surprisingly, many of these movements are operating at LOS E or F. During the peak hour, the amount and directionality of east-to-west and west-to-east traffic leaves few gaps for vehicles to turn into or out of the unsignalized side streets. While not specifically measured in this analysis, this difficulty is also echoed at the over 100 commercial entrances that are located along Maple Avenue. Not only is it a challenge to turn into or out of these commercial entrances, but these movements cause delay, congestion, and safety conflicts (even with the presence of the two-way left turn lane). These challenges and delays are not unexpected at side streets and driveways along a busy arterial, which prioritizes the progression of vehicles along the major street over the movements from the minor street or driveway. An arterial's quality is also indicated by how well travelers are able to progress along the corridor at the expected speeds given the distance between signalized intersections, signal timing, and amount of traffic. During the peak hours, Maple Avenue functions with arterial LOS D. Commuter peak hour conditions are as follows:

Signalized Intersections with Overall LOS E or F

- Maple Avenue and Nutley Street
- Nutley Street and Courthouse Road

Unsignalized Intersections with LOS E or F Side Street Approach

- Maple Avenue and James Madison Drive
- Maple Avenue and Pleasant Street
- Church Street and Lawyers Road
- Church Street and Mill Street
- Church Street and Park Street

Signalized Intersections with Left Turn Queues Exceeding Storage

- Maple Avenue and Nutley Street
- Maple Avenue and Courhouse Road/Lawyers Road
- Maple Avenue and Center Street
- Maple Avenue and Park Street
- Maple Avenue and Glyndon Street
- Maple Avenue and Beluah Road
- Maple Avenue and East Street
- Maple Avenue and Follin Lane
- Nutley Street and Courthouse Road

Signalized Intersections with East-West Through Queues Exceeding Block Length or Blocking Turn Lanes

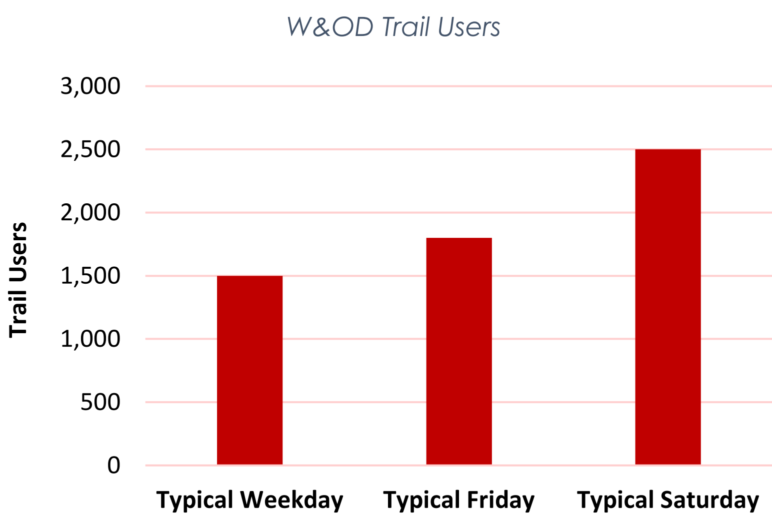
- Maple Avenue and Nutley Street
- Maple Avenue and Courhouse Road/Lawyers Road
- Maple Avenue and Center Street
- Maple Avenue and Park Street
- Maple Avenue and Glyndon Street
- Maple Avenue and Branch Road
- Maple Avenue and Beluah Road
- Maple Avenue and East Street
- Maple Avenue and Follin Lane
- Nutley Street and Courthouse Road

Multimodal Travel Conditions

Driving is not the exclusive way to get around the Town of Vienna, and, increasingly, it is not the only way that residents and visitors are choosing to engage with and enjoy the Town. Fortunately, Vienna has a few multimodal networks that offer travel choice and opportunities for pedestrians, bicyclists, and transit riders.

81 miles of sidewalk in Vienna connect residential neighborhoods with scenic open spaces and with the suburban commercial Maple Avenue corridor. The pedestrian experience is enhanced by marked crosswalks, ADA compliant infrastructure, and pedestrian signals.

The Washington and Old Dominion (W&OD) Trail is a unique feature in Town of Vienna with major street crossings at Park Street, Maple Avenue, Church Street, and Ayr Hill Road. The trail attracts significant pedestrian and bicycle volumes during weekdays and the weekend. An important aspect of this study was considering how trail users, both pedestrians and bicyclists, interact with the Town at or along Maple Avenue.



Street view of W&OD Trail Crossings

The bicycle network is less developed than the pedestrian network. There is a lack of signed and marked bicycle routes and lanes in the Town of Vienna. The Maple Avenue corridor itself is a significant barrier to bicycling due to the heavy vehicular traffic. The sidewalk network along Maple Avenue is also not necessarily wide enough to comfortably support bicycles and pedestrians sharing the space. Despite this, the majority of streets within the Town of Vienna are rated, per the Fairfax County Bicycle comfort rating scale, as comfortable or better for those who choose to cycle in the Town due to the lower speed limits and lower traffic volumes for the side streets off Maple Avenue.

Bicycle rider adjacent to the busy Maple Avenue corridor and Fairfax County Bicycle comfort rating scale

The transit network includes weekday and weekend transit services operated by Fairfax Connector. The routes serve the Town and connect between the Vienna and Tysons Metrorail Stations. Most Fairfax Connector routes in the study area run only on weekdays, with 30 to 40 minutes between buses. Bus stops along Maple Avenue are consistently spaced, one to two blocks apart. Transit frequencies, while appropriate when considering the traffic and distance the routes travel, do not specifically align with local destination trips along corridor. There is also a lack of feeder service to bring people between the residential neighborhoods and the corridor. Nearly half the bus stops along the corridor lack shelters, benches, adequate lighting, or ADA compliant areas to wait for, get on, or get off the bus.

Bus stop lacking shelter or designated waiting area outside of the pedestrian path

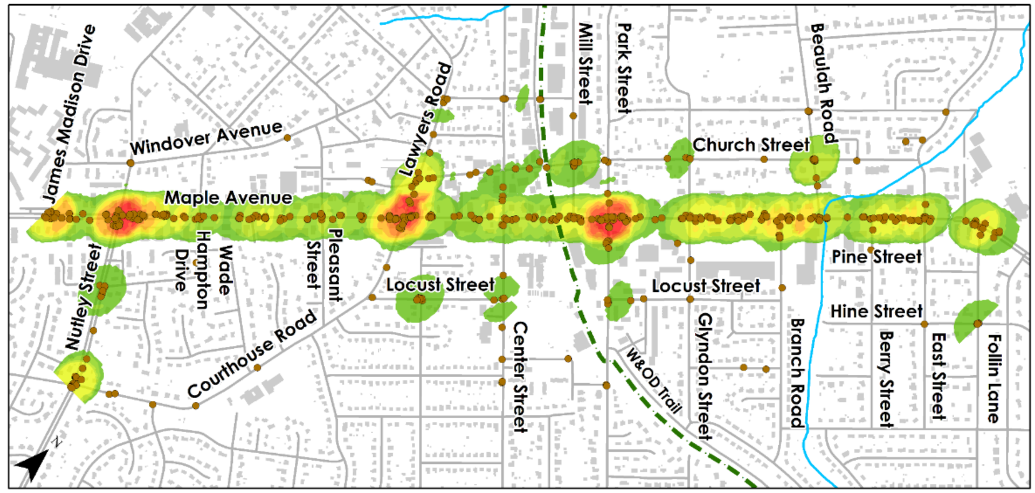
With respect to the multimodal focus of this study, it was integral to understand the tradeoffs and balance between mobility options. It was also recognized that not all mobility options may be able to comfortably fit within the Maple Avenue right of way; as such part of this study was understanding and identifying how all modes could be accommodated and supported from a *Complete Corridors* approach.

Safety and Crashes

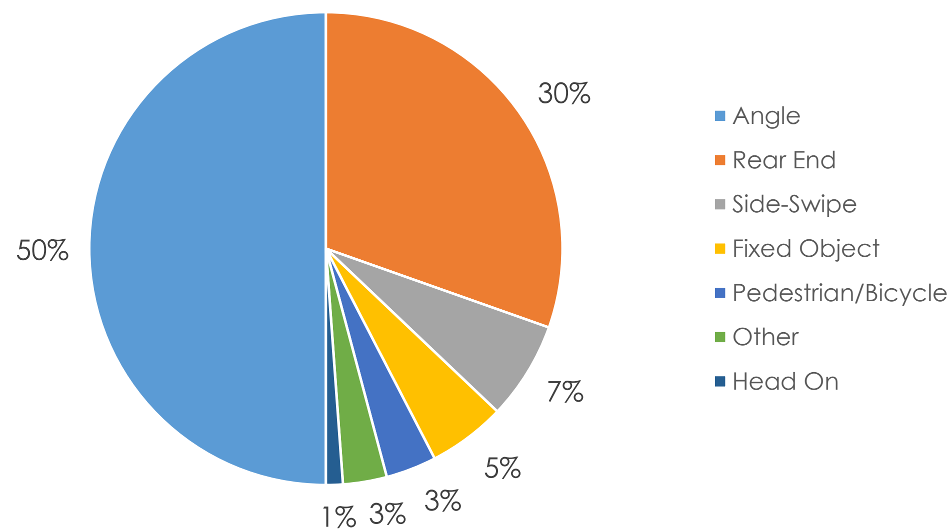
With the many ways of traveling around, along, and across Maple Avenue, safety was a critical concern expressed by the community - particularly the interaction between vehicles and the other travel modes. This study reviewed a 3-year history of reported crashes. During that time, there were a total of 434 reported crashes within the study area limits. Most of the crashes occurred during the daylight hours and during the peak periods of travel. Crashes were influenced by congestion, significant traffic volumes, and unsignalized driveways.

3%	***involved pedestrians***
18%	***occurred on weekends***
34%	***resulted in injuries***
36%	***occurred mid-block, outside the influence area of an intersection***
42%	***occurred during the off-peak period***
75%	***occurred during daylight***
82%	***occurred on weekdays***
83%	***occurred during clear weather***

Maple Avenue Crash Map



Maple Avenue Crash Type



General Transportation Challenges

1. Established, Auto-Oriented Corridor
2. Narrow Sidewalks
3. Dual Identity: "Main Street" versus Arterial
4. Interactions Between Pedestrians and Vehicles
5. Signal Timing
6. Lack of Dedicated, Signed, or Marked Bicycle Facilities
7. Numerous Full Access Commercial Entrances
8. Low Transit Service Frequency Relative to Local Trip Destinations
9. Discontinuous Parallel Street Network South of Maple Avenue
10. Numerous, Unconnected Surface Parking Lots

Future Conditions Summary

A future development scenario was evaluated to assess how resilient the Maple Avenue corridor was to changes in land use, density, peak and daily traffic, and multimodal travel patterns. The development scenario included:

- Three projects approved under MAC zoning
- One proposed project under review for MAC zoning
- Four possible future developments on which public discussion has taken place
- Five potential development sites greater than 1 acre with buildings built more than 50 years ago and not recently renovated

It is noted that outside of the three approved projects, the remaining developments are speculative. The intent of developing a future development scenario was to anticipate the additional challenges that the Maple Avenue corridor could face with a change in land use that may reasonably occur within the next 10 years. In total, the development scenario considered a future where the corridor was redeveloped to include:

- Nearly new 1,100 more dwelling units
- More than 267,000 square feet of new/redeveloped commercial uses
- A newly redeveloped library with 250-space parking garage
- An additional new 60-space semi-public parking garage

Some of these developments would replace vacant or underperforming existing uses and others would be a modern redevelopment of existing properties. The development scenario assumed a mixed-use future, where parcels are developed to include both residential and commercial uses. A potential benefit of mixed-use scenarios is the ability to fulfill one's daily trip needs without getting in a car (i.e. a resident that lives above or adjacent to retail or a restaurant has a greater ability to walk or bike to those destinations, reducing the anticipated impacts on the local road network).

Properties Considered in the Development Scenario

Name /Address	Status	Development Scenario Land Use and Density
Flagship Carwash (540 Maple Avenue West)	Approved under MAC	815 SF Car Wash 5,001 SF restaurant
Vienna Market / Marco Polo		26,000 sf retail 49 Townhouse units
444 Maple Avenue		20,000 SF Retail 160 Multifamily units
380 Maple Avenue	Under review	4,500 SF retail 4,000 SF restaurant 42 Multifamily units
Commonwealth Office Building (226 Maple Ave W)	Sites Greater than One Acre with Buildings Built More than Fifty Years Ago and Not Recently Renovated	1,600 SF retail 6,400 SF restaurant 42 Multifamily units
Bank of America (235 Maple Ave W)		1,600 SF retail 6,400 SF restaurant 59 Multifamily units
Glyndon Shopping Center (227-229 Maple Ave E)		25,600 SF retail 6,400 SF restaurant 111 Multifamily units
Maple Avenue Shopping Center (309-359 Maple Ave E)		96,000 SF retail 24,000 SF restaurant 419 Multifamily units
SunTrust (515-521 Maple Ave E:)		2,400 SF retail 9,600 SF restaurant 81 Multifamily units
BB&T/Kensington Assisted Living (415 Maple Ave W)	Possible Future Development on Which Public Discussion Has Occurred	7,500 SF retail 85 Multifamily units
Patrick Henry Library (101 Maple Ave E)		21,000 SF library 250 public parking spaces
100, 102, 112 Maple Avenue East		8,784 SF retail 2,196 SF restaurant 36 Multifamily units
145 Church Street		8,200 retail 22 Multifamily units 60-space garage

Compared to today, the development scenario was forecasted to result in an additional 784 net new trips during the AM peak hour and 500 net new trips during the PM peak hour that may be added to some parts of the Maple Avenue corridor. These trips will add to the congestion and delays already experienced under existing conditions and add to the challenges of turning into and out of unsignalized intersections and driveways. However, when dispersed across the study area, the trips will not lead to major traffic impacts or level of service degradations that do not align with the current travel conditions along Maple Avenue.

Maple Avenue as an arterial is largely expected to function much the same with less than a five percent increase in intersection control-related peak direction travel time even with the anticipated in the future development scenario. Addressing the current challenges on the corridor will directly respond to the needs of today's road users and be a good launching point to proactively address the changing transportation future.

Signalized Intersections with Worse LOS Compared to Existing Conditions
• Maple Avenue and Park Street
• Maple Avenue and Follin Lane
Unsignalized Intersections with Worse Side Street Approach LOS Compared to Existing Conditions
• Maple Avenue and James Madison Drive
• Maple Avenue and Wade Hampton Drive
• Maple Avenue and Pleasant Street
• Maple Avenue and Berry Street
• Church Street and Lawyers Road
• Locust Street and Center Street

Key Recommendations

The study developed a set of near- and mid-term recommendations to address current and future mobility challenges along the Maple Avenue corridor; recommendations that touched all modes of transportation and addressed current and future travel conditions, travel behaviors, and land use.

An initial ***big ideas*** process was used to develop concepts that addressed the transportation needs of the community – across all modes of travel. Big ideas were distilled, with the help of the community, into working concepts that fit under key themes:

- **More Travel Options**
- **Low Investment, High Impact**
- **Addressing Existing Challenges**
- **Completing the Network**

The concepts were further refined, in collaboration with the community and Town Council, and prioritized as a set of study recommendations:

Near-term recommendations were defined as those actions that can be programmed, planned, and implemented within five years and that are within the Town's purview with limited outside support necessary. ***What can the Town do today to allow the Maple Avenue Corridor to better function for all who use it, regardless of how they use it?***

Mid-term recommendations were defined as those actions that can be programmed, planned, and implemented within five to 10 years. These actions may need further study or concepting and may require or be enhanced through partnerships and collaboration with other public or private entities. ***What are the projects that the Town should plan for, now, to respond to coming changes in transportation, mobility, land use, and user needs?***

Long-term recommendations, while outside of the scope and horizon of this study, were included to speak to key long-term needs that rose to the attention of the study team and the community. The projects included in this category are more transformative in nature and may require significant future private land development, right-of-way acquisition, or further study. The Town may seek to pursue such actions in order to further the positive momentum and synergy of transportation and development in Vienna. ***What do we want Maple Avenue to be? What are the visions and the goals of mobility and access in the Town and how do we get there? How will Maple Avenue support Vienna as a modern 21st century small town?***

A full list and description of recommendations within each of these categories is included in **Chapter 7**. Top priority recommendations, determined in collaboration with the community and Town Council input, are listed below.

Top Priority Recommendations

1. **Improve Washington & Old Dominion Trail Crossings**
2. **Implement Leading Pedestrian Intervals**
3. **Fill Sidewalk Gaps**
4. **Improve Intersection of Church Street and Mill Street**
5. **Implement Local Circulator Service**
6. **Improve the On-Street Bicycle Network**
7. **Pursue Town-Wide Planning Efforts**
    - Bicycle Master Plan
    - Traffic Impact Analysis (TIA) Guidelines
    - Streetscape Master Plan and Design Guidelines
    - Parking Supply and Demand Study

1. Introduction

Maple Avenue (VA Route 123) is a vital transportation and commercial corridor for the Town of Vienna and Northern Virginia.

While functioning as an established, automobile-oriented corridor, Maple Avenue is best characterized by its dual identity.

For the region, Maple Avenue is a primary arterial that connects suburban southern Fairfax to the density and activity of northern Fairfax, Tysons, and beyond. It is classified by the Virginia Department of Transportation (VDOT) as an urban "other principal arterial," a road classification that "*serves the major activity centers of a metropolitan area and the highest traffic volume corridors; carries a high proportion of urban travel on the minimum amount of mileage; carries a significant amount of intra-area travel; and serves demand between the central business district and outlying residential areas.*"[2]

For the Town of Vienna, Maple Avenue is a main street; a place where people want to visit, to walk along, to enjoy retail and entertainment, and to accomplish their daily errands. It is also the designated corridor where a potential for denser mixed-use development has been specifically identified to further position Vienna as a modern 21st century small town.

Despite this dual identity, the fact remains that Maple Avenue serves on average 30,000 vehicles per day (vpd) (33,000 vehicles per weekday). In addition to residents and visitors, Maple Avenue serves a significant amount of through travelers who commute to the east in the morning and return west in the evening, only briefly or not at all stopping in Vienna (35 to 38 percent of daily Maple Avenue traffic is pass through traffic).[3]

The volume of traffic, combined with Maple Avenue's role as a primary commuter route and the limited right-of-way that is used by two lanes of traffic in each direction plus a two-way left turn lane, contributes to existing mobility challenges along this key thoroughfare, challenges that affect the neighboring (and neighborhood) streets in the vicinity of Maple Avenue.

For motorists, Maple Avenue during the peak travel periods *feels* to be at the point of capacity; it is congested and difficult to drive from east to west or west to east along Maple Avenue without experiencing stops and delays. It is also challenging to attempt to turn into or out of the many commercial driveways along the corridor.

This vehicular congestion has negative impacts on other modes of travel along and across Maple Avenue. Transit service is subject to the same delays, stops, and congestion as the vehicle network. The pedestrian and bicycle networks are also challenged for space within the limited right of way. With more than 30,000 vpd and most of the public right-of-way devoted to vehicles, Maple Avenue can at times be a barrier to pedestrian and bicycle movements between the north and south areas of Town. Pedestrian crossings, safest at signalized intersections or designated pedestrian signals, are also subject to delays due to intersection signal cycle lengths that prioritize the need to progress vehicles along a busy arterial. Comfort for bicyclists along Maple Avenue is reduced due to high traffic volumes, higher than compatible vehicle speeds, and the lack of a defined (through signing or marking) bicycle network.

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[2] Functional Classification Comprehensive Guide. VDOT. June 2014

[3] Data and Analysis for Vienna Transportation Planning Process. State Smart Transportation Initiative. June 2017.

These conditions set the context for a Maple Avenue that has several existing challenges:

- Established, auto-oriented corridor
- Narrow sidewalks
- Dual identity – "Main Street" versus "Arterial"
- Interactions between pedestrians and vehicles
- Signal timing
- Lack of dedicated, signed, or marked bicycle facilities
- Numerous full access commercial entrances
- Relatively low transit service for local destinations
- Discontinuous parallel street network south of Maple Avenue
- Numerous unconnected surface parking lots

Recognizing these challenges, the ability of the Maple Avenue corridor to absorb and accommodate potential future growth in traffic is a subject of concern for many residents.

1.1 Study Purpose

This report is a Multimodal Transportation and Land Use Study of the Maple Avenue corridor. It is a ***Multimodal Study*** in that it identifies the current and future challenges of mobility along the corridor in all its forms and examines how people interact with the Maple Avenue corridor when driving, riding transit, walking, and bicycling. It is a ***Land Use Study*** in that it discusses and connects planned and potential changes in land use and density along the corridor with the future mobility issues and opportunities. The core purpose of the Maple Avenue Corridor Multimodal Transportation and Land Use Study is to develop near- and mid-term recommendations that will help to enhance mobility and the travel experience along the corridor as well as to enhance safety and access for all modes of transportation.

Near-term recommendations are defined as those actions that can be programmed, planned, and implemented within five years and that are within the Town's purview with limited outside support necessary.

Mid-term recommendations are defined as those actions that can be programmed, planned, and implemented within five to 10 years. These actions may require further study, conceptualization, or enhancement through partnerships and collaboration with public or private entities.

Long-term recommendations, while outside of the scope and horizon of this study, are included to speak to key long-term needs that rose to the attention of the study team and the community. The projects included in this category are more transformative in nature and may require significant future private land development, right-of-way acquisition, or further study. The Town may seek to pursue such actions in order to foster the positive momentum and synergy of transportation and development in Vienna.

It is the goal of this study to identify recommendations that leverage the existing strengths of the corridor, address some of the current and future challenges, and set the stage for a Maple Avenue corridor that works within the context of the broader economic, mobility, and livability goals of the Town of Vienna. This report discusses the background context and existing conditions of mobility along the Maple Avenue corridor, identifies changes to the transportation conditions resulting from programmed improvements and a future development scenario, and introduces potential recommendations to enhance mobility in Vienna for today and tomorrow's needs.

1.2 Study Area

Recognizing that the challenges and opportunities of the Maple Avenue corridor extend beyond the physical limits of Maple Avenue itself, a broader study area was identified, and includes Church Street, Courthouse Road, and Locust Street and the side streets that connect these roads to Maple Avenue.

Maple Avenue is classified as a principal arterial with a speed limit of 25 miles per hour (mph) in the study area. Based on VDOT

2018 Average Annual daily traffic counts (AADT), the road serves 25,000 to 30,000 vpd, Monday to Sunday, (west and east of Nutley Street, respectively) and 27,000 to 33,000 vpd on a typical weekday. Maple Avenue is part of the National Highway System (NHS) of Virginia. The NHS is a system of roadways of significant importance to the economy, defense, and mobility of the United States. The NHS designation helps identify high priority corridors of national/regional importance, and direct funding where it is most needed.[4]

Church Street is classified as a major collector with a 25-mph speed limit. Based on VDOT 2018 AADT counts, the road serves 4,900 to 5,900 vpd, Monday to Sunday, and 5,200 to 6,300 vpd on a typical weekday. Courthouse Road is also a major collector, a road classification which provides access and traffic circulation within residential neighborhoods, commercial, and industrial areas; distributes trips from the arterials through the aforementioned areas to their ultimate destination; collects traffic from local streets, and channels it to the arterial system.[2] Based on VDOT 2018 AADT counts, the road serves 7,800 vpd, Monday to Sunday, and 8,300 vpd on a typical weekday. Other major collectors in the study area include Park Street, Locust Street, Branch Street, Follin Lane, Echols Street, and East Street. The remaining streets in the study area are local streets.

Nutley Street is classified as a minor arterial, a road classification which provides service for trips of moderate length at a lower level of travel mobility than principal arterials; serves geographic areas that are smaller than their higher arterial counterparts; interconnects with principal arterials; and provides more land access than principal arterials without penetrating identifiable neighborhoods.[2] The speed limit of Nutley Street is 35 mph in the study area. Based on VDOT 2018 AADT counts, the road serves 17,000 and 5,600 vpd, Monday to Sunday, (south and north of Maple Avenue, respectively) and 18,000 and 6,000 vpd on a typical weekday. Other minor arterials in the study are include Lawyers Road. **Figure 1-1** depicts the study area, which includes 31 intersections. An AADT Map is provide in **Figure 1-2**. Maple Avenue and James Madison Drive

1. Maple Avenue and Nutley Street
2. Maple Avenue and Wade Hampton Drive
3. Maple Avenue and Pleasant Street
4. Maple Avenue and Vienna Plaza HAWK Signal
5. Maple Avenue and Courthouse Road/Lawyers Road
6. Maple Avenue and Center Street
7. Maple Avenue and W&OD Trail Crossing
8. Maple Avenue and Mill Street
9. Maple Avenue and Park Street
10. Maple Avenue and Glyndon Street
11. Maple Avenue and Branch Road
12. Maple Avenue and Beulah Road
13. Maple Avenue and Berry Street
14. Maple Avenue and E Street
15. Maple Avenue and Follin Lane
16. Courthouse Road and Nutley Street
17. Church Street and Lawyers Road
18. Church Street and Center Street
19. Church Street and Dominion Street/W&OD Trail Crossing
20. Church Street and Mill Street
21. Church Street and Park Street
22. Church Street and Glyndon Street
23. Church Street and Beulah Street
24. Church Street and East Street
25. Locust Street and Courthouse Road
26. Locust Street and Center Street
27. Locust Street and Park Street
28. Locust Street and Glyndon Street
29. Locust Street and Branch Road
30. Echols Street and Follin Lane

[4] Functional Classification Comprehensive Guide. VDOT. June 2014

Figure 1-1: Study Area

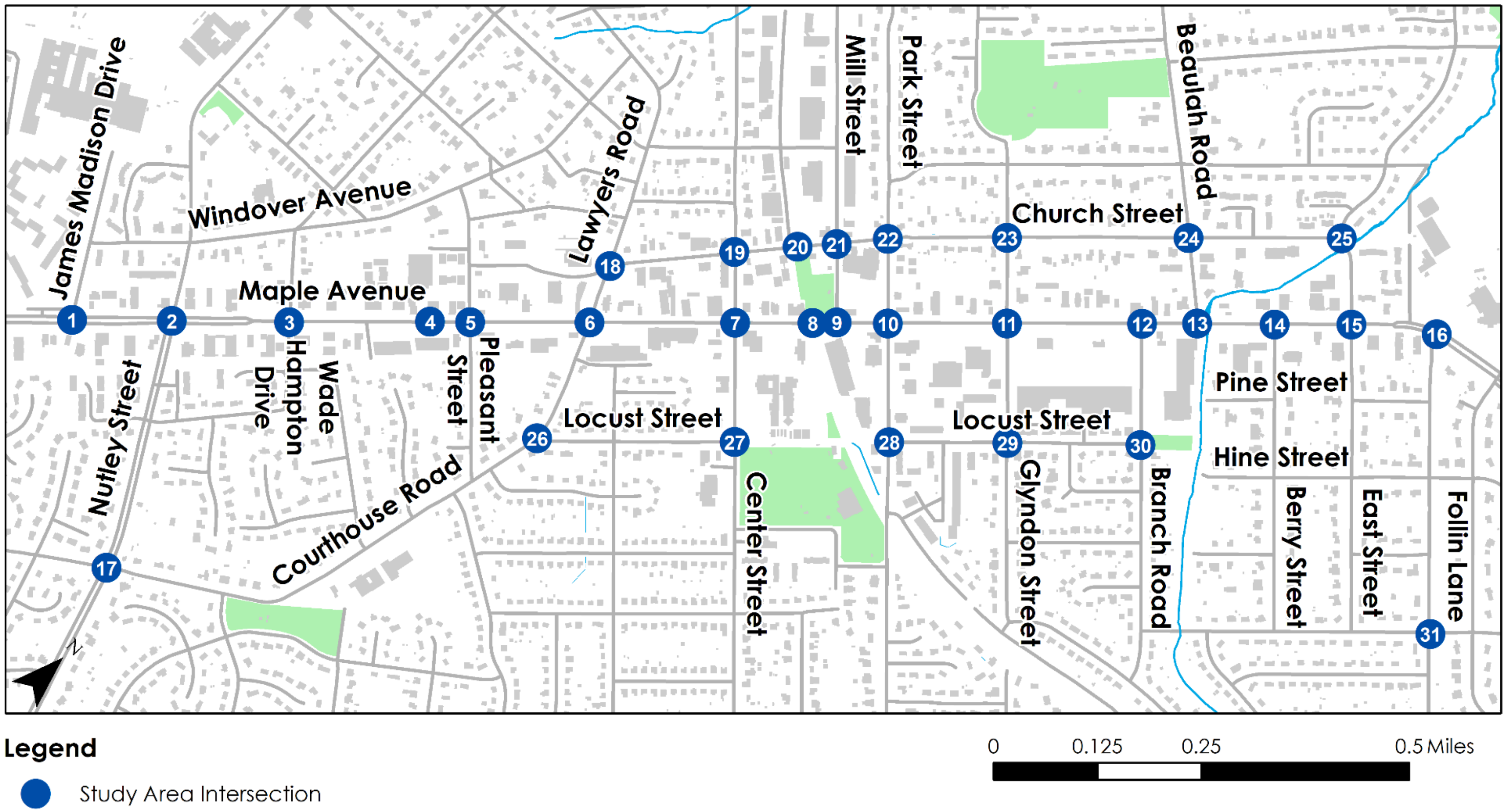
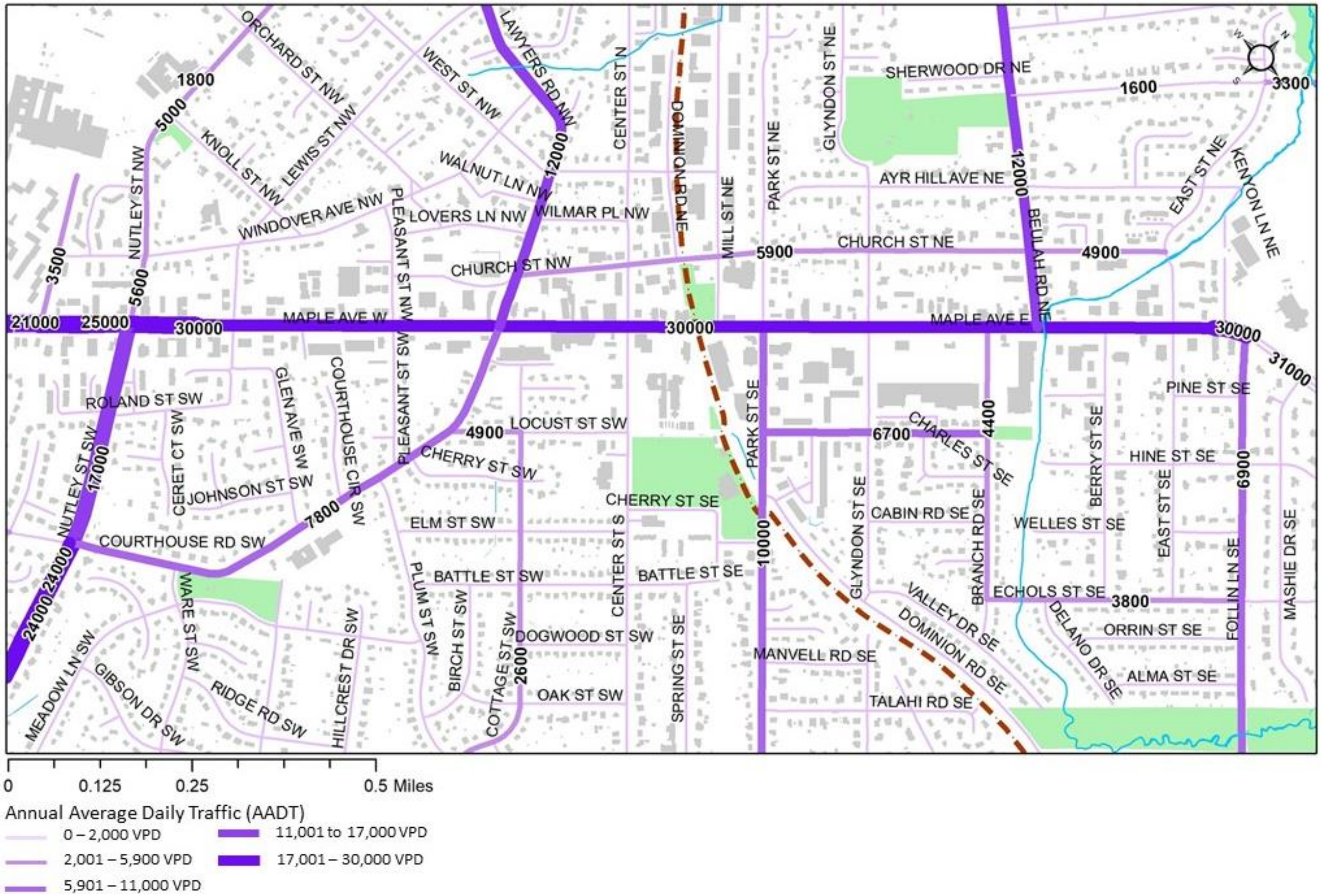


Figure 1-2: Study Area Average Annual Daily Traffic



The study area encircling Maple Avenue and Church Street make up the areas designated as the Central Business District (CBD) in Vienna. The CBD is made up of two commercial corridors:

The Church Street Commercial Corridor, between Lawyers Road and Park Street, is one block off of and parallel to Maple Avenue. Current uses are primarily specialty shops; office buildings; a residential condominium complex; the historic Freeman House; and a park area with the historic train station and train caboose.

The Maple Avenue Commercial Corridor is designated as the principal commercial corridor in Vienna, and provides access to Tysons and the Washington, D.C. metropolitan area via Virginia State Route 123. Commercial spaces along Maple Avenue, from East Street to James Madison Drive, are diverse and include a combination of new and old structures.

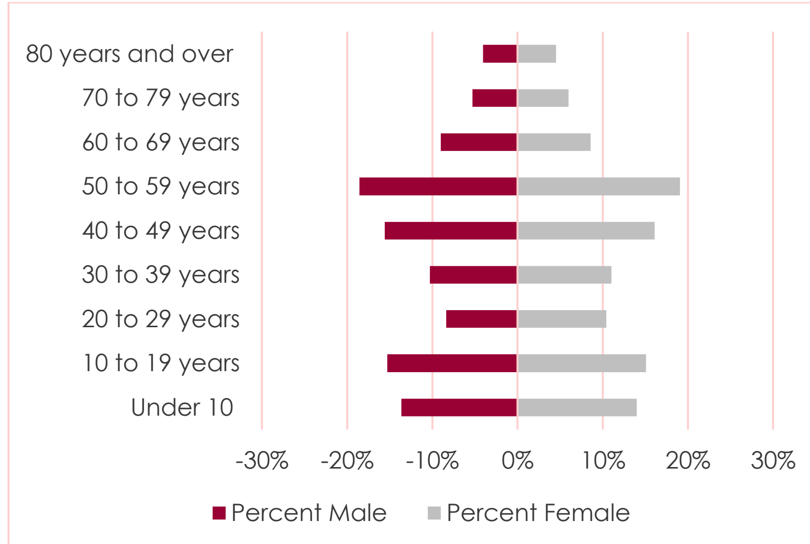
The Maple Avenue Commercial Corridor is also the subject of the currently on-moratorium Maple Avenue Commercial (MAC) voluntary zoning designation. More information about this zoning designation is provided in Chapter 2.

1.3 Community Profile

Community characteristics shape much of the current mobility trends in the Town of Vienna. The total population, based on the most recent 5-year American Community Survey (2013-2017), is 16,474 people. As shown in **Figure 1-3**, Vienna's population is aging, and as this trend continues, the topics of mobility, accessibility, and travel options become increasingly relevant.

It is noted that existing barriers to travel affect different members of the community in different ways and that different travel modes are more or less of an option for different members of the community. This in turn impacts the viability of using other travel options outside of personal vehicles.

Figure 1-3: Age Distribution of Vienna Residents

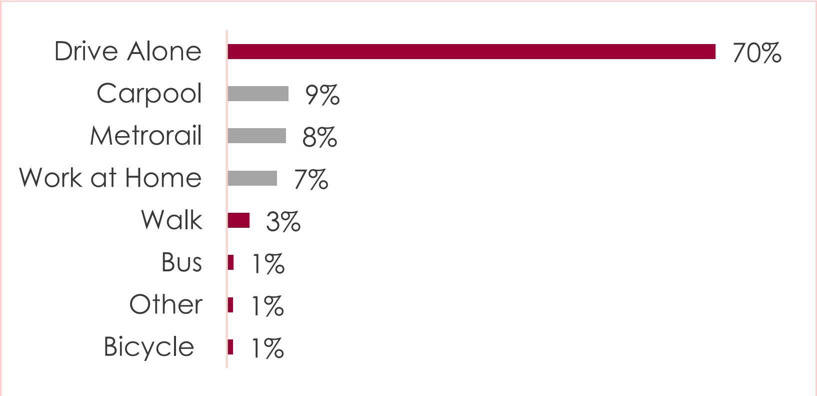


Source: American Community Survey 2013-2017

Multimodal transportation in Vienna has room for growth. According to recent data, most Vienna residents commute by driving alone to work, as shown in **Figure 1-4**, which, combined with through travels, adds to an already congested local transportation network.

It is recognized that while not every vehicular trip can be replaced with a trip via another mode (i.e. walking, bicycling, transit, etc) there are strategies that can be implemented to increase the viability, accessibility, and attractiveness of other means of travel. There are also strategies to minimize the need to travel during the peak periods of congestion.

Figure 1-4: Vienna Residents Means of Transportation to Work

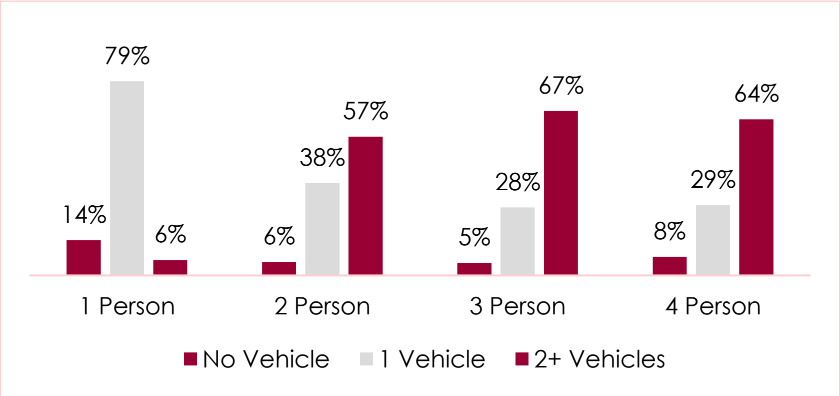


Source: American Community Survey 2013-2017

Vehicle ownership often has a critical role in an individual's travel decisions. Opportunities to increase multimodal mobility in Vienna can be found through targeting specific demographics who have a higher need or desire for non-single occupancy vehicle travel. For example, over a third of two-person, three-person, and four-person households have access to one car or less, as shown in **Figure 1-5**. Ensuring viability of active transportation modes as opposed to driving alone has the potential to convert typical "9 to 5" workers to multimodal and rideshare options (potentially freeing up the single vehicle for other members of the household throughout the day).

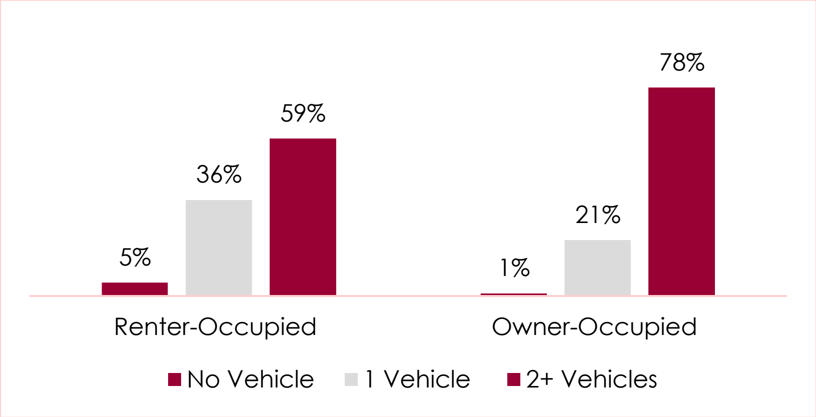
Another example that could influence increased mobility is prioritizing active transportation options near rental housing. **Figure 1-6** shows that renters are more likely to have limited vehicle access than those in owner-occupied units, as such promotion of active travel options could allow them to make more informed decisions about the way they travel the corridor.

Figure 1-5: Number of Vehicles per Household Size in Vienna



Source: American Community Survey 2013-2017

Figure 1-6: Number of Vehicles per Home Ownership in Vienna



Source: American Community Survey 2013-2017

2. Background Context

There are many past and current studies, projects, and planning efforts that consider the future of transportation and land use in the Town of Vienna and the Northern Virginia region as a whole. This chapter discusses those past and ongoing efforts and describes how they serve to contextualize the current conditions and future of mobility and land use in the Town of Vienna.

2.1 Town of Vienna Initiatives

Comprehensive Plan

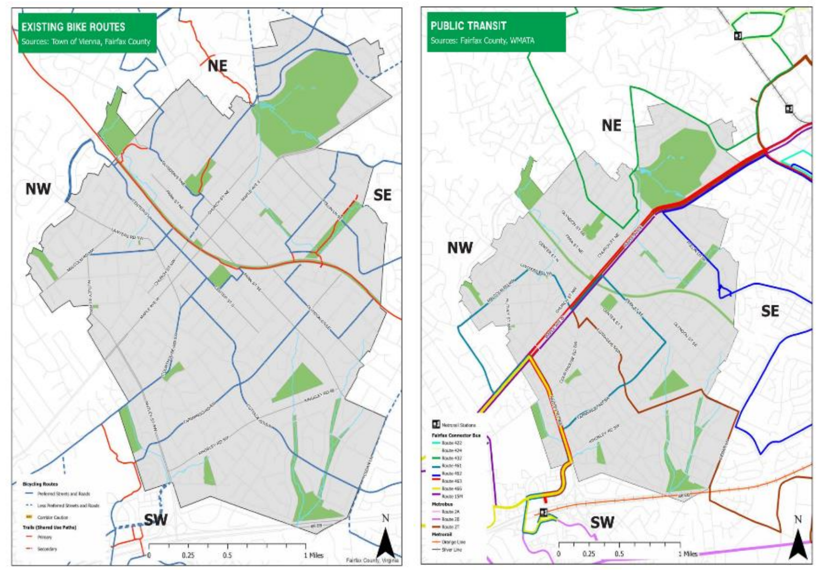
The Town of Vienna adopted a comprehensive plan on May 23, 2016. The plan identified mobility strategies and objectives that serve as important context for this study. Vienna's comprehensive plan addressed the infrastructure of active modes of transportation – namely, needed improvements to bike routes and the public transit network as seen in **Figure 2-1**. The comprehensive plan discussed room for mobility improvements throughout the Town. Additionally, it presented 2014 crash data (**Figure 2-2**) and highlighted Maple Avenue as an area of safety concerns.

According to the comprehensive plan, the Town of Vienna holds the following mobility objectives for the future:

- Improve bicycle connectivity and increase ridership
- Encouraging alternative modes of transit
- Manage the parking supply by lowering demand and limiting the expansion of surface parking areas
- Improve pedestrian connectivity and enhance pedestrian access to Town amenities
- Manage impacts of increased traffic in neighborhoods and encourage street (re)design to accommodate all modes
- Eliminate fatalities from traffic crashes and reduce number of crashes
- Explore public transit opportunities

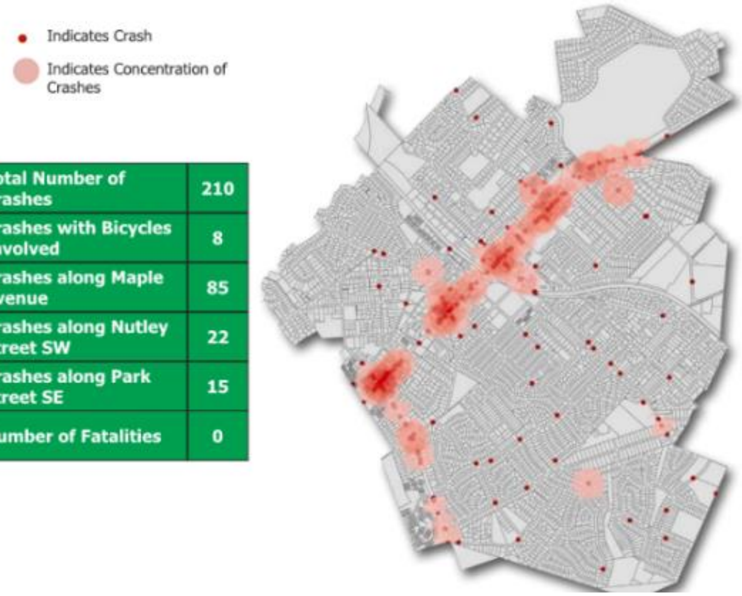
Indicators of plan's implementation were to include quantitative decrease in crashes and traffic delays and increased number of ped/bike commuters and public transit options.

Figure 2-1: Comprehensive Plan Bike Routes and Transit Network



Source: Town of Vienna Comprehensive Plan

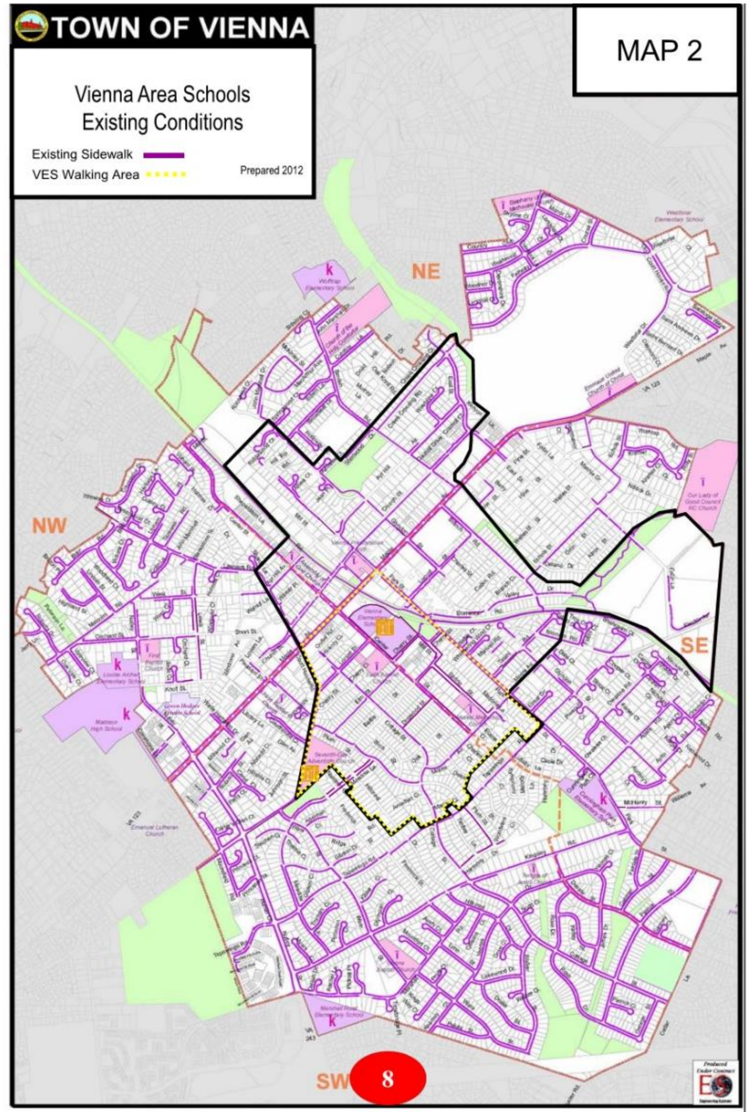
Figure 2-2: Comprehensive Plan Crash Map



Total Number of Crashes	210
Crashes with Bicycles Involved	8
Crashes along Maple Avenue	85
Crashes along Nutley Street SW	22
Crashes along Park Street SE	15
Number of Fatalities	0

Source: Town of Vienna, Virginia Department of Motor Vehicles

Figure 2-3: Vienna Pedestrian Master Plan



Pedestrian Master Plan

The Pedestrian Master Plan for the Town of Vienna was prepared in September 2017. It discusses the Town's priorities, challenges and a set of recommendations for facility, operational and educational improvements, and made safe routes to school a top priority. **Figure 2-3** shows an example of a walking plan for one of the Town's elementary school in 2012. As shown, there is a need to complete the existing pedestrian network throughout Vienna to improve the walkability for users of all ages and needs.

Land Use and Zoning

Commercial land uses are dominant along both Maple Avenue and Church Street, with varying degrees of intensity, size, and mix of uses. In areas adjacent to, but just off of Maple Avenue, townhouse and multi-family zones provide a transition between the higher-density commercial and much lower-density areas of single-family detached homes that make up most of land use in the Town. This transition area serves as a buffer between commercial activities and residential neighborhoods.

Maple Avenue Commercial Zoning

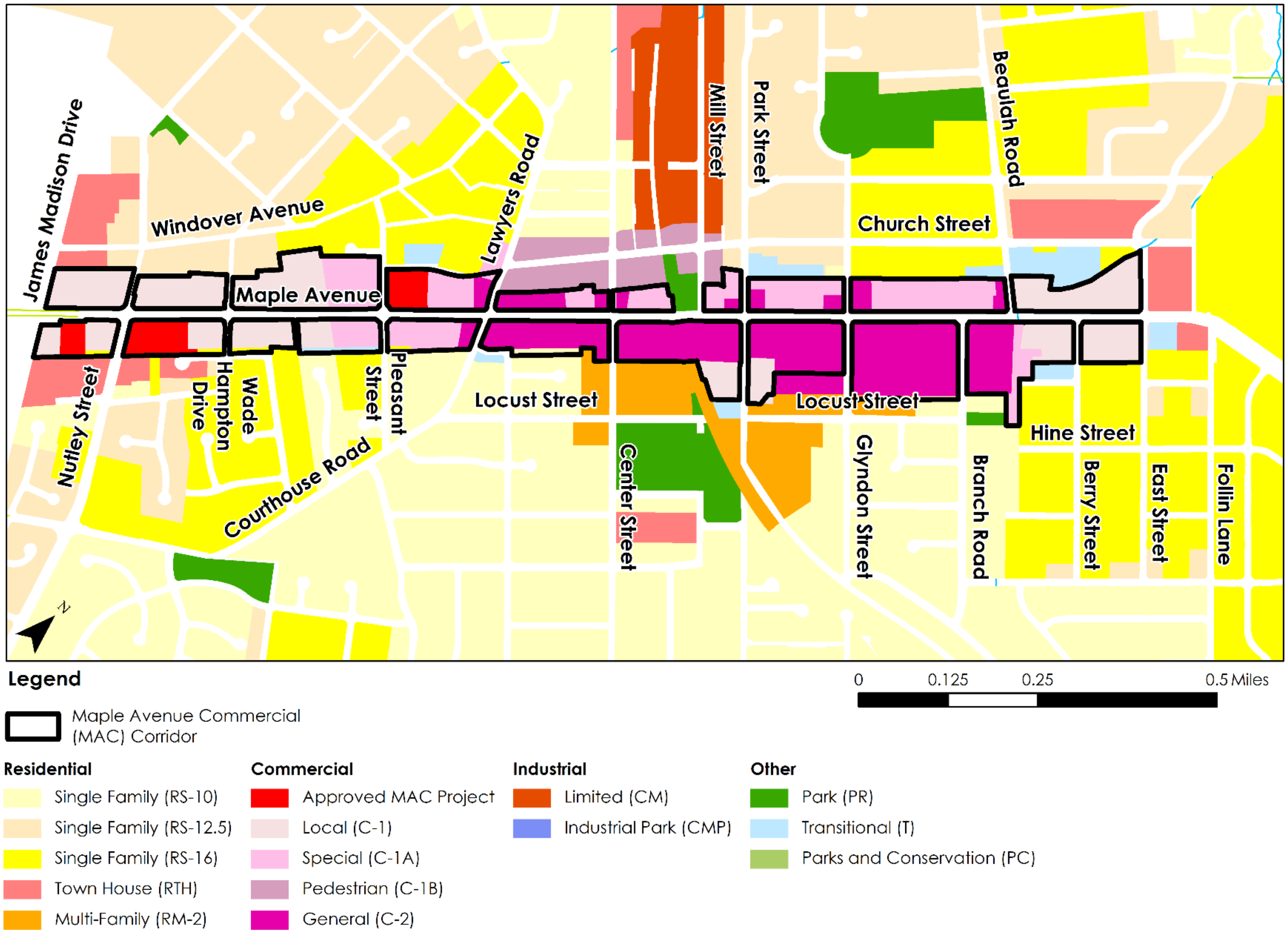
Through a multi-year process, a voluntary zoning district was created for the Maple Avenue Commercial (MAC) Corridor and was adopted by the Town Council in the fall of 2014. This zoning district supported the development of pedestrian-friendly, mixed-use buildings, including ground floor retail and office space, with residential and other uses on upper floors. The optional district, shown along with zoning in **Figure 2-4**, applied to any of the commercially-zoned properties along Maple Avenue between Vienna's western limits and East Street. The zoning district offered incentives for mixed-use opportunities, such as an increased building height and reduced parking requirements. The MAC zone reinforced Maple Avenue's role as the Town of Vienna's "Main Street." The zone was intended to ensure that development along the corridor promotes Vienna's small-town charm and did not compromise the character of residential neighborhoods adjacent to the corridor. It encouraged a higher quality hometown experience for residents, visitors, and businesses by implementing a balanced, community-oriented, collaborative approach to redevelopment. More specific intentions of the MAC zone are listed in **Table 2-1**. It is noted that the MAC Zoning went into moratorium shortly before the inception of this study.

Table 2-1: MAC Zone Purpose and Intent

A	Encourage compact, pedestrian-oriented development along Maple Avenue that collectively accommodates residents, visitors, and businesses
B	Encourage a pedestrian-friendly, human-scale design of streets, buildings, and open spaces
C	Foster mixed-use and destination-style retail development along Maple Avenue
D	Promote a variety of housing options in the Town
E	Enhance the Town's economic vitality by promoting the preservation and creation a variety of business establishments, including restaurants, services, small and locally-owned businesses, and other uses which contribute to the vitality of Maple Avenue
F	Maintain and promote eclectic character and visual interest of building design and site configuration by encouraging a variety of building heights, density, and building mass consistent with Vienna's small-town character and compatible with surrounding residential neighborhoods
G	Provide for a high quality of development along Maple Avenue
H	Improve environmental quality and promote responsible development practices along Maple Avenue
I	Encourage the creation of publicly-accessible community gathering spaces, such as parks, plazas, and other open spaces
J	Encourage the incorporation of art in sites and buildings through a variety of design elements, natural features, installations and displays in highly visible and publicly accessible locations
K	Foster a built environment that is comfortable, safe, accessible, barrier-free and convenient to residents and visitors of all ages and abilities.

Source: Maple Avenue Commercial Zone Regulations

Figure 2-4: Maple Avenue Zoning



2.2 Fairfax County Initiatives

Fairfax County Comprehensive Plan

The Fairfax County comprehensive plan identifies specific objectives within the Vienna planning district, near the Vienna/Fairfax-GMU Metrorail station. Tysons also has a section of the Fairfax County Comprehensive Plan, which thoroughly diagnoses current transportation conditions and outlines objectives for the future. Starting in Vienna, just outside the study area Old Courthouse Road has been identified as needing safety enhancements, widening, and improvements throughout its extents. Interestingly, the both the Fairfax County and Tysons Plan show widening for Maple Avenue on either sides of the Town's borders.

2.3 VDOT and Other Initiatives

Transform 66

Transform 66 is multimodal initiative along the Interstate 66 (I-66) corridor that will provide travel improvements and new opportunities, scheduled to be complete in December 2022. Vienna lies within the project extents and will benefit from many improvements through this initiative. The improvements will enhance safety and bring better connectivity to metrorail stations and adjacent towns for all modes of travel.

- New bike and pedestrian trails
- Added express lanes along I-66
- Interchange improvements / added auxiliary lanes
- Expanded park and ride lots
- Improved bus service and transit routes

Figure 2-5 depicts a concept of improvements near the Vienna/Fairfax-GMU Metrorail Station.

Figure 2-5: Transform 66 Improvements

I-66 Eastbound Widening

Inside the Beltway, the Transform 66 initiative will widen eastbound sections of I-66 by Fall of 2020. While this widening will not happen within Vienna town limits, it will improve travel conditions along routes that could serve as a viable travel alternative to Maple Avenue, creating travel improvements and impacts for Vienna commuters and residents. **Figure 2-6** below shows the project limits for I-66 widening.

Figure 2-6: I-66 Eastbound Widening

3. Existing Conditions

3.1 Multimodal Level of Service and Alternate Mobility Performance Measures

For the purpose of this study, the chosen performance measures were a combination of **quantitative evaluation** (vehicle delay, queuing, and level of service for the auto mode) and **qualitative assessments** (quality, comfort, connectivity, accessibility and travel experience for non-motorized modes). These measures were identified as part of the scoping process and represent a *modern approach* to considering mobility within a planning context. These measures also align with the manner in which traffic results have been presented and discussed within the Town of Vienna with respect to the traffic studies that have been submitted, reviewed, and approved.

Vehicle operations are described using level of service (LOS), which is defined in the Highway Capacity Manual (HCM) as a quantitative stratification of a specific performance measure representing quality of service or how well a transportation facility operates from a traveler's perspective. LOS is graded A (best) to F (worst) and is a typical measure that best describes roadway operations, reflects travelers' perspectives, and is a useful tool for roadway operating agencies with a goal of identifying areas of concern. Different factors influence the perception and reality of a facility's quality. With respect to vehicular travel, some of these factors include: travel time, speed, delay, number of stops, maneuverability, comfort, convenience, safety, user costs, and accessibility.

The primary performance measures used to indicate vehicular quality of service along the Maple Avenue corridor consisted of vehicle delay at signalized and unsignalized intersections and travel speeds along the arterial. Additional measures such as queuing and crash history provide context for how well the road is performing at specific times or at specific locations. While the Town of Vienna does not maintain a LOS standard, overall intersection LOS D during the peak hour of traffic is a typical target for most suburban/urban areas in Northern Virginia. LOS D, by industry standards, indicates that roads and intersections are functioning within quality and service that is tolerable to most users during peak times and that roads are not overbuilt such that they are providing capacity in excess of what may be needed during off-peak times.

There has been some curiosity from community members regarding other measures that could be used to further the discussion about multimodal mobility along Maple Avenue, as well as other ways to recognize the performance, issues, and opportunities of the Maple Avenue corridor beyond vehicle LOS. This section of the report provides a brief overview of some alternate mobility performance measures the Town of Vienna may determine to be useful in future analyses and community dialogue. These alternate performance measures are still drawn from guidance provided in the 6th Edition of the Highway Capacity Manual: A Guide for Multimodal Mobility Analysis (HCM 6), which is the transportation industry's chief reference document. As stated in the HCM 6, providing mobility for people and goods in transportation's most essential function. Mobility, consists of four functions:

- **Quantity of travel**, the magnitude of use of a transportation facility
- **Quality of travel**, users' perceptions of travel with respect to expectations
- **Accessibility**, the ease with which travelers can engage in desired activities,
- **Capacity**, the ability of a transportation facility or service to meet the quantity of travel demanded of it

It was previously introduced that the analysis contained herein represents a *modern* approach. T*raditional, modern,* and *modern+* approaches are defined:

- **Traditional Approach** – Primarily focuses on vehicular performances with little to no direct analysis or assessment of non-passenger vehicle performance. Pedestrian and bicycle volumes, as well as transit bus arrivals, are considered only as far as they affect the performance of the vehicular network. Analysis is based, typically, on the network as a set of isolated intersections and each intersection's performance is based on overall control delay (weighted average delay of all movements), reported as LOS.
- **Modern Approach** – Combine quantitative evaluations and qualitative assessments to define a more rounded interpretation of how well the corridor is performing for all modes of travel under consideration. Quantitative analysis is still largely centered around vehicular performance. Qualitative assessments focus on the supply, demand, quality, and comfort of pedestrian, bicycle, and transit modes. Proxy performance measures can be developed for these modes (i.e. number of transit stops per mile, number of gaps in the sidewalk network, connectivity of bike paths and trails). Vehicular analysis can be based on the network as a set of isolated intersections or as a defined corridor (with additional corridor-centric performance measures: travel time, reliability, queuing, progression, speed, etc.).
- **Modern+ Approach** – These are modern analyses plus additional quantitative evaluations for one or multiple of the active travel modes. Such analyses seek to bring the same level of complexity in the analysis and interpretation of pedestrian, bicycle, and transit networks. Instead of proxy measures more specific elements are calculated and quantified for each mode and then translated into a LOS score.

The true difference in these approaches are the level of complexity and potential results. Traditional approaches are the quickest with respect to analysis but will only net results and mitigation that are oriented to auto performance. Modern approaches require additional analysis time but allow the conversation to take on new dimensions with the consideration of other modes. Modern approaches may frustrate some people who are looking for the same level of complexity among the analysis of all modes and these approaches require interpretation of results to communicate the tradeoffs between modes. Modern+ approaches are the most complex and require significant amounts of input data. Processing time is long and costly. While modern+ approaches allow for the most granular conversation about performance, it also leads to false equivalences between LOS concepts (i.e. LOS A for autos does not equal LOS A for bikes, etc.). From a return on investment perspective, with any modern+ approach the question has to be how much fuller the conversation about multimodal mobility will be with the more granular analysis.

For this study, it was determined that the **modern approach** afforded the appropriate level of detail and conversation about all modes of travel.

The proposed methodology also includes the concept of LOS and LOS Score that are applied as a shorthand to describe a travelers' perspective on the quality of service that is provided by a given travel mode at or along a given road, intersection, corridor, or facility. For all modes, LOS A represents the best operating conditions and LOS F represents the worst operating conditions, both from the traveler's perspectives.

LOS considerations:

- LOS is used to translate complicated analysis and equations into a simplified rating that can be used as shorthand in the public dialogue.

- LOS, generally, is a step function with rigid boundaries between the various letter grades. As such a small or modest increase in vehicle delay could result in a different letter grade or not, depending on how close the base condition was to the threshold
- Identical service measure values (i.e. the same delay) produces different LOS results depending on the travel mode under consideration
- LOS F defines the point of breakdown, where most users consider operations to be unsatisfactory. But additional service breakdown beyond LOS F is not very well defined. (Ancillary measures such as volume to capacity ratio, duration of LOS F, and queuing may be reviewed to try to describe how "bad" the LOS F condition is)
- LOS is and should be reported separately for each mode because each mode's travelers have different perspectives, experiences, and travel expectations. Reporting separately allows for the discussion of tradeoffs

The HCM provides tools to analyze quality and capacity for points (intersections or driveways), links/segments (roads, paths, or walkways), and corridors or facilities (which are defined as lengths of roads/paths/walkways composed of connected points and segments). Maple Avenue is best described as a facility made up of urban street segments, links, and points. The HCM indicates the preferred service/performance measures by transportation system element and mode. Much of the measures used in multimodal analyses are based on the perceptions that an average user will have regarding the mobility. Service measures for each mode are shown in **Table 3-1**. Some components that affect traveler "perception" are shown in **Table 3-2**. Correlation between transportation system element, service measures, and LOS thresholds by system mode are shown in **Table 3-3**.

Table 3-1: HCM Service Measures by Individual System Element

System Element	Service Measure				Analysis Measure
	Auto	Pedestrian	Bicycle	Transit	
Urban Street Facility	Speed	LOS score	LOS score	LOS score	Speed
Urban Street Segment	Speed	LOS score	LOS score	LOS score	Speed
Signalized Intersection	Delay	LOS score	LOS score	-	Delay
Two-way Stop	Delay	Delay	-	-	Delay
All-way Stop	Delay	-	-	-	Delay
Off-Street Ped-Bicycle Facility	-	Space, Events	LOS score	-	Speed

Table 3-2: HCM Components of Traveler Perception Models

System Element	Mode	Model Components
Urban Street Facility	Auto	Weighted Average Segment Auto LOS Score
	Pedestrian	Street segment and signalized intersection Ped LOS Score, midblock crossing difficulty
	Bicycle	Street segment and signalized intersection bicycle LOS Score, driveway conflicts
	Transit	Weighted average segment transit LOS score
Urban Street Segment	Auto	Stops per mile, left-turn lane presence
	Pedestrian	Delays, sidewalk width, perceived separation from motor vehicles, auto volume and speed
	Bicycle	Perceived separation from motor vehicles, pavement quality, auto volume and speed
	Transit	Service frequency, perceived speed, pedestrian LOS
Signalized Intersection	Pedestrian	Street crossing delay, pedestrian exposure to turning vehicle conflicts, crossing distance
	Bicycle	Perceived separation from motor vehicles, crossing distance
Off-Street Ped-Bicycle Facility	Bicycle	Average meetings/minute, active passings/minute, path width, centerline presences, delayed passings

Table 3-3: Sample LOS Thresholds by system mode

System Element	Mode	LOS Criteria	Sample LOS Thresholds assuming 30mph Free Flow Speed and V/C <1					
			A	B	C	D	E	F
Urban Street Facility	Auto	Travel Speed (mph) relative Free flow Speed	>24	>20	>15	>12	>9	≤9
	Pedestrian assuming 60 ft²/p	LOS Score based on Average Pedestrian Space (ft²/p)	≤2.00	≤2.75	≤3.50	≤4.25	≤5.00	>5.00
	Pedestrian assuming 24-40 ft²/p	LOS Score based on Average Pedestrian Space (ft²/p)	N/A	N/A	≤3.50	≤4.25	≤5.00	>5.00
	Bicycle/ Transit	LOS Score based on Bicycle Travel Speed LOS Score based on Transit Travel Speed	≤2.00	≤2.75	≤3.50	≤4.25	≤5.00	>5.00
Urban Street Segment	Auto	Travel Speed (mph) relative Free flow Speed	>24	>20	>15	>12	>9	≤9
	Pedestrian assuming 60 ft²/p	Segment LOS Score based on Average Pedestrian Space (ft²/p) Link LOS Score	≤2.00 ≤1.50	≤2.75 ≤2.50	≤3.50 ≤3.50	≤4.25 ≤4.50	≤5.00 ≤5.50	>5.00 >5.50
	Pedestrian assuming 24-40 ft²/p	Segment LOS Score based on Average Pedestrian Space (ft²/p) Link LOS Score	N/A	N/A	≤3.50 ≤3.50	≤4.25 ≤4.50	≤5.00 ≤5.50	>5.00 >5.50
	Bicycle/Transit	Segment LOS Score based on Bicycle Travel Speed Segment LOS Score based on Transit Travel Speed Bicycle Link LOS Score	≤2.00 ≤1.50	≤2.75 ≤2.50	≤3.50 ≤3.50	≤4.25 ≤4.50	≤5.00 ≤5.50	>5.00 >5.50
Signalized Intersections	Auto	Control Delay (seconds/vehicle)	≤10	≤20	≤35	≤55	≤80	>80
	Pedestrian/ Bicycle	Pedestrian LOS Score based on corner circulation, crosswalk circulation, and pedestrian delay Bike LOS Score based on Bike Delay	≤1.5	≤2.5	≤3.5	≤4.5	≤5.50	>5.50
Two-Way Stop	Auto	Control Delay (seconds/vehicle)	≤10	≤15	≤25	≤35	≤50	>50
	Pedestrian	Control delay (seconds/person) for crossing major street	≤5	≤10	≤20	≤30	≤45	>45
All-Way Stop	Auto	Control Delay (seconds/vehicle)	≤10	≤15	≤25	≤35	≤50	>50

3.2 Pedestrian Network

The Town of Vienna currently has about 81 miles of sidewalk, 16 miles (or 20 percent) of which are contained within the study area. Sidewalk widths vary across the study area with most ranging between four and six feet wide. Nearly all marked pedestrian crossings within the study area are located at traffic signals. Pedestrian pushbuttons are installed at most signalized intersections to call a dedicated crossing phase for pedestrians.

Maple Avenue also has two pedestrian-activated HAWK (**H**igh-Intensity **A**ctivated cross**W**al**K**) signals, one just west of Pleasant Street and another at James Madison Drive. A third HAWK signal on Maple Avenue west of Center Street is included in the Town's Capital Improvement Plan (CIP).

Nearly all pedestrian crossings along and across Maple Avenue have curb ramps that are compliant with the Americans with Disabilities Act (ADA), equipped with wheelchair-accessible slopes, level landing areas, and tactile warning panels to help guide pedestrians with visual impairments. Other local streets in the study area have more variable compliance of curb ramps, such as Church Street and Locust Street, with certain intersections and street crossings having ramps that lack some of these accessibility features. Curb ramp types within the study area are shown in **Figure 3-1**.

Figure 3-1: Curb Ramp Types

Compliant Curb Ramp

- Proper slope
- Level landing
- Tactile warning panel

Location:
Locust Street and Park Street Roundabout

Non-Compliant Curb Ramp

- Steep slope
- Narrow or non-level landing area
- No tactile warning panel

Location:
Maple Avenue
(since upgraded)

No Curb Ramp

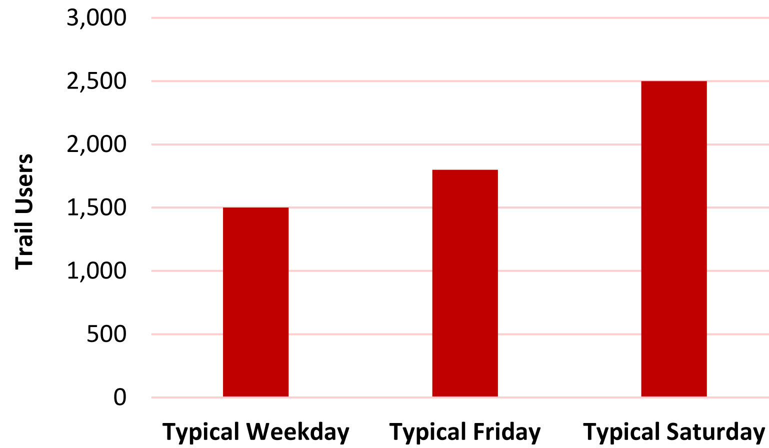
- No ramp present

Location:
Courthouse Road

Existing pedestrian-activated HAWK signal on Maple Avenue

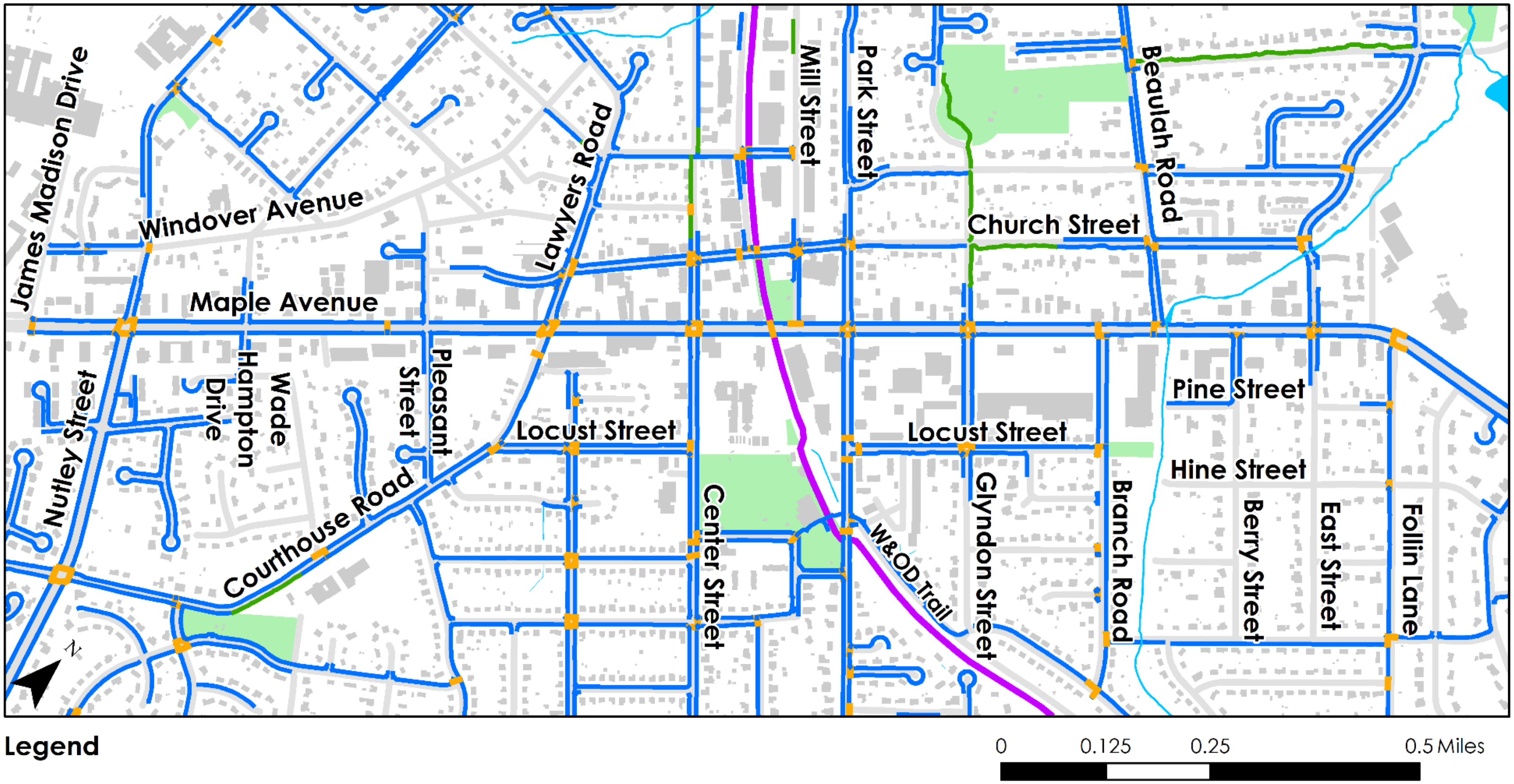
The regional Washington and Old Dominion (W&OD) Trail passes through the study area, providing a car-free, shared-use pathway for pedestrians as well as bicyclists. The W&OD Trail crosses Vienna streets at Park Street, Maple Avenue, Church Street, and Ayr Hill Road, all of which are unsignalized except for the Maple Avenue crossing (a full signalized intersection). Each crossing of the W&OD trail has different treatments – Park Street and Ayr Hill Road with marked crosswalks, Maple Avenue with a concrete crossing, and Church Street with a brick-colored concrete crossing. **Figure 3-2** shows typical trail use. **Figure 3-3** shows the pedestrian network within the study area. **Figure 3-4** shows AM and PM peak hour pedestrian traffic counts at study area intersections. It is noted that counts show movement in crosswalks at intersections.

Figure 3-2: W&OD Trail Use



W&OD Trail crossing at Maple Avenue

Figure 3-3: Existing Pedestrian Network

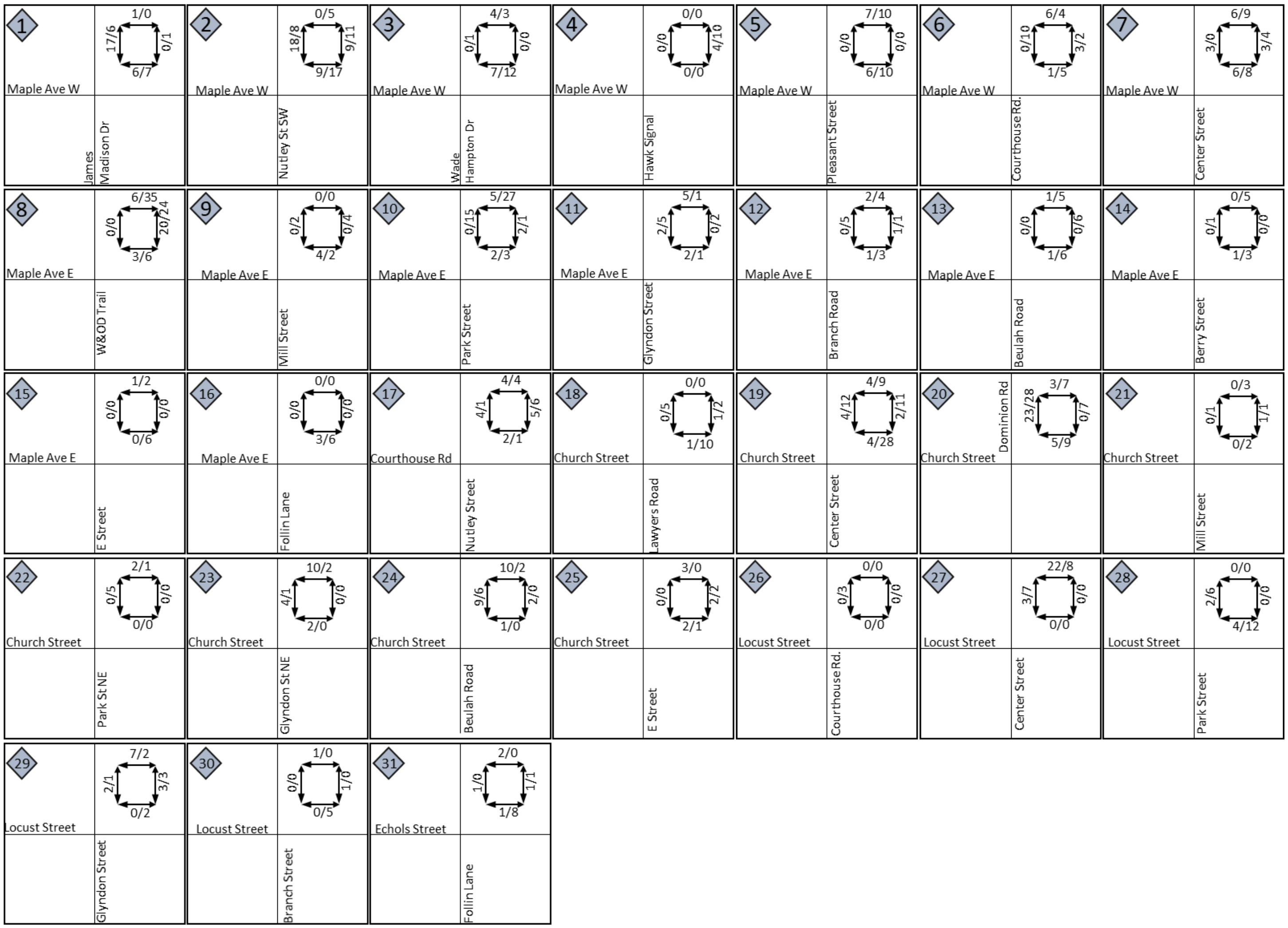


Legend

Pedestrian Network

- Sidewalk
- Crosswalk
- Asphalt Path
- Shared-Use Path

Figure 3-4: Pedestrian Traffic Counts



Issues and Opportunities Assessment

There are several strengths to Vienna's pedestrian experience in the study area, which features a substantially complete sidewalk network on main streets such as Maple Avenue and Church Street. This sidewalk network also extends past these main streets and into adjacent residential neighborhoods, providing pedestrian access and connectivity to and between various neighborhoods. The presence of the W&OD Trail is a significant regional feature that enhances and promotes walking across the Town.

Several challenges exist within the Town's pedestrian network, including high traffic volumes, higher than compatible traffic speeds, and certain segments of narrow, constrained, or non-existent sidewalk. These challenges serve to reduce the level of comfort that one may feel as a pedestrian.

Maple Avenue's key function as a commercial corridor, as evident by the staggering amount of curb cuts and driveways – approximately 111 – and numerous surface parking lots presents conflicts between turning vehicles and pedestrians. Additionally, while most blocks and crosswalks are consistently spaced, longer blocks exist that may frustrate pedestrians looking for safe and accessible pedestrian crossings from one side of Maple Avenue to the other. In the study area, the longest distance between marked pedestrian crossings is about 2,290 feet between Nutley Street and the HAWK signal west of Pleasant Street.

Observed challenges in the pedestrian network include:

- High traffic volumes and speeds
- Narrow sidewalk widths
- Sidewalk obstructions
- Uneven sidewalk surfaces
- Limited landscaping buffer / furnishing zones to separate pedestrians and moving traffic

Turning vehicles at the intersection of Maple Avenue and Nutley Street

3.3 Bicycle Network

The existing bicycle network was reviewed in context with existing mapping and resources that have been prepared by Fairfax County. The Fairfax County Bike Map[5] features a tiered comfort rating that is applied to streets within the County, including the Town of Vienna. Comfort ratings within the study area are shown in **Figure 3-5**.

While it is legal to ride bicycles on most streets in Fairfax County, with the exception of roadways with signed prohibitions or limited-access highways, the level of comfort can vary as a result of traffic volume and speed, presence or lack of dedicated bicycle lanes, and street width. A description of comfort ratings and applicable streets in Vienna is provided below.

The W&OD Trail, shown in purple, provides the highest level of comfort for cyclists due to being paved and entirely separated and protected from motor vehicle traffic.

Most Comfortable

Quiet neighborhood streets, such as Center Street, Mill Street, and East Street, are shown in green. Streets of this nature are considered to be the most comfortable places to cycle and are generally suitable for users of all ages and abilities.

Somewhat Comfortable

Routes shown in blue are considered to be somewhat comfortable for most adults, but higher traffic volumes make these streets less suitable for unaccompanied young children and less experienced cyclists. Some of these streets, such as Courthouse Road, have marked shoulders that provide a de-facto dedicated space to cycle. Other streets, such as Church Street, have curbside parking lanes and no dedicated space to cycle. These conditions require motorists and cyclists to share lanes and to be cautious of conflicting vehicle maneuvers such as passing, pulling into and out of parking spaces, opening car doors into the travel lane, and turning from a shared lane.

Less Comfortable

On streets shown in orange, more experienced cyclists should still feel comfortable, but cyclists can expect to interact with vehicle traffic that is faster and in greater volume. Many of these streets, such as Park Street and Lawyers Road, experience greater levels of congestion during peak hours, but experience lower traffic volumes at other times. As such comfort level on these streets may change over the course of the day.

Use with Caution

Streets shown in grey, such as Maple Avenue and Nutley Street, are arterials that are wider, consist of multiple lanes, and experience significant vehicle volumes or speeds.

Maple Avenue, due to its dual function as a local main street and a regional arterial, and lack of bicycle facilities is not a comfortable street for cycling. However, adjacent streets parallel to Maple Avenue are considered "Somewhat Comfortable" for cycling and present more appealing east-to-west routes as an alternative to Maple Avenue.

Figure 3-6 shows AM and PM peak hour bicycle traffic counts at study area intersections. It is noted that the counts show on-street bike movements. Bikes on the sidewalk or using the crosswalk were counted as pedestrians.

[5] Fairfax County Bicycle Map. https://www.fairfaxcounty.gov/transportation/bike/map

Figure 3-5: Existing Bicycle Network

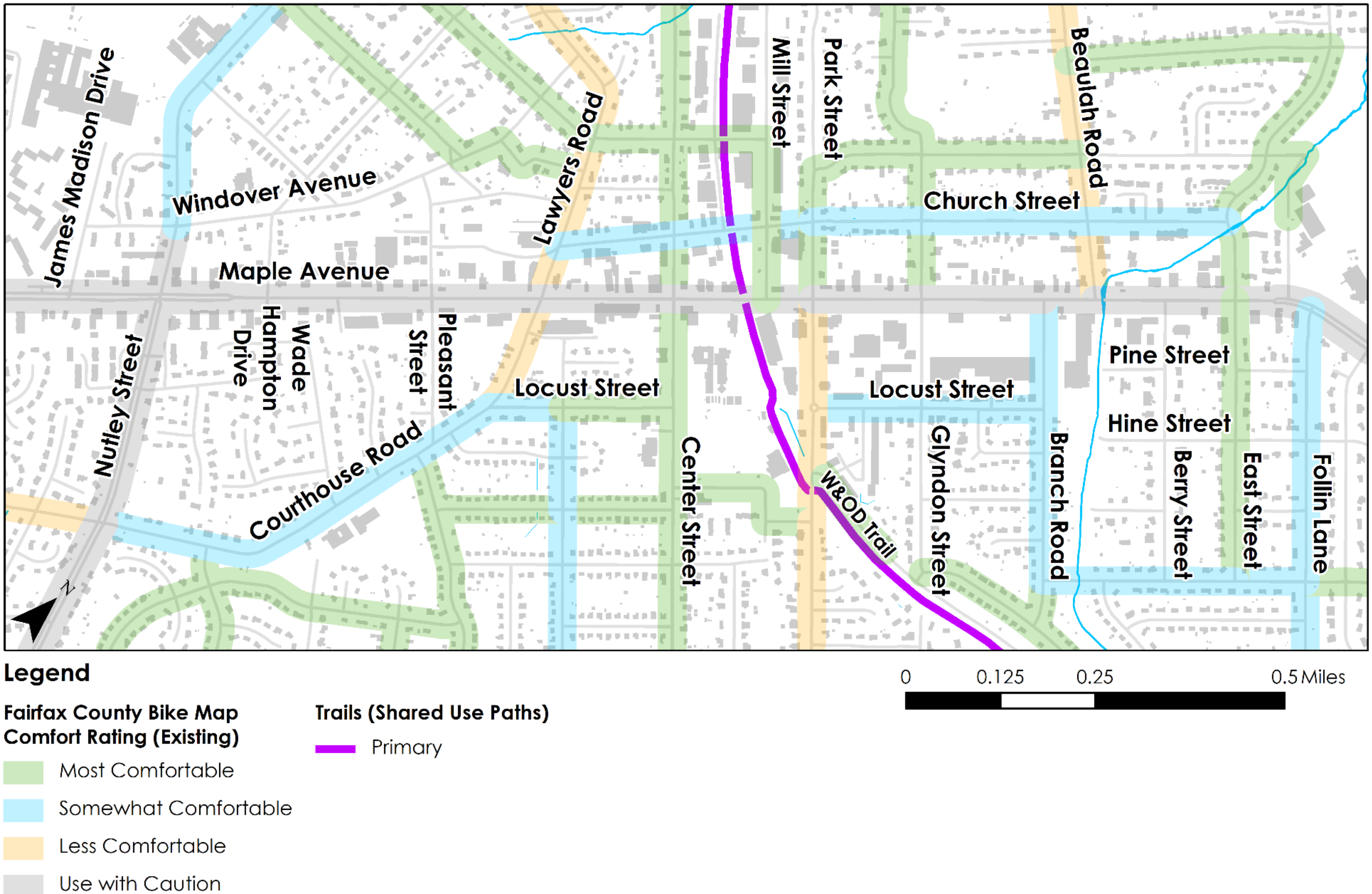
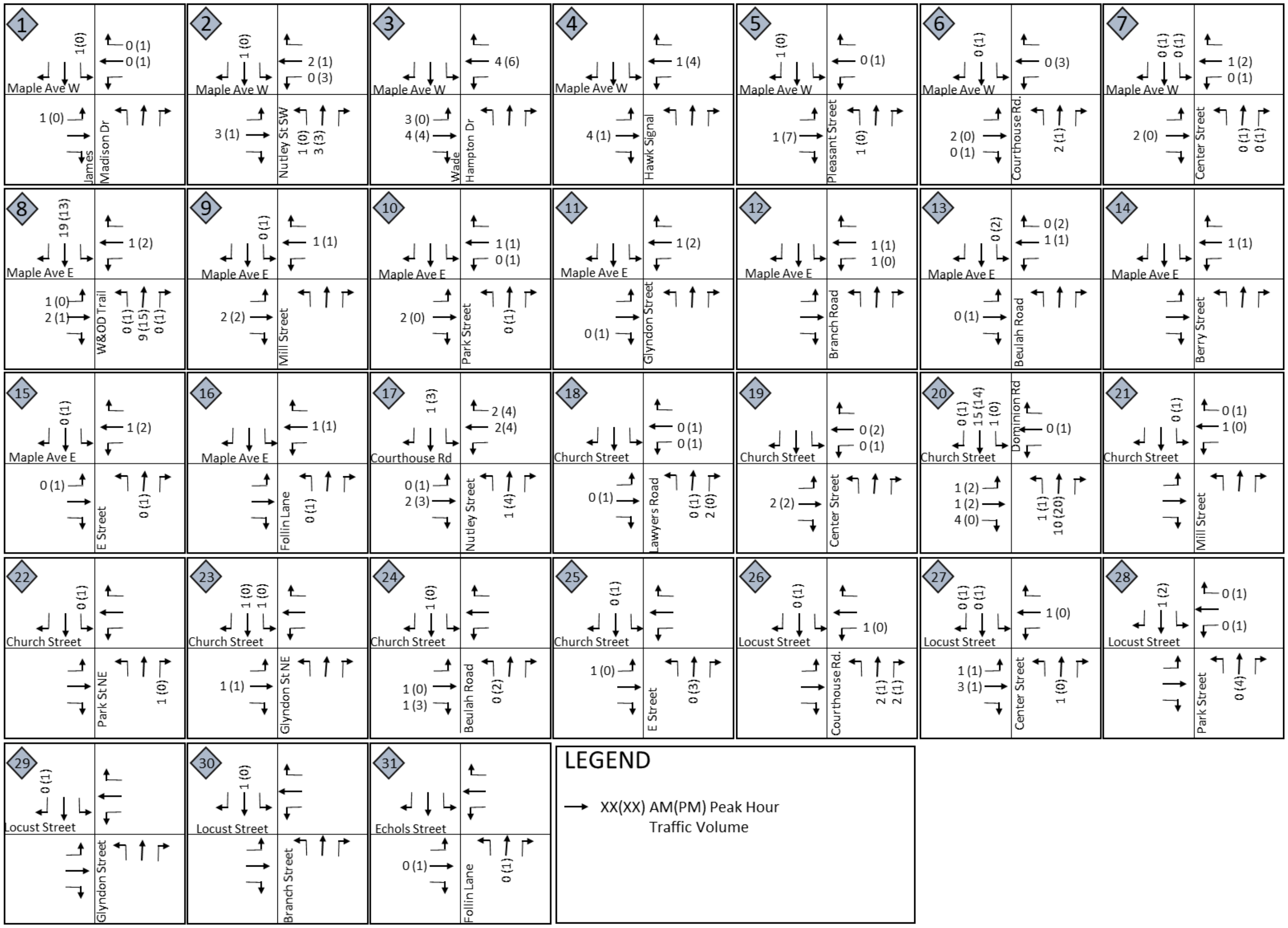


Figure 3-6: Bicycle Traffic Counts



Issues and Opportunities Assessment

Strengths of the bicycle network in the study area include the presence of the W&OD Trail, as well as lower traffic volumes and speeds on residential streets adjacent and parallel to Maple Avenue and Church Street.

Challenges to the bicycle network include the lack of on-street bicycle facilities and, much like the pedestrian network, the significant number of curb cuts and driveways to commercial parking lots. Additionally, Maple Avenue itself and its significant amount of vehicle traffic is a physical barrier to biking in Vienna and getting between the north and south sections of the Town.

On-street bike parking corral on Church Street provides parking for up to eight bikes in place of one vehicle

W&OD Trail crossing at Church Street

3.4 Transit Network

The public transit network in the study area consists of Fairfax Connector bus service and is shown in **Figure 3-7**. Most Fairfax Connector routes in the study area run only on weekdays every 30 to 40 minutes, with connections to and between Metrorail stations and other regional destinations. Bus stops along Maple Avenue are consistently spaced every one-to-two blocks. A new Fairfax Connector route – Route 467 between Dunn Loring and Tysons – started service on March 30, 2019.

Fairfax Connector

Fairfax Connector is the largest local bus system in Northern Virginia with multiple routes that serve Vienna. Six routes run by Fairfax Connector serve the study area:

- Route 432: Old Courthouse – Beulah
- Route 461: Flint Hill – Vienna
- Route 462: Dunn Loring – Navy Federal – Tysons
- Route 463: Maple Avenue – Vienna
- Route 466: Vienna – Oakton
- Route 467: Dunn Loring – Navy Federal – Tysons

Most Fairfax Connector routes were reconfigured in conjunction with the opening of Phase 1 of the Metrorail Silver Line. Route 432 was created to provide service to the Silver Line for an area that had previously lacked bus service, Routes 462 and 463 were rerouted/extended to Tysons Corner, and Route 461 was created so that segments that lost service as part of the rerouted Route 463 would continue to be served. Route 466 is the former Metrobus 2W, which was taken over by Fairfax Connector in 2009 but did not change during the Silver Line restructuring.

Metrobus

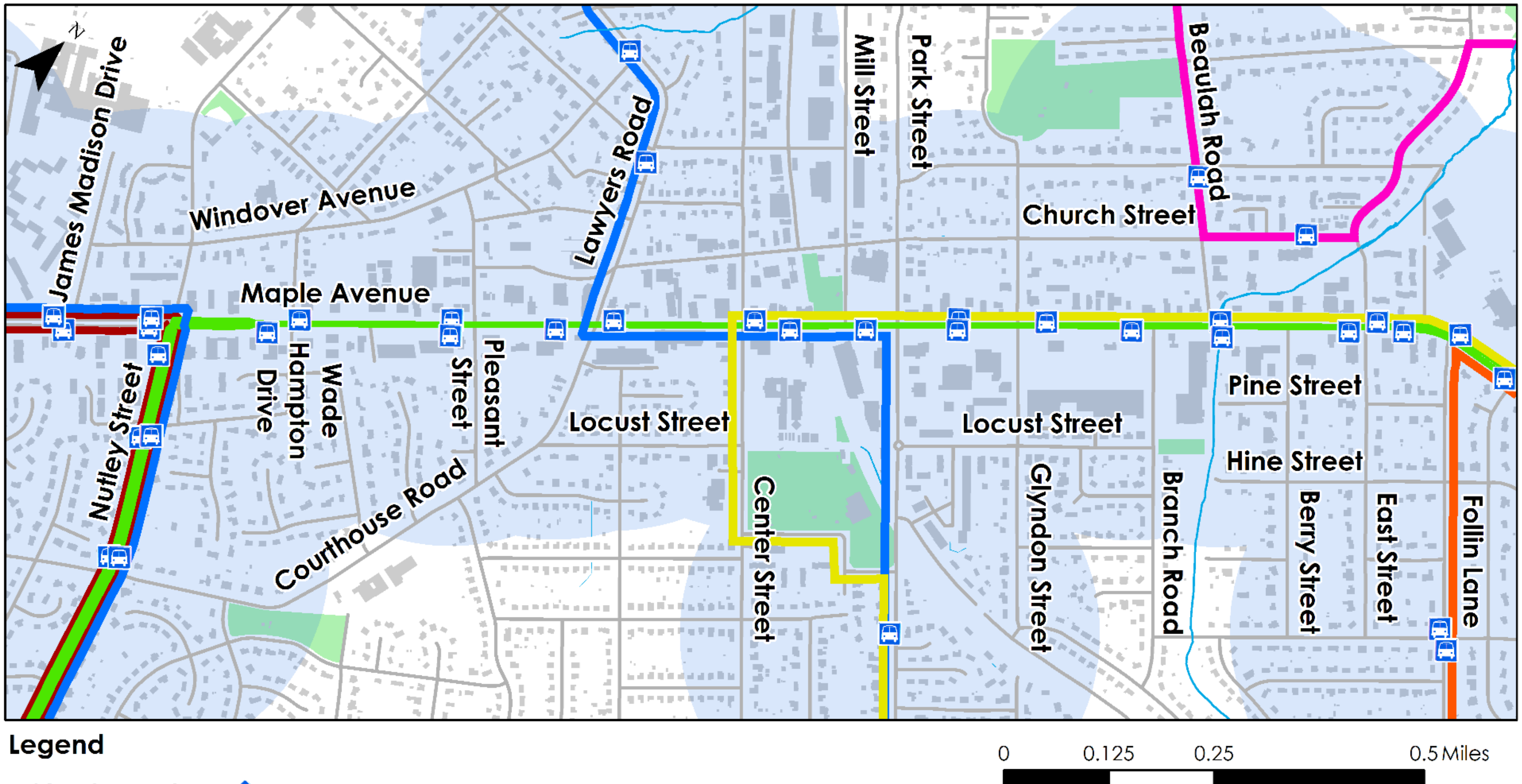
Metrobus, a service of the Washington Metropolitan Area Transit Authority (WMATA), runs routes in the District of Columbia, Maryland, and Virginia. No Metrobus routes run within the study area boundaries, but existing Fairfax Connector bus service may be used to connect to Metrobus service at nearby Metrorail stations.

Metrorail

Metrorail, a service of WMATA, provides heavy rail service in the Washington DC metro region. There are no Metrorail stations within the study area or town boundaries, but several Metrorail stations exist just outside Vienna town limits. These include:

- Vienna/Fairfax-GMU (Orange Line)
- Dunn Loring-Merrifield (Orange Line)
- Spring Hill (Silver Line)
- Greensboro (Silver Line)
- Tysons Corner (Silver Line)

Figure 3-7: Existing Transit Network



Legend

Fairfax Connector

- Route 432
- Route 461
- Route 462
- Route 463
- Route 466
- Route 467

Bus Stop

Quarter-Mile Radius

Issues and Opportunities Assessment

Strengths of the transit network in the study area relate to strengths of the pedestrian network, such as evenly spaced bus stops that are well-connected to sidewalks along Maple Avenue. Some bus stops along Maple Avenue are fitted with passenger facilities such as shelters, seating, and bike racks.

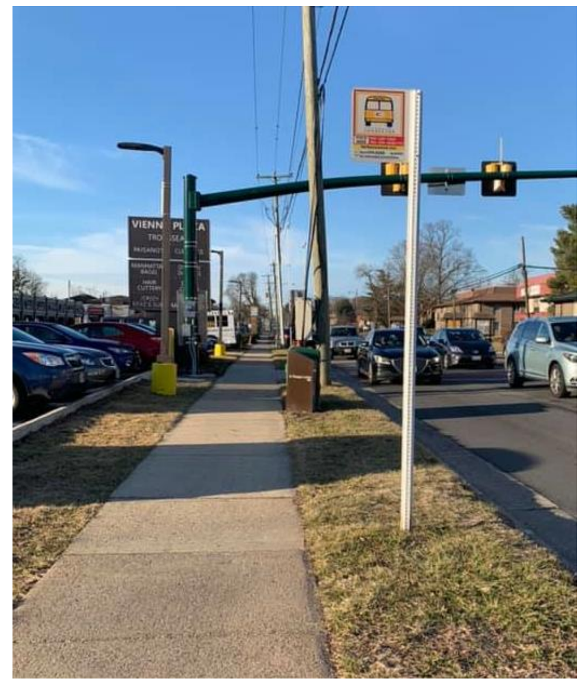
Many bus stops along Maple Avenue feature shelters, seating, and are well-connected to the sidewalk network.

Fairfax Connector offers additional customer information like real-time GPS tracking of buses, a useful trip planning tool for riders to make the transit trip more accessible and reliable.

Challenges to the transit network include what could be considered lower than desired service frequencies to serve local destination trips, especially during the middy hours and on weekends, as well as the lack of local bus service that is intended for non-peak travel between Metrorail stations. Routes 463 and 467 provide seven-day service, while Routes 432, 461, 462, and 466 provide only weekday service, heavily peak period-oriented.

While passenger features like shelters and seating can be found in the corridor, nearly half of the bus stops in the corridor lack such amenities. Several bus stops also lack accessible boarding areas between the sidewalk and the curb and may not comply with the Americans with Disabilities Act (ADA) and further may prevent persons with disabilities from comfortably or easily utilizing the transit system.

A bus stop on Maple Avenue that lacks an accessible boarding area between the sidewalk and the curb



3.5 Vehicle Network

Despite the daily cadence of peak period commuter traffic, the average daily and weekday vehicular traffic has reduced from 2011 to 2018 (see **Figure 3-8, right**).

Considering just weekday traffic, a similar reduction is seen, from under 39,000 vpd in 2011 to under 33,000 vpd in 2018. The values are from annual average daily traffic reports prepared by the Virginia Department of Transportation (VDOT). While there are no comparable reports for peak period/hour travel, it can be assumed that at least moderate reductions in peak period/hour travel are occurring to support this daily reduction.

These downward trends could be the result of changes in car ownership, evolving attitudes towards transit, modified regional commuting patterns, transportation demand management, and capacity enhancements along major parallel routes.

Based on counts collected on February 14, 2019, a Thursday, daily traffic volume of 33,182 vehicles along Maple Avenue was observed (see **Figure 3-8, left**). The day was typical, with no major incident or inclement weather. This daily volume aligns with the VDOT projections.

During the day, there is a near even split of directional travel, with 16,202 total eastbound vehicles and 16,980 total westbound vehicles. Maple Avenue, however, is a directional corridor, heavily influenced by the work commute.

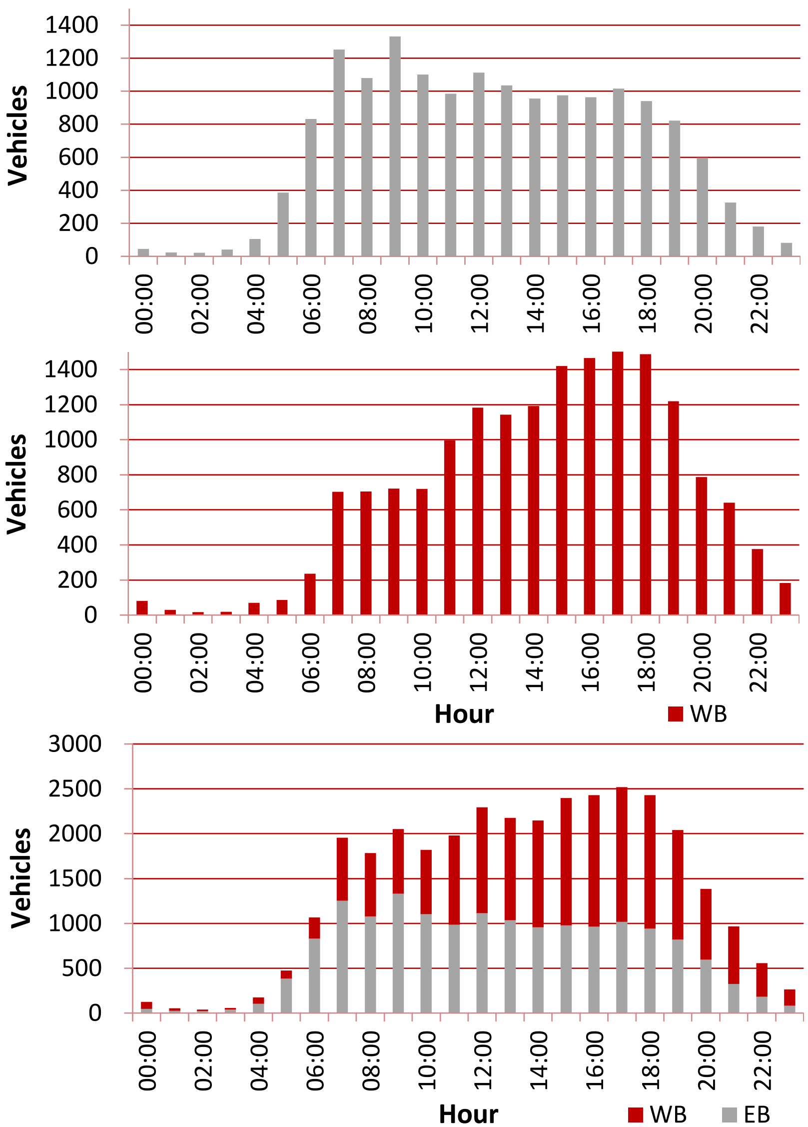
- Before 12:00 PM, there is a 62 to 38 percent split of eastbound/westbound traffic.
- After 12:00 PM, there is a 42 to 58 percent split of eastbound/westbound traffic.
- During the AM Peak Period (6AM to 9AM), there is a 66 to 34 percent split of eastbound/westbound traffic.
- During the PM Peak Period (4PM to 7PM), there is a 40 to 60 percent split of eastbound/westbound traffic.
- During the AM Peak Hour (7:30AM to 8:30AM), there is a 60 to 40 percent split of eastbound/westbound traffic.
- During the PM Peak Hour (4:45PM to 5:45AM), there is a 40 to 60 percent split of eastbound/westbound traffic.

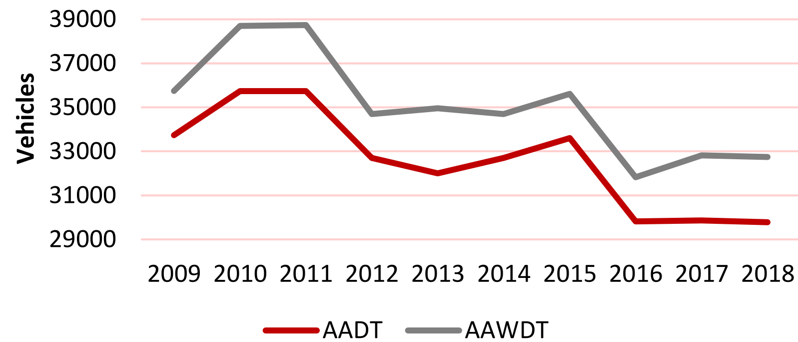
The “before 12:00 PM” and “after 12:00 PM” and peak period values have no bearing on the overall analysis, which is based on the peak hours of traffic. All analysis contained herein is based on the traffic volumes, flow rates, and eastbound / westbound splits that occur during the peak hours.

91 percent of traffic along Maple Avenue is made up of passenger cars. Most vehicles are traveling in compliance with the posted speed limit; 57 percent are traveling at speeds less than 25 mph and less than 17 percent of vehicles are traveling at speeds higher than 30 mph.

There was a daily traffic volume of 7,900 vehicles observed along Church Street. Directionality on Church Street closely mirrors Maple Avenue. Before 12:00 PM, there is a 63 to 37 percent split of eastbound/westbound traffic. In the afternoon, there is a 43 to 57 percent split of eastbound/westbound traffic. 89 percent of traffic along Church Street are passenger cars. Most vehicles are traveling in compliance with the posted speed limit; 95 percent are traveling at speeds less than 25 mph and less than 1 percent of vehicles traveled at speeds higher than 30 mph.

Figure 3-8: Hourly (Left) and Annual Daily Weekday (Right) Traffic Along Maple Avenue





Based on a State Smart Transportation Initiative Study performed for the Town in June 2017, additional traffic factors about Maple Avenue are known:

- Approximately 47 percent of trips along Maple Avenue are less than 5 miles
- Approximately 11 percent of trips along Maple Avenue are "local," starting and ending entirely within Vienna
- Approximately 52 percent of trips along Maple Avenue are "internal-external," meaning the trips start or stop in Vienna, or have an interim destination within Vienna that accounts for more than a 5-minute delay
- Approximately 37 percent of trips along Maple Avenue are "pass-through," meaning these trips travel through but never stop in Vienna

Analysis Approach

Lane designations at each study are network are shown in **Figure 3-9**. Peak Hour Traffic volumes are shown in **Figure 3-10**.

Figure 3-9: Existing Lane Designations

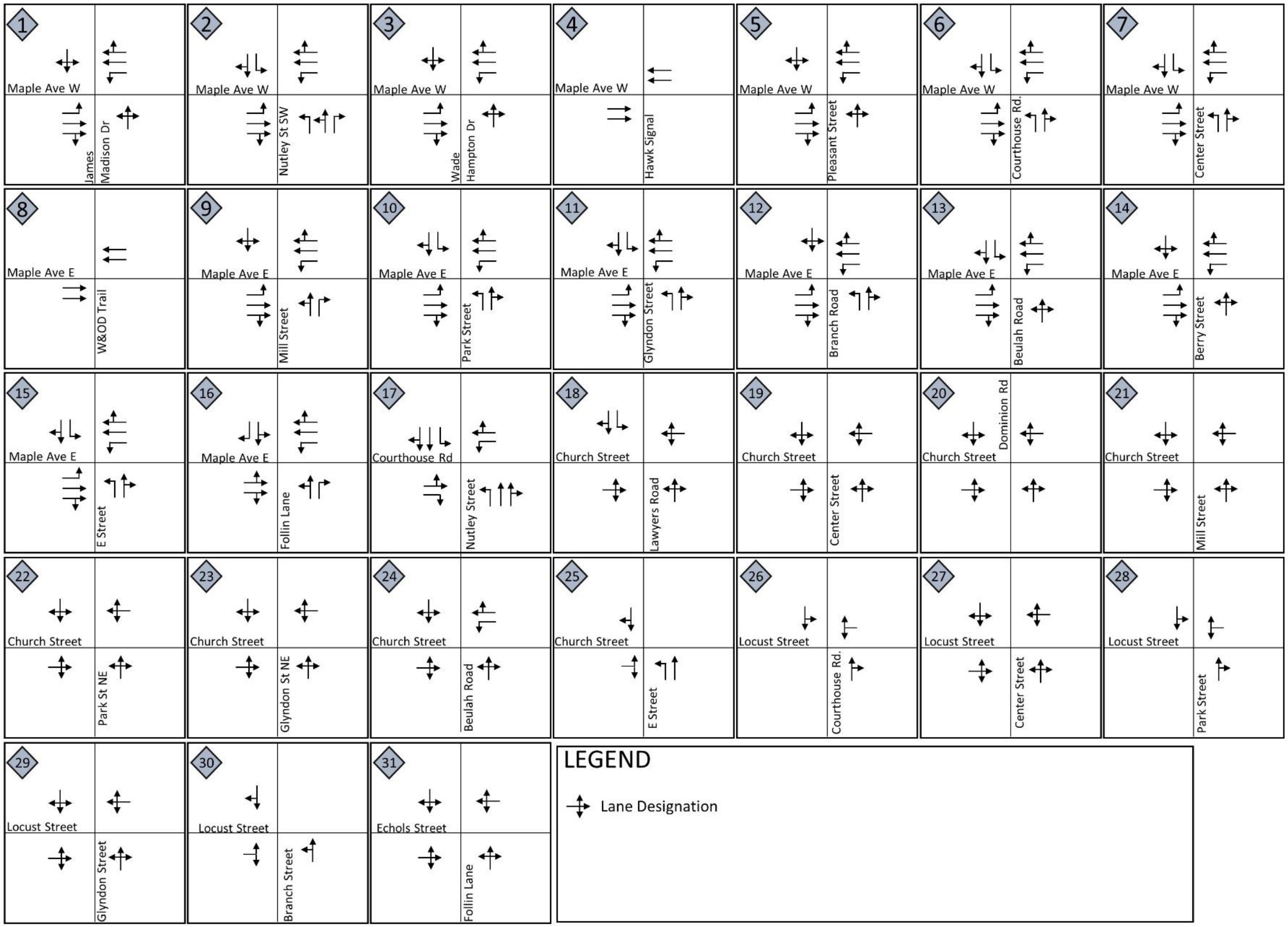
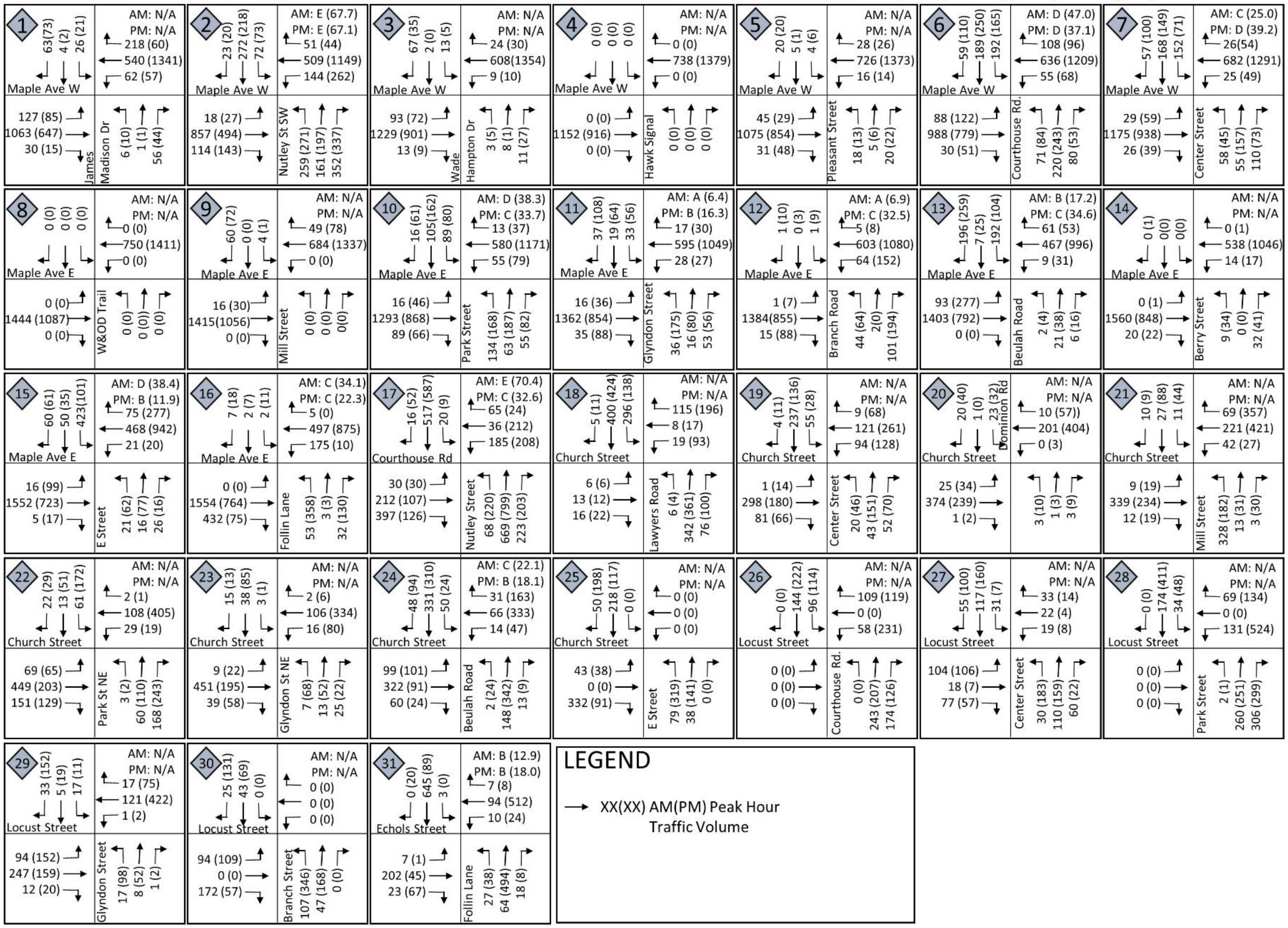


Figure 3-10: Existing Peak Hour Traffic Volumes



The balanced AM and PM peak hour traffic data was analyzed using Synchro 10. This tool is based on the HCM 6 methodology. It considers aggregated traffic stream characteristics such as speed, flow, and density to evaluate roadway conditions using performance measures defined in the HCM 6.

HCM 6 defines capacity as the maximum number of vehicles that can pass over a road segment or through an intersection within a fixed-time duration. Operational conditions are described by a level of service (LOS), which is a qualitative measure that describes the operational conditions of an intersection or street and is an indicator of motorist perceptions within a traffic stream. HCM 6 defines six levels of service, LOS A through F, with A as the best and F the worst. **Table 3-4** shows the level of service delay per vehicle for signalized and unsignalized intersections.

Bicycle and pedestrian volumes were incorporated into the intersection analyses and transit vehicles were included as part of the heavy vehicle inputs.

Overall intersection delay and LOS results for signalized intersections are shown in **Table 3-5**. Overall intersection delay and LOS results for unsignalized intersections are shown in **Table 3-6**. Synchro output reports for intersection delay, LOS, and queuing by movement are provided in **Appendix C**. Synchro analysis shows that of the 14 signalized study intersections, 12 intersections operate with overall LOS D or better during both the AM and PM peak hours. Synchro analysis shows that of the 17 unsignalized study intersections, 8 intersections operate with side street approach LOS E or F during either the AM and PM peak hours.

Table 3-4: Intersection Capacity Level of Service and Ranges of Delay

Level of Service (LOS)	Average Control Delay per Vehicle (seconds)		General Service Description for Signalized Intersections
	Signalized Intersection	Unsignalized Intersection	
A	≤ 10	≤ 10	Free Flow
B	> 10 – 20	> 10 – 15	Stable Flow (slight delays)
C	> 20 – 35	> 15 – 25	Stable Flow (acceptable delays)
D	> 35 – 55	> 25 – 35	Approaching Unstable Flow (tolerable delays)
E	> 55 – 80	> 35 – 50	Unstable Flow (intolerable delay)
F	> 80	> 50	Forced Flow (congested and queues fail to clear)

Source: Highway Capacity Manual

Additionally, 95th Percentile Queues were obtained from Synchro and **Table 3-7** shows the turning movements that exceed the available storage length. **Table 3-8** shows the through movements with queues that exceed adjacent turn bays and therefore block access to turn lanes. Additionally, if a through movement queue exceed the available block length, the value is shown in **red**.

Table 3-5: AM and PM Peak Hour Intersection Delay (seconds per vehicle) and Level of Service

Intersection	Existing	
	AM LOS	PM LOS
2. Maple Avenue and Nutley Street	**E (62.6)**	**E (62.3)**
4. Maple Avenue and Vienna Plaza Hawk Signal	N/A	N/A
6. Maple Avenue and Courthouse Road/Lawyers Road	D (42.8)	C (30.9)
7. Maple Avenue and Center Street	C (25)	D (39.2)
8. Maple Avenue and W&OD Trail Crossing	N/A	N/A
10. Maple Avenue and Park Street	D (38.3)	C (33.7)
11. Maple Avenue and Glyndon Street	A (6.9)	B (16.3)
12. Maple Avenue and Branch Road	A (6.4)	C (32.5)
13. Maple Avenue and Beulah Road	B (17.2)	C (34.6)
15. Maple Avenue and E Street	D (38.4)	B (11.8)
16. Maple Avenue and Follin Lane	C (34.1)	C (22.8)
17. Courthouse Road and Nutley Street	**E (59.1)**	C (32.6)
24. Church Street and Beulah Street	C (22.1)	B (18.1)
31. Echols Street and Follin Lane	B (12.9)	B (18)

**Delay and LOS result are based on control delays at signalized intersections. These results may not reflect the full impacts of downstream congestion and queuing which prevents vehicels from clearing intersections in a single cycle.*

Table 3-6: AM and PM Peak Hour Unsignalized Intersection Delay (seconds per vehicle) and Level of Service

Intersection	Mvmt	Existing	
		AM LOS	PM LOS
1. Maple Avenue and James Madison Drive	NB	**E (35.9)**	B (14.9)
	SB	**F (105.5)**	**E (36.3)**
3. Maple Avenue and Wade Hampton Drive	NB	C (19.9)	C (23.1)
	SB	B (12.8)	C (17.7)
5. Maple Avenue and Pleasant Street	NB	**F (132.2)**	**F (94.8)**
	SB	D (31.5)	**E (36.8)**
9. Maple Avenue and Mill Street	NB	A (0)	A (0)
	SB	B (12.1)	B (14.2)
14. Maple Avenue and Berry Street	NB	C (23)	B (13)
	SB	A (0)	B (10.7)
18. Church Street and Lawyers Road	EB	**E (47.5)**	D (28.8)
	WB	D (25.1)	**F (55.2)**
19. Church Street and Center Street	Overall	C (17.1)	D (26.6)
20. Church Street and Dominion Road/W&OD Trail Crossing	N/A	B (12.9)	C (16.7)
21. Church Street and Mill Street	Overall	D (27.4)	**F (112.1)**
22. Church Street and Park Street	Overall	**F (54.9)**	**F (57.8)**
23. Church Street and Glyndon Street	Overall	B (13.2)	C (15.3)
25. Church Street and E Street	EB	C (15.3)	C (18.4)
26. Locust Street and Courthouse Road	Overall	B (12.8)	C (15.3)
27. Locust Street and Center Street	EB	B (13.8)	D (26.3)
	WB	A (0)	A (0)
28. Locust Street and Park Street	Overall	A (6.4)	B (12.3)
29. Locust Street and Glyndon Street	Overall	B (10.4)	C (22)
30. Locust Street and Branch Road	Overall	A (9.5)	B (14.7)

Table 3-7: AM and PM Peak 95th Percentile Queue Lengths that Exceed Storage Length

Intersection	Lane	Storage Length	Existing Queues	
			AM	PM
2. Maple Avenue and Nutley Street	EBL	40	26	33
	WBL	200	**#239**	184
	NBL	200	246	**#407**
6. Maple Avenue Courthouse Road/Lawyers Road	EBL	100	67	**#137**
	WBL	120	72	m25
	NBL	190	#122	#166
	SBL	125	**#329**	**#307**
7. Maple Avenue and Center Street	NBL	70	73	75
	SBL	90	**167**	**106**
10. Maple Avenue and Park Street	NBL	160	170	**#222**
	SBL	115	**120**	114
11. Maple Avenue and Glyndon	NBL	115	59	**#238**
13. Maple Avenue and Beulah Road	EBL	105	m8	**#220**
	SBL	250	**#294**	179
15. Maple Avenue and E Street	SBL	170	**#586**	150
16. Maple Avenue and Follin Lane	WBL	160	**#326**	35
17. Courthouse Road and Nutley Street	EBR	190	**#343**	39
	NBL	110	77	**196**

-95th percentile volume exceeds capacity; queue may be longer. Queue shown is maximum after two cycles

m - Volume for 95th percentile queue is metered by upstream signal

Table 3-8: AM and PM Peak 95th Percentile Queue Lengths that Block Turn Lane and/or Exceed Block Length

Intersection	Lane	Block Length	Existing Queues	
			AM	PM
2. Maple Avenue and Nutley Street	EBT	560	**#675**	366
	WBT	700	211	463
	NBT	550	251	#409
	SBT	420	**#483**	#407
6. Maple Avenue Courthouse Road/Lawyers Road	EBT	690	456	286
	WBT	730	313	237
	NBT	800	#475	#488
	SBT	190	**294**	**#528**
7. Maple Avenue and Center Street	EBT	890	m573	266
	WBT	600	106	218
	NBT	670	167	#366
	SBT	350	266	**#392**
10. Maple Avenue and Park Street	EBT	930	741	395
	WBT	720	316	**779**
	NBT	560	144	379
	SBT	450	168	#372
11. Maple Avenue and Glyndon	EBT	720	**777**	240
	WBT	1170	42	374
	NBT	660	60	182
	SBT	460	58	223
12. Maple Avenue and Branch Road	EBT	810	62	386
	WBT	360	215	355
13. Maple Avenue and Beulah Road	EBT	360	45	182
	WBT	940	133	313
15. Maple Avenue and E Street	EBT	450	**#903**	78
	WBT	940	203	m530
	NBT	440	54	158
16. Maple Avenue and Follin Lane	EBT	460	**m#460**	247
	WBT	430	68	286
17. Courthouse Road and Nutley Street	EBT	360	309	220
	WBT	670	93	338
	NBT	720	511	537
	SBT	550	m162	383
31. Echols Street and Follin Lane	WBT	240	89	**#542**
	NBT	230	47	**322**

Capacity Considerations

One of the most asked questions during this study was whether or not Maple Avenue is at capacity, i.e. whether or not Maple Avenue has reached a point of where there are too many vehicles for the road to "function properly." This is no simple answer to this question, as there are many factors that affect roadway capacity and many ways to define capacity itself. This section of the report will attempt to explain the concept of capacity and provide a ***planning level*** answer for this question, one that will allow Vienna to make strategic decisions about how, when, and where to focus transportation investments and the role that land use decision play in Vienna mobility.

Based on the HCM, capacity is "*the maximum sustainable flow rate at which vehicles can be expected to traverse a point or uniform section of a lane or roadway given a time period under prevailing roadway, environmental, traffic, and control conditions.*" There are a few critical factors in this definition:

- Different capacities exist for specific movements, groups of lanes, entire intersections, and sections of a road
- Because prevailing roadway conditions affect capacity, any change in a multitude of variables reduces or increases capacity. As such, the capacity of Maple Avenue changes from hour to hour, day to day, scenario to scenario.
- When we talk about capacity, instead of maximums, it is more prudent to discuss the most reasonable flow of traffic (flow rate) that can be achieved repeatedly for peak periods of sufficient demand.

It is helpful to understand the base conditions where ideal, unrestricted capacity can be determined: i.e. good weather, dry and well performing pavement, familiarity of roadway users, no major traffic impediments. These base conditions are not often achievable; as such, calculating capacity requires adjustments to the base condition. The following is an abbreviated list of some of the factors that influence capacity:

- Roadway Conditions
  - Number of lanes and exclusive/shared turn lanes
  - Adjacent land use
  - Functional classification
  - Lane widths
  - Design and posted speeds
  - Horizontal and vertical curves
  - Horizontal and vertical clearance
  - Grades / elevation
  - Presence of exclusive turn lanes
  - On-street parking
  - Intersection spacing
- Traffic Conditions
  - Percentage of large vehicles (trucks, buses, etc.)
  - Directionality of traffic flow
  - Lane use/distribution
  - Motorist population/familiarity
  - Presence of driveways and driveway spacing
  - Downstream congestion
- Control Conditions
  - Type of control (signal, all-way stop, two-way stop, yield, roundabout)
  - Signal timing (green time allocation, cycle length, phasing, protected and permitted turns)
  - Turn restrictions
  - Lane use / Two-way left turn lane
- Technology
  - Transit and emergency signal priority
  - Adaptive signal control
- Environmental Conditions
  - Weather
  - Lighting
  - Road surface condition

Recognizing the influence of all these factors, reasonable capacities for Maple Avenue, expressed as peak hour volumes and daily service volumes are presented below:

Capacity of a road is generally expressed as an hourly flow of traffic. As a *planning level exercise*, capacity can also be expressed as a daily flow. Each lane of an intersection or each lane of a road segment is able to process vehicles at a *theoretical maximum flow rate* is of 1,900 vehicles per hour per lane (vphpl). This ideal condition assumes no signals or interruption of traffic. This serves as the base capacity value, per lane, to be adjusted by the aforementioned prevailing conditions.

When signals are present, when traffic accumulates, and when the various other prevailing conditions are considered, that maximum capacity will be reduced to a more reasonable and appropriate value for a signalized corridor such as 900 vphpl. As a practical example if 1,900 vpvpl is the maximum unrestricted through volume capacity, once a traffic signal is considered less than half the maximum capacity is available for through movements (because other conflicting movements need to be served by the signal as well).

If 900 vphpl is achievable during the peak hour with respect to on-ground traffic conditions, a four-lane road w/two-way left turn lane could accommodate 3,600 vph (4*900). At a daily level, based on a generalized service table in the HCM, a value of 32,800 vehicles per day (two-way) is assumed for a four-lane road operating at LOS E. The two-way left turn lane offers some additional capacity by separating a portion of turning traffic from through movements.

For context, when reviewing the Generalized Peak Hour Two Way Volumes as published by Florida Department of Transportation (FDOT), a value of approximately 2,900 vph (two-way) is estimated for an urban 4-lane undivided roadway operating with LOS E and when reviewing the Generalized Daily Volumes as published by FDOT, a value of approximately 32,100 vpd (two-way) is estimated for an urban 4-lane undivided roadway operating with LOS E.

It is important to note that the quoted HCM and FDOT peak and daily values assume a specific progression/arrival type of vehicles; a specific cycle length; a specific phasing of left turns; a specific percentage of traffic turning left and turning right; a specific and standard intersection spacing; and other specific factors.

Additionally, this type of analysis assumes a uniformity to Maple Avenue that does not exist. Block by block there is a difference in the number of commercial entrances, signal control, and other factors which result in different capacities across the corridor.

As such, none of these numbers are sufficient to stand as the "absolute capacity" of Maple Avenue. From a planning level, these numbers may be indicative that Maple Avenue is operating near or over capacity at specific times of the day or for specific segments of the road.

Reviewing the data shown in Figure 3-8, hourly two-way traffic along Maple Avenue approaches 2500 vph in the evening and the daily weekday traffic along Maple Avenue is just under 33,000 vpd.

Using the HCM and FDOT hourly capacity ranges for four lanes of 2,900 to 3,600 vph indicates that Maple Avenue is operating below capacity in the peak period when considering both directions, based on the traffic count data collected as part of this study. When considering the peak direction only, Maple Avenue (in aggregate) is just under the hourly capacity range for two lanes range of 1,450 to 1,800 vph for most hours of the peak period, with specific intersections likely being at or over capacity during certain hours of the day, based on the intensity of turning movements at the intersection and the influence of downstream congestion.

From a planning level perspective, Maple Avenue appears to be operating within the daily capacity range of 32,000 to 33,000 vpd. This indicates that Maple Avenue experiences congestion, queuing, and reduced mobility queuing during certain hours of the day.

Does this mean that Maple Avenue is overcapacity at all hours of the day – No.

Does this mean that every intersection along Maple Avenue will operate with intolerable delays – No.

Does this mean that all development in the Town of Vienna is to be halted until additional capacity can be achieved (or sufficient traffic demand can be reduced) – this is a more complicated answer.

While it is true that Maple Avenue is congested in the peak direction during the peak periods, it is also true that there is available capacity in the off-peak direction and during off-peak hours

Being near or even at capacity (for a limited time during the day) means that Maple Avenue is fulfilling its function as a principal arterial. It is not overbuilt to the extent that there is excess and unused capacity in the peak direction, and it is not underbuilt to the extent that travel along the corridor is o unreasonable with respect to other similar roadways in the region.

With respect to land use and development decisions, transportation and mobility are just two factors among myriad that are considered in the decision-making process. Allowing development to proceed that is ignorant of the potential transportation impacts would be unwise; this is why the public process exists to study and evaluate land use decisions and to identify important mitigations and strategies to reduce traffic or to minimize its impacts. A well-considered public process will arm the community and decisionmakers with enough information to understand the benefits, tradeoffs, challenges, and opportunities of development, and if they so choose to move forward, to do so while maintaining or improving the resiliency and operating performance of Maple Avenue.

Issues and Opportunities

With respect to vehicle operations, most signalized intersections are operating with moderately acceptable delays for a busy arterial street. Green time is prioritized to east-west and west-east through movements, outside of required pedestrian crossing time. Longer cycle lengths of 120 to 140 seconds are needed to accommodate the mix of traffic and needs of pedestrians which leads to higher but not intolerable delays. Delays at certain intersections are more critical and there are many individual movements with delays that result in LOS E or F and volumes greater than capacity (i.e. demand is unable to be served by a single signal cycle based on available green time). This is evident based on queues that extend beyond block and turn lane storage length. Additionally, there is out of network traffic congestion outside of Vienna, originating from Tysons and areas beyond, that exacerbates delay within Vienna.

Delays at unsignalized intersections and commercial entrances during the peak periods are approaching or exceeding LOS E or F operation. It is difficult to turn on to or off of these side streets; there are not enough suitable "natural" gaps in traffic to accommodate these movements in congested conditions. The occasional through motorists may yield to allow turning movements or may at choose to not to "block the box" when there is downstream congestion. These behaviors are not recognized in the analysis and, as such, the result may be overstated in terms of the magnitude of the delays; still, the service level is characterized appropriately. Unsignalized movements are secondary priority along a busy arterial.

It is noted that Church Street, Courthouse Road, and Locust street generally function well compared to Maple Avenue (which reveals why motorists attempt to bypass at least part of the congestion along Maple Avenue). These traffic movements result in specific intersections along Church Street (i.e., Lawyers, Mill, and Park) with more peak hour traffic volumes than can be sufficiently accommodated via unsignalized stop controlled approaches without intolerable delays (i.e. LOS E or F).

Key strengths of the vehicular network are recognized as the following:

- Most intersections operate at LOS D or better
- Center two-way left turn lane removes turning traffic from through lanes, increasing capacity
- Pedestrian crossings integrated into signal network

Key challenges of the vehicular network are recognized as the following:

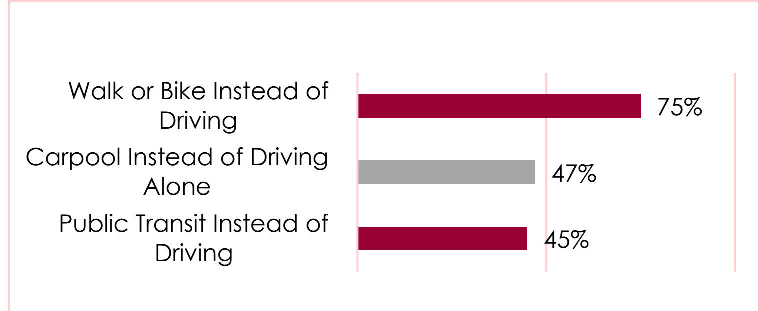
- Significant amount of pass through traffic
- Predominant east-west movement with little network redundancy (incomplete grid and parallel network)
- Number of full access commercial entrances
- Difficulty turning from side streets

3.6 Existing Conditions Engagement

Previous Community Surveys

Every two years the National Citizen Survey is conducted in Vienna. The most recent version of this survey was in October 2018. The survey concluded that Vienna residents are prioritizing high functioning mobility. As shown in **Figure 3-11**, people in Vienna use alternative modes of transit over the national average (comparatively higher percentages in red).

Figure 3-11: Mode Choice in Vienna



Source: The National Citizen Survey "Community Livability Report" Vienna, VA (2018)

The survey also reported that almost 90 percent of respondents think that providing public parking opportunities in commercial districts and increasing green spaces should be a priority over the next 3 to 5 years. Regarding Maple Avenue projects and improvements, about 85 percent of respondents agreed that buildings along Maple Avenue should be designed to create a sense of place (strong identity and character) and sidewalks should be widened with landscaping and areas for outdoor seating.

Engagement Approach

The study team pursued a multifaceted approach to outreach, tiered to align with each phase of the study. The outreach process involved hosting in-person, hands-on meetings with the community that occurred in coordination with key deliverables or prior to key decision points of the study. Briefings were also made to the Town Council, Planning Commission, and Transportation Safety Commission (TSC).

Corridor Walk

Members of the study team, the TSC, Town Council, and other key study stakeholders participated in a group walking tour of the corridor on March 15, 2019 in order to observe field conditions and discuss known challenges along the corridor.

Corridor Walk participants on Maple Avenue

Town Council Briefing #1

Following the inventory, assessment, and analysis of the transportation network elements and operations within the study area, the study team presented these existing conditions findings to Town Council on April 1, 2019.

Public Workshop #1

On April 4, 2019, the study team presented existing conditions findings to the community at the first public workshop. This workshop began with the same overview presentation as the first Town Council Briefing, and then shifted to an open forum during which members of the community reacted to initial findings, provided comments and feedback, and offered additional information and context regarding the understanding and interpretation of existing conditions. In addition to the presentation, the workshop included information boards, maps, and comment cards.

Public Workshop #1 open forum session

4. Safety Review

VDOT maintains a publicly available database that contains locations and related data for all motor vehicle crashes reported to law enforcement. A safety analysis for the Maple Avenue study area was completed using VDOT's most recent historical crash data for the last three (3) years, from December 2015 through November 2018. A summary of observed trends resulting from the analysis of these crashes is discussed below.

4.1 Crash Analysis

Crash data was analyzed to identify crashes that occurred within the influence area of an intersection or along the mainlines of Maple Avenue, Church Street, Locust Street and other adjacent roadways within the study area. For the purposes of this analysis, the intersection influence area is defined as the area within 250 feet of an intersection or within the distance necessary to consider the full turn-lane storage length in approach to the intersection. The analysis also identified locations with high crash frequencies ("hotspots"), crash patterns, and common trends that occurred at crash hotspot locations within the study area.

During the three-year analysis period, there were a total of 434 crashes within the study area limits, distributed throughout the study area as indicated in **Figure 4-1**.

There were no fatal injuries as a result of the crashes within the study area during the study period. 147 of the crashes resulted in injury, and 287 resulted in property damage only, as indicated in **Table 4-1**.

Table 4-1: Crashes by Severity

Year	Severity		
	Fatalities	Injuries	Property Damage Only
2015	0	3	14
2016	0	62	116
2017	0	37	76
2018	0	45	81
TOTAL	**0**	**147**	**287**

A summary of the common crash types within the Maple Avenue study area is exhibited in **Figure 4-2**. The predominant crash type was angle crashes, which accounted for 217 crashes, or approximately 50 percent of all reported crashes. The second most common crash type was rear end crashes, with 132 crashes or 30 percent, followed by same direction sideswipe crashes, with 29 crashes, or seven percent.

Angle crashes are common at intersections and rear end crashes are common in congestion or near approaches to intersections. Each of these crash types may be exacerbated by aggressive lane change behavior, tight spacing between following vehicles, and sudden vehicle braking. Additionally, drivers may not be anticipating sudden braking from vehicles ahead as they slow to safely access the many commercial entrances and driveways along Maple Avenue within the study area.

Figure 4-1: Study Area Crashes

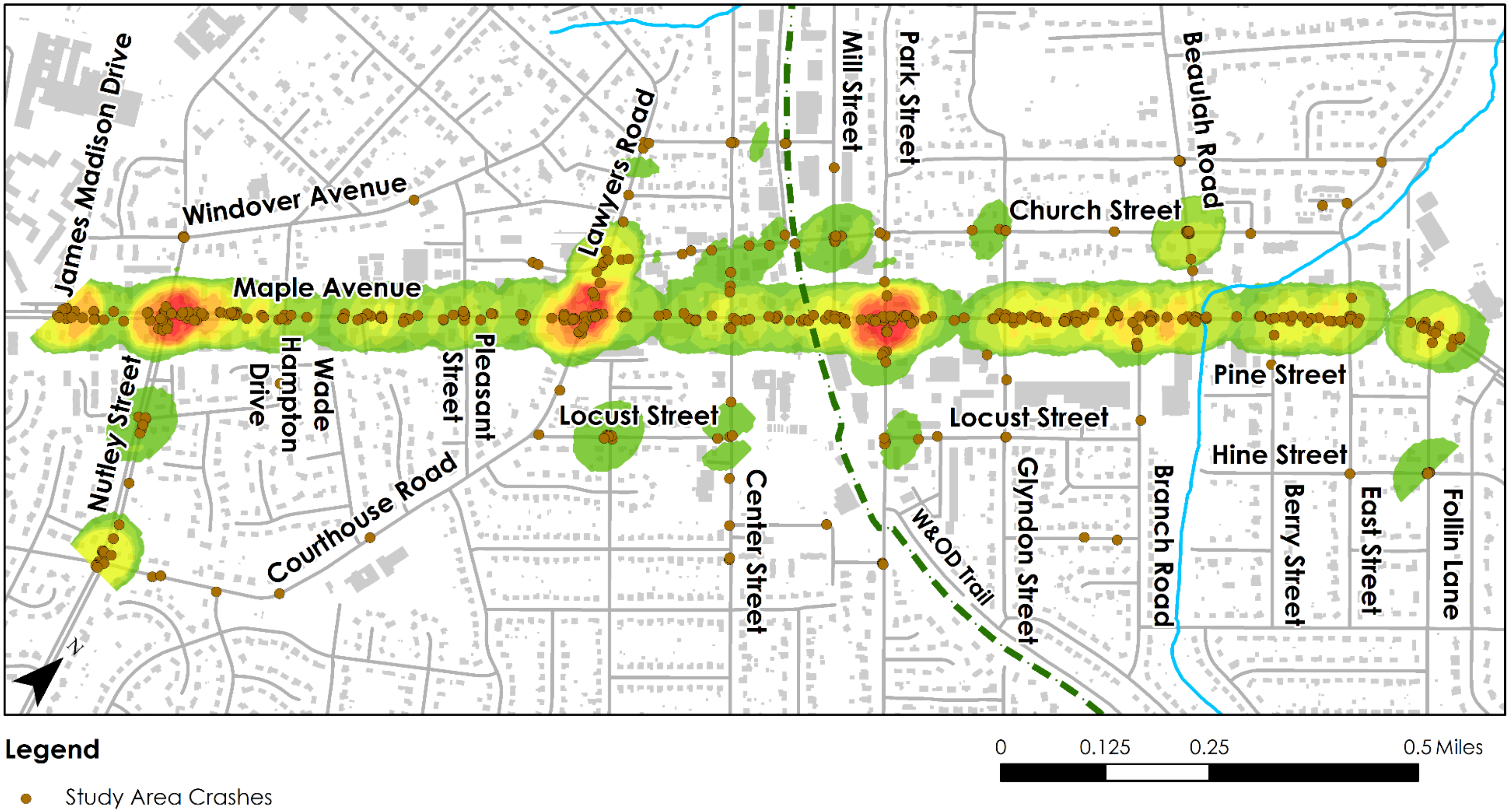
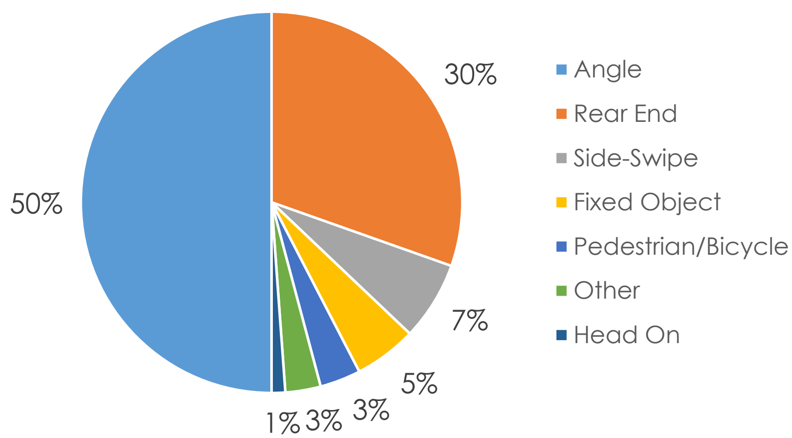


Figure 4-2: Type of Collision



Additional crash trends within the study area include the following:

- 82 percent of crashes occurred on weekdays; 18 percent occurred over the weekend.
- 75 percent of crashes occurred during daylight conditions; 21 percent of crashes occurred in the dark; and five percent occurred at dawn or dusk;
- 83 percent of crashes occurred during clear weather conditions; 15 percent of crashes occurred during rain or mist; and less than one percent occurred during snow, sleet, severe wind, or other weather conditions.
- Approximately 42 percent of crashes occurred during the off-peak period; 39 percent of crashes occurred during the PM peak period (3:00 – 7:00 pm); and 18 percent of crashes occurred during the AM peak period (6:00 – 10:00 am).

Intersection Crashes

276 of the crashes within the study area occurred within intersection influence areas. The intersections with the highest number of crash occurrences are discussed in the following sections.

Intersection 2: Nutley Street and Maple Avenue

There was a total of 32 reported crashes (or approximately seven percent) at Intersection 2, the Nutley Street and Maple Avenue intersection. Of these, 24 resulted in property damage only, and eight resulted in injury. 18 crashes occurred during the PM peak, nine occurred during off-peak hours, and five occurred during the PM peak. 25 crashes occurred under clear weather conditions, six occurred in rain or mist, and one occurred during snow or sleet. 13 crashes were the result of rear-end crashes and another 13 resulted from angle crashes. Head-on collisions, off-road fixed objects, and pedestrians or bicyclists were each accounted for two crashes.

Intersection 6: Lawyers Road/Courthouse Road and Maple Avenue

There were 27 reported crashes (six percent) at Intersection 6, the Lawyers Road/Courthouse Road and Maple Avenue intersection. Of these, 17 resulted in property damage only and 10 resulted in injury. 13 crashes occurred during the off-peak period, 10 occurred during the PM peak period, and four occurred during the AM peak. 20 crashes occurred under daylight conditions; six occurred in the dark; and one occurred in dusk/dawn conditions. 25 collisions occurred during clear weather conditions; one occurred during rain or mist; and one occurred during other weather conditions. 13 crashes were rear end collisions, ten were angle crashes, two were collisions with fixed objects off-road, one was a same direction side-swipe collision, and one was another type of collision.

Intersection 10: Park Street and Maple Avenue

Intersection 10, the Park Street and Maple Avenue intersection, experienced 28 crashes (also approximately six percent). 21 of these crashes resulted in property damage only, and seven resulted in injury. 15 collisions occurred during the off-peak period, 12 occurred during the PM peak, and one occurred during the AM peak period. 15 of the collisions that occurred at Intersection 10 were angle collisions and nine were rear ends. There was one head-on collision, one side swipe collision in the same direction, one pedestrian/bicyclist collision, and one other collision. 24 of these crashes occurred within clear weather conditions; three occurred during periods of rain or mist; and one occurred during severe wind.

Midblock Crashes

158 crashes, or approximately 36 percent of all crashes, occurred outside of intersection influence areas. This number of crashes occurring *between intersections* are likely related to the many commercial entrances and driveways along the corridor. Of these crashes, 38 percent resulted in injury, 55 percent were angle crashes, and 26 percent were rear-end crashes.

Crash Countermeasures

While it is recognized that not every crash is preventable and that there are many variables that affect the likelihood and severity of a crash, there are still viable crash countermeasures that could be considered to address the specific crash types that exist along the Maple Avenue corridor. The following is a short list of potential countermeasures as identified by FHWA[6] and VDOT[7][8]. It is noted that implementation of any of these countermeasures would be constrained by cost, ROW, and other context-appropriate factors.

All Crash Types

- Adaptive signal control – 8 percent reduction in injury and fatal crashes
- Extend left-turn lane – 15 percent reduction in crashes
- Convert signalized intersection to roundabout – 48 percent reduction in fatal crashes and 78 percent reduction in all other crash types

Rear End Crashes

- Add left or right turn lanes at intersections
- Prohibit turns from through lanes
- Enhance visibility of signals / add advance warning signs
- Yellow change interval (signal timing adjustment) – 8 to 14 percent reduction in total crashes; 36 to 50 percent reduction in red-light running
- Add all-red clearance (signal timing adjustment)
- Improve intersection lighting – 12 percent reduction in all crash types during the night

Angle Crashes (specifically left turn crashes)

- Restricted crossing U-Turn – 54 percent reduction in injury and fatal crashes
- Median U-turn intersection – 30 percent reduction in injury and fatal crashes
- Update left-turn phasing (protected versus protected-permissive and/or lead versus lag)

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[6] https://safety.fhwa.dot.gov/provencountermeasures/

[7] http://www.virginiadot.org/business/resources/ted_hsip_2011/HSIP_General_Crash_Pattern_and_Countermeasures.pdf /

[8] https://www.virginiadot.org/business/resources/HSIP/Virginia_State_Preferred_CMF_List.pdf

- Change from permissive (green ball) to flashing yellow arrow – 46 percent reduction in injury and fatal crashes

Midblock crashes / Driveway-related crashes

- Corridor Access Management – 25 to 31 percent reduction in injury and fatal crashes, inclusive of the following potential strategies:
    - Driveway closure, spacing, design, consolidation, or relocation, limited-movement designs for driveways (such as right-in/right-out)
    - Raised medians
    - Intersection designs such as roundabouts or those with reduced left-turn conflicts (such as J-turns, median U-turns, etc.)
    - Provide right turn lanes
- Improve segment lighting – 32 percent reduction in all crash types during the night

The recommendation of any crash countermeasure should follow a detailed crash history analysis and corridor safety review.

4.2 Safety Review Summary

There were no collision-related fatalities reported within the study area from December 1, 2015 through November 30, 2018, a three-year period. Most crashes within the study area occurred within an intersection influence area (64 percent) and resulted in property damage only (66 percent). The majority of crashes were either angle or rear end crashes. Together, these account for approximately 80 percent of all collisions-types within the study area.

Angle crashes are common at intersections, and rear end crashes are common along signalized arterial corridors under congested conditions and may be exacerbated by aggressive lane change behavior, tight spacing between following vehicles, and sudden vehicle breaking. Additionally, drivers may not be anticipating sudden breaking from vehicles ahead as they slow to safely access the many commercial entrances and driveways along Maple Avenue within the study area.

4.3 Field Observations

Field observations were conducted at study area intersections and along the mainline of Maple Avenue, Church Street, and Locust Street on February 14, 2019. The purpose of these observations was to document any observed transportation conditions, behaviors, or issues that result in or would be the result of recurring congestion. Some observations:

- During the peak times, travelers from Lawyers Road use Church Street, Ayr Hill Avenue, Wilmar Place, Courthouse Road, Park Street, Locust Street, and Tapawingo Road to avoid portions of Maple Avenue. These alternative routes are also occasionally suggested by GPS guidance apps
- During peak times, there were numerous observations of people “blocking” the box and failing to leave intersections and driveways clear for turning movements
- During peak times, through vehicle queueing occasionally blocks access to left turn lanes. This results in vehicles missing an opportunity to turn left and other inefficiencies in signal timing
- At Church Street and Lawyers Road there is poor compliance with the stop sign which creates safety conflicts with pedestrians.
- Some drivers position their cars partially out of commercial driveways to force through vehicles to yield. This creates additional delays and congestion particularly for vehicles making a left and needing to clear at least 3 lanes (including the two-way left turn lane.)

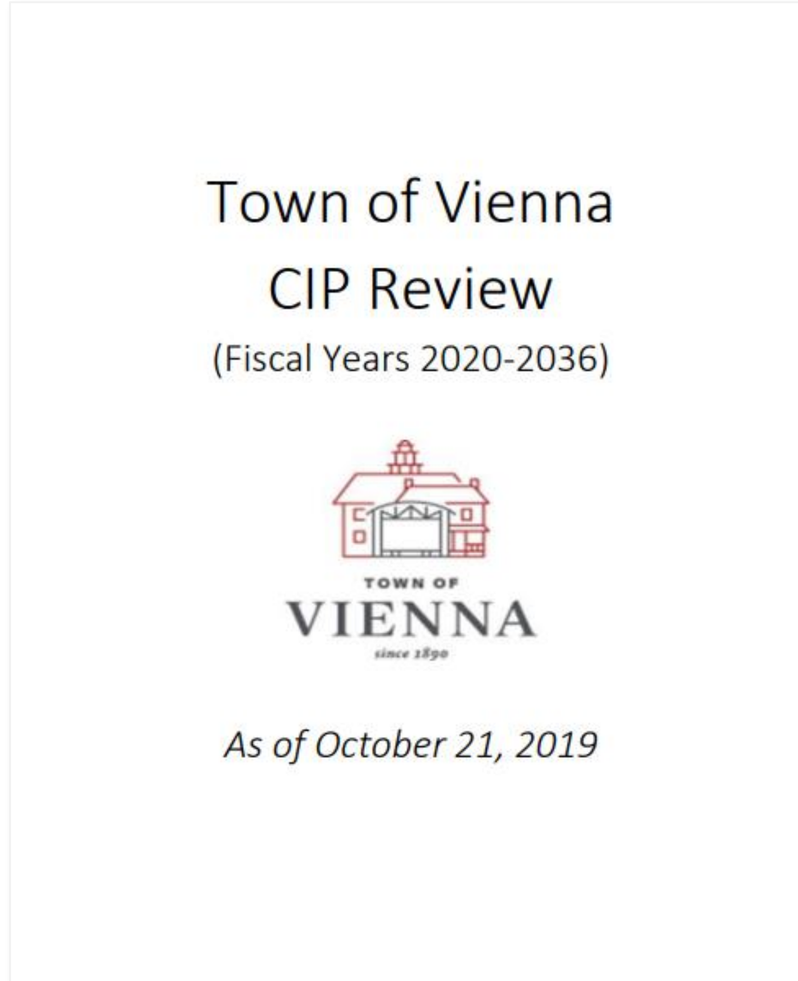
5. Future Planning Context

5.1 Capital Improvements Program

The Town of Vienna's Capital Improvements Program (CIP) is a plan of the major public improvement projects that are proposed for the upcoming years. A capital improvement is defined as:

- The acquisition of land;
- The construction of improvements or additions to existing structures, such as sewers, water lines, buildings or recreational facilities;
- Non-recurring rehabilitation or major repair to all or part of a facility (e.g., reconstruction of sewer lines or roadways) that is not considered to be recurring maintenance; and
- Specific planning, engineering or design studies related to a project described above.

Vienna's CIP includes projects from nearly all government departments and operations. The CIP projects that are most relevant to transportation and mobility are led by the Department of Public Works. These projects are listed below in **Table 5-1** and mapped in **Figure 5-1**.


Town of Vienna
CIP Review
(Fiscal Years 2020-2036)
TOWN OF
VIENNA
since 1890
As of October 21, 2019

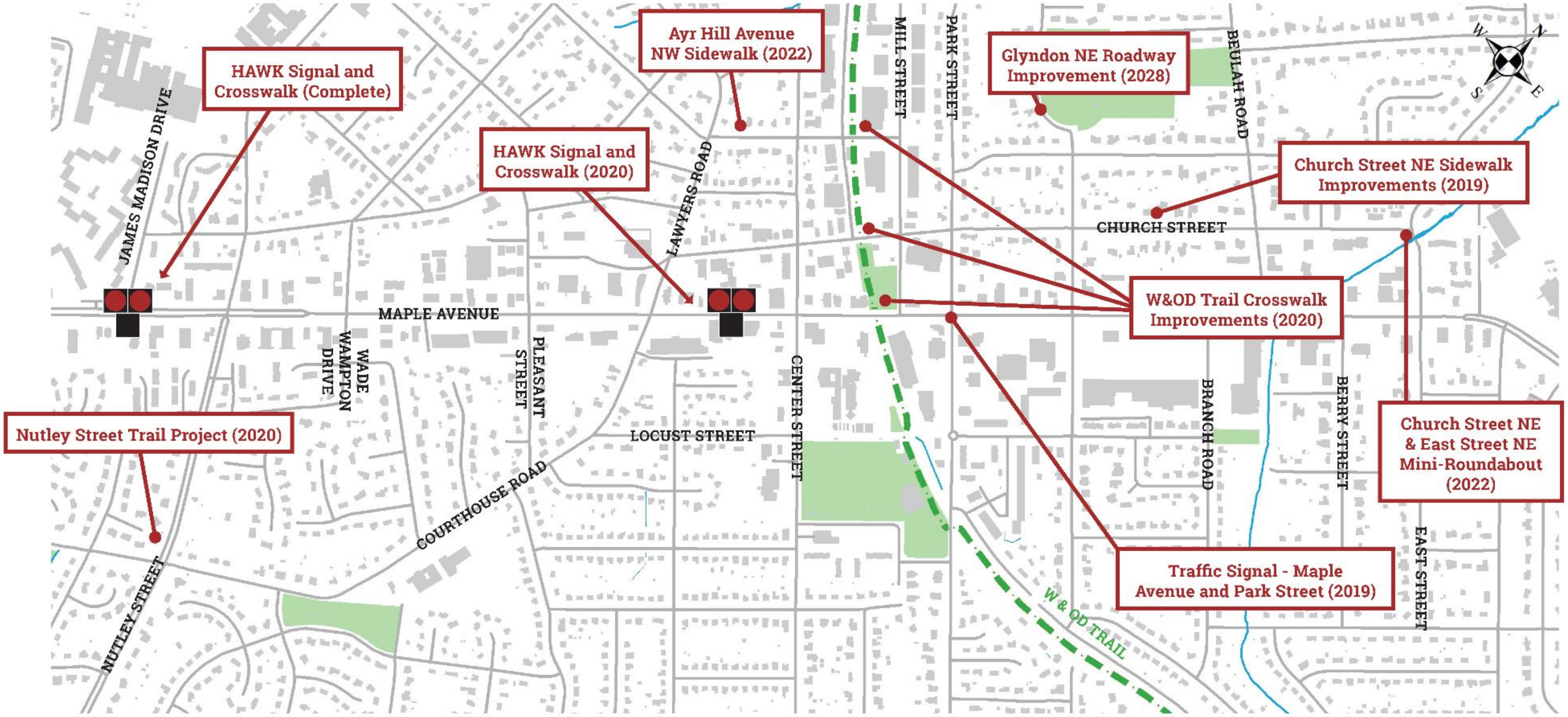
Source: Town of Vienna

Table 5-1: Mobility Improvements in CIP

Project	Description	Funding Year(s)
Sidewalk Improvements: Church Street	Fill a gap between two existing sidewalks by adding approximately 600 feet of new sidewalk between Glyndon Street and Beulah Road on the north side of Church Street.	2019
Traffic Signal: Maple Avenue and Park Street	This intersection has two traffic poles with long mast arms holding signal heads at a diagonal, which does not align with traffic lanes. Separate left-turn traffic lights have been added, which puts extra strain on the poles. A Virginia Department of Transportation (VDOT) Congestion Mitigation and Air Quality (CMAQ) grant will allow the Town of Vienna to replace the traffic signals at this intersection with a four-pole configuration with underground wiring and pedestrian audible countdown signals.	2019
Nutley Street Trail Project	Upgrade the existing sidewalk on the west side of Nutley Street from Marshall Road to Tapawingo Road into an 8-foot wide multi-use trail. This project will provide a safer route for pedestrians from Maple Avenue to the new trail system along I-66 and the Vienna Metrorail station.	2020
HAWK Signal and Crosswalk	Install a HAWK signal and crosswalk along Maple Avenue between Center Street and Lawyers Road. The HAWK signal and crosswalk will help create a more connected and safer pedestrian network in the downtown area and provide better access to Church Street from Maple Avenue.	2024
W&OD Trail Crosswalk Improvements	Install new striping along Maple Avenue, Church Street, and Ayr Hill Avenue crosswalks for the W&OD Trail. Existing crosswalks for the trail have been identified in a 2017 ULI TAP study as areas that can be improved for the safety and convenience of trail users.	2020
Mini-Roundabout: Church Street and East Street	Convert the existing "T" intersection into a mini-roundabout at Church Street and East Street. This project will improve vehicular and pedestrian safety at this heavily travelled intersection.	2022

Project	Description	Funding Year(s)
Sidewalk Reconstruction: Ayr Hill Avenue	Eliminate the existing ditches and install curb, gutter, and sidewalk along Ayr Hill Avenue NW from Lawyers Road to east of Dominion Road. The storm drain system must be designed to connect the existing pipes from Lawyers Road to Dominion Road. A full sidewalk project will provide a safe route for pedestrians walking to the businesses on Mill Street and Dominion Road, plus access to the regional trail.	2022
Roadway Improvement: Glyndon Street	Upgrade Glyndon Street from Ayr Hill Avenue to Jean Place with a full pavement rebuild, and new curb, storm drainage, stormwater managements and sidewalk to mitigate the potential for flooding the properties 320, 340 and 344 Glyndon Street NE and flooding in the property and homes 348, and 352 Glyndon Street NE. This project will provide safer pedestrian access to Glyndon Park and should reduce the potential for property damage from flooding along the length of the project.	2022
Central Business District Wayfinding Signage	Update and install new wayfinding signs and gateway arches throughout the Central Business District. Wayfinding signage is a way to help brand the Town and will also help residents and visitors navigate through the Central Business District.	2020
Maple Avenue /Nutley Street Signal Improvements (Adaptive Signal Implementation)	Three-phase project that includes traffic signal controller and cabinet upgrades and installation of traffic management software that will allow the Town to better manage congestion and improve traffic flow in real-time.	Est. operation 2023

Figure 5-1: Programmed Mobility Improvements



Source: Town of Vienna Capital Improvement Plan (CIP)

TOWN-WIDE:

- Road improvements
- Sidewalk improvements
- Central Business District Wayfinding Signage (Phase I) (2020)
- Maple Avenue Adaptive Signal Implementation

Maple Avenue / Nutley Street Signal Improvements

In December 2018, the Town completed an inventory and needs assessment of the existing traffic signals. The purpose of this effort was to document the equipment, operations, and condition of existing infrastructure (10 intersections along Maple Avenue plus 7 additional signalized intersections). The effort identified elements needed at each intersection to improve and upgrade the signals to meet the Town's desired goal of communication, monitoring, and management of signals from a remote centralized location. The resulting recommendations, when implemented, will allow the Town of Vienna to operate Maple Avenue as an adaptive signal controlled (ASC) corridor during some or all hours of the day.

Conventional traffic signal operations are based on running one or more timing plans in an attempt to accommodate the anticipated amount of traffic during a specific time period. For many jurisdictions there can be as many 8 or more different signal timing plans (Weekday AM peak, Weekday PM peak, Weekday mid-day peak, Weekday off-peak, Weekend AM peak, Weekend PM peak, Saturday peak, and Sunday peak). The number of traffic signal timing plans depends on the prevailing characteristics of the traffic on the specific road and how responsive performance metrics are to desired delays, congestion, and mobility. Traffic operators look for signal plans that are the "best fit" for the majority of traffic during specific time periods.

While conventional traffic signal operations are appropriate in a wide variety of situations, it is recognized that these systems do not monitor the real-time performance of the road and cannot adjust, dynamically, to changes in the traffic stream or to traffic demand that significantly conflicts with their prescribed timing. While conventional traffic signals make up approximately 99 percent of all signalized operation in the Unites States, there are known limitations[9]:

- Timing plans work well initially, they can become inefficient and outdated as traffic patterns change over time
- Plans are less effective if there are seasonal traffic changes caused by tourism or shopping or when special events or incidents occur.

The Federal Highway Administration (FHWA) has estimated that 5 percent of all traffic delay nationally is caused by outdated signal-timing plans. In contrast, Adaptive Signal Control Technology (ASCT) systems are designed to adjust how much green time is given to one or multiple movements in direct response to the amount of traffic on the ground, which is being continuously recorded and monitored. The purpose of this active management of traffic signals is to better promote efficient use of available capacity, to create efficient flow across a corridor from signal to signal, and to reduce or mitigate the impacts of congestion.

As stated by FHWA Center for Accelerating Innovation[10], "by receiving and processing data from strategically placed sensors, ASCT can determine which lights should be red and which should be green" in direct response to traffic conditions.

As stated in FHWA ASCT Brochure[11] the main advantages of adaptive signal control compared to conventional controls are that it can:

- Automatically adapt to unexpected changes in traffic

[9] http://www.virginiadot.org/vtrc/main/online_reports/pdf/15-R24RB.pdf

[10] https://www.fhwa.dot.gov/innovation/everydaycounts/edc-1/asct.cfm

[11] https://www.fhwa.dot.gov/innovation/everydaycounts/edc-1/pdf/asct_brochure.pdf

- Continuously (or near-continuously) distribute green light time within a prescribed priority for all traffic movements
- Improve travel time reliability
- Reduce congestion by creating smoother flow, improving fuel consumption
- Prolong the effectiveness of traffic signal timing
- Reduce the complaints about outdated signal timing
- Make traffic signal operations proactive by monitoring and responding to gaps in performance.
- Improve incidence response and operational recovery

ASCT is also scalable based on the amount of data and hands-on management an agency has the capacity to take on and the frequency of changes that an agency desires to see on the subject corridor. ACST "lite" applications make timing updates every few minutes while more "robust" systems can make time updates with every cycle (every 120 to 140 seconds along Maple Avenue). Lite systems require less data and are less complex to operate while more robust systems typically collect data every second and require intensive calibration to accurately reflect the specifics of the subject corridor.

The benefits of ASCT have been researched and documented for many years. FHWA reports that adaptive signal controls can reduce delays by up to 10 percent on typical corridors and by up to 50 percent on corridors with particularly old or ill-fitting conventional signal timing plans. A 2015 study by Virginia Center for Transportation Innovation and Research (VCTIR)[12], found a 37 percent reduction in the number of stops per vehicle, a 5 percent reduction in PM peak period travel time, and a 23 percent improvement in PM peak period travel time reliability. Ancillary improvements to safety, in the form of crash reduction were also observed due to the reduced likelihood of crash types affected by congestion. It should be noted that despite these proven benefits, ASCT will not be a panacea for all the mobility related issues of the Maple Avenue corridor. ASCT is best suited to address moderate traffic conditions and to respond to sudden changes in traffic beyond what is anticipated within a given timing plan. Some challenges to ASCT adoption and implementation are:

- ASCT shows more benefit on the peak-period fringes – the one or two hours leading up to and following the peak period and during abnormal traffic patterns.
- Heavy pedestrian traffic, inefficient intersection geometry, and high volume/capacity (V/C) ratios (generally above 90%) limit the potential for travel time benefit
- Expertise is needed to implement and maintain ASCT.
- There may be a higher cost to implement and maintain.
- ASCT may impact the walk signal/pedestrian phase
- ASCT could result in more delays at side street movements (signalized or unsignalized) during peak periods
- Numerous unsignalized commercial entrances may affect the ability to create efficient platoons of traffic.

The nature of congestion along Maple Avenue is generally not driven by sudden change. There is recurrent and significant daily congestion related to commuter movements along Maple Avenue. There are also out-of-network bottlenecks in Tysons and southern Fairfax that impact traffic within the Town extents. As such there is a limitation to the amount of travel time reductions that can be realized. Similarly, due to the numerous commercial entrances and the significant pedestrian movements across the corridor there could be interruptions to the ideal traffic stream that the ASCT attempts to create. These challenges will need to be considered as part of the 2023 implementation of ASCT along Maple Avenue.

[12] http://www.virginiadot.org/vtrc/main/online_reports/pdf/15-r24.pdf

5.2 Regional Transportation Trends

In Vienna, Northern Virginia, the Washington DC region, and beyond, evolving trends in transportation and mobility are occurring due to demographic shifts and advancements in technology. Several trends impacting mobility:

- **Behavioral:** Shared mobility options are growing in popularity, which is increasing interest in on-demand options. The growth of telecommuting is also contributing to behavioral change.
- **Technological:** Data-sharing is expanding, and mobile device technology is growing, including those with location-based services.
- **Socio-Demographic:** Environmental awareness is becoming more heightened and regional economic growth is continuing. Reduced interest in car ownership, changes in land use, shifts towards urbanization, and increasing housing costs also contribute to social and demographic change.

The rise of shared mobility is also prompting significant changes to the state of transportation systems and options. Shared mobility enables users to gain short-term access to transportation modes on an 'as-needed' basis. The ecosystem of shared services continues to grow and includes:

- **Bikeshare** systems provide users with on-demand access to bicycles at a variety of pick-up and drop-off locations, through either station-based models (users access bicycles via unattended docking stations) or dockless models (users may access/unlock a bicycle and park it at any location within a predefined geographic region). Currently, the regional, station-based Capital Bikeshare system does not extend to Vienna and no dockless bikeshare companies are operating in the town.
- **Carshare** provides access to a private vehicle without the costs and responsibilities of car ownership. Typically, carshare access is granted by joining an organization that maintains a fleet of cars at neighborhood parking lots, employment centers, and university campuses. Carshare operators typically provide gasoline, parking, and maintenance while users pay a fee each time they use a vehicle. Zipcar and other popular carshare companies do not currently operate in Vienna but are common elsewhere in Northern Virginia and Washington DC.
- **Carpool/Vanpool** can take on many forms, including informal carpooling among strangers or app-based carpooling that allows people to arrange shared rides on-demand. Informal carpooling – or "slugging" – is a common practice for Northern Virginia commuters and the app-based Waze Carpool is available in the greater Washington DC region.
- **Scooter Share**, not unlike bikeshare, provides users with on-demand access to scooters at a variety of pick-up and drop-off locations. Scooters can be accessed (unlocked) at unattended docking stations or picked up and returned (parked) to any location within a predefined geographic region. Several app-based scooter share companies – many on a pilot program basis – are currently operating in Northern Virginia and Washington DC. In November 2019, the Fairfax County Board of Supervisors approved regulations for shared mobility devices, which include bicycles and scooters. Vienna has also defined the terms of pilot scooter implementation within the Town's boundaries.
- **Transportation Network Companies** (TNCs), such as Uber, Lyft, and Via, provide prearranged and on-demand transportation services. Ride requests, bookings, and payment are facilitated through smartphone mobile applications.

5.3 Future Development Scenario

A single future development scenario was developed and evaluated to assess how resilient the Maple Avenue corridor is to changes in land use and density, changes in peak and daily traffic, and changes in multimodal needs resulting from a growing diversity in travel patterns and attitudes.

The development scenario included:

- Three approved developments to be completed under MAC zoning
- One proposed development under review for MAC zoning
- Two possible future developments on which public discussion has taken place
- Five potential development sites greater than 1 acre with buildings built more than 50 years ago and not recently renovated.

It is noted that outside of the three approved projects, the remaining developments are speculative. The intent of developing a future development scenario is to anticipate potential additional challenges that the Maple Avenue corridor will face with a change in land use that could reasonably occur within the next 10 years.

The development scenario was assumed to be comprised of mixed-use redevelopments similar to those approved under the MAC Zoning

Table 5-2 describes the parcels that were considered in the future development scenario.

Figure 5-2 shows the locations of the subject parcels.

Table 5-2: Development Scenario Land Use and Density

Name /Address	Current Land Use and Density	Status	Development Scenario Land Use and Density
Flagship Carwash (540 Maple Avenue West)	N/A	Approved under MAC	815 SF Car Wash 5,001 SF restaurant
Vienna Market / Marco Polo	N/A		26,000 sf retail 49 Townhouse units
444 Maple Avenue	2.76 ac; 119 room hotel; 3,500 SF restaurant		20,000 SF Retail 160 Multifamily units
380 Maple Avenue	Office; 23,620 SF	Under review	4,500 SF retail 4,000 SF restaurant 42 Multifamily units
Commonwealth Office Building (226 Maple Ave W)	Office; 1.53 ac; 19,920 SF	Sites Greater than One Acre with Buildings Built More than Fifty Years Ago and Not Recently Renovated	1,600 SF retail 6,400 SF restaurant 42 Multifamily units
Bank of America (235 Maple Ave W)	Bank; 1.17 ac; 4,859 SF		1,600 SF retail 6,400 SF restaurant 59 Multifamily units
Glyndon Shopping Center (227-229 Maple Ave E)	Shopping center; 2.21 ac; 31,904 SF		25,600 SF retail 6,400 SF restaurant 111 Multifamily units
Maple Avenue Shopping Center (309-359 Maple Ave E)	Shopping center; 10.43 ac; 117,074 SF		96,000 SF retail 24,000 SF restaurant 419 Multifamily units
SunTrust (515-521 Maple Ave E;)	Bank; 1.61 ac; 18,651 SF		2,400 SF retail 9,600 SF restaurant 81 Multifamily units
BB&T/Kensington Assisted Living (415 Maple Ave W)	Bank; 0.92 ac; 2,600 SF	Possible Future Development on Which Public Discussion Has Occurred	7,500 SF retail 85 Multifamily units
Patrick Henry Library (101 Maple Ave E)	Library; 1.43 ac; 13,817 SF		21,000 SF library 250 public parking spaces
100, 102, 112 Maple Avenue East	Medical office; 0.74 ac; 10,980 SF		8,784 SF retail 2,196 SF restaurant 36 Multifamily units
145 Church Street	N/A		8,200 retail 22 Multifamily units 60-space garage
		TOTAL	815 SF car wash; 21,000 SF library; 202,184 Sf retail; 63,997 SF restaurant; 1,084 dwelling units; 60-space garage; 250-space garage

Figure 5-2: Development Scenario Parcels

Site	Name
1	Flagship Carwash
2	Wawa
3	Kensington Assisted Living
4	444 Maple Avenue
5	380 Maple Avenue
6	Jades Shopping Center
7	Vienna Plaza
8	Vienna Market
9	Commonwealth Office Building
10	Bank of America
11	Vienna Shopping Center
12	145 Church Street NW
13	Vienna Shopping Center

Site	Name
14	Virginia Tire and Auto
15	100 Maple Avenue E
16	Patrick Henry Library
17	Bear Branch Tavern
18	BP Gas Station
19	Glyndon Shopping Center
20	Vienna Vintner
21	Fed Ex
22	Maple Avenue Shopping Center
23	Starbucks
24	Vienna Crossing
25	Suntrust

Vehicular trip generation for the development scenario was prepared using the following methodologies:

For properties approved or under review by MAC

- Trip generation data was directly sourced from the approved traffic studies. This was done to align with the trips and local intersection impacts that were discussed publicly for each development. It is noted that because some of the studies are older, the original underlying data used to develop trips does not align with new trip calculations – this is because of updates to the Institute of Transportation Engineers Trip Generation Manual that occurred following the approval of the traffic studies (i.e. the 10th Edition is now current and the Flagship Carwash, 444 Maple Avenue, and Vienna Market traffic studies were performed under the 9th Edition of the manual)
- Removal of existing trips, consideration of pass-by trips, and application of internal capture (or lack of these approaches) were also directly sourced from the approved studies, if applicable

For all other properties

- Peak hour traffic volumes generated by proposed developments were calculated using the most applicable land use codes of the 10th Edition of the ITE Trip Generation Manual and using the peak hour of the adjacent street
- Removal of existing trips for properties to be developed was only considered for 100, 102, 112 Maple Avenue East; the Patrick Henry Library; the Maple Avenue Shopping Center; and the Glyndon Shopping Center
- Pass-by trips were considered for applicable land uses using the information contained in the ITE Trip Generation Handbook 3rd Edition
- Internal capture was applied for applicable land use pairs using the methodology contained in the ITE Trip Generation Handbook 3rd Edition

It is noted that this trip generation methodology is generally consistent with nationally accepted practices and with the requirements that are typically assigned to traffic studies prepared in the Town of Vienna. It is noted that this methodology is also generally conservative; it examines a density scenario and associated number of trips that may be higher than what would actually be achieved in the future given changes in traffic patterns, travel behaviors, and the transportation demand management and parking requirements of the Town. It also assumes that all this development occurs at the same time instead of incrementally over a period of years.

Table 5-3 and **Table 5-4** show the AM and PM trip generation for the proposed developments. The following trips are shown in the tables:

- **Gross Trips** - Total vehicle trips estimated to be generated to an isolated site of a specific land use and density
- **Internal Capture Trips** – Trips that will occur on-site (and likely not in vehicles) due to the complementary nature of land uses in a mixed-use development
- **Pass-by Trips** – Trips that are already in the traffic network and turn at development sites while passing on the way to or from the destination. These trips do not add any impact to the traffic network except at the development driveway(s)
- **New Trips** – New vehicle trips added as a result of development (Gross - Internal - pass-by = New Trips)
- **Existing Trip Credit** – Existing trips at properties to be redeveloped are removed from the study network prior to adding in the new trips so as not to double count total trips.
- **Net New Trips** – Resulting new trips that impact the study area intersections after the consideration of trip credit (New trips - Existing Trip Credit = Net New Trips).

Table 5-3: Future Development Scenario AM Peak Hour Trip Generation

Name /Address	Development Scenario Lane Use and Density	ITE Land Use code	AM Gross Trip Generation In / Out / Total	AM Internal Capture In / Out / Total	AM Pass-by In / Out / Total	AM New Trips In / Out / Total	AM Existing Trip Credit In / Out / Total	AM Net New Trips In / Out / Total
Flagship Carwash (540 Maple Avenue West)	815 SF Car Wash	N/A	1 / 0 / 1	N/A	N/A	1 / 0 / 1	N/A	1 / 0 / 1
	5,001 SF restaurant	934 – Fast-food with Drive thru	116 / 112 / 228	N/A	91 / 88 / 179	24 / 24 / 48	N/A	24 / 24 / 48
		Total	117 / 112 / 229	N/A	91 / 88 / 179	25 / 24 / 28	N/A	25 / 24 / 49
Vienna Market / Marco Polo	26,000 sf retail	820 – Shopping Center	21 / 13 / 34	1 / 0 / 1	12 / 8 / 20	8 / 5 / 13	N/A	8 / 5 / 13
	49 Townhouse units	230 – Townhouse	5 / 22 / 27	0 / 1 / 1	N/A	5 / 21 / 26	N/A	5 / 21 / 26
		Total	26 / 35 / 61	1 / 1 / 2	12 / 8 /20	13 / 26 / 39	N/A	13 / 26 / 39
444 Maple Avenue	20,000 SF Retail	826 – Specialty Retail	36 / 38 / 74	2 / 1 / 3	12 / 13 / 25	22 / 24 / 46	N/A	22 / 24 / 46
	160 Multifamily units	220 – Apartment	16 / 66 / 82	1 / 2 / 3	N/A	15 / 64 / 79	N/A	15 / 64 / 79
		Total	52 / 104 / 156	3 / 3 / 6	12/ 13 / 25	37 / 88 / 125	N/A	37 / 88 / 125
380 Maple Avenue	4,500 SF retail	820 – shopping center	8 / 6 / 14	N/A	N/A	8 / 6 /14	N/A	8 / 6 /14
	4,000 SF restaurant	932 – High-Turnover (Sit-Down)	32 / 24 / 56	N/A	N/A	32 / 24 /56	N/A	32 / 24 /56
	42 Multifamily units	221 – Multifamily Mid-rise	4 / 9 / 13	N/A	N/A	4 / 9 / 13	N/A	4 / 9 / 13
		Total	44 / 39 / 83	NA	NA	44 / 39 / 83	31 / 4 / 35	13 / 35 / 48
Commonwealth Office Building (226 Maple Ave W)	1,600 SF retail	820 – shopping center	1 / 1 / 2	N/A	N/A	1 / 1/ 2	N/A	1 / 1/ 2
	6,400 SF restaurant	930 – Fast Casual 932 – High-Turnover (Sit-Down)	23 / 16 / 39	2 / 0 / 2	9 / 7 / 16	12 / 9 / 21	N/A	12 / 9 / 21
	42 Multifamily units	221 – Multifamily Mid-rise	4 / 11 / 15	0 / 2 / 2	2 / 1 / 3	2 / 8 / 10	N/A	2 / 8 / 10
		Total	28 / 28 / 56	2 / 2 / 4	11 / 8 / 19	15 / 18 / 33	N/A	15 / 18 / 33
Bank of America (235 Maple Ave W)	1,600 SF retail	820 – shopping Center	1 / 1 / 2	N/A	N/A	1 / 1 /2	N/A	1 / 1 /2
	6,400 SF restaurant	930 – Fast Casual 932 – High-Turnover (Sit-Down)	23 / 16 / 39	3 / 0 / 3	10 / 8 / 18	10 / 8 / 18	N/A	10 / 8 / 18
	59 Multifamily units	221 – Multifamily Mid-rise	5 / 16 / 21	0 / 3 / 3	N/A	5 / 13 / 18	N/A	5 / 13 / 18
		Total	29 / 33 / 62	3 / 3 / 6	10 / 8 / 18	16 / 22 / 38	N/A	16 / 22 / 38
Glyndon Shopping Center (227-229 Maple Ave E)	25,600 SF retail	820 – shopping Center	15 / 9 / 24	1 / 1 / 2	N/A	14 / 8 / 22	19 / 11 / 30	-5 / -3 / - 8
	6,400 SF restaurant	930 – Fast Casual 932 – High-Turnover (Sit-Down)	23 / 16 / 39	6 / 2 / 8	8 / 7 / 15	9 / 7 / 16	N/A	9 / 7 / 16
	111 Multifamily units	221 – Multifamily Mid-rise	10 / 30 / 40	1 / 5 /6	N/A	9 / 25 / 34	N/A	9 / 25 / 34
		Total	48 / 55 / 103	8 / 8 / 16	8 / 7 / 15	32 / 40 / 72	19 / 11 / 30	13 / 29 / 42
Maple Avenue Shopping Center (309-359 Maple Ave E)	96,000 SF retail	820 – shopping Center	56 / 34 / 90	5 / 5 /10	N/A	51 / 29 / 80	68 / 42 / 110	-17 / -13 / -30
	24,000 SF restaurant	930 – Fast Casual 932 – High-Turnover (Sit-Down)	82 / 62 / 144	20 / 6 / 26	29 / 28 / 57	33 / 28 / 61	N/A	33 / 28 / 61
	419 Multifamily units	221 – Multifamily Mid-rise	39 / 112 / 151	3 / 17 / 20	N/A	36 / 95 / 131	N/A	36 / 95 / 131

Name /Address	Development Scenario Lane Use and Density	ITE Land Use code	AM Gross Trip Generation In / Out / Total	AM Internal Capture In / Out / Total	AM Pass-by In / Out / Total	AM New Trips In / Out / Total	AM Existing Trip Credit In / Out / Total	AM Net New Trips In / Out / Total
		Total	177/ 208 / 385	28 / 28 / 56	29 / 28 /57	120 / 152 / 272	68 /42 /110	52 / 110 / 162
SunTrust (515-521 Maple Ave E;)	2,400 SF retail	820 – shopping Center	1 / 1 / 2	N/A	N/A	1 / 1 / 2	19 / 11 / 30	-18 / -10 / -28
	9,600 SF restaurant	930 – Fast Casual 932 – High-Turnover (Sit-Down)	33 / 25 / 58	4 / 0 / 4	14 / 13 / 27	15 / 12 / 27	N/A	15 / 12 / 27
	81 Multifamily units	221 – Multifamily Mid-rise	8 / 21 / 29	0 / 4 / 4	N/A	8 / 17 / 25	N/A	8 / 17 / 25
		Total	42 / 47 / 89	4 / 4 / 8	14 / 13 / 27	24 / 30 / 54	19 / 11 / 30	5 / 19 / 24
BB&T/Kensington Assisted Living (415 Maple Ave W)	7,500 SF retail	820 – shopping center	4 / 3 / 7	N/A	N/A	4 / 3 / 7	N/A	4 / 3 / 7
	85 Assisted Living units	254 – Assisted Living	10 / 6 / 16	N/A	N/A	10 / 6 / 16	N/A	10 / 6 /16
		Total	14 / 9 / 23	N/A	N/A	14 / 9 / 23	N/A	14 / 9 / 23
Patrick Henry Library (101 Maple Ave E)	21,000 SF library	590 – Library	15 / 6 / 21	N/A	N/A	15 / 6 / 21	10 / 4 / 14	5 / 2 / 7
	250 public parking spaces	090 – Park and ride lot	21 / 84 / 106	N/A	N/A	21 / 84 / 106	N/A	21 / 84 /106
		Total	36 / 90 / 127	N/A	N/A	36 / 90 / 127	10 / 4 / 14	26 / 86 / 113
100, 102, 112 Maple Avenue East	8,784 SF retail	820 – shopping Center	5 / 3 / 8	N/A	N/A	5 / 3 / 8	N/A	5 / 3 /8
	2,196 SF restaurant	930 – Fast Casual 932 – High-Turnover (Sit-Down)	7 / 6 / 13	1 / 1 / 2	2 / 2 / 4	4 / 3 / 7	N/A	4 / 3 / 7
	36 Multifamily units	221 – Multifamily Mid-rise	3 / 10 / 13	0 / 1/ 1	N/A	3 / 9 / 12	N/A	3 / 9 / 12
		Total	15 / 19 / 34	1 / 2 / 3	2 / 2 / 4	12 / 15 / 27	24 / 7 / 31	-12 / 8 / -4
145 Church Street	8,200 retail	820 – shopping Center	5 / 3 / 8	N/A	N/A	5 / 3 / 8	N/A	5 / 3 / 8
	22 Multifamily units	221 – Multifamily Mid-rise	2 / 6 / 8	N/A	N/A	2 / 6 /8	N/A	2 / 6 / 8
	60-space garage	090 – Park and ride lot	6 / 19 /25	N/A	N/A	6 / 19 / 25	N/A	6 / 19 /25
		Total	13 / 28 / 41	N/A	N/A	13 / 28 / 41	N/A	13 / 28 /41
		Grand Total	641 / 807 / 1449	50 / 51 / 101	189 / 175 / 364	402 / 581 / 984	171 / 79 / 250	230 / 502 / 734

Table 5-4: Future Development Scenario PM Peak Hour Trip Generation

Name /Address	Development Scenario Lane Use and Density	ITE Land Use code	PM Gross Trip Generation In / Out / Total	PM Internal Capture In / Out / Total	PM Pass-by In / Out / Total	PM New Trips In / Out / Total	Existing Trip Credit In / Out / Total	Net New Trips In / Out / Total
Flagship Carwash (540 Maple Avenue West)	815 SF Car Wash	N/A	31 / 32 / 63	N/A	N/A	31 / 32 / 63	N/A	31 / 32 / 63
	5,001 SF restaurant	934 – Fast-food with Drive thru	85 / 79 / 164	N/A	60 / 55 / 115	25 / 24 / 49	N/A	25 / 24 / 49
		Total	116 / 111 / 227	N/A	60 / 55 / 115	56 / 56 / 112	N/A	56 / 56 / 112
Vienna Market / Marco Polo	26,000 sf retail	820 – Shopping Center	54 / 58 / 112	1 / 2 /3	32 / 34 / 66	21 / 22 / 43	N/A	21 / 22 / 43
	49 Townhouse units	230 – Townhouse	21 / 10 / 31	2 / 1 / 3	N/A	19 / 9 / 28	N/A	19 / 9 / 28
		Total	75 / 68 / 143	3 / 3 / 6	32 / 34 / 66	40 / 31 / 71	N/A	40 / 31 / 71
444 Maple Avenue	20,000 SF Retail	826 – Specialty Retail	24 / 30 / 54	2 / 3 / 5	8 / 9 / 17	14 / 18 / 32	N/A	14 / 18 / 32
	160 Multifamily units	220 – Apartment	69 / 37 / 106	3 / 2 / 5	N/A	66 / 35 / 101	N/A	66 / 35 / 101
		Total	93 / 67 / 160	5 / 5 /10	8 / 9 / 17	80 / 53 / 133	N/A	80 / 53 / 133
380 Maple Avenue	4,500 SF retail	820 – shopping Center	10 / 9 / 19	N/A	N/A	10 / 9 / 19	N/A	10 / 9 / 19
	4,000 SF restaurant	932 – High-Turnover (Sit-Down)	36 / 34 / 70	N/A	N/A	36 / 34 /70	N/A	36 / 34 / 70
	42 Multifamily units	221 – Multifamily Mid-rise	10 / 7 / 17	N/A	N/A	10 / 7 /17	N/A	10 / 7 / 17
		Total	56 / 50 / 106	N/A	N/A	56 / 50 / 106	6 / 28 / 34	50 / 22 / 72
Commonwealth Office Building (226 Maple Ave W)	1,600 SF retail	820 – shopping Center	3 / 3 / 6	2 / 2 / 4	1 / 0 / 1	0 / 1 / 1	N/A	0 / 1 / 1
	6,400 SF restaurant	930 – Fast Casual 932 – High-Turnover (Sit-Down)	44 / 32 / 76	2 / 4 / 6	15 / 15 / 30	28 / 13 / 40	N/A	27 / 13 / 40
	42 Multifamily units	221 – Multifamily Mid-rise	11 / 7 / 18	3 / 1 / 4	N/A	8 / 6 / 14	N/A	8 / 6 / 14
		Total	58 / 42 / 100	7 / 7 / 14	16 / 15 / 31	35 / 20 / 55	N/A	35 / 20 / 55
Bank of America (235 Maple Ave W)	1,600 SF retail	820 – shopping Center	3 / 3 / 6	2 / 2 / 4	1 / 0 / 1	0 / 1 / 1	N/A	0 / 1 / 1
	6,400 SF restaurant	930 – Fast Casual 932 – High-Turnover (Sit-Down)	44 / 32 / 76	3 / 5 / 8	18 / 16 / 34	23 / 11 / 34	N/A	23 / 11 / 34
	59 Multifamily units	221 – Multifamily Mid-rise	16 / 10 / 26	4 / 2 / 6	N/A	12 / 8 /20	N/A	12 / 8 / 20
		Total	63 / 45 / 108	9 / 9 / 18	19 / 16 / 35	45 / 20 / 65	N/A	35 / 20 / 55
Glyndon Shopping Center (227-229 Maple Ave E)	25,600 SF retail	820 – shopping Center	47 / 51 / 98	18 / 26 / 44	9 / 9 / 18	20 / 16 / 36	80 / 83 / 163	-60 / -67 / -127
	6,400 SF restaurant	930 – Fast Casual 932 – High-Turnover (Sit-Down)	44 / 32 / 76	17 / 18 / 35	11 / 10 / 21	16 / 4 / 20	N/A	16 / 4 / 20
	111 Multifamily units	221 – Multifamily Mid-rise	30 / 19 / 49	18 / 9 / 27	N/A	12 / 10 / 22	N/A	12 / 10 / 22
		Total	121 / 102 / 223	53 / 53 / 106	20 / 19 / 39	48 / 30 / 78	80 / 83 / 163	-32 / -53 / - 85
Maple Avenue Shopping Center (309-359 Maple Ave E)	96,000 SF retail	820 – shopping Center	176 / 190 / 366	18 / 49 / 67	51 / 51 / 102	107 / 90 / 197	290 / 308 / 598	-183 / -218 / -401
	24,000 SF restaurant	930 – Fast Casual 932 – High-Turnover (Sit-Down)	167 / 120 / 287	63 / 67 / 130	40 / 39 / 79	64 / 14 / 78	N/A	64 / 14 / 78
	419 Multifamily units	221 – Multifamily Mid-rise	112 / 72 / 184	67 / 33 / 100	N/A	45 / 39 / 84	N/A	45 / 39 / 84
		Total	455 / 382 / 837	148 / 149 / 297	91 / 90 / 181	216 / 143 / 359	290 / 308 / 598	-74 / -165 / -239

Name /Address	Development Scenario Lane Use and Density	ITE Land Use code	PM Gross Trip Generation In / Out / Total	PM Internal Capture In / Out / Total	PM Pass-by In / Out / Total	PM New Trips In / Out / Total	Existing Trip Credit In / Out / Total	Net New Trips In / Out / Total
SunTrust (515-521 Maple Ave E;)	2,400 SF retail	820 – shopping Center	4 / 5 / 9	2 / 2 / 4	1 / 1 / 2	1 / 2 / 3	N/A	1 / 2 / 3
	9,600 SF restaurant	930 – Fast Casual 932 – High-Turnover (Sit-Down)	66 / 49 / 115	4 / 6 / 10	27 / 26 / 53	35 / 17 / 52	N/A	35 / 17 / 52
	81 Multifamily units	221 – Multifamily Mid-rise	22 / 14 / 36	5 / 3 / 8	N/A	17 / 11 / 28	N/A	17 / 11 / 28
		Total	92 / 68 / 160	11 / 11 / 22	28 / 27 / 55	53 / 30 /83	N/A	53 / 30 / 83
BB&T/Kensington Assisted Living (415 Maple Ave W)	7,500 SF retail	820 – shopping Center	14 / 15 / 29	1 / 4 / 5	4 / 4/ 8	9 / 7 / 15	N/A	9 / 7 / 15
	85 Multifamily units	221 – Multifamily Mid-rise	8 / 14 / 22	4 / 1 / 5	N/A	4 / 13 / 17	N/A	4 / 13 / 17
		Total	22 / 29 / 51	5 / 5 / 10	4 / 4 / 8	13 / 20 / 33	N/A	13 / 20 / 33
Patrick Henry Library (101 Maple Ave E)	21,000 SF library	590 – Library	82 / 89 / 171	N/A	N/A	82 / 89 / 171	54 / 59 / 113	28 / 30 / 58
	250 public parking spaces	090 – Park and ride lot	27 / 81 / 108	N/A	N/A	27 / 81 / 108	N/A	27 / 81 / 108
		Total	109 / 170 / 279	N/A	N/A	109 / 170 /279	54 / 59 / 113	55 / 111 / 166
100, 102, 112 Maple Avenue East	8,784 SF retail	820 – shopping Center	16 / 17 / 33	7 / 9 / 16	3 / 3/ 6	6 / 5 / 11	N/A	6 / 5 / 11
	2,196 SF restaurant	930 – Fast Casual 932 – High-Turnover (Sit-Down)	16 / 11 / 27	6 / 3 / 9	4 / 4 / 8	6 / 4 / 10	N/A	6 / 4 / 10
	36 Multifamily units	221 – Multifamily Mid-rise	10 / 6 / 16	6 / 3 / 9	N/A	4 / 3 / 8	N/A	4 / 3 / 8
		Total	42 / 34 / 76	19 / 15 / 34	7 / 7/ 14	16 / 12 / 28	11 / 28 / 39	5 / -16 / -11
145 Church Street	8,200 retail	820 – shopping Center	15 / 16 / 31	N/A	6 / 6/ 12	9 / 10 / 19	N/A	9 / 10 / 19
	22 Multifamily units	221 – Multifamily Mid-rise	6 / 4 / 10	N/A	N/A	6 / 4 / 10	N/A	6 / 4 / 10
	60-space garage	090 – Park and ride lot	7 / 19 / 26	N/A	N/A	7 / 19 / 26	N/A	7 / 19 / 26
		Total	28 / 39 / 67	N/A	6 / 6 / 12	22 / 33 / 88	N/A	22 / 33 / 55
		Grand Total	1330 / 1207 / 2537	260 / 257 / 517	291 / 282 / 573	779 / 668 / 1447	441 / 506 / 947	338 / 162 / 500

Peak hour trips were assigned to the study area network based on the information contained in approved traffic studies and based on trip distribution that matched the existing turning movement percentages at study area intersections. Development total net new trips are shown in **Figure 5-3**. The resulting future scenario peak hour traffic volumes (**Figure 5-4**) were developed by adding the development scenario traffic (**Figure 5-3**) with existing conditions peak hour traffic volumes (**Figure 3-10**).

Figure 5-3: Development Scenario Peak Hour Traffic Volumes

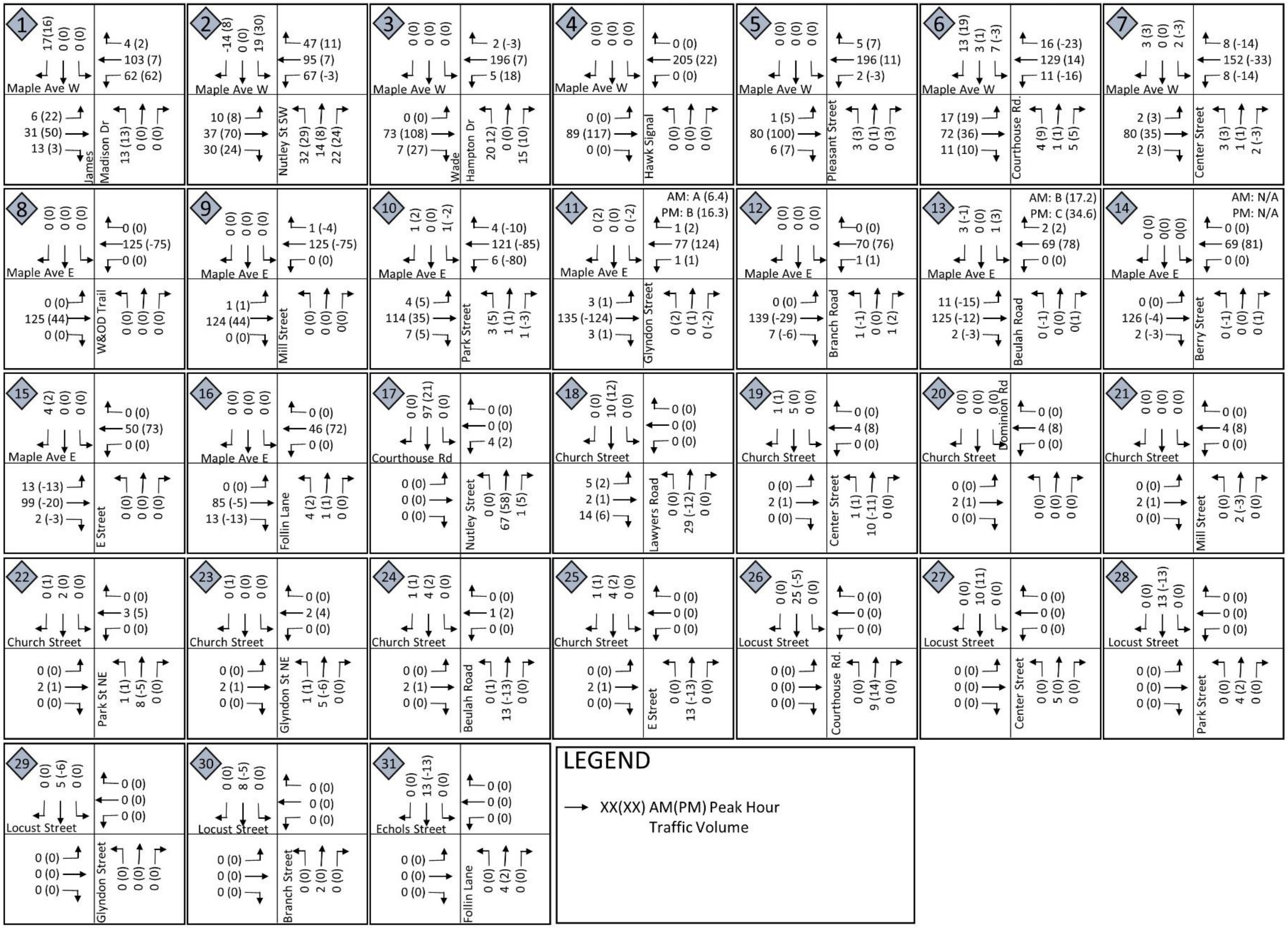
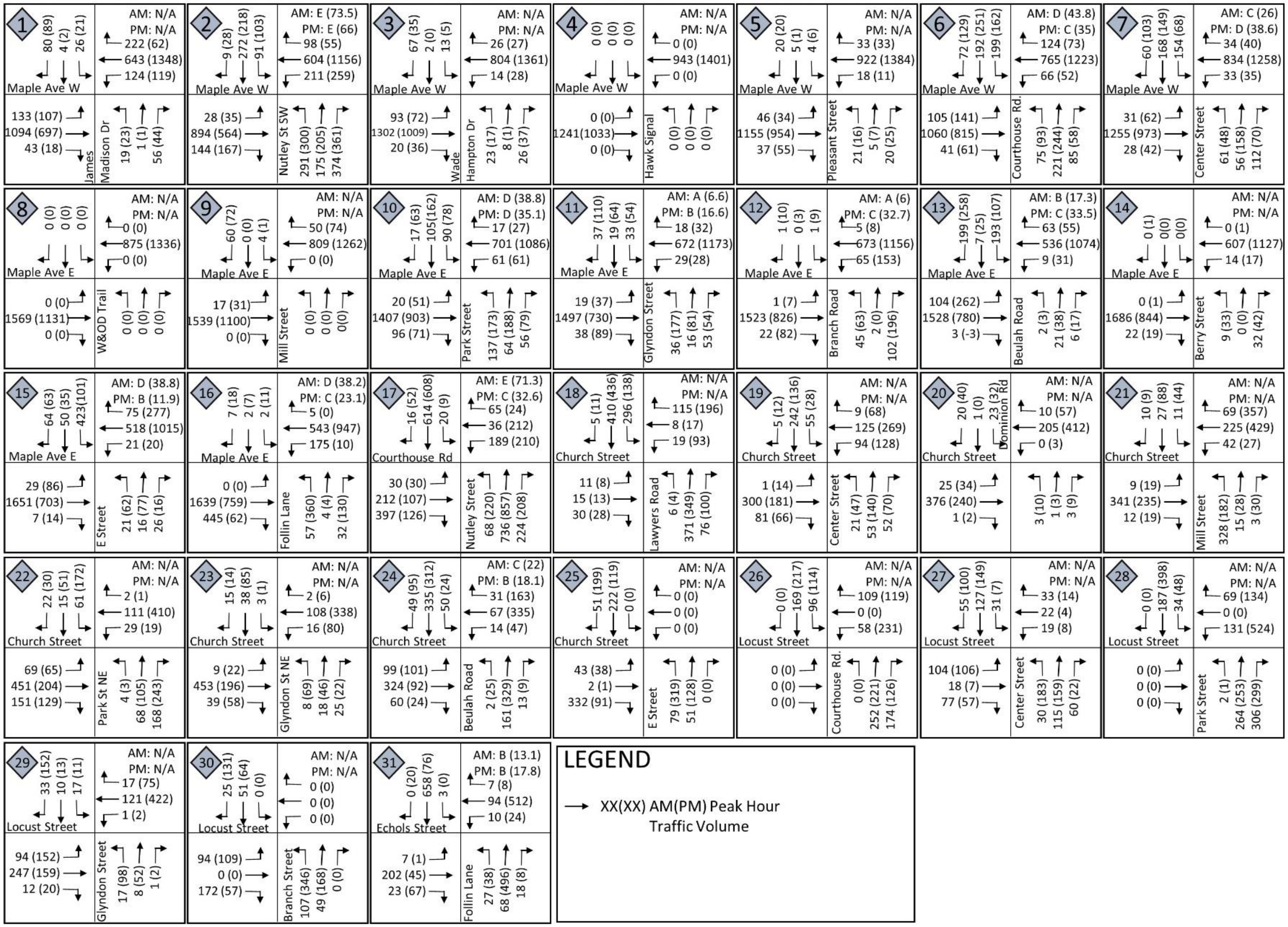


Figure 5-4: Future Scenario Peak Hour Traffic Volumes



6. Future Conditions

6.1 Pedestrian Network

The future of the pedestrian network in Vienna is not anticipated to be significantly different from the one that is in place today due to the existing network being nearly complete and generally well-connected. Programmed improvements in the Town's CIP will be targeted to fill existing sidewalk gaps, upgrade shared-use trail crossings, and install additional HAWK signals to enhance pedestrian crossings across Maple Avenue. Additionally, street frontage improvements by developers at new or renovated developments along Maple Avenue will have the potential to upgrade, enhance, or provide new pedestrian facilities in the public domain.

6.2 Bicycle Network

Similar to the pedestrian network, the future bicycle network in Vienna is not expected to differ significantly compared to existing conditions. There are no adopted or programmed plans for a defined local bicycle network along the Maple Avenue corridor or elsewhere in the town. Town Council has expressed interest in developing a Bicycle Master Plan; such a document would potentially include recommendations for on-street bike facilities, designated bicycle routes, and bikeshare systems.

6.3 Transit Network

With the exception of minor route alignment adjustments at Metrorail stations outside of this study's immediate area, the Fairfax Connector Transit Development Plan does not envision changes to existing transit routes or propose new routes to serve Vienna along Maple Avenue.[13] The potential for developer-financed street frontage improvements may also enhance existing bus stops through the provision of new or improved shelters, signage, sidewalk connections, and boarding areas. As part of the transportation demand management requirements, certain developers have also committed to funding shuttle service between their properties and the Vienna/Fairfax-GMU metrorail station.

6.4 Vehicle Network

Considering the development scenario discussed in Chapter 5, an additional 784 net new trips during the AM peak hour and 500 net new trips during the PM peak hour may be added to some parts of the Maple Avenue corridor. These trips will add to the congestion and delays already experienced under existing conditions and add to the challenges of turning into and out of unsignalized intersections and driveways. However, when dispersed across the study area, the trips will not lead to major traffic impacts or level of service degradations that do not align with the current travel conditions along Maple Avenue.

Table 6-1 shows the anticipated AM and PM peak hour intersection delays and LOS for signalized intersections. **Table 6-2** shows the anticipated AM and PM peak hour intersection delays and LOS for unsignalized intersections. **Table 6-3** shows the anticipated AM and PM peak hour left turn lane queue lengths. **Table 6-4** shows the anticipated AM and PM peak hour through queue lengths.

[13] Fairfax County Transit Development Plan, March 2016

Table 6-1: AM and PM Peak Hour Future Scenario Signalized Intersection Delay (seconds per vehicle) and LOS

Intersection	Existing		Future	
	AM LOS	PM LOS	AM LOS	PM LOS
2. Maple Avenue and Nutley Street	**E (62.6)**	**E (62.3)**	**E (73.5)**	**E (66)**
4. Maple Avenue and Vienna Plaza Hawk Signal	N/A	N/A	N/A	N/A
6. Maple Avenue and Courthouse Road/Lawyers Road	D (42.8)	C (30.9)	D (43.8)	C (35)
7. Maple Avenue and Center Street	C (25)	D (39.2)	C (26)	D (38.6)
8. Maple Avenue and W&OD Trail Crossing	N/A	N/A	N/A	N/A
10. Maple Avenue and Park Street	D (38.3)	C (33.7)	D (38.8)	D (35.1)
11. Maple Avenue and Glyndon Street	A (6.9)	B (16.3))	A (6.6)	B (16.6)
12. Maple Avenue and Branch Road	A (6.4)	C (32.5)	A (6)	C (32.7)
13. Maple Avenue and Beulah Road	B (17.2)	C (34.6)	B (17.3)	C (33.5)
15. Maple Avenue and E Street	D (38.4)	11.8 (B)	D (38.8)	B (11.9)
16. Maple Avenue and Follin Lane	C (34.1)	C (22.8)	D (38.2)	C (23.1)
17. Courthouse Road and Nutley Street	**E (59.1)**	C (32.6)	**E (71.3)**	C (32.6)
24. Church Street and Beulah Street	C (22.1)	B (18.1)	C (22)	B (18.1)
31. Echols Street and Follin Lane	B (12.9)	B (18)	B (13.1)	B (17.8)

**Delay and LOS result are based on control delays at signalized intersections. These results may not reflect the full impacts of downstream congestion and queuing which prevents vehicels from clearing intersections in a single cycle.*

Table 6-2: AM and PM Peak Hour Future Scenario Unsignalized Intersection Delay (seconds per vehicle) and LOS

Intersection	Mvmt	Existing		Future	
		AM LOS	PM LOS	AM LOS	PM LOS
1. Maple Avenue and James Madison Drive	NB	**E (35.9)**	B (14.9)	**F (442.7)**	D (32.7)
	SB	**F (105.5)**	**E (36.3)**	**F (433)**	**F (122.7)**
3. Maple Avenue and Wade Hampton Drive	NB	C (19.9)	C (23.1)	**E (41.8)**	**E (37.1)**
	SB	B (12.8)	C (17.7)	C (16.9)	C (20.3)
5. Maple Avenue and Pleasant Street	NB	**F (132.2)**	**F (94.8)**	**F (509)**	**F (194.3)**
	SB	D (31.5)	**E (36.8)**	**F (83.6)**	**F (52.6)**
9. Maple Avenue and Mill Street	SB	B (12.1)	B (14.2)	B (13.7)	B (13.2)
14. Maple Avenue and Berry Street	NB	C (23)	B (13)	D (29.2)	B (12.4)
	SB	A (0)	B (10.7)	A (0)	B (11.1)
18. Church Street and Lawyers Road	EB	**E (47.5)**	D (28.8)	**F (59.9)**	D (30.3)
	WB	D (25.1)	**F (55.2)**	D (28.6)	**F (56.8)**
19. Church Street and Center Street	Overall	C (17.1)	D (26.6)	C (17.9)	C (24.8)
20. Church Street and Dominion Road/W&OD Trail Crossing	N/A	B (12.9)	C (16.7)	B (14.1)	C (17.7)
21. Church Street and Mill Street	Overall	D (27.4)	**F (112.1)**	D (28.2)	**F (115.4)**
22. Church Street and Park Street	Overall	**F (54.9)**	**F (57.8)**	**F (57.9)**	**F (59.2)**
23. Church Street and Glyndon Street	Overall	B (13.2)	C (15.3)	B (13.4)	B (10.6)
25. Church Street and E Street	EB	C (15.3)	C (18.4)	C (15.5)	C (18.2)
26. Locust Street and Courthouse Road	Overall	B (12.8)	C (15.3)	B (13.3)	C (15.5)
27. Locust Street and Center Street	EB	B (13.8)	D (26.3)	C (20.6)	D (30.3)
	WB	A (0)	A (0)	B (13.3)	C (15.4)
28. Locust Street and Park Street	Overall	A (6.4)	B (12.3)	A (6.5)	B (12.1)
29. Locust Street and Glyndon Street	Overall	B (10.4)	C (22)	B (10.4)	C (21.7)
30. Locust Street and Branch Road	Overall	A (9.5)	B (14.7)	A (9.5)	B (14.7)

Table 6-3: AM and PM Peak Hour Future Scenario o95th Percentile Queue Lengths that Exceed Storage Length

Intersection	Lane	Storage Length	Existing Queues		Future Queues	
			AM	PM	AM	PM
2. Maple Avenue and Nutley Street	EBL	40	26	33	**45**	**55**
	WBL	200	**#239**	184	**#405**	**252**
	NBL	200	**246**	**#407**	**#295**	**#436**
6. Maple Avenue Courthouse Road/Lawyers Road	EBL	100	67	**#137**	85	**#192**
	WBL	120	72	m25	91	m18
	NBL	190	#122	#166	#135	**#190**
	SBL	125	**#329**	**#307**	**#344**	**#299**
7. Maple Avenue and Center Street	NBL	70	**73**	**75**	**76**	**79**
	SBL	90	**167**	**106**	**168**	**103**
10. Maple Avenue and Park Street	NBL	160	**170**	**#222**	**174**	**216**
	SBL	115	**120**	114	**121**	106
11. Maple Avenue and Glyndon	NBL	115	59	**#238**	59	**#250**
13. Maple Avenue and Beulah Road	EBL	105	m8	**#220**	m7	**#274**
	SBL	250	**#294**	179	**#296**	184
15. Maple Avenue and E Street	SBL	170	**#586**	150	**#586**	150
16. Maple Avenue and Follin Lane	WBL	160	**#326**	35	**#326**	35
17. Courthouse Road and Nutley Street	EBR	190	**#343**	39	**#421**	39
	NBL	110	77	**196**	71	**196**

-95th percentile volume exceeds capacity; queue may be longer. Queue shown is the maximum after two cycles

m - Volume for 95th percentile queue is metered by upstream signal

Table 6-4: AM and PM Peak Hour Future Scenario 95th Percentile Queue Lengths that Block Turn Lane and/or Exceed Block Length

Intersection	Lane	Block Length	Existing Queues		Future Queues	
			AM	PM	AM	PM
2. Maple Avenue and Nutley Street	EBT	560	**#675**	366	**#751**	433
	WBT	700	211	463	374	**809**
	NBT	550	251	#409	278	#436
	SBT	420	**#483**	#407	**#450**	**#429**
6. Maple Avenue Courthouse Road/Lawyers Road	EBT	690	456	286	532	385
	WBT	730	313	237	388	189
	NBT	800	#475	#488	#489	#503
	SBT	190	**294**	**#528**	**313**	**#576**
7. Maple Avenue and Center Street	EBT	890	m573	266	m655	m247
	WBT	600	106	218	160	221
	NBT	670	167	#366	170	#363
	SBT	350	266	**#392**	268	**#399**
10. Maple Avenue and Park Street	EBT	930	741	395	#859	462
	WBT	720	316	**779**	379	421
	NBT	560	144	379	147	376
	SBT	450	168	#372	170	#375
11. Maple Avenue and Glyndon	EBT	720	**777**	240	**855**	180
	WBT	1170	42	374	56	353
	NBT	660	60	182	60	183
	SBT	460	58	223	58	224
12. Maple Avenue and Branch Road	EBT	810	62	386	106	325
	WBT	360	215	355	214	319
13. Maple Avenue and Beulah Road	EBT	360	45	182	47	68
	WBT	940	133	313	174	343
15. Maple Avenue and E Street	EBT	450	**#903**	78	**#1011**	78
	WBT	940	203	m530	226	m551
	NBT	440	54	158	54	158
16. Maple Avenue and Follin Lane	EBT	460	**m#460**	247	**m#571**	275
	WBT	430	68	286	75	317
17. Courthouse Road and Nutley Street	EBT	360	309	220	327	220
	WBT	670	93	338	93	338
	NBT	720	511	537	530	585
	SBT	550	m162	383	m162	m473
31. Echols Street and Follin Lane	WBT	240	89	**#542**	89	**#530**
	NBT	230	47	**322**	48	**319**

As shown in Table 6-1, while the development scenario will result in increased delays at nearly every signalized study area intersection, most signalized intersections will operate with the same level of service in comparison with existing conditions. The exception to this is the intersections of Maple Avenue and Park Street during the PM peak hour and Maple Avenue and Follin Lane during the AM peak hour. Both of these intersections will still operate at LOS D or better.

Table 6-2 presents the delays and level of service for stop-controlled minor street approaches to Maple Avenue. Maple Avenue is the major street and does not have to stop (or yield) at these intersections; as such the side street movements have low priority and must wait for an opportunity to turn right, turn left, or to cross Maple Avenue.

This "opportunity" can be described as a concept known as the "critical gap" which is the minimum time needed for a driver to make their maneuver from a side street. The critical gap to make a right turn is different than the critical gap to make a left turn due to the number of lanes crossed and the number of conflicting vehicles.

In laymen's terms, a driver must decide how much time and distance exists between their position and the position of oncoming vehicles along Maple Avenue and whether that time and distance gap is sufficient to make a turn safely and completely (or partially if there is a median wait area).

In the analysis, during the peak hour, Maple Avenue is congested. The analysis, assuming typical driver behavior, does not find enough available gaps along Maple Avenue for vehicles to make their maneuvers from the side streets. This is why there is high side street delay in the existing conditions and higher delay in the future conditions.

As shown in Table 6-2, the development scenario will result in some significant increased delays at unsignalized intersection approaches to Maple Avenue, a few of which will operate with worse level of service in comparison with existing conditions. It is noted that under congestion, Synchro delay calculation results at unsignalized intersections are impractically high. Based on the lack of appropriate critical gaps, each added minor street vehicle experiences large delays. As such, even a small increase in traffic volumes results in these seemingly large average delay values for the minor street approach. The "spike" in delays is essentially the existing delay compounded onto additional vehicles.

As stated before, however, the analysis does not account for real world behavior of a yielding and letting someone into the traffic stream (or being a more ambitious motorist and forcing entry into the traffic stream). As such, while the magnitude of delays is overstated, the levels of service are not. Under the development scenario, with the additional traffic along the Maple Avenue corridor, it may be more difficult to make movements into and out of unsignalized intersections and driveways.

As shown in Table 6-3, the development scenario will result in additional queueing for turn lanes along Maple Avenue. This is the result of additional turns near developments and additional cross traffic.

As shown in Table 6-4, the development scenario will result in additional queueing in the through lanes but will generally not lead to any additional impacts to upstream intersections not already experienced in existing conditions.

Table 6-5 shows the anticipated AM and PM peak hour arterial LOS and travel times.

Table 6-5: AM and PM Peak Future Scenario Arterial LOS

Arterial		Existing				Future			
		AM LOS AM Travel Time (sec)		**PM LOS PM Travel Time (sec)**		**AM LOS AM Travel Time (sec)**		**PM LOS PM Travel Time (sec)**	
Church Street	EB	D	74.4	D	59.9	D	74.6	D	60.3
	WB	C	44.5	D	55.7	C	44.6	D	56
Maple Avenue	EB	D	498.1	D	492.2	D	527.8	D	503.4
	WB	C	452.1	C	492.2	C	457.8	D	509.3

Arterial LOS signifies how well the corridor is operating based on the expected travel time given the posted speed limit/free flow speed, the arterial classification, and the travel distance. This is in comparison to delays experienced due to signalized intersection control. It is important to note that Table 6-5 is not to be taken as the absolute travel time of Maple Avenue. This analysis does not consider the impact and influence of downstream queues and congestion, i.e. bottlenecks stemming from Tysons or southern Fairfax. Instead it is to be looked at in a relativistic manner, to compare how future traffic (i.e., with the addition of development scenario traffic volumes) will affect control delays at individual intersections and how the total delay changes across the corridor will affect travel time.

In laymen's terms, considering the travel time along Maple Avenue to be a factor of both the delay caused by intersections and the delay caused by downstream congestion. Table 6-5 only references that portion of travel time affected by delay caused by intersections.

As shown in Table 6-5, Maple Avenue as an arterial is largely expected to function with much of the same intersection-based delays and, as such, there is forecast to be less than a five percent increase in peak direction intersection-dependent travel time with the future development scenario (i.e. less than an additional 30 seconds from one end of the corridor to the other end). Table 6-5 also confirms that future traffic volumes will have little additional impacts on Church Street.

It is recognized that the absolute future travel times (i.e. caused by intersection and caused by incremental congestion effects) along Maple Avenue would also be a useful metric, however that level of future forecast requires a detailed microsimulation analysis that is beyond the scope of this study. The purpose of Table 6-5, then, is to suggest that proportional impacts to travel time of the development scenario will be far outweighed by the existing congestion challenges, most of which stem from out of network bottlenecks and through traffic.

Based on these factors, addressing the current challenges of the vehicle network in the corridor will directly respond to the needs of today's road users and be a good launching point to proactively address the changing transportation future.

Future Conditions Engagement

Town Council Briefing #2

The study team provided a briefing of future conditions findings to Town Council on June 10, 2019. Information presented included the future development scenario, future vehicle conditions based on the future land use scenario, and assessments of future pedestrian, bicycle, and transit conditions.

Public Workshop #2

On June 12, 2019, the study team presented future conditions findings to the community at the second public workshop. This workshop began with the same overview presentation as the second Town Council briefing and included the following boards and exhibits:

- **Corridor Map**
- **Trips Generated per Mixed-Use Scenario Development**

This board listed the projected vehicle trips generated for each development site included in the future development scenario.

- **Potential Public Space and Sidewalk Improvements**
  This board listed the length of street frontage and driveways for each development site included in the future development scenario that may be subject to improvements in the future.
- **Programmed Mobility Improvements**
  This board mapped future transportation infrastructure and mobility improvements that have been programmed into the Town's Capital Improvements Plan (CIP).

Following the presentation, workshop attendees were invited to participate in various activities, including a transportation priority survey and a mock investment scenario. These activities allowed members of the community to convey priorities for transportation in the corridor, as well as demonstrate how they would allocate a finite amount of transportation funds to individual project. Online versions of these activities were made available on the Town's webpage to engage community members who were unable to attend the in-person workshop.

Public Workshop #3 priorities activity

7. Multimodal Improvements

7.1 Improvements

Following the review of existing and future conditions, a variety of improvement concepts were considered to improve multimodal transportation in Vienna. These concepts were oriented to address existing challenges, described in Chapter 3 and Chapter 4, and future impacts and changes, described in Chapter 5 and 6. Concepts were categorized and are summarized below. Where applicable, concepts were modelled in Synchro10 to compare against future conditions and to demonstrate high level benefits. It is noted that most of these comparisons will be vehicle based and not speak to the benefits anticipated to be realized by the other travel modes.

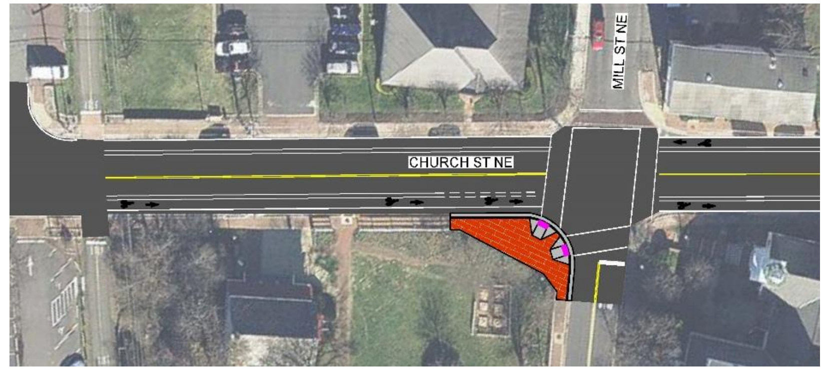
Low Investment, High Impact

The following improvements require relatively low investments on the part of the Town and have a positive impact on existing conditions, improving driver and pedestrian safety as well as multimodal accessibility.

Concept A. Church Street and Mill Street: Slip Lane Removal and Intersection Redesign

This improvement proposes a redesign of the intersection at Church Street and Mill Street to remove the existing slip lane at the southwest corner of the intersection, as shown in **Figure 7-1**. The potential redesign normalizes intersection geometry, realigns crosswalks for shorter and more direct pedestrian crossings, and expands public space at the northeast corner of the Town Green.

Figure 7-1: Church Street and Mill Street Concept



The slip lane removal will also create conditions that encourage safer and slower turning movements for vehicles, therefore greatly elevating pedestrian access and safety.

Potential challenges with this improvement may include the curb work required, the potential need for utility relocation, and compatibility with the Town Green and historic considerations. Based on the Synchro analysis for this concept, overall delays at the intersection are shown to improve (shown in **Table 7-1**). While the removal of the slip lane slightly increases delays for the eastbound right-turning movement, the westbound left movement is able to clear the intersection more quickly and enables the intersection to operate with less delay overall.

Table 7-1: Church Street and Mill Street Concept Traffic Impacts

Approach	Future		Future with Concept	
	AM LOS	PM LOS	AM LOS	PM LOS
Overall	D (28.2)	**F (115.4)**	D (25.6)	**F (107.4)**

Concept B. W&OD Trail Crossing Redesign

This concept proposes a redesign of the three crossings of the W&OD Trail at Maple Avenue, Church Street, and Park Street to reflect design guidance shown in **Figure 7-2**. The trail crossing redesigns would provide the following enhancements:

- Raised trail crossings (at Church Street and Park Street)
- High-visibility markings
- Consistent signage
- Relocated signal push buttons (at Maple Avenue)
- Lighting improvements

The trail crossing improvements would increase the visual prominence of the trail crossings, clearly indicating pedestrian and cyclist priority.

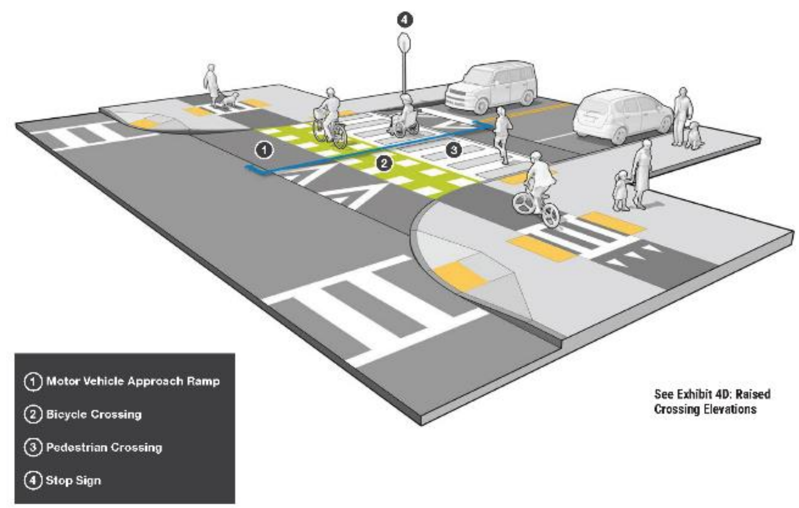
Raised crossings – also known as raised intersections or speed tables – are an effective strategy for reducing conflicts between motorists, pedestrians, and bicyclists because they work to slow travel and turning speeds of motor vehicles, increase the visibility of people crossing on foot and bike, and increase compliance of motorists when they are required to yield to pedestrian right-of-way. Raised crossings are only proposed for the unsignalized Church Street and Park Street trail crossings, due to the trail crossing at Maple Avenue being signal-controlled with a dedicated crossing signal phase for trail users.

This concept may be challenged by right-of-way constraints and utility conflicts, as well as affect emergency vehicle response times due to the speed-lowering effects of the raised crossing. Conceptual redesigns for two of the identified intersections are shown in **Figure 7-3**.

Other potentially needed improvements at the Maple Avenue crossing would be to identify/designate/create a space for bicyclist and other trail users to safely wait to cross the street and not impede the pedestrian sidewalk along Maple Avenue.

These improvements are consistent with the Technical Assistance Panel Report by the Urban Land Institute (ULI) that was sponsored by the Town of Vienna and the Metropolitan Washington Council of Governments (MWCOG) and published in 2017.

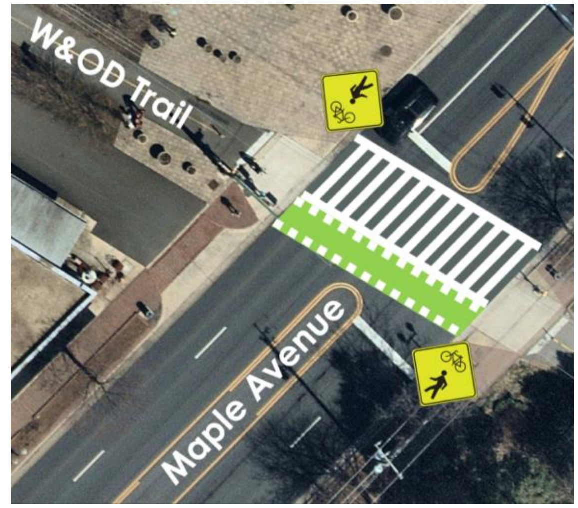
Figure 7-2: Trail Crossing Redesign Concept



Source: MassDOT Separated Bike Lane Planning & Design Guide *https://www.mass.gov/files/documents/2017/10/26/SeparatedBikeLaneChapter4_Intersections.pdf*

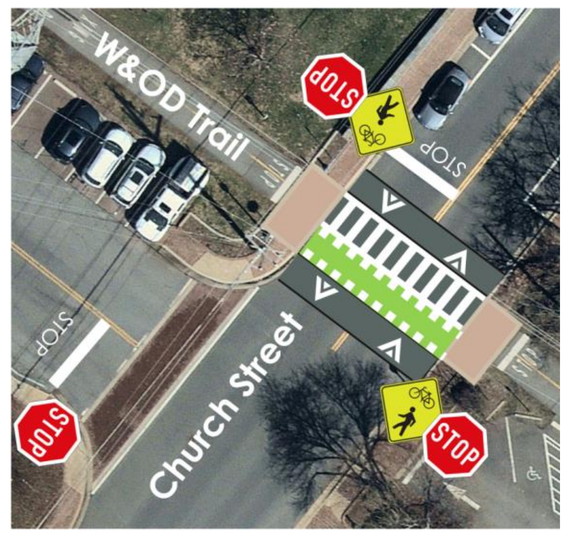
Figure 7-3: W&OD Trail Crossing Concept at Maple Avenue and Church Street

Existing Crossing



High-Visibility Crosswalk Concept

Existing Crossing



Raised Crosswalk Concept

Additional W&OD Trail crossing improvements would provide uniformity throughout the town to address the existing variety of trail, crossing identification (as shown in **Figure 7-4**). Improvements could consist of one or more of the following:

- **<u>Signage</u>**: Adopt a consistent trail crossing sign style to use Town-wide.
- **<u>Markings</u>**: Install high-visibility markings at Church Street
- Push buttons: Relocate pedestrian signal buttons back from the street to increase safety
- **<u>Lighting</u>**: Enhance or add pedestrian scale lighting at trail crossings

Figure 7-4: W&OD Trail Crossing Existing Conditions

Maple Avenue Crossing

Church Street Crossing

Park Street Crossing

Concept C. Leading Pedestrian Intervals

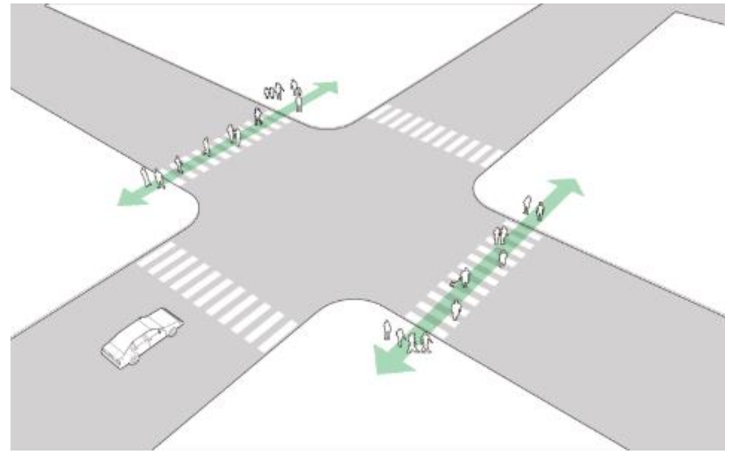
This concept introduces leading pedestrian intervals (LPIs) to signal timing settings at intersections that see significant pedestrian activity. LPIs typically give pedestrians a three- to seven-second head start when entering an intersection with a corresponding green signal in the same direction of travel for motorists, as depicted in **Figure 7-5.**

The provision of a head-start for pedestrians will provide enhanced pedestrian visibility, reinforced pedestrian right-of-way, and a reduction of pedestrian-vehicle collisions, as much as 60 percent (according to the National Association of City Transportation Officials (NACTO)).

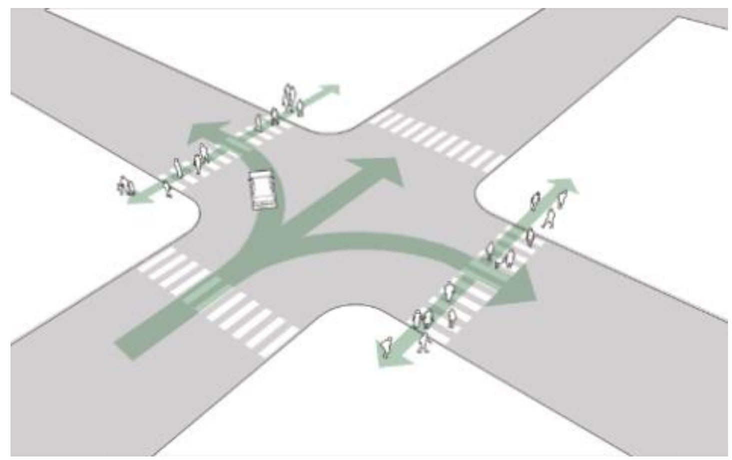
However, LPIs create potential conflicts with leading left-turn signals and right-on-red regulations, in addition to impacting overall signal timing settings.

Six key pedestrian crossing locations were identified within the study area and were targeted as potential LPI locations as shown in **Figure 7-6**.

Figure 7-5: Leading Pedestrian Interval Concept

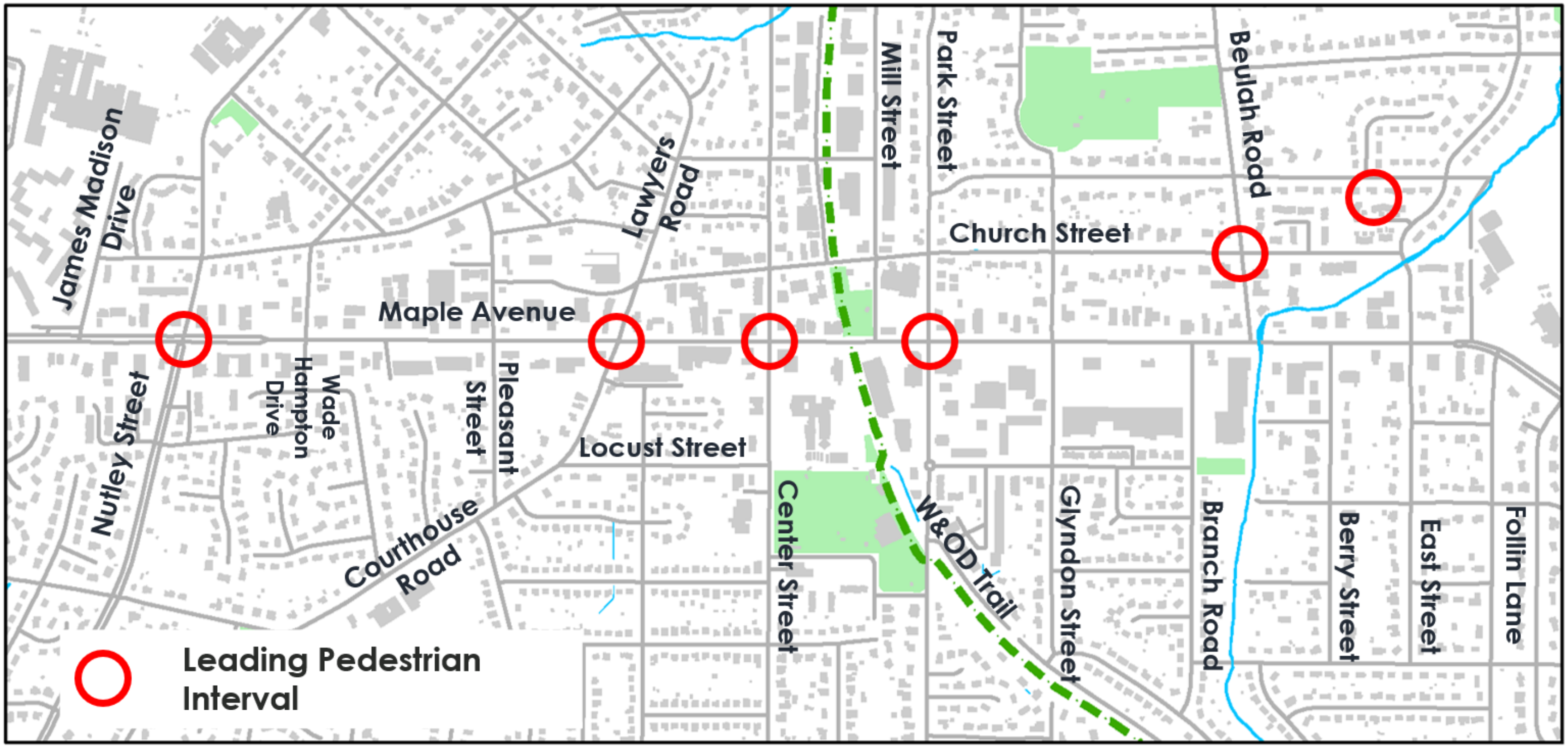


Phase 1: "Walk" signal for pedestrians



Phase 2: Delayed green light for vehicles

Figure 7-6: Potential LPI Locations



Concept D. All Way Stops

To enhance pedestrian and bicycle crossings and provide traffic calming at some two-way stop control intersections, the modification to all-way stops is suggested. The installation of stop signs and marking of stop bars at all intersection approaches is proposed at the following key intersection:

- **Church Street and Dominion Road**. This intersection coincides with a crossing of the W&OD Trail and currently only features "yield" signage.
- **Center Street and Locust Street**. This intersection is located in the vicinity of several residential blocks and key community facilities such as Vienna Elementary School, Town Hall, and Water and Caffi Fields.

Notifications to build awareness and education of the change would need to be provided. The intersections would also need to be evaluated to determine if the all way stop was compatible with the amount of traffic. Existing conditions at these intersections are shown in **Figure 7-7**. Operationally, according to the analysis, the implementation of all way stops will improve delays at the side streets as shown in **Table 7-2**. Minor street approaches improve a LOS letter designation in the AM peak hour and two LOS letters in the PM peak hour. There are minimal traffic impacts to the major road movements.

Table 7-2: All Way Stop Concept Traffic Impacts

Intersection	Approach	Future		Future with Concept	
		AM LOS	PM LOS	AM LOS	PM LOS
Center and Locust	Eastbound	C (20.6)	D (30.3)	B (12.2)	B (11)
	Westbound	B (13.3)	C (15.4)	A (9.5)	A (9.2)
Church and Dominion	Overall	B (14.1)	C (17.7)	B (10.8)	B (13)

Figure 7-7: Existing Pedestrian Crossings

Church Street and Dominion Road

Center Street and Locust Street

Provide More Travel Options

This collection of concepts highlights multimodal travel and mobility alternatives that could be implemented throughout the town to provide more travel options for Vienna residents.

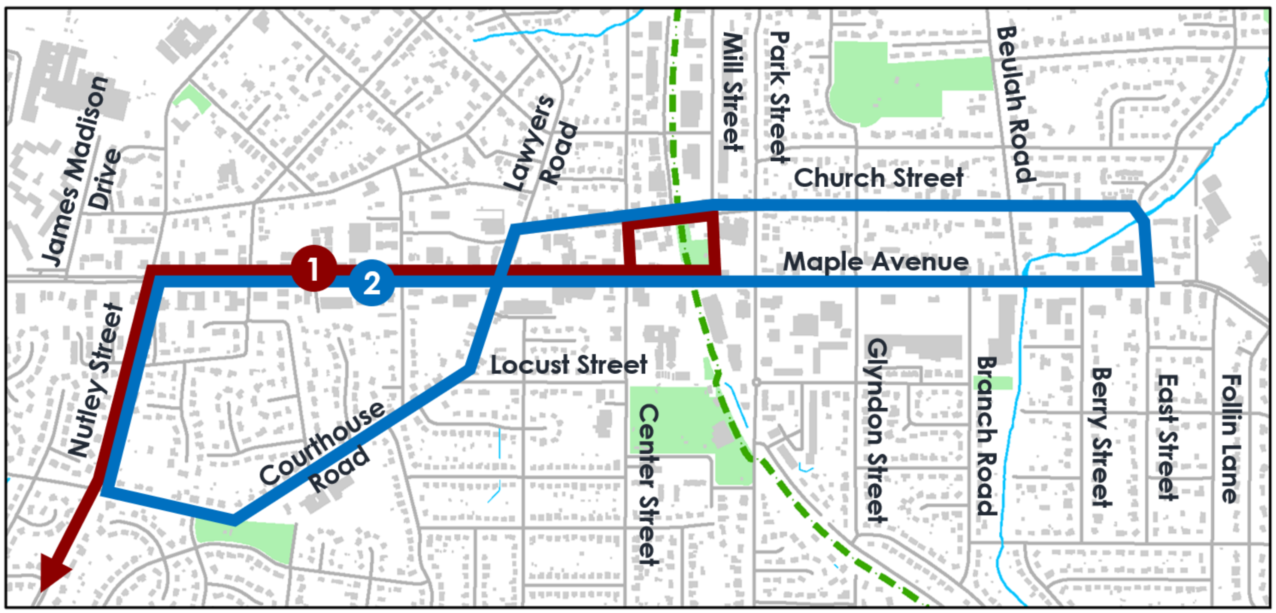
Concept E. Local Circulator

A potential local circulator route or routes could provide frequent, all day bus service to and between Maple Avenue and Church Street. This would fill a critical existing deficiency in locally-oriented bus service. Potential Route Options, shown in **Figure 7-8,** include:

1. **Maple Avenue to Metro Express**
2. **Maple Avenue – Church Street Loop**

The circulator concept could fill the existing local-destination transit gap and serve local trips for existing and future residents. Similarly, routes could be identified that bring residents from neighborhoods to the commercial corridor. The relative cost, attraction and consistency of ridership, integration with Fairfax Connector service, desired headways, and geometric constraints are recognized challenges.

Figure 7-8: Local Circulator Potential Route Options



Microtransit Alternative

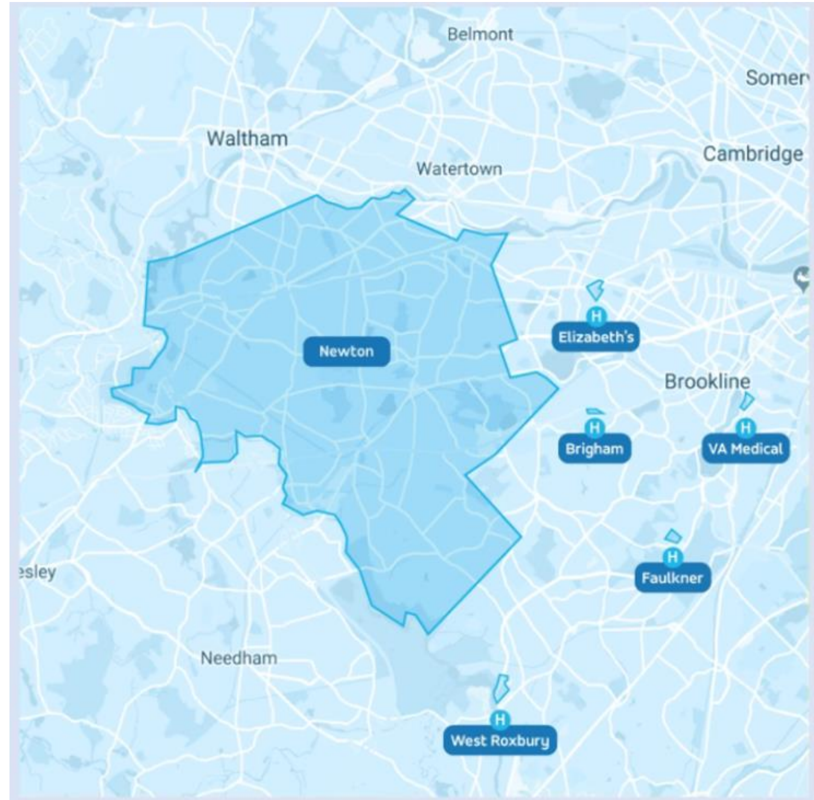
Another option similar to a circulator bus, but more flexible, would be to explore the provision of microtransit service. Microtransit is a type of privately or publicly operated (or subsidized), technology-enabled transit service that typically uses multi-passenger or pooled shuttles or vans to provide on-demand services with flexible routing. Under this concept, the town could define a geographic service area within which a passenger could request a trip via a mobile application (or telephone call) and be picked up and dropped off within a short distance of their desired locations within the zone. Depending on the level of investment (i.e., number of vehicles), demand for the service, and congestion, the wait time for trips and the extent to which rides are shared will vary.

The most likely scenario of microtransit operation in Vienna is to define the town boundary as the main service area zone and establish one or more other nodes at high-activity locations nearby to the town such as Metrorail stations at Vienna, Dunn Loring, or Tysons Corner. **Figure 7-9** shows an example of a service area in Newton, Massachusetts with a similar structure. Similar microtransit programs are being piloted regionally in northeast Washington DC and Montgomery County, Maryland.

Further study and consideration should be given to:

- Researching potential operators
- Defining the service area and span (when service operates)
- Pick-up and drop-off locations and policies
- Estimating potential ridership and anticipated costs
- Accessibility for persons with disabilities
- Payment methods and pricing
- Marketing and communication of the new program

Figure 7-9: Microtransit Service Area in Newton, Massachusetts



Source: Via

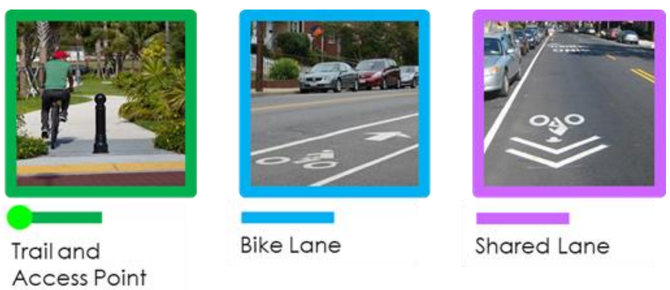
Concept F. Bicycle Network

As discussed in the existing conditions section of this report, there are significant gaps in the bicycle network in the immediate area surrounding Maple Avenue. Due to high traffic volumes and activity, there are restraints that make bike lanes along Maple Avenue not feasible. Instead, the conceptual network was created to provide access to local business and recreation facilities from both the north and the south via Church Street and Locust Street, respectively, as well as create connections to the W&OD Trail.

Figure 7-12 shows a proposed bike network concept that would enhance bike-ability throughout the Town of Vienna. The proposed conceptual network provides access to the central business district of Vienna along Maple Avenue, without adding bike lanes to Maple Avenue itself.

Specific facilities within the conceptual bike network are described in the following section and shown in **Figure 7-10**.

Figure 7-10: Bicycle Facility Types



F1. Church Street – Shared Lanes

Installing shared lane markings along Church Street between Pleasant Street and Park Street as shown in **Figure 7-11**. This concept preserves existing on-street curbside parking that currently serves the uses along Church Street. The shared lanes would be complimented by "Bicycles May Use Full Lane" signage and would provide a new bike facility parallel to Maple Avenue.

Shared lanes may be unfamiliar to both cyclists and drivers and are not ideal for new cyclists or children. They are most appropriate along local streets that have slow vehicle speeds.

Figure 7-11: Shared Lanes on Church Street

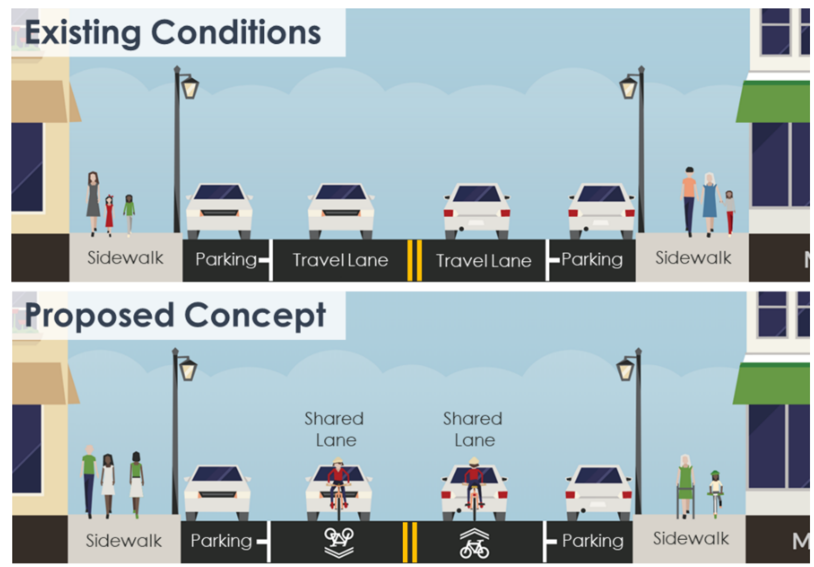
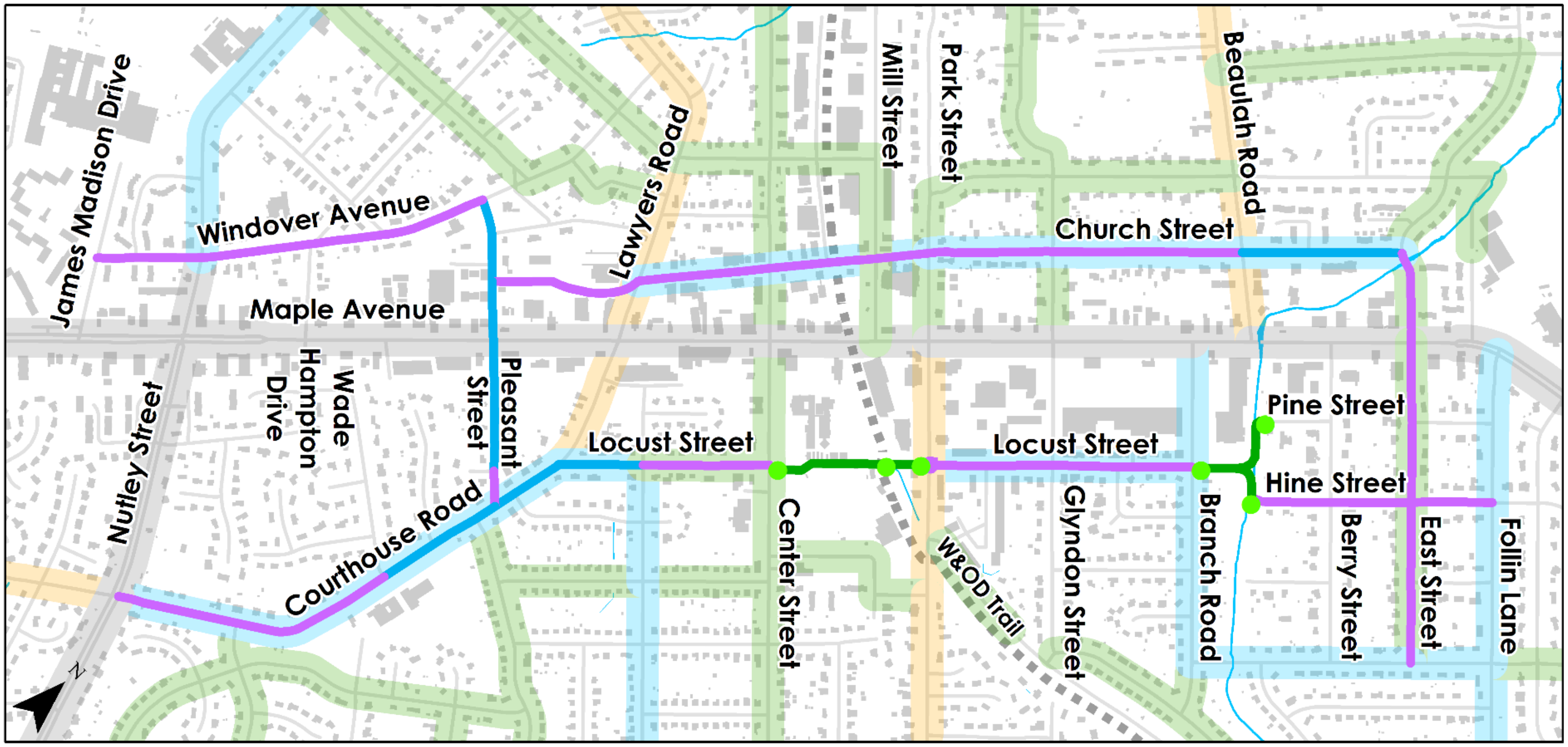


Figure 7-12: Proposed Bicycle Network



Legend

Recommended Bicycle Facilities	**Fairfax County Bike Map Comfort Rating (Existing)**
Trail and Access Point	Most Comfortable
Bike Lane	Somewhat Comfortable
Shared Lane	Less Comfortable
	Use with Caution

0 0.125 0.25 0.5 Miles

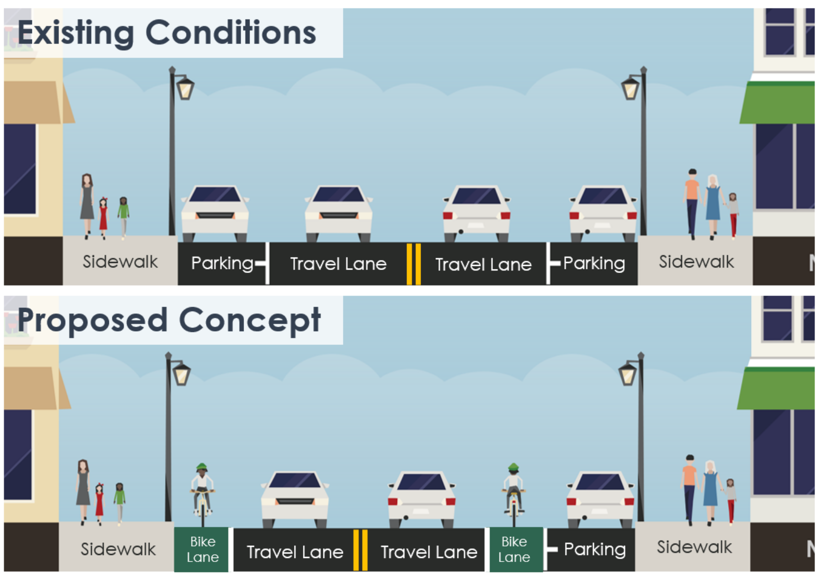
Church Street – ALTERNATIVE CONCEPT

Alternatively, installing dedicated bike lanes along Church Street is a future concept that could be considered by the Town. This concept would remove on-street parking on one side of Church Street to make room for a pair of dedicated bike lanes.

The dedicated bike lanes would provide a new bike facility parallel to Maple Avenue and increased safety for cyclists. The reduction of on-street parking may decrease traffic and the narrower traffic lanes may decrease speeds. **Figure 7-13** shows the removal of one parking lane to provide a bike lane on each side of the street.

NOTE: This concept should only be considered if the Town constructs a new parking structure in the vicinity to meet the parking needs of Church Street and its businesses.

Figure 7-13: Buffered Bike Lanes on Church Street – Concept 2



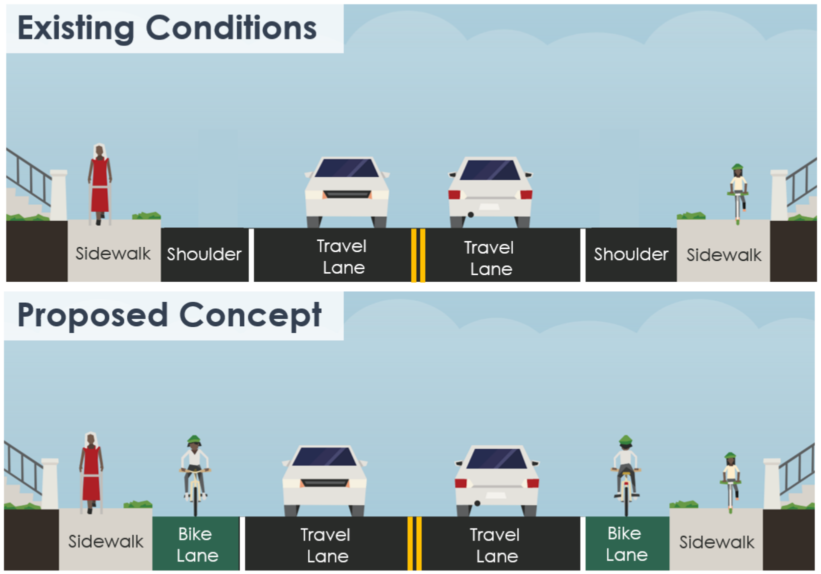
F2. Courthouse Road – Shoulders to Bike Lanes

Converting the existing shoulders along Courthouse Road to bike lanes is an additional concept, as shown in **Figure 7-14**. Existing shoulders between Locust Street and Glen Avenue present ample width for bike lanes. However, the narrower cross section between Glen Avenue and Nutley Street can only accommodate shared lanes.

Figure 7-14: Shoulders to Bike Lanes on Courthouse Road

The bike lanes would provide a new facility parallel to Maple Avenue with increased safety for cyclists. Additionally, the narrower traffic lanes may decrease vehicle speeds. However, there are potential conflicts at adjacent residential driveways. There are also design constraints due to the variable and inconsistent width of existing shoulders. **Figure 7-15** shows a cross section rendering of the concept.

Figure 7-15: Courthouse Road Bike Lanes Concept



F3. Locust Street and Hine Street – Shared Lanes

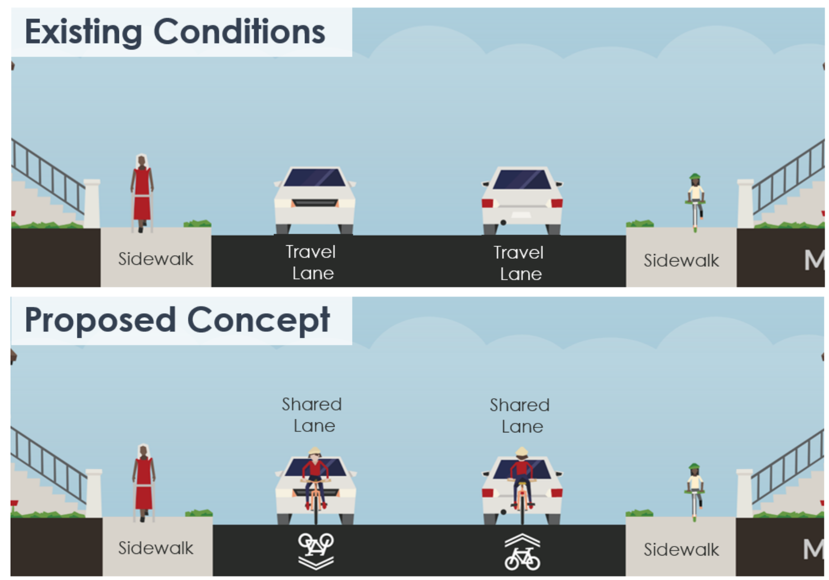
Another concept for the bicycle network consists of installing shared lanes on Locust Street and Hine Street. This concept would provide improved bike routes parallel to Maple Avenue and more direct connections to the W&OD Trail.

Shared lanes may be unfamiliar to both cyclists and drivers and are not ideal for new cyclists or children. They are most appropriate along local streets that have slow vehicle speeds, making Locust Street and Hine Street viable candidates.

Figure 7-16 shows the concept in the context of the existing neighborhood and **Figure 7-17** is a cross section rendering of the concept.

Figure 7-16: Locust Street and Hine Street Draft Concept

Figure 7-17: Locust Street and Hine Street Shared Lanes Concept



F4. Pleasant Street – Bike Lanes and Shared Lanes

To further complete the network, a concept to install bike lanes and shared lanes along Pleasant Street is proposed. Dedicated bike lanes in both directions are proposed where street width allows, while a bike lane in one direction and a shared lane in the other are proposed on narrower segments as shown in **Figure 7-18** and **Figure 7-19**.

This concept provides a new bike facility across Maple Avenue and increases visibility for cyclists. The narrower traffic lanes may decrease vehicle speeds and there are opportunities for coordination with private redevelopment efforts. Variable curb widths present design challenges. Along with the improvement, there would come an increased need for enforcement. Similarly, there is no easy way for bicyclists (at present) to cross Maple Avenue at Pleasant Street.

Figure 7-18: Pleasant Street Bike Lanes and Shared Lanes

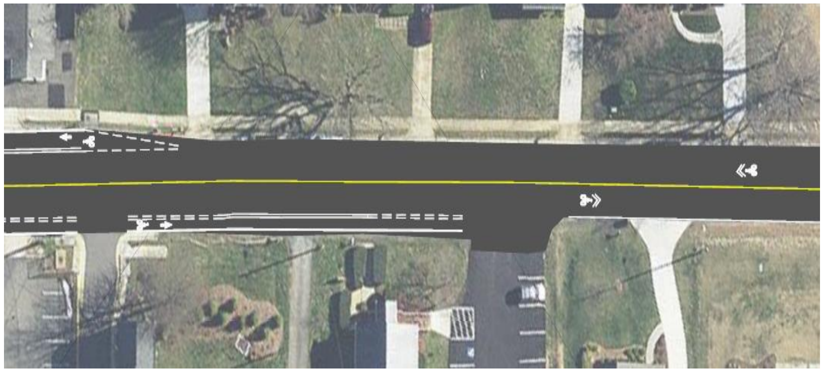
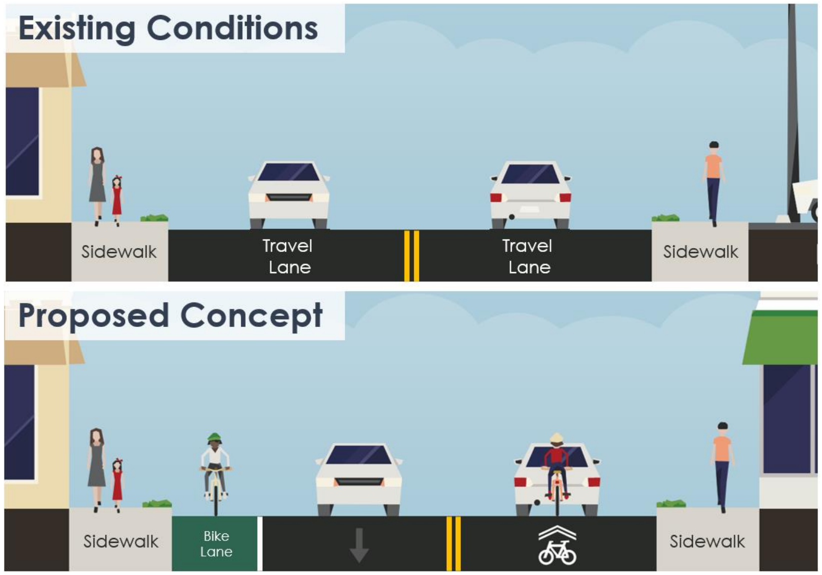


Figure 7-19: Pleasant Street Bike Lanes and Shared Lanes



Concept G. Locust Street: Trail Improvement / Extension

Improvements to the existing path between the existing eastern and western segments of Locust would enable bicyclists pedestrians to continuously travel along Locust Street as a viable parallel alternative to Maple Avenue and would also enhance access the W&OD Trail. **Figure 7-20** shows the extents of the concept that follows the existing path from Center Street to the W&OD Trail.

The right-of-way of the existing path is owned by the Town of Vienna, which removes the need for property acquisition for the segment between Center Street and the W&OD Trail. However, the segment east of the W&OD Trail to the Park Street roundabout is privately-owned land, which would require a property acquisition or easement process. This improvement would also likely require the collaboration and coordination with Fairfax County Public Schools.

Figure 7-20: Locust Street Trail Improvement/Extension+

Concept H. Pleasant Street and Courthouse Road: Operational Improvements

This concept would improve operations at Pleasant Street and Courthouse Road through the following:

1. Relocation of the existing HAWK signal approximately 400 feet to the west, to be situated at the middle of the block and serve potential future public parking
2. Installation of a new traffic signal at the intersection of Maple Avenue and Pleasant Street to absorb additional left turns, relieving the demand for turns at Courthouse Road

This concept creates a signalized crossing at the intersection of Maple Avenue and Pleasant Street, proving a new opportunity for marked pedestrian and bicycle crossings between the north and the south. **Figure 7-21** shows the components of this concept.

According to the results from the Synchro analysis that was done to model this concept, there would be improved delays for vehicles travelling on Pleasant Street. Relocating a portion of left turns from Courthouse Road does not yield improved LOS at the intersection and there are not reported benefits to the overall, Maple Avenue arterial LOS, as shown in **Table 7-3**.

Table 7-3: Pleasant Street and Courthouse Road Concept Traffic Impacts

Intersection	Approach	Future		Future with Concept	
		AM LOS	PM LOS	AM LOS	PM LOS
Pleasant Street and Maple Avenue	Northbound	**F (509)**	**F (194.3)**	**E (69.0)**	**E (79.8)**
	Southbound	**F (83.6)**	**F (52.6)**	**E (66.4)**	**E (76.0)**
Courthouse /Lawyers and Maple Avenue	Overall	45.4 (D)	40.3 (D)	D (36.1)	D (54.4)
Maple Avenue Arterial LOS	Eastbound	D (527.8)	C (503.4)	D (566.6)	D (517.8)
	Westbound	C (457.8)	D (509.3)	C (476.3)	D (519.1)

Figure 7-21: Pleasant St and Courthouse Rd Operational Improvements

Concept I. Capital Bikeshare: Explore Feasibility/Deployment

Another multimodal improvement is to explore the feasibility and deployment of Capital Bikeshare docking stations in Vienna. This improvement will fill gaps of the regional bikeshare network, leverage W&OD Trail access, and provide new cycling options for Vienna residents and visitors. The siting of bikeshare stations may present a challenge and will require further evaluation and coordination with regional efforts. Co-locating near existing bus stops, metrorail stations, and popular destinations may serve to create multimodal hubs in Vienna, furthering travel options.

Complete the Network

The next set of improvements are projects related to completing existing street and sidewalk networks in the town of Vienna.

Concept J. Curb Reconstruction

One improvement regarding curb reconstruction is to install perpendicular curb ramps to replace existing diagonal curb ramps at study area intersections as feasible. Perpendicular curb ramps provide are better aligned with marked crosswalks and provide better directional cues for blind or visually impaired pedestrians and wheelchair users as shown in **Figure 7-22.**

Some challenges with this improvement are that it can create signal timing and drainage changes as well as longer crossing distances.

Another improvement would be to reduce the curb radii at key intersections to facilitate safer, slower vehicle turning movements at street corners. This reduction allows for more comfortable, shorter pedestrian crossings.

Curb radii reduction requires curb work and can create utility conflicts. Additionally, it can conflict with large truck turning movement.

Figure 7-22: Diagonal vs Perpendicular Curb Ramps

Example of a diagonal curb ramp

Example of perpendicular curb ramps

Concept K. Roadway Operation/Safety Improvements

This improvement addresses bottlenecks and safety at specific intersections through a combination of signal timing, geometry modifications, and phasing changes. It is a relatively quick implementation and low-cost measure, utilizing the existing network more efficiently and prioritizing safety. These improvements are responsive to current, but not future traffic and are limited by right-of-way constraints.

Concept L. Branch Road – Beulah Road: Realignment/Connection

Constructing a new local street is a concept that could improve vehicle traffic between Branch Road and Beulah Road. Through this concept, the two existing, T-intersections at Beulah Road at Maple Avenue and Branch Road at Maple Avenue would be converted into one, four-way intersection. This would simplify movements along Maple Avenue and may present new development or public space opportunities. This concept would create a new street network connection and also enhance pedestrian and bicycle connections.

As shown in **Figure 7-32**, the first alignment option proposes moving the existing Branch Road to connect directly with Beulah Road and loop around the adjacent shopping plaza along Wolftrap Creek and tie into Branch Road at Locust Street SE. It would require significant right-of-way and consideration regarding Wolftrap Creek and environmental impact.

The Synchro analysis of option one is shown in **Table 7-4**. The improvement yields mixed traffic results compared to future conditions.

Figure 7-24, shows the second option, which relocates a segment of Beulah Road around existing infrastructure to tie into Branch Road through a parking lot. It would require significant right-of-way and property impacts.

The synchro analysis of option two is shown **Table 7-5**. The improvement yields mixed traffic results compared to future conditions.

Table 7-4: Beulah-Branch Option 1 Traffic Impacts

Intersection	Approach	Future		Future with Concept	
		AM LOS	PM LOS	AM LOS	PM LOS
Glyndon and Maple Avenue	Overall	A (6.6)	16.6 (B)	A (8.2)	C (31.4)
Beulah and Maple Avenue	Overall	B (17.3)	33.5 (C)	C (24.7)	D (35.3)
Berry and Maple Avenue LOS	Northbound	D (29.2)	B (12.4)	C (23.5)	B (14)
	Southbound	A (0.0)	B (11.1)	A (0.0)	B (11.1)
Maple Avenue Arterial LOS	Eastbound	D (527.8)	C (503.4)	D (576.0)	C (470.6)
	Westbound	C (457.8)	D (509.3)	C (442.6)	D (595.7)

Table 7-5: Beulah-Branch Option 2 Traffic Impacts

Intersection	Approach	Future		Future with Concept	
		AM LOS	PM LOS	AM LOS	PM LOS
Glyndon and Maple Avenue	Overall	A (6.6)	16.6 (B)	A (6.0)	C (31.4)
Beulah and Maple Avenue	Overall	B (17.3)	33.5 (C)	C (20.8)	C (25.3)
Berry and Maple Avenue LOS	Northbound	D (29.2)	B (12.4)	**E (41.3)**	C (17.6)
	Southbound	A (0)	B (11.1)	A (0)	B (11.1)
Maple Avenue Arterial LOS	Eastbound	D (527.8)	C(503.4)	D (560.9)	C (454.8)
	Westbound	C(457.8)	D (509.3)	C(439.7)	D (589.1)

Figure 7-23: Branch Road and Beulah Road Connection (Realignment Option 1)

Figure 7-24: Branch Road and Beulah Road Connection (Realignment Option 2)

Concept M. Raised Medians

Raised medians can provide protective refuge islands for pedestrians and create space for landscaping and gateways, providing a visible, attractive centerpiece that contributes positively to the identity of Maple Avenue and Vienna.

Raised medians can help to prevent crashes caused by crossover traffic, reduce glare and distraction from headlights in oncoming lanes, and separate left-turning traffic from through traffic. While they may require the loss of mid-block turn lanes and two-way left turn lanes, they can maintain turn lanes at intersections and support progression of traffic by diverting left turns to intersections.

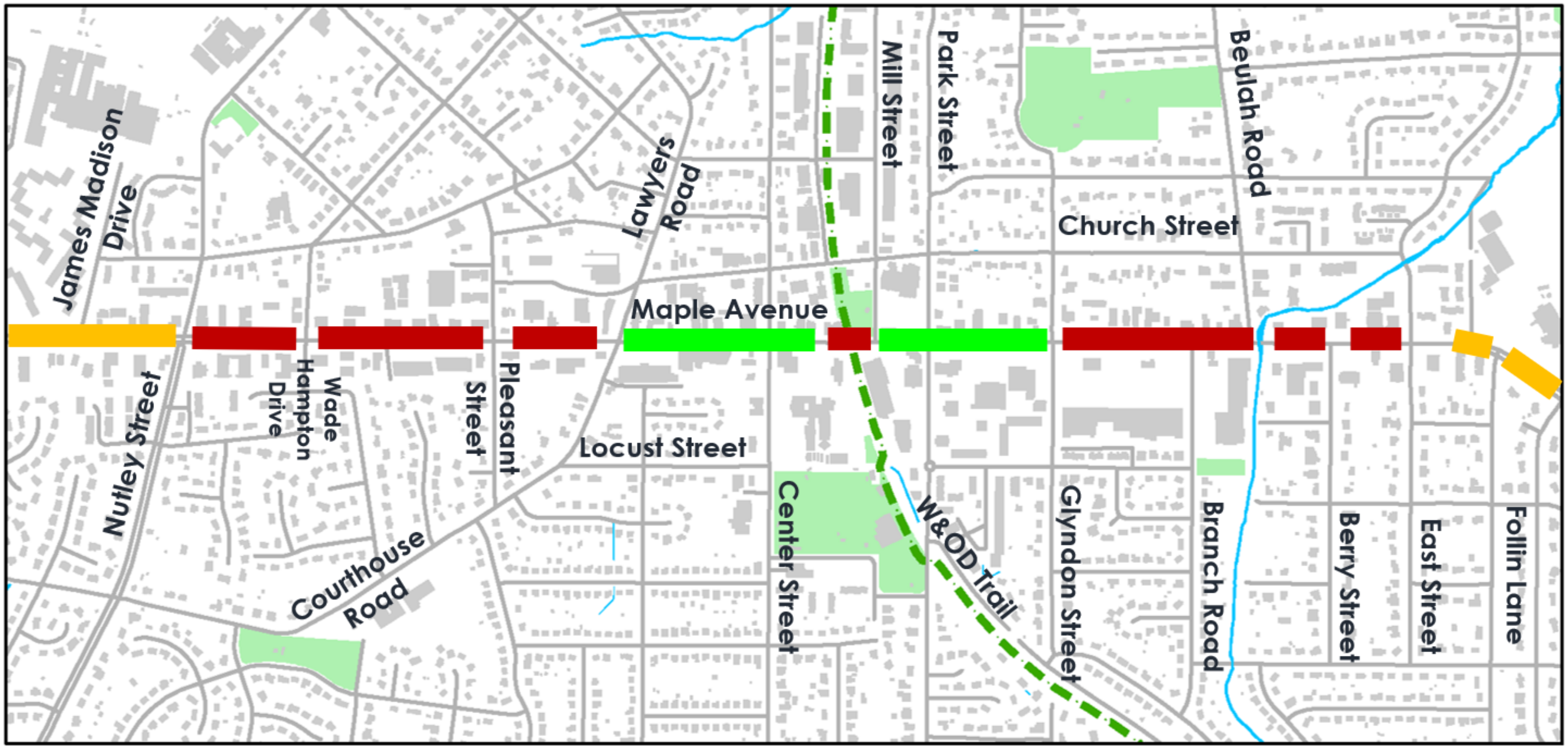
However, raised medians can alter property access on thoroughfares with many driveways, as is the case along Maple Avenue, leading to an increase in the frequency of U-turn movements in order to access certain properties. An example of a raised median is shown in **Figure 7-25.**

This concept proposes the installation of raised medians along Maple Avenue in four key locations as shown in **Figure 7-26:**

1. Glyndon Street to Branch/Beulah Road
2. W&OD Trail Crossing
3. Lewis Street/Wade Hampton Drive to Courthouse Road/Lawyers Road
4. Nutley Street to Lewis Street/Wade Hampton Drive

Figure 7-25: Raised Median Example

Figure 7-26: Existing and Potential New Raised Median Locations



Legend

- Existing
- Potential New
- Existing Two-Way Left Turn Lane (to remain)

Address Existing Challenges

The following concepts proposed improvements that address existing multimodal challenges that Vienna is facing.

Concept N. Fill Sidewalk Gaps

This concept proposes the installation of concrete sidewalks along segments of Church Street, Glyndon Street, and Courthouse Road. This includes areas with no sidewalks as well as areas with existing asphalt paths (as shown in **Figure 7-27**). It creates opportunities for increased pedestrian connectivity, access, and comfort and completes the sidewalk network in the study area. Furthermore, it satisfies Americans with Disabilities Act infrastructure compliance for access for persons with disabilities. Conflicts may arise related to right-of-way constraints and utility conflicts.

Figure 7-27: Existing "Asphalt Path" Sidewalk to be Replaced

Concept O. Maple Avenue: Bus Stop Enhancements

Bus stop enhancements include the installation of shelters, seating, level boarding areas, and real-time arrival information screens at bus stops along corridor as shown in **Figure 7-28**. Enhanced bus stops with these features would provide amenities to enhance passenger access and comfort present opportunities for coordination/cost-sharing with developers. Conflicts may arise related to right-of-way constraints and utility conflicts.

Figure 7-28: Maple Avenue Bus Stop Enhancements

Concept P. Church Street and Lawyers Road: Intersection Redesign

This concept redesigns the intersection of Church Street and Lawyers Road to improve pedestrian access and safety as well as create safer vehicle turning movements. Curb work is required for this improvement and there is potential need for utility relocation and traffic impacts to turn restrictions.

The first option (**Figure 7-29**) tightens curb radii, realigns crosswalks, and provides a pedestrian refuge island. This redesign could be designed to maintain or eliminates the left turn from southbound Lawyers Road to Church Street.

The second option (**Figure 7-30**) provides two offset "T" intersections. This redesign eliminates the existing slip lane at the southwest corner of the intersection, tightens curb radii, and realigns crosswalks for shorter pedestrian crossings. Through movements along Church Street are eliminated.

The Synchro results for the offset "T" concept show significant improvements in delay for the eastbound approach on Church Street during both the AM and PM peak hour (shown **Table 7-6**). Through the concept, left turns onto Lawyers Road have fewer conflicting movements decreasing delay.

Table 7-6: Lawyers Road and Church Street Traffic Impacts

Approach	Future		Future with Concept	
	AM LOS	PM LOS	AM LOS	PM LOS
Eastbound	**F (59.9)**	D (30.3)	C (15.5)	C (16.3)
Westbound	D (28.6)	**F (56.8)**	D (27)	**F (61.4)**

Concept Q. Nutley Street and Courthouse Road: Operational and Geometric Improvement

This concept extends the turn bay on Nutley Street to provide greater capacity for northbound vehicles turning left onto Courthouse Road. Updated phasing to signal and eastbound right turn overlap is required. Curb work is required, and trees would be impacted.

As shown in **Table 7-7**, Synchro reports show an improvement in overall delay at the intersection during the AM peak hour because of the added capacity.

Table 7-7: Nutley and Courthouse Concept Traffic Impact

Approach	Future		Future with Concept	
	AM LOS	PM LOS	AM LOS	PM LOS
Overall	**E (71.3)**	C (32.6)	**E (56.3)**	C (31.1)

Figure 7-29: Church St and Lawyers Rd Intersection Redesign (Option 1)

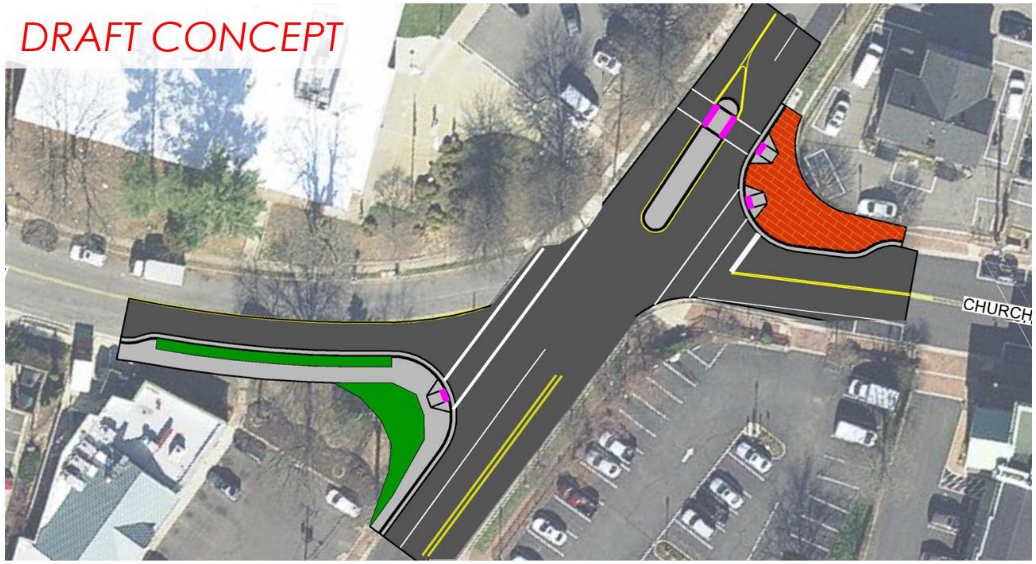
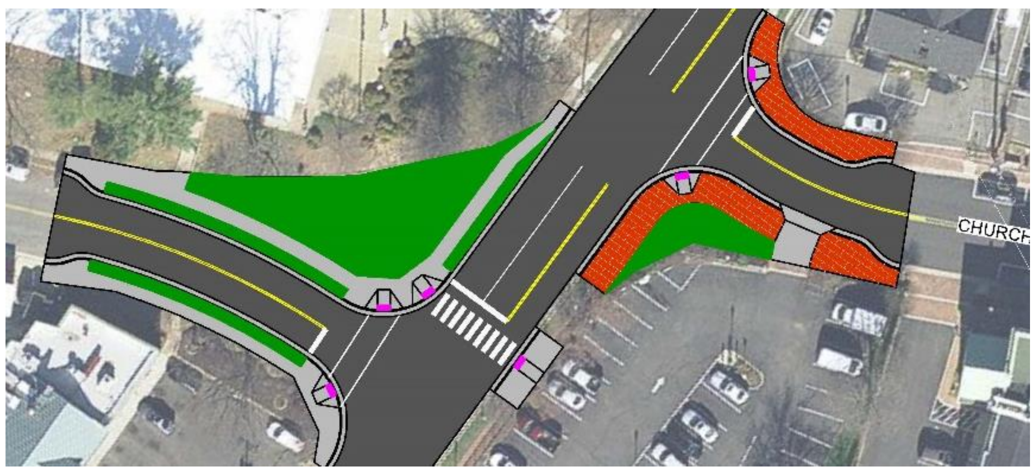


Figure 7-30: Church St and Lawyers Rd Intersection Redesign (Option 2)



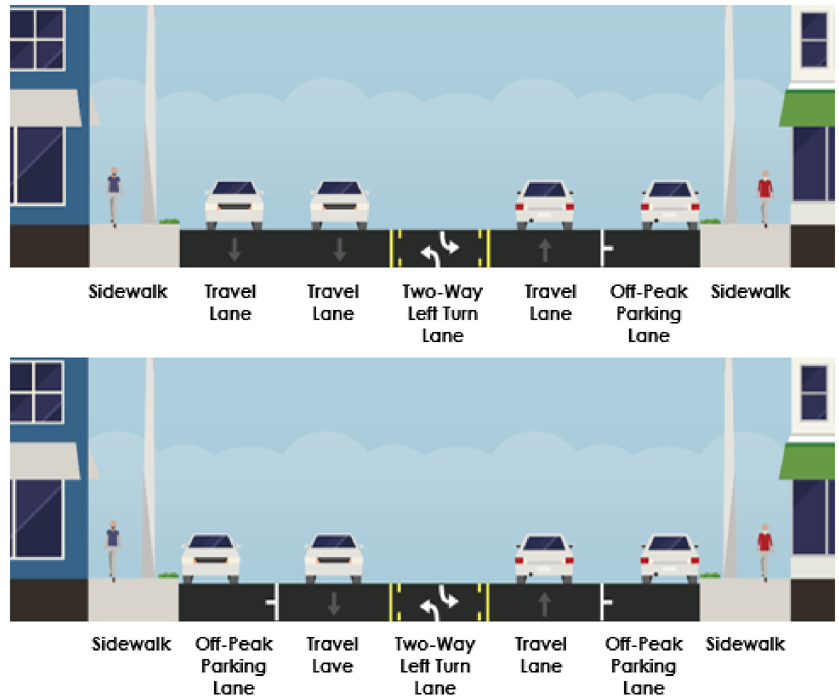
Concept R. Maple Avenue Off-Peak Parking Lanes

Providing public, on-street parking along the curbside lanes of Maple Avenue during off-peak periods would provide parking that may help stimulate or support evening activity and make use of excess capacity during non-peak times. Upon further study, this concept could be deployed in specific segments. Challenges include the coordination that would be required with VDOT, enforcement, driver familiarity and safety, as well as compatibility with traffic flow. The cross-section for this concept is shown in **Figure 7-31**. A reassessment of the number and location of commercial entrances may also be necessary for compatibility purposes. According to the synchro analysis, the off-peak parking lanes would add slightly under 2 minutes of travel time in eastbound direction along the Maple Avenue corridor from Nutley Street to Follin Lane as shown in **Table 7-8**.

Table 7-8: Off-Peak Parking Lanes Traffic Impacts

Arterial Approach LOS	Future		Future with Concept	
	PM LOS	Travel Time	PM LOS	Travel Time
Eastbound	D	503.4	D	617.1
Westbound	D	509.3	C	465.6

Figure 7-31: Maple Ave Off-Peak Parking Lane Configurations

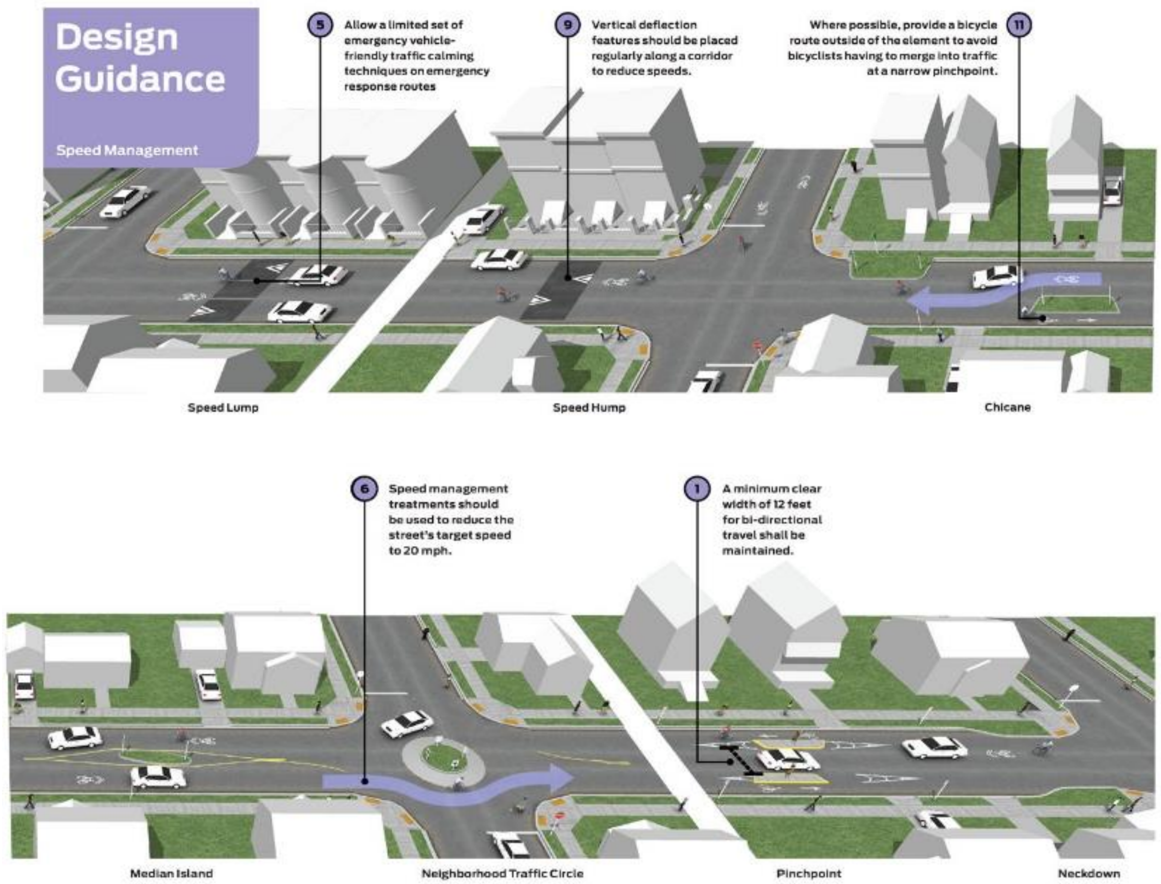


Studies and Strategies

Neighborhood Traffic Calming Studies

Conducting a neighborhood traffic calming study or studies would help the Town identify specific strategies, concepts, ands solutions to address unsafe conditions in residential neighborhoods related to traffic and transportation. Such a study could also help to expand the scope and application of Vienna's existing traffic calming guidance.

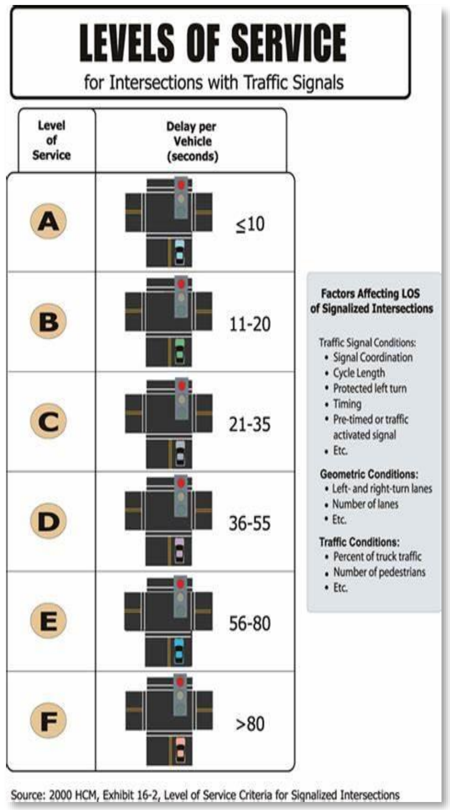
The results of a study of this nature would promote and protect residential character of established communities and focus traffic and traffic flow improvements on major routes.



Town Traffic Impact Analysis (TIA) Guidelines

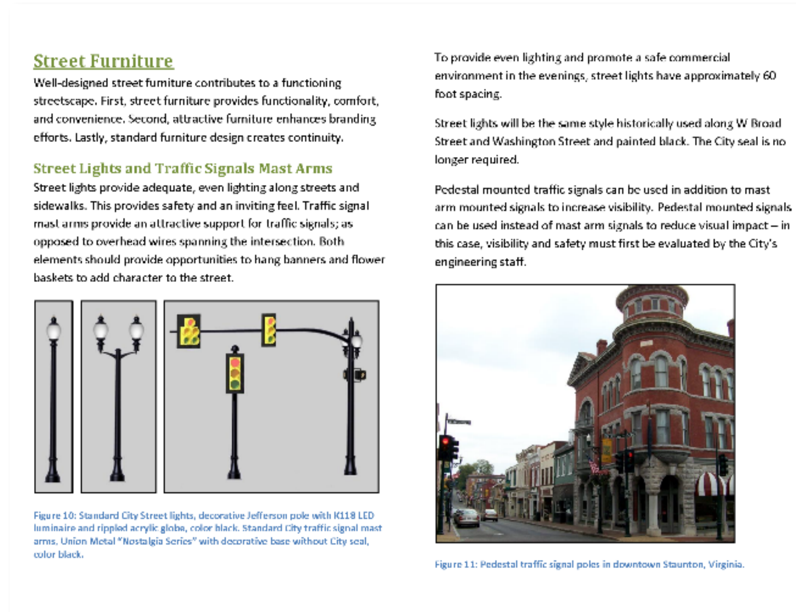
Establishing a set of townwide traffic impact analysis guidelines would establish formal guidelines for how traffic studies will be conducted and evaluated within the Town of Vienna.

Such an undertaking could be completed in the near-term and allow for more transparency and public agreement with the process, consistency across traffic studies, and more formal and reliable documentation of development impacts and required improvement criteria.



Develop Streetscape Master Plan and design Guidelines

Developing a townwide Streetscape Master Plan and Design Guidelines would work to further highlight and build upon Vienna's history and brand through cohesive design of street improvement projects.



Street Furniture

Well-designed street furniture contributes to a functioning streetscape. First, street furniture provides functionality, comfort, and convenience. Second, attractive furniture enhances branding efforts. Lastly, standard furniture design creates continuity.

Street Lights and Traffic Signals Mast Arms

Street lights provide adequate, even lighting along streets and sidewalks. This provides safety and an inviting feel. Traffic signal mast arms provide an attractive support for traffic signals; as opposed to overhead wires spanning the intersection. Both elements should provide opportunities to hang banners and flower baskets to add character to the street.

Figure 10: Standard City Street lights, decorative Jefferson pole with K118 LED luminaire and rippled acrylic globe, color black. Standard City traffic signal mast arms. Union Metal "Nostalgia Series" with decorative base without City seal, color black.

To provide even lighting and promote a safe commercial environment in the evenings, street lights have approximately 60 foot spacing.

Street lights will be the same style historically used along W Broad Street and Washington Street and painted black. The City seal is no longer required.

Pedestal mounted traffic signals can be used in addition to mast arm mounted signals to increase visibility. Pedestal mounted signals can be used instead of mast arm signals to reduce visual impact – in this case, visibility and safety must first be evaluated by the City's engineering staff.

Figure 11: Pedestal traffic signal poles in downtown Staunton, Virginia.

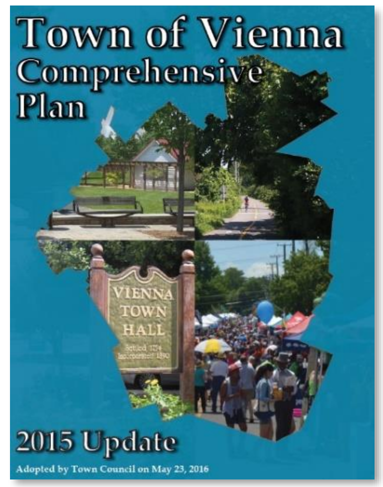
Town Parking Supply and Demand

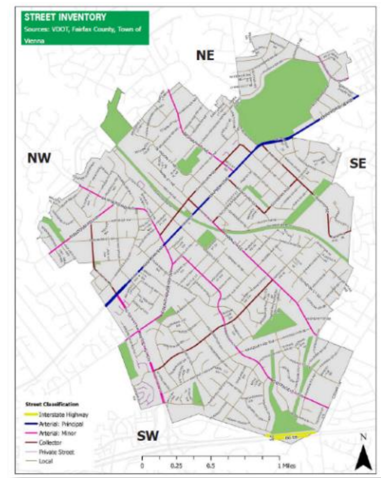
Conducting a townwide parking study to evaluate the existing supply and demand of public parking could be completed in the near-term and would provide many benefits, including:

- Gain an accurate inventory of public and private parking supply
- Identify peak and off-peak parking demand
- Identify strategies to supplement existing parking supply and have a more efficient use of existing supply
- Identify need for and location of new parking facilities

Long Range Transportation Master Plan

Conducting a town-wide transportation master plan would begin a comprehensive process to build consensus on transportation investments that balance roadway, public transit, bicycle, pedestrian, and other transportation modes and support Vienna's goals for land use, economic development, and the environment through the safe and efficient movement of people and goods.





Signal Timing/Phasing/Lane Configuration Improvement

This study endorses the planned deployment of the Town's adaptive signal controller technology and recommends that corridor signal timing be updated at regular intervals (i.e. every two years).

Maple Avenue – Develop Access Management Strategy

Developing a corridor-wide access management strategy would identify feasible opportunities to close, consolidate, or relocate commercial driveways and curb cuts. Identifying such opportunities would streamline implementation at the appropriate time, such as when adjacent private development occurs.

7.2 Community Engagement

Town Council Briefing #3

The study team provided a briefing of draft transportation network improvements – or "Working Concepts" – to Town Council on August 19, 2019. The preliminary working concepts were presented by mode of transportation (pedestrian network, bicycle network, transit network, street network, and safety/access).

Following the presentation, Councilmembers discussed and provided comments on the range of potential concepts.

Public Workshop #3

On September 4, 2019, the study team presented preliminary working concepts to the community at the third and final public workshop. The workshop presented the same preliminary working concepts as the third Town Council briefing, but grouped them into four main categories:

1. **Low Investment, High Impact**
2. **Provide More Travel Options**
3. **Complete the Network**
4. **Address Existing Challenges**

In lieu of a formal presentation, the workshop primarily consisted of an open house format where attendees could visit tables dedicated to each of the four concept categories and review the preliminary working concepts in greater detail. Scorecards were available at each table and asked that community members rank each category's concepts by personal preference/priority. The goals of this third and final public workshop were to discuss and prioritize working concepts, identify gaps between the concepts and existing challenges in the corridor, and identify additional options for the study team to consider.

Additional Feedback Opportunities

Community feedback was also received via email and the Town website in addition to that received at in-person public workshop meetings and was considered throughout the concept development process.

Town Council Briefing #4

At the request of Town leadership, the study team attended a fourth Town Council briefing on November 7, 2019. This briefing provided an additional opportunity for the draft study concepts to be evaluated and discussed in greater detail among Councilmembers. The result of this Council briefing was a more refined hierarchy of concept groupings, as well as more detailed guidance on prioritization of the concepts included in the study.

7.3 Public Feedback Summary

As noted, concepts were presented at the third public workshop hosted at Vienna City Hall on September 4, 2019 to get feedback from the public.

Prioritization Rankings of Alternatives

Attendees were asked to rank the concepts in order of priority for each of the categories. Approximately twelve rankings were tallied for each category and are summarized into the tables below.

Figure 7-32: Low Investment, High Impact Rankings

I. Low Investment, High Impact		
Priority	Concept	Points
1	Crosswalks: W&OD Trail Crossing Redesign	36
2	Leading Pedestrian Intervals (LPI)	32
2	All-Way Stops	32
4th	Additional W&OD Trail Crossing Considerations	29
5th	Church Street and Mill Street: Slip Lane Removal and Intersection redesign	25

Figure 7-32 shows that of the low investment, high impact proposed improvements, the W&OD trail crossing redesign scored the highest, LPIs and All-Way stops tied for second, and the Church Street and Mill Street slip lane removal and redesign gained the least amount of interest.

Figure 7-33: More Travel Options Rankings

II. More Travel Options		
Priority	Concept	Points
1	Bicycle Network	49
2	Trail Improvement / Extension: Locust Street	48
3	Pleasant Street and Courthouse Road: Operational Improvements	43
4th	Capital Bikeshare	35
5th	Local Circulator	29

Figure 7-33 shows that of the concepts that provide more travel options, the bicycle network had the most interest. Only one point away from the bike network was the trail extension concept on Locus street which has direct benefits to pedestrians and bicyclists. The local circulator had the least amount of interest.

Figure 7-34: Complete the Network Rankings

III. Complete the Network		
Priority	Concept	Points
1	Roadway Operation / Safety Improvements	37
2	Raised Medians	35
3	Curb Reconstruction	34
4th	Branch Road - Beulah Road: Realignment / Connection	31

Figure 7-34 shows that of the concept that improve completion of the network, prioritizing roadway operations and safety was most favored. This concept is synonymous with the proposed signal timing improvement study which also scored as top priority under the Studies and Strategies category. The realignment and Branch Road and Beulah Road received the least amount of interest, though only 6 points behind the top priority.

Figure 7-35: Address Existing Challenges Rankings

IV. Address Existing Challenges		
Priority	Concept	Points
1	Fill Sidewalks Gaps	54
2	Church St and Lawyers Road: intersection redesign	41
3	Nutley St and Courthouse Road: Operational and geometric Improvements	39
4th	Bus Stop Enhancement at maple Avenue	36
5th	Maple Avenue Off-Peak Parking Lanes	30

Figure 7-35 shows that filling the sidewalk gaps is the existing challenge that received the highest prioritization points. People were also interested in the Church Street and Lawyers Road redesign as well as the improvements at Nutley Street and Courthouse Road. The Maple Avenue off-peak parking lanes had the least amount of interest.

Figure 7-36: Studies and Strategies Rankings

V. Studies and Strategies		
Priority	Concept	Points
1	Signal Timing / Phasing / Lane / Signage and enforcement Configuration Improvements	54
2	Long Range Transportation Master Plan	38
3	Develop Streetscape Master Plan and Design Guidelines	35
4th	Conduct Neighborhood Traffic Calming Studies	34
5th	Develop Town Traffic Impact Analysis Guidelines	32
6th	Conduct Town Parking Supply and Demand Study	31
7th	Access Management Strategy for Maple Ave	21

As shown in **Figure 7-36**, of the studies and strategies that could be done in the future, a signal timing/phasing/lane/signage and enforcement configuration improvement study was the clear favorite, scoring 16 points above the next highest ranking. From there, the studies received relatively equal priority, except for an access management strategy study for Maple Avenue which received the least amount of interest. This underscores the priority that residents place on improving vehicle operations.

Comment Card Summary

Comment cards were available for attendees to document their thoughts, concerns and opinions regarding the concepts. A scan of the comment cards can be found in **Appendix G.** In summary, responses fell into four general categories:

Bike Comments:

Responses identified streets that would benefit from bike lanes and viewed this improvement favorably. There was some concern about conflicts between vehicles and bicyclists. Bike parking was highlighted as a priority.

Pedestrian Comments:

Responses echoed concerns about pedestrian safety of existing conditions and gave suggestions about specific areas for improvement. Clear signage was a priority.

Traffic Comments:

Congestion is a top concern. While Maple Avenue is viewed as important, emphasis was specifically placed on traffic on local streets. Comments suggest adjusting signal timings and implementing flashing, yellow, traffic lights around town to improve delays.

There were split feelings regarding roundabouts in the town. Overall, comments expressed a need for ensuring pedestrian safety at them and only implementing them at low volume intersection.

Site Improvement Comments:

Specific access to business and community centers were highlighted. Prioritizing green space was a value as well. Respondents showed hesitance toward the Beulah Road and Branch Road Alternative 1 concept.

7.4 Prioritization Methodology

Following the development and presentation of study recommendations within the above categories, the study team reevaluated both the recommendations list and its groupings at the request of and in coordination with Town Council. The product of this collaboration is a condensed list of priority projects that best address community needs, timing concerns, and technical feasibility. Additionally, a revised, three-tier prioritization framework was developed to better categorize the suite of recommended transportation improvements.

Top Priority Recommendations

1. **Church Street and Mill Street (Concept A)**
2. **W&OD Trail Crossing Redesign (Concept B)**
3. **Leading Pedestrian Intervals (Concept C)**
4. **Local Circulator (Concept E)**
5. **Bicycle Network (Concept F)**
6. **Fill Sidewalk Gaps (Concept N)**
7. **Studies and Strategies:**
    - Bicycle Master Plan
    - Traffic Impact Analysis Guidelines
    - Streetscape Master Plan and Design Guidelines
    - Parking Supply and Demand Study

The study has developed a collection of near- and mid-term recommendations along Maple Avenue for all modes of transportation that address the current and future mobility challenges along the corridor in coordination with impacts related to existing and future land uses and travel behaviors.

In addition to the prioritization, the remaining concepts have been organized into the three below categories.

Near-term recommendations are defined as those actions that can be programmed, planned, and implemented within five years.

Mid-term recommendations are defined as those actions that can be programmed, planned, and implemented five to 10 years out.

Longer-term recommendations, while outside of the scope and timeline horizon of this study, are included to speak to key long-term needs that rose to the attention of Council and the community as a result of the study process. The projects included in this category are more transformative in nature and may be contingent on future private land development, right-of-way and property acquisition, or further study. As resources, funding, and schedules are further developed, the Town may seek to pursue such actions in order to further the positive momentum of transportation and development in Vienna. These projects speak to the larger question of what is the vision for Maple Avenue and for Vienna as a whole and how the corridor can best be oriented to serve its various users.

Near-Term Recommendations

Concepts

A	Church Street and Mill Street
B	W&OD Trail Crossing Redesign
C	Leading Pedestrian Intervals
D	All Way Stops
G	Locust Street: Trail Improvement / Extension
H	Pleasant Street and Courthouse Road
K	Roadway Operation/Safety Improvements
N	Fill Sidewalk Gaps
Q	Nutley Street and Courthouse Road
	Studies and Strategies (Study)
	Traffic Impact Analysis Guidelines
	Bicycle Master Plan
	Traffic Calming Studies
	Parking Supply and Demand Study
	Access Management Strategy

Mid-Term Recommendations

Concepts

E	Local Circulator
F	Bicycle Network
I	Capital Bikeshare
J	Curb Reconstruction
O	Maple Avenue: Bus Stop Enhancements
P	Church Street and Lawyers Road
	Studies and Strategies (Implement)
	Traffic Impact Analysis Guidelines
	Bicycle Master Plan
	Traffic Calming Studies
	Parking Supply and Demand Study
	Access Management Strategy
	Studies and Strategies (Study)
	Streetscape Master Plan and Design Guidelines
	Long Range Transportation Master Plan

Longer-Term Recommendations

Concepts

L	Branch Road – Beulah Road
M	Raised Medians
R	Maple Avenue Off-Peak Parking
	Studies and Strategies (Implement)
	Streetscape Master Plan and Design Guidelines
	Long Range Transportation Master Plan

7.5 Opinions of Probable Cost

Opinions of probable cost were developed for the priority recommendations. These costs represent a review of high and low unit costs for more substantial line item elements that would be included in each project. The high and low costs were vetted against recent bid tabs from the Town of Vienna, VDOT, and Fairfax County. Opinions of probable costs are based on a likely construction cost with multipliers applied for mobilization, erosion and sediment, drainage, maintenance of traffic, utility relocation, construction engineering inspection (CEI), preliminary engineering, and a contingency. Opinions for probable costs are for planning purposes only and do not represent full cost estimates.

It is noted that a detailed benefit cost analysis was not included in the scope of work for this study – in truth such analyses are complex, given the different and inconsistent ways that benefits can be measured for the different modes. For example, for the Church and Mill Street improvement, one could speak of the dollar investment per daily delay savings, however no such measures are readily available or comparable for the other options. The benefits have been described herein qualitatively (and supported by quantitative measures where appropriate). A thorough benefit cost analysis could be pursued to further the prioritization process, but such an analysis should be in line with the typical process, scope, and scale used to weigh the investments and outcomes of projects that are ultimately included in a CIP.

Concept	Opinion of Probable Cost
Church Street and Mill Street (Concept A)	\$80,000 – \$149,000
W&OD Trail Crossing Redesign (Concept B)	\$20,000 to \$45,000 (per crossing)
Leading Pedestrian Intervals (Concept C)	\$7,500 – \$15,000
Local Circulator (Concept E)	\$275,000 – \$345,000 (annual operating, Maple 2 Metro) \$415,000 – \$475,000 (annual operating, Maple-Church) \$150,000 - \$250,000, vehicle (replica trolley) \$200,000 to \$250,000 (30-foot transit bus)
Bicycle Network (Concept F)	\$180-000 - \$237,000
Fill Sidewalk Gaps (Concept N	\$250,000 - \$400,000

8. Conclusion

This Multimodal Transportation and Land Use Study of the Maple Avenue corridor was developed to assist the Town of Vienna in identifying recommendations that leverage the existing strengths of the Maple Avenue corridor; in addressing current and future mobility challenges; in understanding and developing a plan for the potential impacts related to changes in adjacent land use and density; and, in setting the stage for a Maple Avenue corridor that works within the context of the Town of Vienna's broader economic, mobility, and livability goals.

The core purpose of the Maple Avenue Corridor Multimodal Transportation and Land Use Study was to develop near- and mid- term recommendations that will help to enhance mobility and the travel experience along the corridor as well as to enhance safety and access for all modes of transportation.

The study confirmed a number of existing challenges along the corridor, collected existing conditions multimodal transportation data, and sought to provide context for the resiliency of the Maple Avenue corridor with respect to future change in land use and density.

Maple Avenue, during the peak periods, does experience congestion. There are a lack of alternative routes, to the north and south of Maple Avenue, that can provide relief and serve travelers destined to Tysons or southern Fairfax during the commuter peak periods. Certainly, these routes do not exist without traversing in part through residential and transitional neighborhoods that may not be compatible with the desired speed and traffic volumes.

There are opportunities to capitalize on and to enhance the viability of active transportation modes. Vienna can leverage the strengths of the walking and transit networks to influence the ways people travel, potentially reducing peak period demands.

With respect to the future, a development scenario was tested and indicated that, for the types of mixed-use development Vienna is currently targeting, additional traffic will not substantially alter the operations or perceived travel along Maple Avenue. There is congestion along the corridor today and will be in the future, based on the development scenario impacts.

This report suggests, however, that the additional traffic does not represent a significant increase in peak hour volumes such that there would be a signification degradation in the level of service nor a degradation that could not be addressed with multimodal solutions (though some solutions will require strategic planning and more study beyond the near and mid-term horizon of this study).

It is also relevant to state, again, that this report assumed a worst-case scenario of trip generation, assumed all future developed occurred collectively rather than incrementally, assumed that transit offering remained largely the same, and assumed no TDM requirements or parking reduction requirements for any development. Each of these assumptions, had they been considered, would have further reduced vehicle volumes and resulting impacts discussed in this study.

There are a limited number of options to improve vehicle operation along Maple Avenue in the near- and mid-term horizon. The road is constrained to 5 lanes and significant redevelopment across the corridor would be needed to change this cross section. What make sense then is recommendations and improvements that make the most efficient use of those 5 lanes, while balancing the needs of bicyclists, pedestrians, and transit riders both on and off the corridor.

Within this study, implementable recommendations were developed that address specific areas of traffic concern, elevate other modes of travel, and promote transportation safety.

Ultimately, while beyond the scope of this study, it may be the future task of the Vienna community to define the ultimate vision for the Maple Avenue corridor and transportation in Vienna as a whole. With such a vision defined, concrete steps, projects, and priorities can be mapped out and implemented to achieve transformative, safe, and context-appropriate mobility options and opportunities for travel along Maple Avenue, along Church Street, and within all Vienna.


OLD CABOOSE