RSG INC.
RESOURCE SYSTEMS GROUP, INC.

Documentation for:

VT 22A-SOUTH WATER STREET-MACDONOUGH DRIVE INTERSECTION STUDY

FINAL REPORT

City of Vergennes, Vermont

Prepared for the:

City of Vergennes; and

Addision County Regional Planning Commission

October 2006

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VT 22A-MACDONOUGH DRIVE-SOUTH WATER STREET INTERSECTION STUDY – FINAL DRAFT REPORT

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INTRODUCTION

The purpose of this study is to identify, evaluate, and recommend short and long range improvements to the intersection of VT 22A, South Water Street, and MacDonough Drive in the City of Vergennes, VT.

This study is a joint effort of the Addison County Regional Planning Commission (ACRPC), City of Vergennes, and the Vermont Agency of Transportation (VTrans). The study was conducted by Resource Systems Group, Inc., a transportation planning and engineering consulting firm, under contract o the ACRPC.

Existing conditions satisfy warrants for the installation of a traffic signal. However a more comprehensive analysis and public outreach was desired by the City and the Addison County Regional Planning Commission before moving forward with installation of a traffic signal.

This report contains the following two sections:

- **Part I: Existing and Future Conditions:** This section describes the land use and highway system context for the study intersection, documents existing roadway, bicycle, and pedestrian facilities, evaluates congestion under existing and future conditions, evaluates safety, and provides a screening of natural, cultural, and historic resources that may affect design alternatives. The analyses in this section are combined with comments from a public meeting to develop a purpose and need statement for the project.
- **Part II: Alternatives Analysis and Recommendations:** Three alternatives are developed and evaluated relative to the issues identified in the purpose and need statement. Order of magnitude cost estimates are provided and potential impacts to natural and cultural resources are screened. Comments from meetings with adjacent land owners are summarized. A fourth alternative is presented based on the landowner comments. An implementation plan is provided that recommends phasing of the recommended alternative, costs for each phase, potential funding sources, and next steps.

PART I: EXISTING AND FUTURE ISSUES

This section describes the land use and highway system context for the study intersection, documents existing roadway, bicycle, and pedestrian facilities, evaluates congestion under existing and future conditions, evaluates safety, and provides a screening of natural, cultural, and historic resources that may affect design alternatives. The analyses in this section are combined with comments from a public meeting to develop a purpose and need statement for the project.

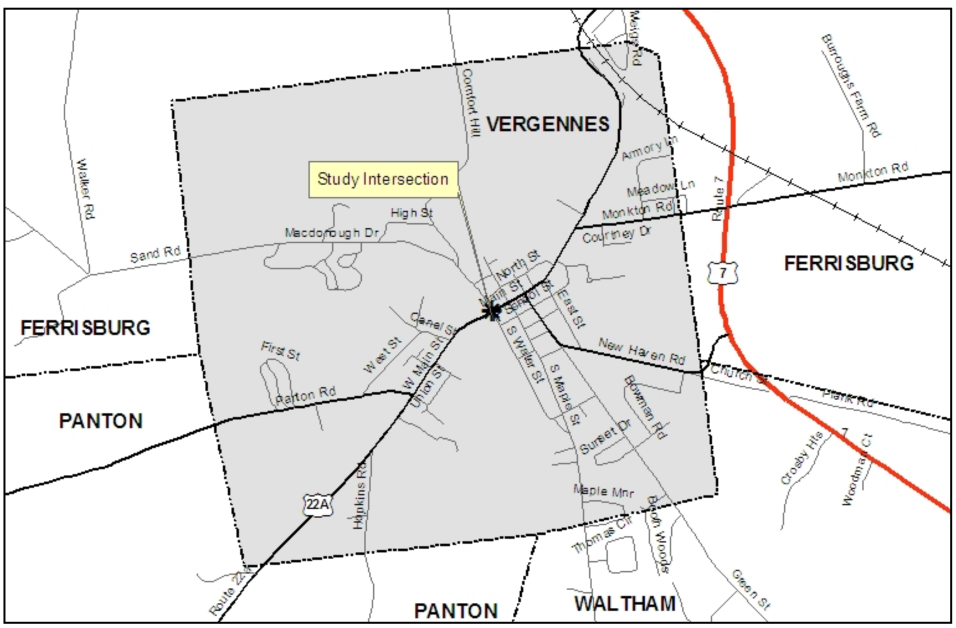
1.0 STUDY AREA OVERVIEW

Vergennes is located in Addison County on the western edge of the state. The study intersection is located close to the geographic center of the city along VT 22A at the western edge of the central business district.

Figure 1shows the location of the study intersection. In general, VT 22A follows a north/south path from US 4 in Fair Haven, VT to US 7 just north of the City of Vergennes. Although VT 22A follows a northeast/southwest alignment through the study intersection, this report uses the following conventions to simplify the discussions:

- VT 22A is described as the northbound and southbound approaches;
- MacDonough Drive is described as the eastbound approach; and
- South Water Street is described as the westbound approach.

Figure 1: Intersection Location



1.1 LAND USE

The study intersection is at the edge of downtown Vergennes. To the east, lot sizes are small, development is relatively dense and setbacks are small. Street cross-sections include on-street parking and sidewalks. The area is mixed with street-side retail, commercial and office space, municipal and ecclesiastical buildings.

The existing land use shown in Figure 2 has been identified using the E911 site location dataset. The data have been organized into the general categories of residential, commercial, industrial, public/institutional and other as shown in Table 1.

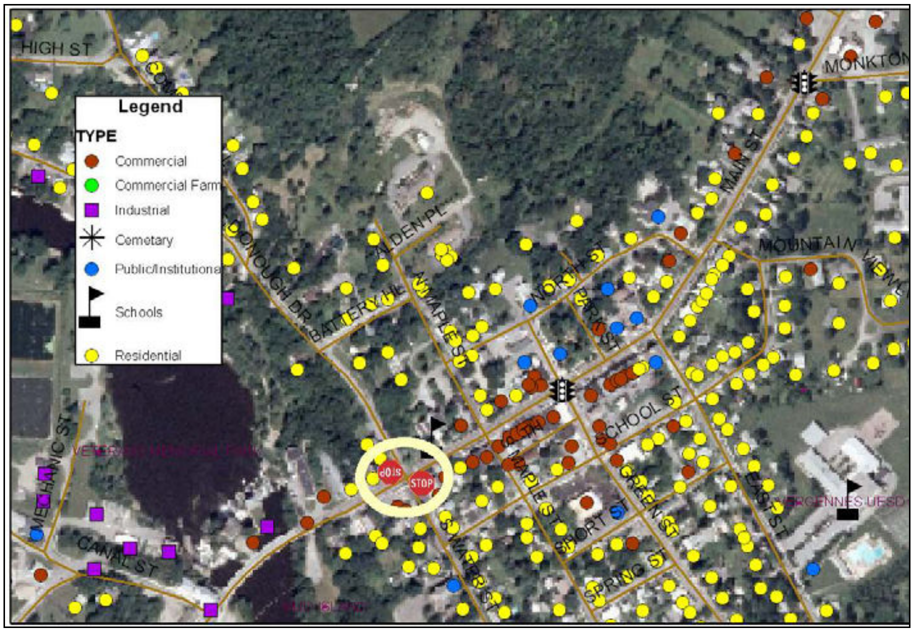
To the southwest of the study intersection, the Otter Creek river frontage is the dominating characteristic. The land use is mixed commercial and recreational. Sidewalks continue but there is no on-street parking and lot sizes increase as well as set-backs.

Though relatively small in total area at 1 square mile, Vergennes was founded as the urban center for the surrounding farming towns and maintains its well-planned vital core. The population as of the 2000 Census is 2741. This number represents an increase of 163 people over the 1990 census (an approximate increase of 6%).

Table 1: Description of General Land Use Categories

Generalized Land Use Category	E911 Specific Categories
Residential	Single Family Residential Multi-Family Residential Mobil Home Other Residential Seasonal Single Family
Commercial	Commercial - retail/service Other Commercial
Farm	Commercial - farm
Public / Institutional	Government/Town Health Care Church Educational Cultural Police Station Fire Station Gathering Place
Industrial	Industrial

Figure 2: Existing Land Use



1.2 PREVIOUS STUDIES AND PROJECTS

The Gateway Project and a recent traffic signal warrant analysis for the intersection of VT 22A-MacDonough Drive-South Water Street are the two most relevant projects.

The Gateway Project is designed to improve pedestrian access and usability of the Otter Creek basin and downtown areas. This project includes improvements to the parking area and boat launch on the east side of VT 22A, a new pedestrian crossing at the bottom of the VT 22A hill, and an improved walkway and stairs on the west side of VT 22A. The City will also be issuing an RFP soon for the engineering work necessary to construct a new sidewalk on the west side of VT 22A from MacDonough Drive, south, to Canal Street. Additional trail projects are anticipated along the Basin. A rail trail is currently being constructed by the City that will cross MacDonough Drive west of the study intersection.

A signal warrant analysis indicated that existing conditions warrant a signal under the Four-Hour and Eight-Hour volume warrants[1]. These warrants are advisory and the characteristics of the area should be considered before installing a signal. Adequate level-of-service would be provided with a signal.

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[1] VT 22A-Sout Water Street Traffic Signal Warrant Analysis, RSG, 15 March 2005.

2.0 TRANSPORTATION SYSTEM CHARACTERISTICS

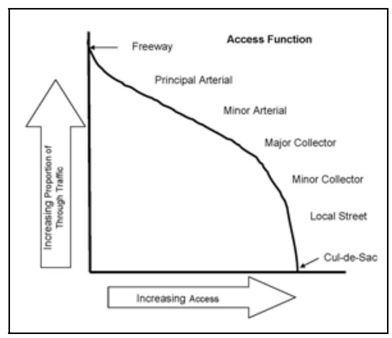
2.1 HIGHWAY SYSTEM CONTEXT

The study intersection is a component of a connected local, state, and national highway network. This section provides background information on the different highway classification systems and their relevance in the study area.

Functional Class

The Federal Highway Administration's roadway functional classification system, depicted in Figure 3, is organized as a hierarchy of facilities, based on the degree to which the roadway serves mobility and access to adjacent land uses. Freeways and interstate highways, at the top of the hierarchy, are devoted exclusively to vehicle mobility, with no direct access to adjacent land. Arterials and Collectors provide both mobility and access to adjacent land uses. The local road system is devoted exclusively to providing local access, with limited capacity and relatively slow speeds.

Figure 3: Conceptual Roadway Functional Hierarchy

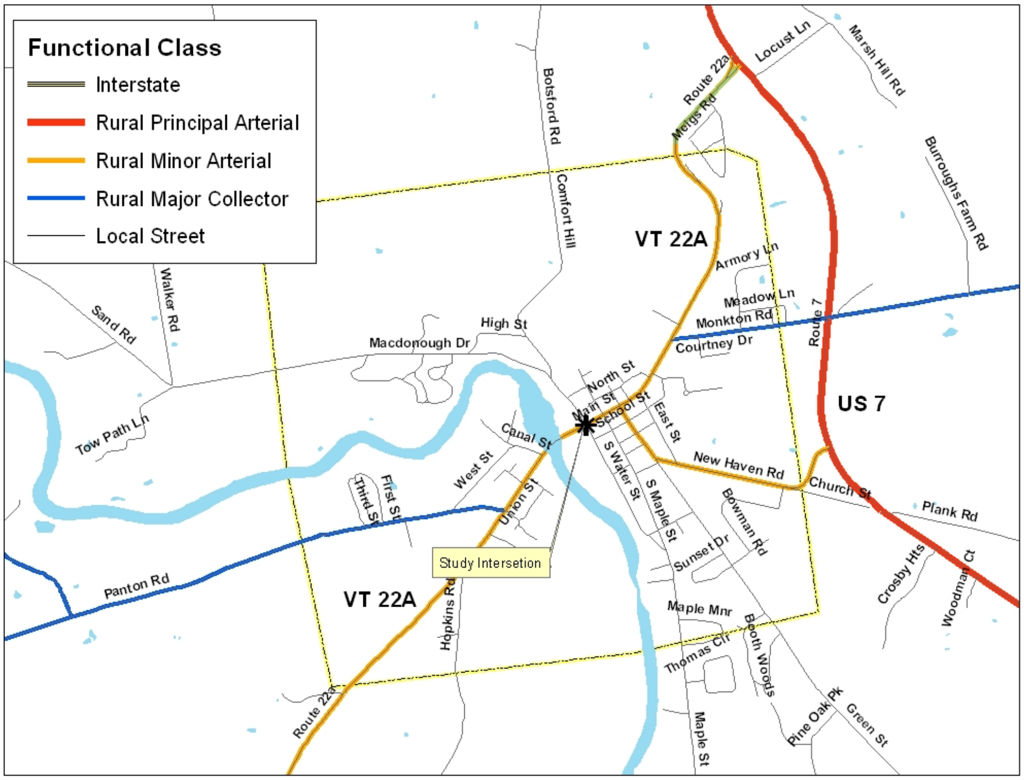


The functional classification of all roads along and adjacent to the study corridor is shown below in Figure 4. VT 22A is designated a rural minor arterial along its entire length. The minor arterial designation suggests that mobility has a higher priority than accessibility along the corridor.

South Water Street and MacDonough Drive are classified as local streets and need to provide access to adjacent homes and businesses. They also serve as collector streets because they provide a connection to VT 22A..

As an arterial passes through a city center such as downtown Vergennes, the roadway's actual function changes. It must also accommodate a higher level of direct access to adjacent land, increased local circulation by vehicles and people traveling on foot or by bicycle, and provide for connection to the collector and local street systems through intersections such as the as South Water Street-MacDonough Drive.

Figure 4: Functional Classification



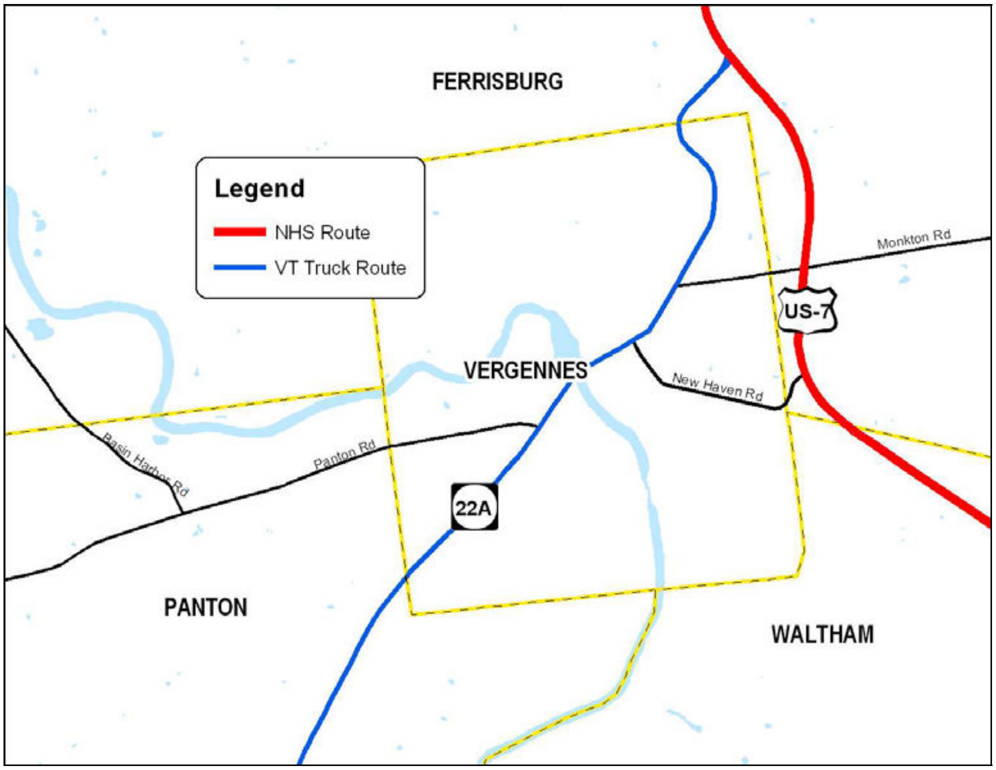
National Highway System and VT Truck Network

The National Highway System (NHS) was designated in 1995 and consists of approximately 155,000 miles of highway that provides an interconnected system of principal arterial routes serving major population centers, major transportation facilities, major travel destinations, and meets national defense requirements. The NHS includes all Interstates and some US and state routes. All NHS-designated highways must adhere to Federal Highway Administration standards (rather than State and/or local).

Title 23 V.S.A. Section 1432 as amended by the 2000 Vermont Legislature, establishes the Vermont Truck Network where trucks with overall lengths less than 72 feet (including 53-foot tractor-trailer combinations) may travel without permits. All NHS routes are part of the Vermont Truck Network.

Figure 5 shows the road segments in the study area classified as part of the National Highway System and/or a designated as part of the Vermont Truck Network. Within the study area, VT 22A has been designated as part of the truck network. As a result, the study intersection needs to be designed to accommodate large trucks, including appropriate turning radii and allowance for starting on the surrounding grades.

Figure 5: National Highway System (NHS) and Designated Truck Routes



Roadway Jurisdiction

VTrans has established a roadway classification system to identify the levels of jurisdiction over each section of road across the state. These classifications identify whether, for example, VTrans or the Town is responsible for pot hole patching on a particular section of road. The following categories are used by VTrans[1]:

- Interstate/US Route/State Route: Form the primary transportation network through the State. US routes include all US numbered highways not designated as Class 1 town highways. State routes include all state numbered highway routes not designated as Class 1 town highways. The interstates, US routes, and state routes are the responsibility of VTrans.
- Class 1 Town Highway: Forms the extension of state numbered highway routes through a town, and which carry a state highway route number. Class 1 town highways are subject to concurrent responsibility and jurisdiction between the Municipality and VTrans on several

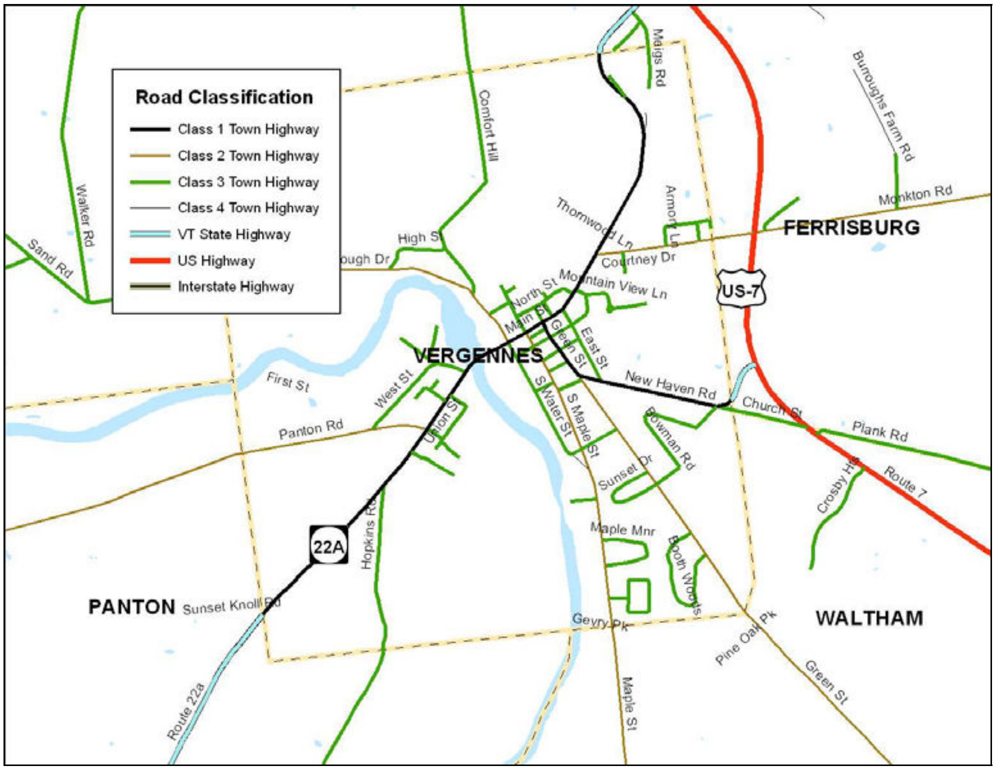
[1] Road classification description sources: VTrans "Handbook for Local Officials" (2004).

matters. VTrans is responsible for scheduled surface maintenance or resurfacing while municipalities are responsible for pot hole patching, crack filling, etc; VTrans is responsible for center line pavement markings, while *municipalities are responsible for sidewalks, crosswalks and parking*. VTrans has exclusive authority to designate Class 1 highways.

- Class 2 Town Highway: Those town highways selected as the most important highways in each town. As far as practicable they shall be selected with the purposes of securing trunk lines of improved highways connecting two towns and to places which by their nature have more than a normal amount of traffic. The selectmen, with the approval of the Vermont Agency of Transportation, shall determine which highways are to be class 2 highways. Class 2 highways are primarily the responsibility of municipalities. VTrans is responsible for center line pavement markings if municipalities notify VTrans of the need to replace them, while *municipalities are responsible for sidewalks, crosswalks and parking*. Class 2 mileage normally may not exceed 25 percent of the total Class 2 and Class 3 mileage in the municipality.
- Class 3 Town Highway: All other town highways that are "negotiable under normal conditions all seasons of the year by a standard pleasure car." *Class 3 town highways, including sidewalks, crosswalks, and parking, are the responsibility of municipalities.*
- Class 4 Town Highway: All other town highways are considered Class 4 town highways. The majority of these receive limited or no maintenance. They are negotiable at your own risk, usually impassable in winter, and referred to as "jeep trails" at other times of the year. *Class 4 town highways, including sidewalks, crosswalks, and parking, are the responsibility of municipalities.*

Figure 6 shows the roadway jurisdictional classifications in and around the study area.

Figure 6: Road Jurisdiction



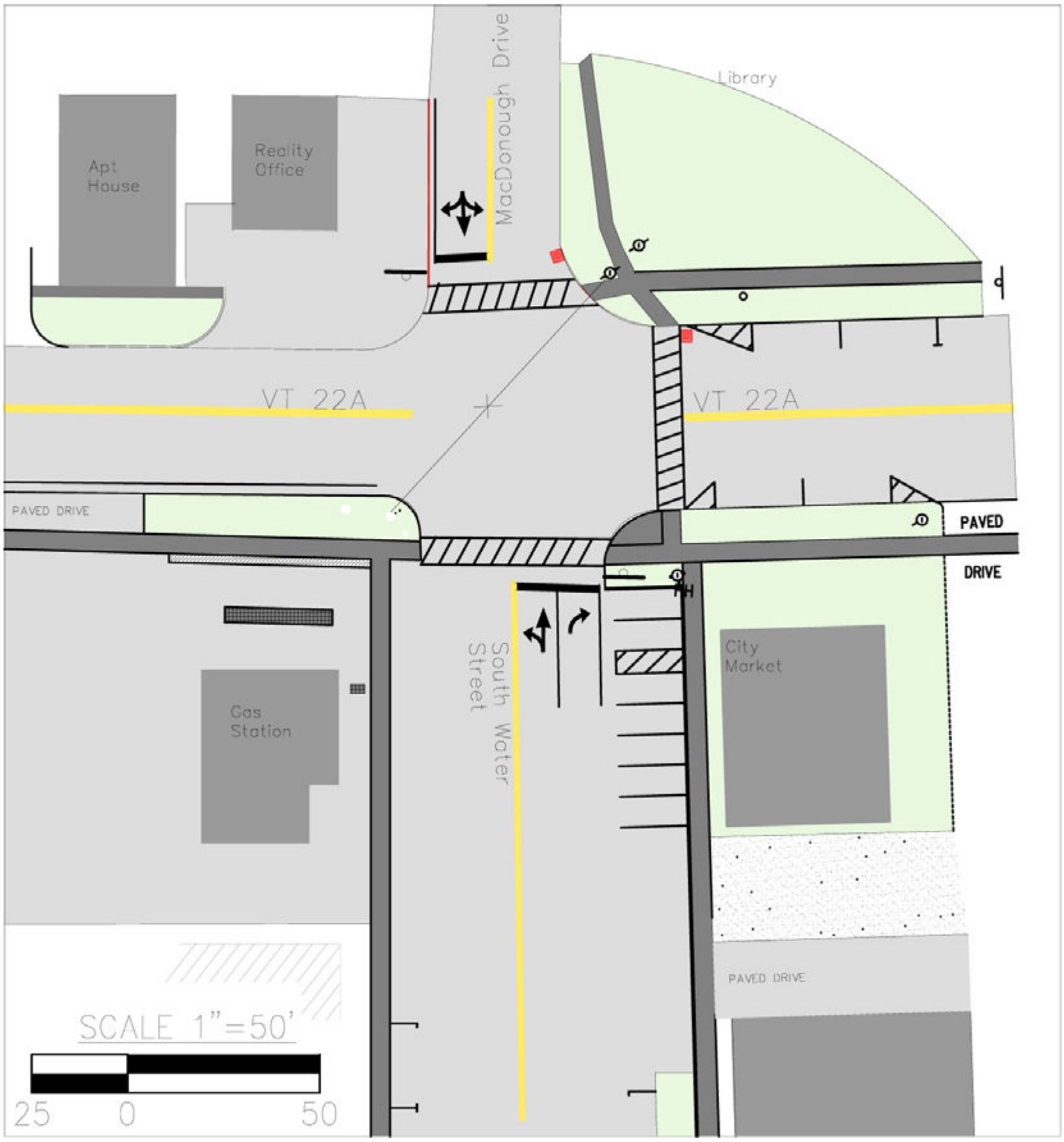
VT 22A within Vergennes is a Class 1 Town Highway. VTrans and the City share responsibilities and jurisdiction over Class 1 Town Highways.

MacDonough Drive is a Class 2 Town Highway and South Water Street is a Class 3 Town Highway. Both roads are owned and maintained by the City of Vergennes. A traffic signal, if installed at this intersection, will be owned, maintained, and operated by Vergennes.

2.2 ROADWAY AND INTERSECTION CHARACTERISTICS

The VT 22A-MacDonough Drive-South Water Street intersection is controlled by stop signs on the minor streets of South Water Street and MacDonough Drive. A flashing warning beacon is located over the center of the intersection. This beacon provides a supplemental emphasis for stop signs and alerts drivers traveling northbound on VT 22A that special conditions exist at the intersection. South Water Street has a 50' right-turn bay at the intersection. All other approaches have one lane. There is one travel lane exiting the intersection for each approach. Figure 7 illustrates the existing layout of the intersection.

Figure 7: Existing Intersection Geometry



South of the intersection, the VT 22A cross-section consists of 2’ shoulders, a 13’ southbound lane and a 19’ northbound lane. North of the intersection, the VT 22A cross-section consists of on-street, parallel parking on both sides of the roadway (8’ wide), an 18’ travel lane in the northbound direction and a 13’ travel lane in the southbound direction. There are no marked shoulders.

MacDonough Drive has a 12’ travel lane westbound and a 15’ travel lane eastbound. There is a 2’ shoulder along the south side of the roadway.

Utility poles are located at the north and south corners of the intersection.

In the study area, VT 22A follows a straight alignment.

The VT 22A northbound approach to the study intersection has an uphill grade of 10% from Otter Creek,, the VT 22A southbound approach has a downhill grade of 8% from downtown, and the MacDonough Drive approach has an uphill grade of 9%.

The grade on VT 22A has some important implications. First, the grade limits sight distances from the side streets. In addition, installation of a signal at this location would impact traffic on VT 22A significantly. Southbound stopping traffic (from downtown) would have to break on a downhill and northbound starting traffic (from Otter Creek) would have to start on an uphill. The impact of the grade would be magnified by trucks, a large proportion of the traffic. While more strenuous on engines during most of the year, winter conditions could make these maneuvers nearly impossible.

All roadways within the study area are posted at 25 miles per hour.

There are two existing signalized intersections at the VT 22A intersections with Green Street and Monkton Road. The Green Street intersection is approximately 630 feet north of the South Water Street-MacDonough Drive intersection. Given this proximity, coordination should be considered with a possible traffic signal at the South Water Street-MacDonough Drive intersection. The traffic signal at Monkton Road is approximately 2,100 feet (0.4 miles) east of the South Water Street-MacDonough Drive intersection and 1,500 feet east of Green Street (0.25) miles. Coordination should also be considered with the Monkton Road intersection, although it will be less critical.

2.3 PEDESTRIAN AND BICYCLE FACILITIES

The City of Vergennes has a well connected sidewalk network and sidewalks are provided along most of the streets. Figure 8 shows the location of bicycle and pedestrian facilities along VT 22A. The one critical gap in the sidewalk network near the study intersection is on the north side of VT 22A between the MacDonough Drive and Canal Street. As noted in Figure 8, the City has plans to construct a new sidewalk to close this gap.

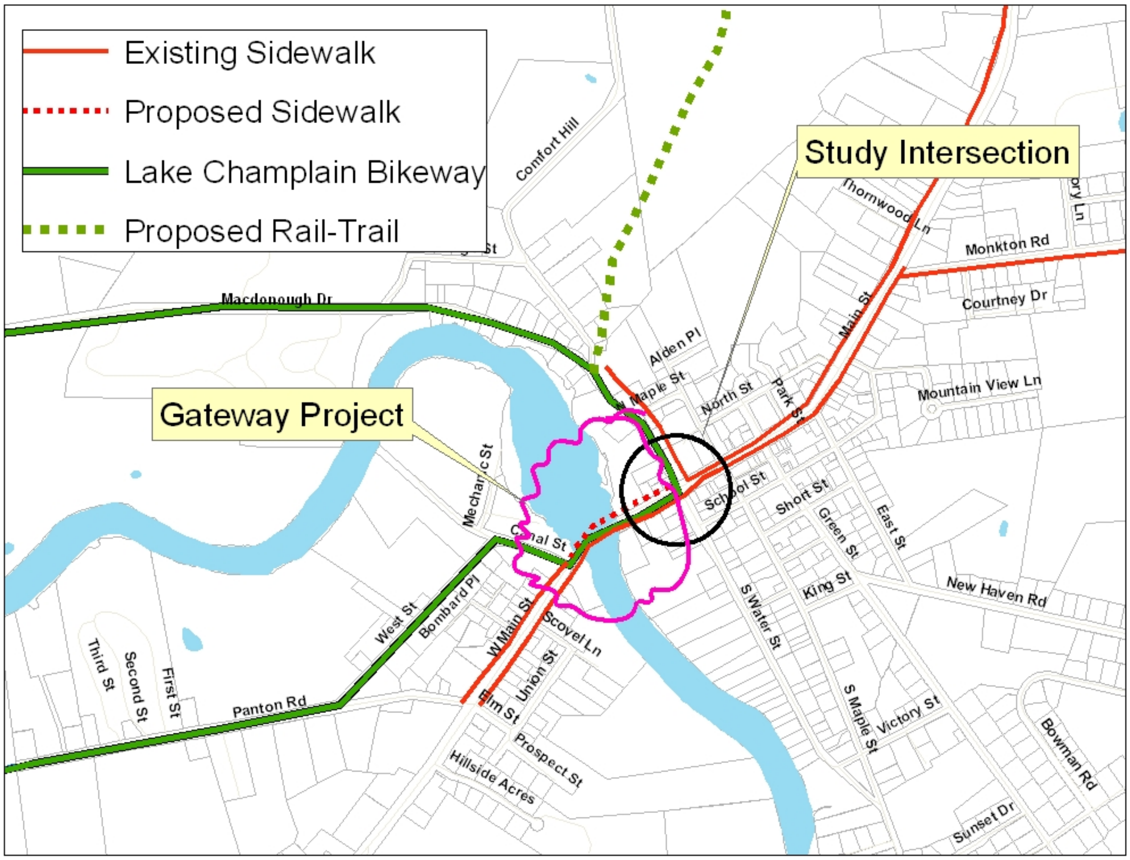
There are cross-walks at the study intersection as illustrated in Figure 7 above.

As one book-end of the CBD, this intersection currently sees a significant pedestrian volume. As the Gateway Project and other redevelopment efforts at and around the Otter Creek are implemented, the number of pedestrians and cyclists will increase.

Vergennes lies along the Champlain Bikeway – a network of roadways that have been identified as a bike route that entirely circumnavigates Lake Champlain. MacDonough Drive and VT22A are part of this network and many bike routes are based from Vergennes.

The final design for this intersection will need to accommodate significant pedestrian and cyclist traffic.

Figure 8:Bicycle and Pedestrian Facilities Along VT 22A



3.0 TRAVEL DEMAND

3.1 TRAFFIC VOLUMES

Average Annual Daily Traffic (AADT) Volumes

Figure 9 shows the 2005 Average Annual Daily Traffic (AADT) volumes throughout the study area. These traffic volumes are based on data collected by VTrans and adjusted to 2005 average annual daily conditions. AADT volumes are shown at various points along the VT 22A corridor as well as along significant corridor connections.

The graphic shows that the highest traffic volumes along the corridor can be found along VT 22A within the downtown which has an estimated AADT of 11,236 at its highest volume and 9676 closer to the study intersection. MacDonough Drive has an estimated 2005 AADT of 1,144 and South Water Street has an estimated 2005 AADT of 500.

Figure 9: 2005 AADT at Locations along and Adjacent to Study Corridor

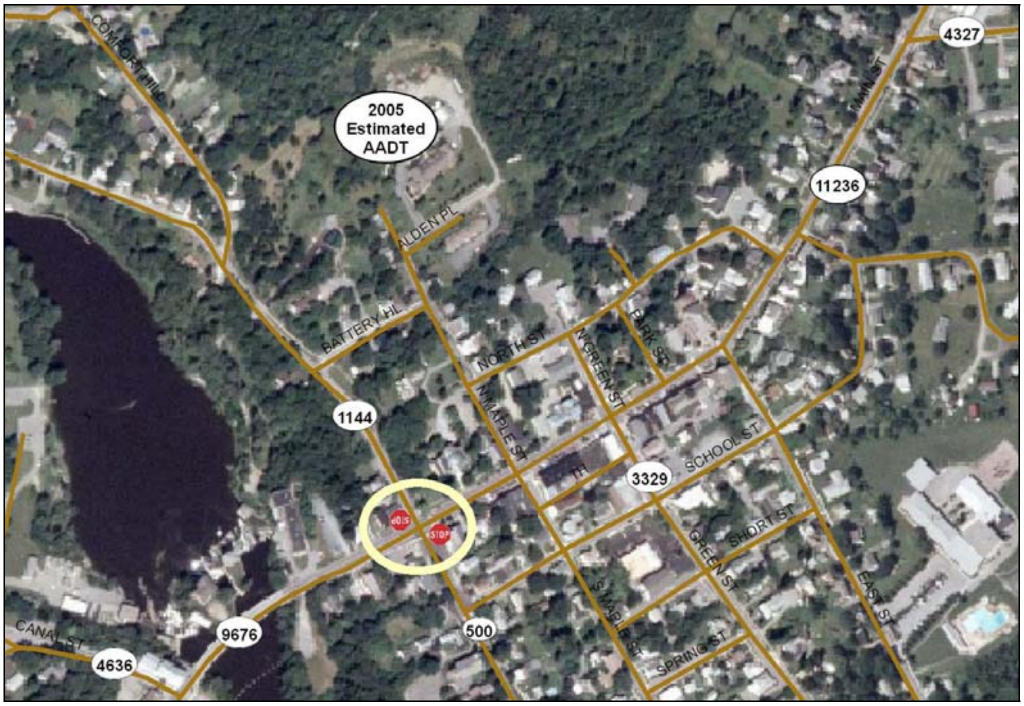
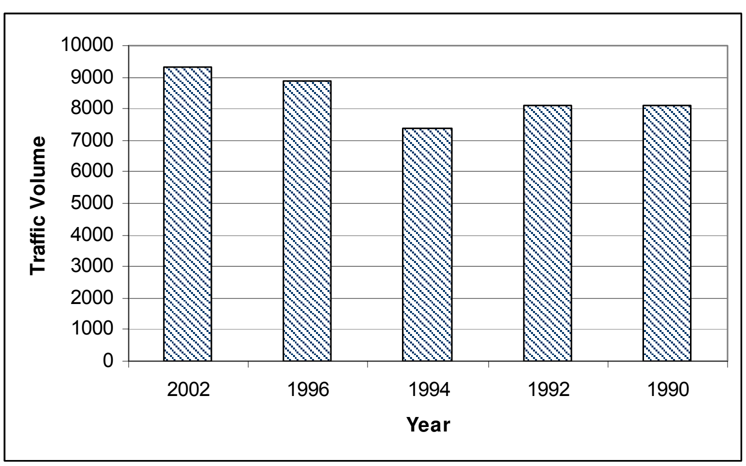


Figure 10 below shows historical AADT volumes along VT 22A just southeast of the VT 22A-Monkton Road intersection. This location shows a level trend in the early 1990's, decreasing through the mid-1990's, then increasing to 2002.

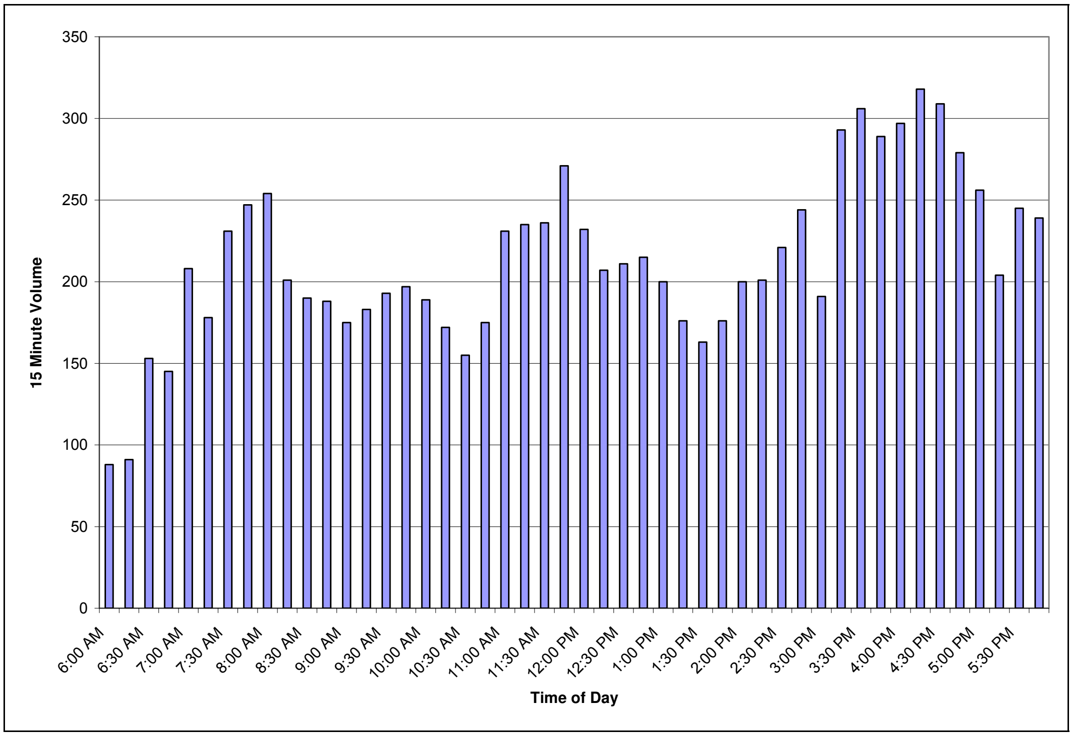
Figure 10: Historical AADT on VT 22A



Traffic Variations throughout the Day

A twelve hour count was conducted at the study intersection by VTrans. The raw traffic count data are presented below in Figure 11 illustrating the variation in volume throughout the day.

Figure 11: Variation in Traffic Volume throughout the Day at the Study Intersection



As illustrated above, volumes at this location get larger throughout the day with noticeable peaks at three times – the AM peak hour (7:30-8:30 AM), the midday hour (11:00 AM –Noon), and the PM peak hour (4:00 – 5:00 PM).

3.2 TRUCK TRAFFIC

Figure 12 illustrates the hourly variations in medium and large trucks on VT 22A throughout the day based on a vehicle classification count conducted by VTrans south of Monkton Road. Large trucks have a separate tractor and trailer and can be as long as 72 feet. Medium trucks generally are single unit vehicles such as package delivery trucks (UPS for example) and the types of trucks that deliver beverages to convenience stores.

The number of trucks traveling on VT 22A peaks during the morning rush hour and remains relatively constant until dropping off after 6:00 PM. As noted in Table 2, approximately 400 large trucks per day travel along VT 22A. There are very few large trucks traveling on South Water Street or MacDonough Drive.

Figure 12: Hourly Variations in Medium and Heavy Trucks on VT 22A

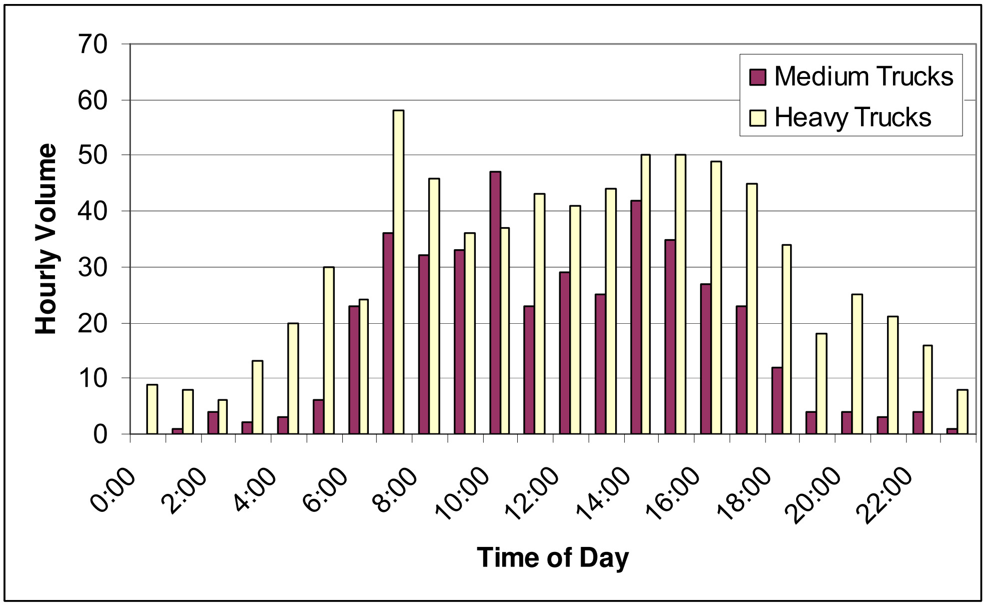


Table 2: Large Truck Trips per Day

	Large Trucks/Day
VT 22A	400
MacDonough Dr.	8
South Water	2

Trucks in this area are limited by turning radii at the study intersection. While the Vermont Truck Network, which includes VT 22A, should be passable for trucks as long as 72 feet (WB-67), MacDonough Drive and South Water Street do not have that requirement. However, the turning radii for the right turn from VT 22A onto South Water is too small for a passenger car and the turning radii for the right turn from MacDonough Drive onto VT 22A is too small for anything larger than a passenger car.

4.0 CONGESTION, SAFETY, AND ACCESS MANAGEMENT

4.1 CONGESTION ANALYSIS

Development of 2005 AM and PM Peak Hour DHV Volumes

Traffic counts were conducted by VTrans on Thursday, September 2, 2004. The ground count has been adjusted in two ways.

First, the ground counts were adjusted to reflect the design hour volume (DHV) of traffic. The design hour is the 30th highest hour of traffic for the year, the design standard in Vermont. Data from the intersection count were compared to estimated DHVs based on AADT counts conducted by VTrans on MacDonough Drive and South Water Street in 2002. The 2002 AADT counts were grown to 2004 and then converted to DHVs using the appropriate factors published by VTrans in the 2004 Red Book[1]. Taking the average of these adjustments resulted in a DHV factor of 0.96 (The ground count was multiplied by 0.96 to produce the DHV).

The second adjustment accounts for annual growth in background traffic. The 2004 DHV at the intersection was factored to 2005 using the 1.02 growth factor for Rural Primary and Secondary roadways published in the VTrans 2004 Red Book.

Development of Preliminary 2015 DHV Volumes

The ten year traffic forecast from 2005 to 2015 includes background growth plus traffic from anticipated development projects. The background growth of 16% between 2005 and 2015 is the statewide average for rural primary and secondary highways published in the VTrans 2004 Red Book. In addition to background growth, the projections include traffic from the following development projects:

- A 30-acre business park along Panton Road,
- A 50-unit subdivision between Hopkins Road and Hillside Road,
- Redevelopment of the Shade Roller building into 1st floor retail, 2nd floor office and 3rd floor housing, and
- A specialty retail building in the vacant parcel across from the Shade Roller building.

Traffic from these projects was estimated and then added explicitly to the adjusted count data to establish the 2015 design hour volumes. Appendix A contains the raw traffic volumes, adjustment factors, traffic from other developments, and the final volumes used in the analysis.

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[1] "Continuous Traffic Counter Grouping Study and Regression Analysis Based on 2004 Data"; Vermont Agency of Transportation ; Traffic Research Unit; April 2005.

LOS Methodology

Level of service (LOS) is a qualitative measure rating the operating conditions as perceived by motorists driving in a traffic stream. The *Highway Capacity Manual*[1] (HCM) defines six grades of LOS at an intersection, based on the control delay per vehicle.

Table 3 shows the various LOS grades, qualitative descriptions, and quantitative definitions for unsignalized and signalized intersections.

Table 3: LOS Criteria for Signalized and Unsignalized Intersections

LOS	Characteristics	--Unsignalized-- Total Delay (sec)	--Signalized-- Total Delay (sec)
A	Little or no delay	≤ 10.0	≤ 10.0
B	Short delays	10.1-15.0	10.1-20.0
C	Average delays	15.1-25.0	20.1-35.0
D	Long delays	25.1-35.0	35.1-55.0
E	Very long delays	35.1-50.0	55.1-80.0
F	Extreme delays	> 50.1	> 80.1

The VTrans policy on LOS states that:

- Minor Arterials in urban or village areas will generally be designed for a level of service C or better. However, in heavily developed urban areas, reduced level of service criteria such as D or E may be appropriate as judged on a case by case basis."
- "Collectors in urban or village areas will generally be designed for a level of service D or better. However, in heavily developed village or urban areas, level of service E may be appropriate as judged on a case by case basis.

VT 22A is a minor arterial and MacDonough Drive is a collector. Therefore, LOS D is a reasonable design target for this intersection. LOS E may also be acceptable if modifications to achieve a better LOS have unacceptable impacts to community character, or cultural, natural, or historic resources.

Level of Service Results

Table 4 presents the LOS results for the study intersection for the 2005 and 2015 AM and PM peak hours. The analysis assumes no changes to the existing lane configuration or intersection control. During the 2005 and 2015 AM peak hour all approaches to the intersection operate at acceptable levels of service. During the 2005 PM peak hour, the South Water Street approach operates at LOS

[1] Transportation Research Board, National Research Council, *Highway Capacity Manual: Special Report 209,* Washington DC, 2000.

E. By 2015, the LOS is projected to worsen to LOS F on South Water Street and LOS E on MacDonough Drive.

Table 4: LOS Results for the Study Intersection

Approach	2005 AM		2015 AM		2005 PM		2015 PM	
	LOS	Delay (seconds)	LOS	Delay (seconds)	LOS	Delay (seconds)	LOS	Delay (seconds)
Eastbound: MacDonough Drive	C	20	C	24	D	30	E	49
Westbound: South Water St	C	22	D	30	E	49	F	>100
Northbound: VT 22A	A	1	A	1	A	1	A	1
Southbound: VT 22A	A	1	A	1	A	1	A	1

Detailed level of service worksheets are contained in Appendix B.

4.2 SAFETY ANALYSIS

Crash Histories

Crash histories were collected from VTrans (January 1998-December 2002) in the study area. VTrans maintains a statewide database of all reported crashes along all state highways and federal aid road segments.[1]

A reportable crash is a collision with at least one of the following results caused by the event:

- property damage exceeding $1,000
- personal injury
- fatality

Four reported crashes occurred between 1999 and 2003 at the study intersection. This number is not sufficient to indicate an existing deficiency.

High Crash Locations

In order to be classified as a High Crash Location (HCL), an intersection or road section (0.3 mile section) must meet the following two conditions:

1. It must have at least 5 crashes over a 5-year period
2. The Actual Crash Rate must exceed the Critical Crash Rate.

[1] This data is exempt from Discovery or Admission under 23 U.S.C. 409.

Based on the most current crash data available from VTrans (1998-2002), the VT 22A-Macdonough Drive-Water Street intersection is not a High Crash Location.

Sight Distances

At the study intersection, speeds are posted at 25 miles per hour. For that speed, 150' of stopping sight distance and 275' of corner sight distance are recommended. Because of the grade on VT 22A, the northbound traffic from Otter Creek requires a stopping sight distance of 130' and the southbound traffic from downtown requires stopping sight distance of 180'.

Because the on-street parking is too close to the intersection, stopping sight distance is limited for southbound vehicles on VT 22A encountering traffic exiting MacDonough Drive. Removing parking would allow for sufficient stopping sight distance.

The on-street parking north of the intersection also limits corner sight distance. Looking south, there is adequate corner sight distance. Looking north, if the imposing parking were removed, corner sight distance would still be limited by the crest curve by about 60'.

Figure 13 and Figure 14 show photographs taken in the field of some of the approximate sight distances study intersection.

Figure 13: Sight Distance Photographs from MacDonough Drive

View Along VT 22A Towards the North	View Along VT 22A Towards the South

Figure 14: Sight Distance Photographs from Water Street

View Along VT 22A Towards the South

View Along VT 22A Towards the North

4.3 ACCESS MANAGEMENT

As illustrate in Figure 15 through Figure 17, three of the 4 corners have poorly defined curb cuts (the northwest corner of VT 22A-MacDonough Drive has no commercial access points). The access to these properties are not well defined which can cause confusion and multiple conflict points between entering and exiting vehicles.

In addition, driveways should be located as far away from street junctions as possible to avoid conflicts with traffic within the functional area of the intersection. The functional area provides storage space and maneuvering room to and from turning lanes for approaching vehicles. All of these locations include pull-in parking that requires users to back into the intersection to exit.

Figure 15: The Eastern Corner of the Intersection

Figure 16: The Southern Corner of the Intersection

Figure 17: The Western Corner of the Intersection

5.0 NATURAL AND CULTURAL RESOURCES

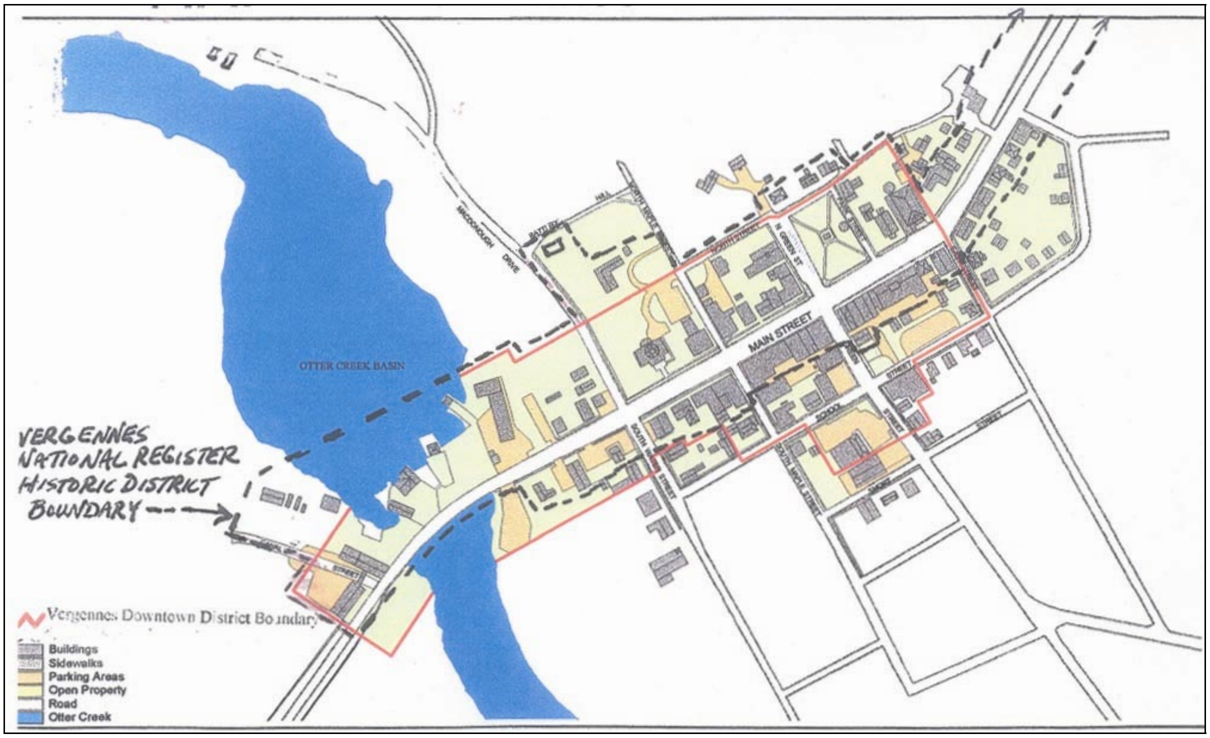
This section provides an overview of historic and archeological resources, wetlands, steep slopes, and endangered species in the study area. New sidewalks or reconfiguration of existing parking lots could be affected by the presence of these resources. The goal of any design project is to avoid impacts if possible or minimize impacts if other options are not reasonable.

5.1 HISTORIC AND ARCHEOLOGICAL RESOURCES

An Archeological Resources Assessment (ARA) will need to be conducted for the proposed project area.

The study area is located within the Vergennes Village Historic District (See Figure 18), which is listed in the National Register of Historic Places.

Figure 18: Vergennes Historic District



An historic resource review conducted according to Section 106 of the National Historic Preservation Act is required for any changes to this intersection. The same type of review would also be required for projects identified in this plan for which federal funds are used.

The buildings on the eastern and western corners of the study intersection are considered historic.[1]

Three of the four corners of the intersection are within City-designated historical/archaeologically sensitive areas. The northern corner is within an area assumed to be a location of a War of 1812 battery. The southern corner is included in the area identifying Fort William and the western corner is in the area identified as MacDonough's Shipyard.

5.2 WETLANDS

Class II wetlands, including a 50-foot protective buffer, are protected under the Vermont Wetland Rules. Any intrusion into the identified wetland or its buffer requires a Conditional Use

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[1] Vergennes Historic District Listed in the National Register of Historic Places (from Vermont Division for Historic Preservation) *Historic Architecture of Addison County*, 1992.

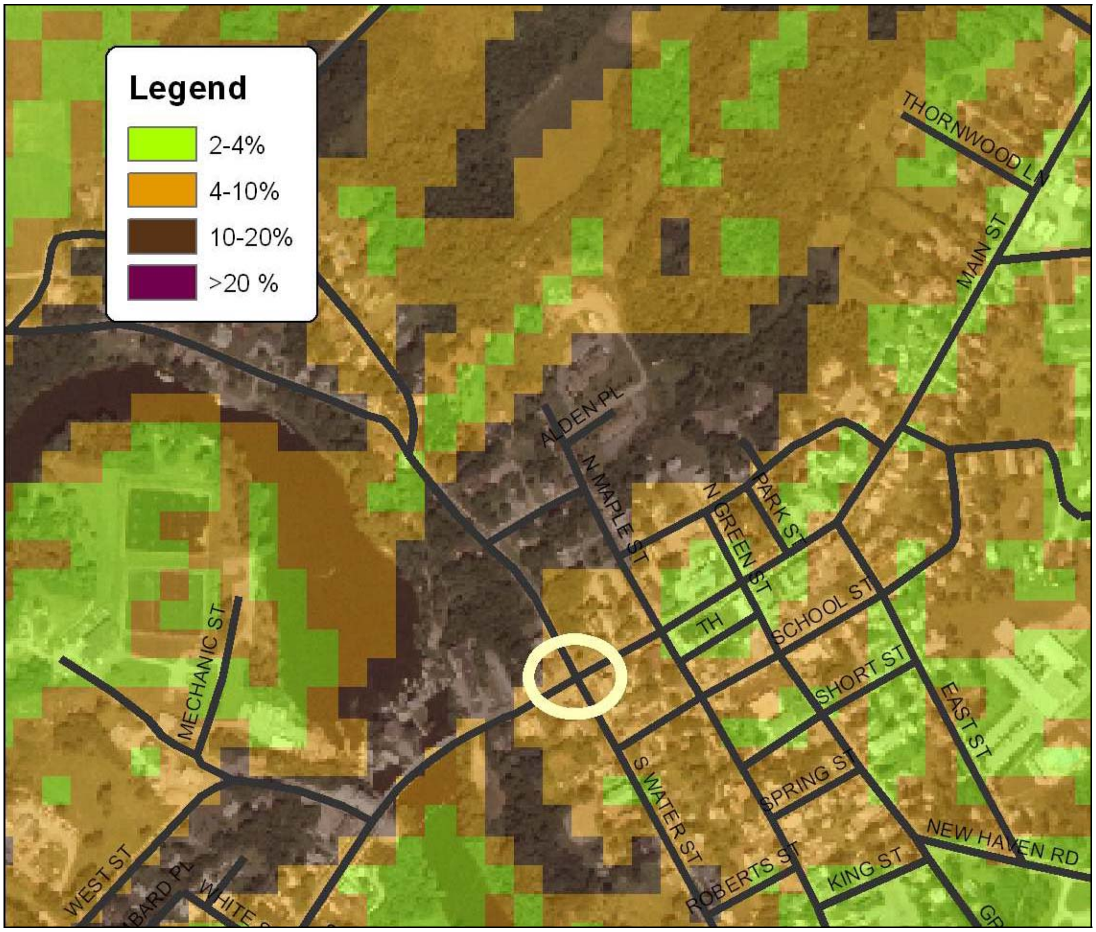
Determination from the Water Quality Division of the Department of Environmental Conservation. An examination of the Class II wetlands boundaries (Figure 19), as identified in the Vermont Significant Wetlands Inventory shows no identified wetlands within the study area. However, a few Class II wetlands have been identified just north of the study area along MacDonough Drive and west of the study area along the Otter Creek.

Figure 19: Class II Wetlands Boundaries and 50-foot Buffers Relative to the Study Area

5.3 STEEP SLOPES

A composite GIS image of the study area showing slopes generated from US Geologic Survey data was examined for the presence of steep slopes (i.e. greater than 10%) and is shown in Figure 20.

Figure 20: Steep Slopes in the Project Vicinity



Based on this data, a majority of the study area has slopes greater than 4%. The study intersection is on a steep slope. The center of Vergennes' downtown is the high point sloping sharply down to the Otter Creek.

5.4 ENDANGERED SPECIES

There are no rare, threatened, or endangered species or significant communities as identified by the Vermont Department of Fish and Wildlife in the vicinity of the study area. The nearest identified location of a rare or threatened species is an invertebrate species in the Otter Creek northwest of the project.

There are no deer wintering areas in the vicinity of the study area as identified by the Vermont Agency of Natural Resources. Deer wintering areas generally begin at the edge of mature coniferous tree cover. Any disturbance on identified deer wintering areas may require mitigation. The nearest identified deer wintering area is located southeast corner of Waltham, more than 3 miles away.

6.0 PUBLIC COMMENTS

A public meeting was held on September 22, 2005 at the Bixby Library. The consultants provided and overview of the project and summarized the findings of Sections 1.0 through 5.0. The meeting was attended by:

- Neil Curtis, Resident, DRB member;
- Carolyn Tallen, Library Clerk;
- April Jin, Mayor;
- Renny Perry, City Manager; and
- Rick Kehne, Addison County Regional Planning Commission

The following comments and questions were raised:

- The trucks cause lots of dust and noise for on-street eateries.
- All roads in Vergennes are within the city's jurisdiction but VT22A carries a state number and is a class 1 town highway. Does the town need state approval to modify VT22A? Renny commented that it is a blend of shared responsibility and City does need permission but also receives help in major maintenance.
- In bad weather folks might not make it up the hill.
- There isn't more traffic, just more trucks.
- Even in good weather trucks have to stop often back down the hill and start again to make it up.
- The tankers and trucks carrying hazardous materials are of the largest concern.
- The delays presented in the project seemed about right. Citizens rarely turn left from South Water Street, and instead use the roadway network to get to the Green Street traffic light.
- The problem with a signal is trucks have to stop and start and then we hear the grinding. Renny added that trucks would probably need to be stopped halfway back or entirely before the bridge to get a sufficient start.
- The crash history was questioned. VTrans records only show 4 crashes in 5 years but many present thought there were many more, often requiring formal assistance from fire, ambulance or wreckers. Many fender benders.
- The LOS isn't all that bad relative to potential expense of a signal but many factors are not measured including future bike/ped usage, the impact of the portage by the bridge, and future use of crosswalks. A signal at this location would provide traffic breaks which would provide more safety to cyclists and pedestrians at the bridge.
- The sight distance is very limited, especially with a left-turner present.
- Parking in this area is important to maintain.

- The intersection is avoided even when coming down the hill – it is the confusion and friction, not congestion that is the biggest issue.
- South Water Street is a side road but it is too wide, undefined, no curbs, parallel parking. Could there be angled parking? A median down the center? Trucks hang out in the road.
- Could we shift the right-angle parking in front of the market down? The curb-cut for the apartments is too wide. Could it be narrowed?
- If confusion was cleaned up at this intersection, would you still want a signal? Yes, for pedestrians down below. If a pedestrian light system was installed, would you still want a signal here? Don't know.
- The old buildings down by the bridge are being bought/renovated. That will increase pedestrian traffic up the hill.

7.0 PURPOSE AND NEED STATEMENT

The purpose and need statement is a summary of the context and issues related to the project that justifies a need for action. It is based upon the analyses of existing and future conditions presented above in Sections 1.0 through 6.0, and incorporates the comments received at the September 22, 2005 public meeting. Alternative designs will be evaluated relative to their ability to satisfy the project's purpose and need statement.

7.1 PROJECT PURPOSE

The purpose of this project is to improve safety and mobility for vehicles, pedestrians, and cyclists traveling through the VT 22A-South Water Street-MacDonough Drive intersection.

The intersection forms the junction of a state highway and two local roads. It is a gateway to the central business district and located in the middle of a long, 8-10% grade. VT 22A is part of the Vermont Truck Network and carries roughly 400 large trucks per day. Traffic flow through the intersection is also affected by vehicles accessing adjacent properties through poorly defined curb cuts.

The high truck volume, steep grades, and surrounding access management deficiencies create operational and safety problems that will be exacerbated as congestion increases in the future. The intersection is not identified as a High Crash Location by the Vermont Agency of Transportation but has a local history of frequent crashes.

The Otter Creek is located just south of the intersection and is an important recreational and cultural resource. Three of the intersection's four corners are within the City's designated historic district. Solutions must be designed in a manner that minimizes impacts to, or possibly even enhances, these community resources.

7.2 PROJECT NEEDS

Land Use and Cultural Resources:

- The study area is located at a gateway to the central business district of Vergennes which is characterized by a dense mixture of retail, office, residential, and institutional uses. In addition to retail shops and restaurants, the Bixby Library, city offices, Opera House, a house of worship, and central green are all located just northeast of the project intersection.
- The Otter Creek and its basin are important to the residents and visitors to Vergennes.
- Three of the intersection's four corners are within the City's designated historic district.

Design Issues:

- VT 22A has an 8-10% grade on its approaches to the intersection. In addition, MacDonough Drive has a 9% grade falling away from the intersection. These grades impact travel speeds on the roadways and sight distances at the intersection.
- Three of the four intersection corners have poorly defined curb cuts to adjacent properties. Vehicles turning into and out of these access points and parking areas conflict with through traffic and cause safety and congestion concerns.
- Parking along VT 22A contributes to limited sight distances at the intersection.
- The steep grade on VT 22A from the Otter Creek bridge to the intersection causes operational challenges for large trucks. If a large truck stops on the hill while waiting for a turning vehicle or a pedestrian, it can not re-start without backing up. This problem is aggravated further during winter driving conditions.

Traffic Volumes:

- There are approximately 12,000 vehicles per day passing through the study intersection. A significant percentage of this traffic is large trucks (approximately 400 large trucks per day). The number of large trucks is projected to increase. The large trucks are noisy as they climb VT 22A towards the intersection, and as brakes are applied on the descent. The trucks also need to accelerate as they climb the hill which creates the perception that they will not be able to stop as they approach the intersection.
- Traffic is projected to increase by 16% between 2005 and 2015.

Congestion:

- The South Water Street and MacDonough Drive approaches are controlled by stop signs while VT 22A operates freely.

- Levels of service for the AM peak period are acceptable for 2005 and 2015.
- During the PM peak hour in 2005, South Water Street is estimated to experience an average delay of 49 seconds per vehicle (LOS E).
- During the PM peak hour in 2015, poor level of service is projected on the MacDonough Drive approach with an average delay of 49 seconds per vehicle (LOS E) and South Water Street is projected to have an average delay exceeding 100 seconds (LOS F).
- Because VT 22A is not controlled by a stop sign or traffic signal, it operates under acceptable levels of service in all time periods and years of analysis.

Safety:

- VT 22A is not identified as a high crash location by VTrans. In the immediate vicinity of the study intersection, there were four crashes reported in the period 1998-2002.
- Residents and local police consider the intersection to be unsafe and note that there are many near crashes and multiple fender benders. These incidents are not included in the VTrans crash records.
- Sight distances at the study intersection are limited. Traffic traveling southbound on VT 22A does not have sufficient stopping sight distance to see vehicles exiting MacDonough Drive. Vehicles exiting South Water Street do not have adequate corner sight distance when cars are parked on VT 22A, to see on-coming southbound vehicles on VT 22A.

Bicycle and Pedestrian Facilities:

- The intersection serves by a well-connected network of sidewalks. Sidewalks are located on both sides of VT 22A northeast of the intersection, and on the east side of VT 22A southwest of the intersection. A sidewalk for the west side on VT 22A is planned as part of improvements to the Otter Creek Basin. Sidewalks are located on both sides of South Water Street. There is a sidewalk along the northern side of MacDonough Drive. Sidewalks are generally 4-5 feet wide, are separated from the travel lane by a green strip and have ramps to cross walks. Vehicles approaching the cross-walk across VT 22A on the downhill have a potential difficulty in stopping, especially in winter weather conditions that may cause safety concerns at this location.
- Improvements to the Otter Creek basin area, and redevelopment of buildings south of the Otter Creek, will increase pedestrian traffic along and across VT 22A at the study intersection.
- The Champlain Bikeway passes through the study intersection and the City is developing a multi-use rail-trail that will connect to MacDonough Drive just west of the intersection. As a result, the intersection needs to accommodate bicycle traffic.

PART II: ALTERNATIVES ANALYSIS AND RECOMMENDATIONS

In this part of the report, three alternatives are developed and evaluated relative to the issues identified in the purpose and need statement. Order of magnitude cost estimates are provided and potential impacts to natural and cultural resources are screened. Comments from meetings with adjacent land owners are summarized. A fourth alternative is presented based on the landowner comments. An implementation plan is provided that presents a phasing plan for the recommended alternative, costs for each phase, potential funding sources, and next steps.

1.0 DEVELOPMENT OF ALTERNATIVES

This section describes how the three alternatives were developed. Seven key areas for potential improvements are listed in Table 5 and identified in Figure 21.

Table 5: Intersection Design Components

Location (See Figure 21)	Description	Purpose
1	Traffic Signal	Address projected congestion and provide protected pedestrian crossings.
2	Truck-preemption device	Ensures trucks receive green time when they reach the intersection so they are not forced to stop on the hill.
3	Curbing and parking definition.	Provide clear definition for parking area to reduce confusion near the intersection.
4	Revise parking	Reduce blocking and potential conflicts between cars stopped at the intersection and cars entering and exiting parking spaces, discourage parked cars from baking into opposing lane.
5	Formalize parking with striping	Provide a clearly defined parking area for use by the customers of the gas station and the Small City Market
6	Install a median	Discourage vehicles from cutting across South Water Street too close to the intersection to reach the parking spaces in front of Small City Market with the goal of simplifying movements near the intersection.
7	Consolidate two lanes to one	Provide additional space to accommodate angled parking and reduce crossing distance for pedestrians.

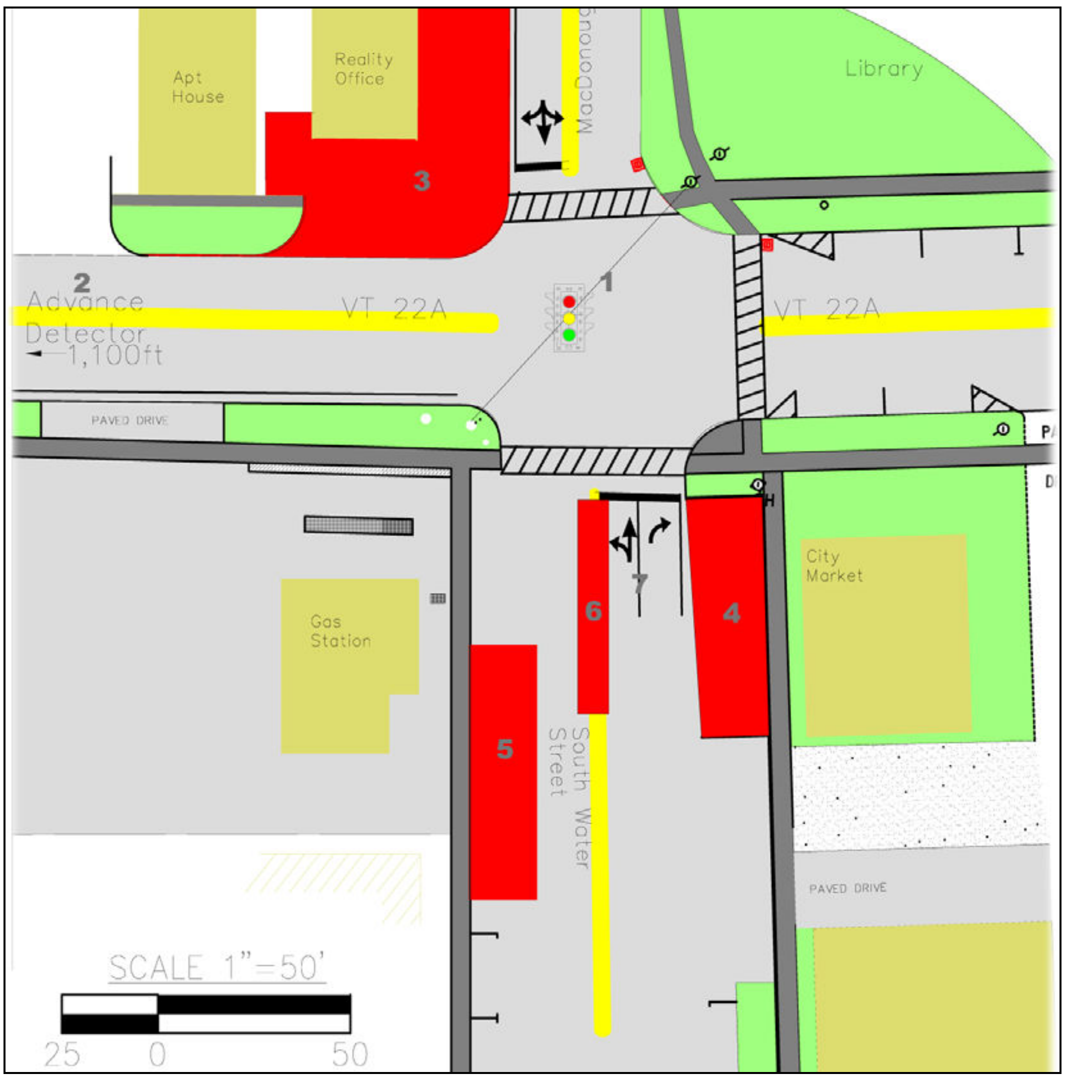
Table 6 shows how the various components have been combined into three overall alternatives. All three alternatives include modifications to the southwest corner at the real estate office, modifications to the parking in front of Small City Market, and parking changes in front of the gas station.

Alternative 1 and Alternative 2 assume that a traffic signal is installed with truck preemption. Alternative 1 includes the median and the reduction from two to one lane on the South Water Street approach to VT 22A. Alternative 2 does not include the median and maintains two lanes exiting South Water Street. Alternative 3 assumes that the intersection will continue to be controlled by a stop sign. Because a stop sign does not provide as much capacity as a traffic signal, two lanes will need to be provided on the South Water Street approach. With two lanes, there is not enough room to install a median.

Table 6: Alternatives

Location	Component	Do Nothing	Alternative 1	Alternative 2	Alternative 3
1	Traffic Signal	No	Yes	Yes	No
2	Truck Preemption	No	Yes	Yes	No
3	Southwest Corner: Define Parking and Intersection Corners at Real Estate Office	No	Yes	Yes	Yes
4	Revise Parking in front of Small City Market	No	Yes	Yes	Yes
5	Formalize Parking in front of Gas Station	No	Yes	Yes	Yes
6	S. Water Street Median	No	Yes	No	No
7	Reduce Lanes on S. Water Street	No	Yes	No	No

Figure 21: Intersection Design Components



2.0 ALTERNATIVES DESCRIPTIONS

2.1 COMPONENTS INLCUDED IN ALL ALTERNATIVES

The following components are included all three alternatives: modifications to the southwest corner at the real estate office, modifications to the parking in front of Small City Market, and parking changes in front of the gas station. This section provides additional discussion on the purpose and design of these proposed modifications.

Southwest Corner Parking and Access Modifications

The wide-open curb cut on the southwest corner causes confusion for drivers and pedestrians accessing the intersection. A sidewalk is striped but poorly defined. Parking on-site is necessary to meet zoning regulations and the needs of the real estate office. Providing definition between the travel lanes and parking area will provide clear messages and direction to drivers of vehicles passing through the intersection, drivers that are entering and exiting the parking area, and pedestrian and cyclists.

To balance these needs, four defined head-in parking spaces on MacDonough Drive, one parallel parking space along VT 22A, and curbing, sidewalks, and grass are recommended as shown in Figure 22.

Reconfigure On-Street Parking on South Water Street in front of Small City Market and the Gas Station

Currently, 90° angle, head-in parking is provided along South Water Street in front of the Small City Market. This parking is important to the market but its location is too close to the intersection. Because of the proximity, there are multiple conflict points between vehicles entering and exiting the parking spaces and vehicles passing through the intersection to and from South Water Street.

To reduce these conflicts, the curb at the intersection should be extended and the area filled in with grass as shown in Figure 23. The parking spaces should be converted to angled spaces and shifted away from the intersection. This change results in a decrease from 7 to 5 parking spaces on this side of the street.

On the opposite side of the street, on-street parking occurs but is not clearly defined through striping of any sort. In addition, the gas station has a wide curb-cut and a diesel gas pump. To access the diesel pump, vehicles must park in South Water Street.

Parking should be formalized into angled parking with striping and curbing as shown in Figure 23. The parking space angle on each side of the street has been established to maintain the necessary travel lane width. These parking spaces will also serve customers of the Small City Market that are traveling eastbound on South Water Street from VT 22A. Space for vehicles to access the diesel fuel pump is maintained in Figure 23.

Figure 22: Southwest Corner Modifications

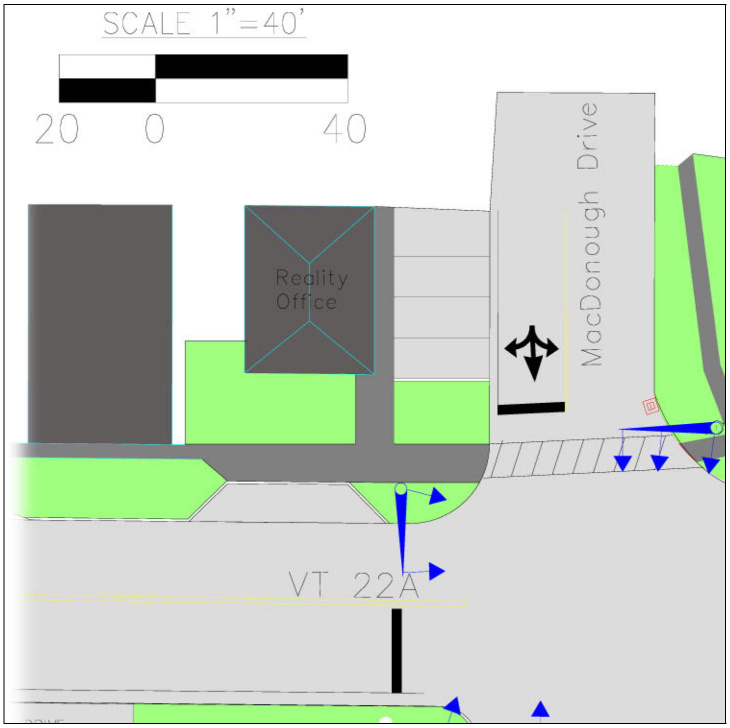


Figure 23: Parking Modifications along South Water Street

2.2 ALTERNATIVE 1 – TRAFFIC SIGNAL WITH SOUTH WATER STREET MEDIAN

Alternative 1 includes the installation of a traffic signal, a median on South Water Street, and reduction of the South Water Street approach to one lane. The concept plan is presented in Figure 25 on page 35.

This alternative includes the access and parking modifications to the southwest corner of the intersection and the changes to on-street parking along South Water Street as described above. The traffic signal would include actuated pedestrian signals at all cross-walks and a remote detector on the northbound VT 22A approach to ensure trucks will receive a green light when they arrive at the intersection.

This is the only alternative that includes the median on South Water Street. The intersection operates inefficiently in part because of the disorganized nature of the South Water Street approach. Drivers entering South Water Street from VT 22A tend to make sweeping turns in and out of the parking spaces in front of Small City Market. The median as proposed will not completely eliminate these movements. However, it would force those movements to occur further away from the street intersection and would also encourage vehicles to slow down as they enter South Water Street.

Existing conditions satisfy the need for a traffic signal at the intersection. This conclusion is based upon an analysis completed by RSG[1] of applicable traffic signal warrants as specified in the 2003 Manual on Uniform Traffic Control Devices (MUTCD). Existing conditions satisfy Warrant 1: Eight-Hour Vehicular Traffic Warrant and Warrant 2: Four-Hour Vehicular Traffic Warrant. The analysis is contained in Appendix C.

To justify installation of a traffic signal, it is only necessary to satisfy one warrant. However, the warrant analysis is advisory and the characteristics of the area should be considered before installing a traffic signal. This study is examining the overall implications for adding a signal.

While under the existing geometry VT 22A is projected to maintain LOS A, during the PM peak hour the South Water Street and MacDonough Drive approach are projected to operate at levels-of-service between LOS F and D respectively. Installing a signal would improve level-of-service on both side streets to LOS B through 2015.

To accommodate the operational needs of large vehicles, installing a video detector upstream, south on VT 22A that would only be activated by large vehicles is recommended. When the detector is tripped, it would recall the green signal back to V 22A. Figure 24 illustrates the video detector that is recommended. See Appendix D for additional information.

Figure 24: Video Detector

[1] *VT 22a-South Water Street Traffic Signal Warrant Analysis*, RSG, 15 March 2005

The location of the detector will depend on the time necessary to safely clear the side streets and the speed of trucks traveling north on VT 22A. Based on the intersection clearance and minimum green time required for the side streets, the detector should be 22 seconds away from the intersection. The speed of trucks will have a significant impact of how far back the detector should be located and should be verified with data collected in the field. Assuming the detector is 22 seconds away, its location will range between 800 and 1,100 feet south of the intersection, with speeds that range from 25 mph to 35 mph. The detector would be mounted on its own pole and connected to the controller with underground wires.

The traffic signal should also be coordinated with the existing traffic signal located on Green Street. The controller for the proposed traffic signal at South Water Street would serve as the master controller. A micro-wave radio transmitter would provide the connection and has been included in the cost estimate presented below.

2.3 ALTERNATIVE 2 – TRAFFIC SIGNAL WITHOUT SOUTH WATER STREET MEDIAN

Alternative 2 includes the installation of a traffic signal, maintains the two existing lanes on South Water Street, and does not include a median. The concept plan is presented in Figure 26 on page 36.

This alternative includes the access and parking modifications to the southwest corner of the intersection and the changes to on-street parking along South Water Street as described above. The traffic signal would include actuated pedestrian signals at all cross-walks, a remote detector on the northbound VT 22A approach to ensure trucks will receive a green light when they arrive at the intersection, and would be coordinated with the Green Street traffic signal.

This alternative will have more capacity than Alternative 1 because two lanes will be maintained on South Water Street. Because this alternative maintains the two lanes on South Water Street, there is not enough width to accommodate the median. Therefore, Alternative 2 will not address the problem of cross-cutting traffic.

2.4 ALTERNATIVE 3 – STOP CONTROL AND NO MEDIAN

Alternative 3 assumes that a traffic signal is not installed. Two lanes on the South Water Street approach will need to be maintained and a median is not provided. This alternative includes the access and parking modifications to the southwest corner of the intersection and the changes to on-street parking along South Water Street as described above.

The concept plan is presented in Figure 27 on page 37.

The projected level of service on South Water Street in 2015 during the PM peak hours is F with an average delay per vehicle of more than 100 seconds. This LOS projection assumes two lanes are provided on South Water Street. Therefore, if a traffic signal is not installed, two lanes should remain on the South Water Street approach. This alternative provides less capacity than Alternatives 1 and 2. Because it does not include the median, it does not help address the problem of cross-cutting traffic.

Figure 25: Alternative 1Traffic Signal and Median – Conceptual Design

Figure 26: Alternative 2 Traffic Signal no Median – Conceptual Design

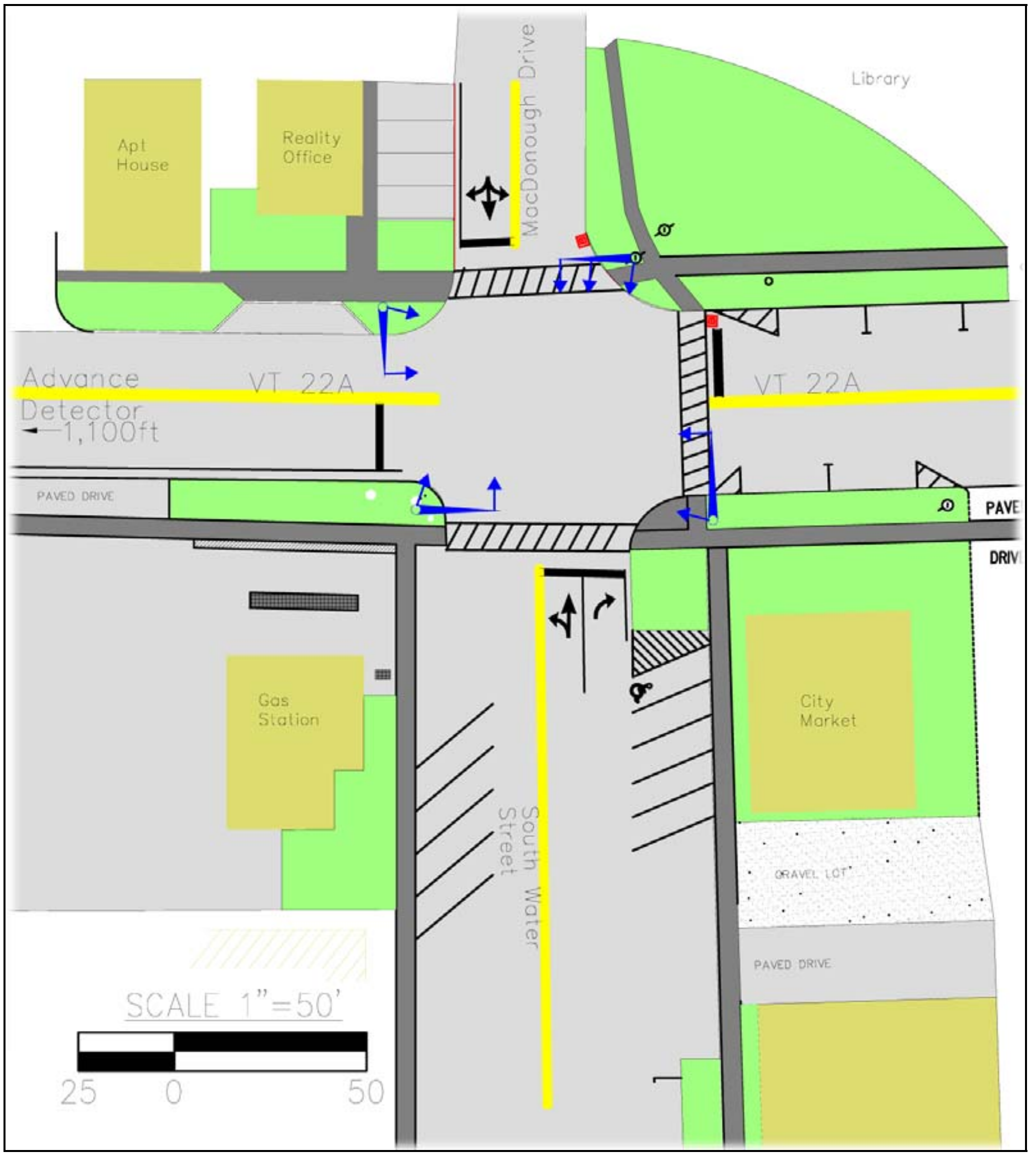
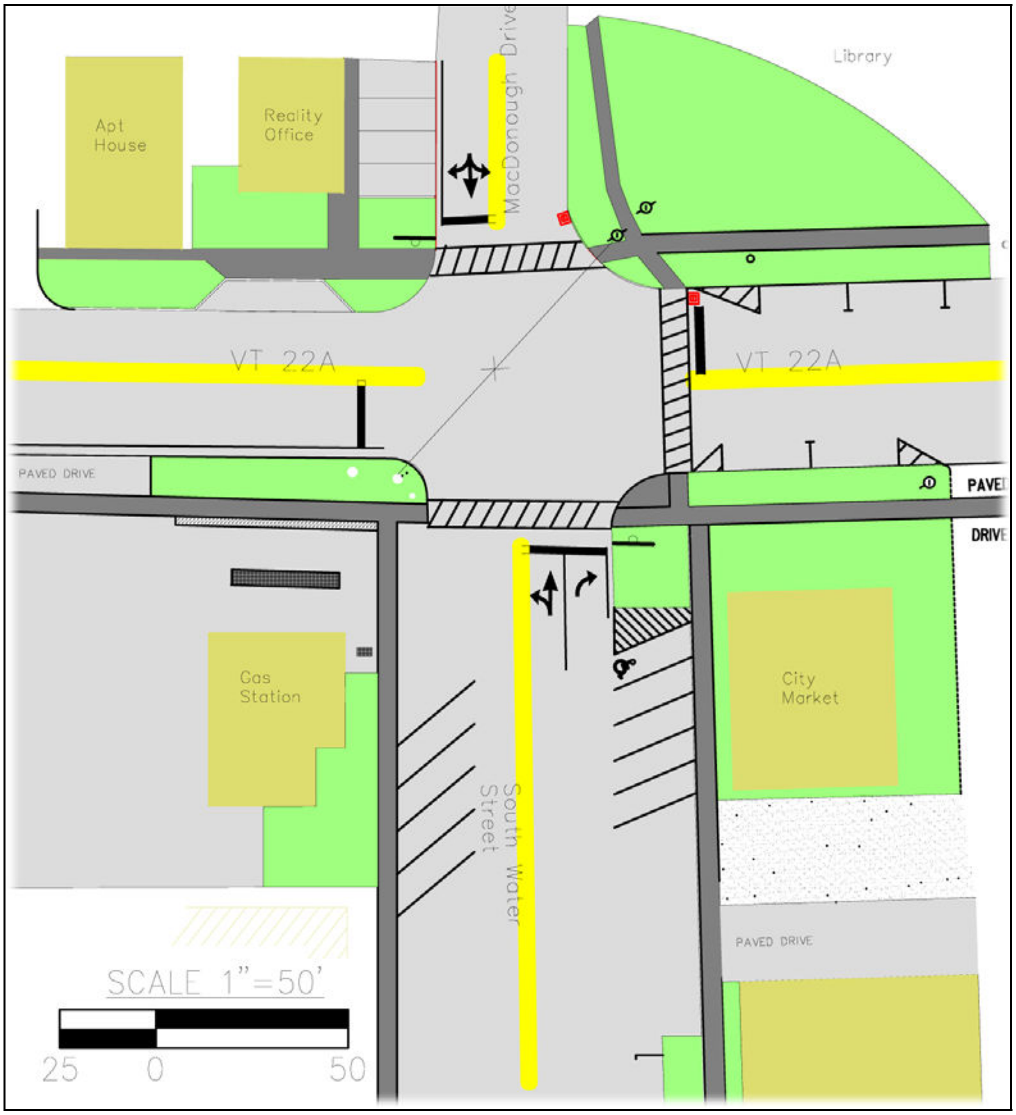


Figure 27: Alternative 3 Stop Signs no Median - Conceptual Design



3.0 EVALUATION OF ALTERNATIVES

Table 7 compares the three alternatives and the do-nothing option relative to 1) order of magnitude cost that include engineering, construction, contractor overhead and profit, and a thirty percent contingency; 2) engineering issues; 3) natural and cultural resource impacts, 4) local and regional issues; and 5) potential permits required.

Table 7: Alternatives Evaluation Matrix

		Alternative 0 Do Nothing	**Alternative 1** Signalization & Install median	**Alternative 2** Signalization & No Median	**Alternative 3** Stop Control & No Median
COST (order of magnitude)	Design, Permitting and Construction	$0	$240,000	$230,000	$34,000
	Annual Town Maintenance Costs (surface repair, plow, striping, signs, sweeping, etc.)	$0	$1,000	$1,000	$1,000
ENGINEERING	Traffic Safety	No Change	Improve	Improve	Improve
	Traffic Capacity	Worse over time	Adequate LOS	Slightly better than Alt 1	Worse over time
	Alignment Change	No Change	No Change	No Change	No Change
	Bicycle/Pedestrian Access	No Change	Improve	Improve	No Change
	Hydraulic Performance	No Change	No Change	No Change	No Change
IMPACTS	Agricultural Lands	No	No	No	No
	Archaeological	No	No	No	No
	Historic Structures/Sites	No	No	No	No
	Floodplain	No	No	No	No
	Fish and Wildlife	No	No	No	No
	Rare, Threatened & Endangered Species	No	No	No	No
	Public Lands	No	No	No	No
	Noise	No	No	No	No
	Wetlands	No	No	No	No
LOCAL & REGIONAL ISSUES	Community Character	No Change	Improve	Improve	Improve
	Economic Impacts	No Change	Potential	Potential	Potential
	Conformance to Regional Transportation Plan	No	Yes	Yes	Yes
	Satisfies Purpose & Need	No	Yes	Yes	Yes
PERMITS	Act 250	No	No	No	No
	401 Water Quality	No	No	No	No
	404 Corps of Engineers Permit	No	No	No	No
	Stream Alteration	No	No	No	No
	Conditional Use Determination	No	No	No	No
	Storm Water Discharge	No	No	No	No
	Shoreland Encroachment	No	No	No	No
	Endangered & Threatened Species	No	No	No	No
	State Historic Preservation Office Clearance	No	Potential	Potential	Potential
	NEPA Category	N/A	Categorical Exclusion	Categorical Exclusion	Categorical Exclusion
LOCAL MATCH?		No	Yes	Yes	Yes

The alternatives are most distinguishable within the following areas:

- **Cost.** Alternative 1 (Traffic Signal with Median) has the highest overall cost because it includes all of the components and addresses all of the issues. Alternative 3 (Stop Signs no Median) has the lowest cost because it includes the fewest components.
- **Safety.** Alternative 1 (Traffic Signal with Median) offers the best overall safety improvement. It provides protected exits from South Water Street and MacDonough Drive, provides pedestrian phases, and includes the median which will encourage vehicles to enter South Water Street at slower speeds and reduces conflicts with vehicles parking in front of the Small City Market.
- **Traffic Capacity.** Alternative 2 (Traffic Signal no Median) provides the most capacity for moving vehicles because it includes a traffic signal and maintains two lanes on South Water Street. Alternative 1 also provides adequate capacity for vehicles and represents a significant improvement relative to Alternative 3 (Stop Signs no Median).
- **Pedestrian Access and Connectivity.** Alternative 1 (Traffic Signal with Median) provides the most improvements for pedestrians. It includes pedestrian signals and by eliminating one lane on South Water Street, reduces the roadway crossing distance. The median will also improve safety for pedestrians by providing a refuge space between lanes and helping to slow traffic entering from VT 22A. Alternative 2 (Traffic Signal no Median) also provides the pedestrian signals but the crossing distance remains unchanged and the traffic calming benefits of the median are not provided. Alternative 3, (Stop Signs no Median) does not provide any additional benefits for pedestrians relative to a Do-nothing scenario.

Areas where the three alternatives do not differ significantly:

- **Community Character.** All three alternatives include the modifications to parking, access, and green space that will improve the aesthetics of the intersection.
- **Potential Economic Impact.** The number of on-street parking spaces has not changed due to any of the alternatives. However, the changes proposed on South Water Street decrease the number of spaces directly in front of the Small City Market from seven to five. This decrease is compensated for by increasing and formalizing the number of parking spaces on the opposite side of the street. Shifting some parking to the opposite side of the street may be perceived as an inconvenience and the median proposed in Alternative 1 may also be perceived as making the Small City Market less accessible. However, it is unlikely that these changes will result in any significant change in sales.
- **Cultural and Natural Resource Impacts.** With the exception of the modifications recommended to the parking lot for the real estate office on the southwest corner of MacDonough Drive, all of the components would be constructed within the City's existing right-of-way which has been disturbed many times over. Based on the preliminary screening presented in Part I of this report, there does not appear to be any significant cultural or natural resource constraints for any of these alternatives.

4.0 LANDOWNER MEETINGS

The following comments were offered by the owners, or their representatives, of businesses located on the three corners of the intersection. The business owners were provided a copy of Project Memo #2- Alternatives Analysis and Preliminary Recommendations (30 Jan 2006). The memorandum presented the three alternatives described above all of which would affect the parking and access configurations to the three businesses.

Phil O'Brien, owner the gas station on the southeast corner of VT 22A-South Water Street, was interviewed on February 23, 2006. Corey, owner of the Small City Market on the northeast corner, and Richard Esty, representing the Caldwell Banker Real Estate Office on the southwest corner, were interviewed on March 2, 2006.

Comments from Phil O'Brien (Gas Station Owner)

- Gas is delivered daily to the station in smaller trucks (not tractor-trailers). Therefore the changes suggested to the intersection will not affect delivery of gas.
- The proposed angled parking spaces on South Water Street in front of the gas station may block access for trucks that use the diesel fuel pump.
- Mr O'Brien would not object if the City upgrades the sidewalk on South Water Street in front of his business.
- Mr. O'Brien is moderately concerned about the effect of the median proposed on South Water Street (Alternative 1) and does not support the installation of the median.
- Mr. O'Brien pointed out that it is not uncommon for large trucks to drop and axle when traveling northbound on VT 22A up the hill. He has had to tow many trucks when that occurred.

Comments from Richard Esty (Real Estate Office)

- The primary concern was a need to maintain a total of 6 parking spaces to accommodate: three employees, one space for the adjacent apartment building, and two for customers. The plans show 4 spaces on MacDonough Drive and one on-street parking space along VT 22A in front of the building.
- Renny stated that the current thinking for the sidewalk project planned for that side of VT 22A is that it will be directly adjacent to the street. If that design is pursued, the on-street parking in front of the real estate office will not be possible. Head-in parking on VT 22A was discussed, but Joe Segale felt that allowing vehicles to back into VT 22A was not ideal from a safety perspective. If the sidewalk's alignment could be shifted, it appears that two on-street parking spaces on VT 22A would be possible. This would allow a total of 6 spaces for Real Estate Office.

Comments from Corey (Small City Market)

- If a traffic signal is installed with the remote vehicle detector as described, will it cause confusion for existing drivers because the timing will be constantly changing? Joe Segale explained that fixed timing plans are now rare and most traffic signals are fully actuated meaning the green time changes to accommodate traffic demand.
- The most profitable time for the store is the AM and PM peak hours. The store is a convenient market and needs to be easily accessible. People stop there because its fast and that is why they are willing to pay higher costs for some of the products.
- The angled parking and median will probably not be effective at controlling the way vehicles enter and exit the store. Therefore, the median will probably not be effective at reducing potential conflicts.
- The real safety concern at the intersection is along VT 22A. Can medians be installed on the VT 22A approaches? These would help to slow traffic and would provide pedestrian refuges.
- The plans show a total of five parking spaces in front of Small City Market, a reduction of two compared to existing conditions. Corey said that he could probably live with 6 spaces if necessary.
- The Small City Market leases the building. Corey is hoping to purchase the building and wants to construct a small addition on the side facing the parking lot to accommodate new cooler space. He would take over one of the apartments as an office space as well. The addition will result in the loss of one on-site parking space.

4.1 ALTERNATIVE 4 – TRAFFIC SIGNAL WITH MEDIANS ON VT 22A

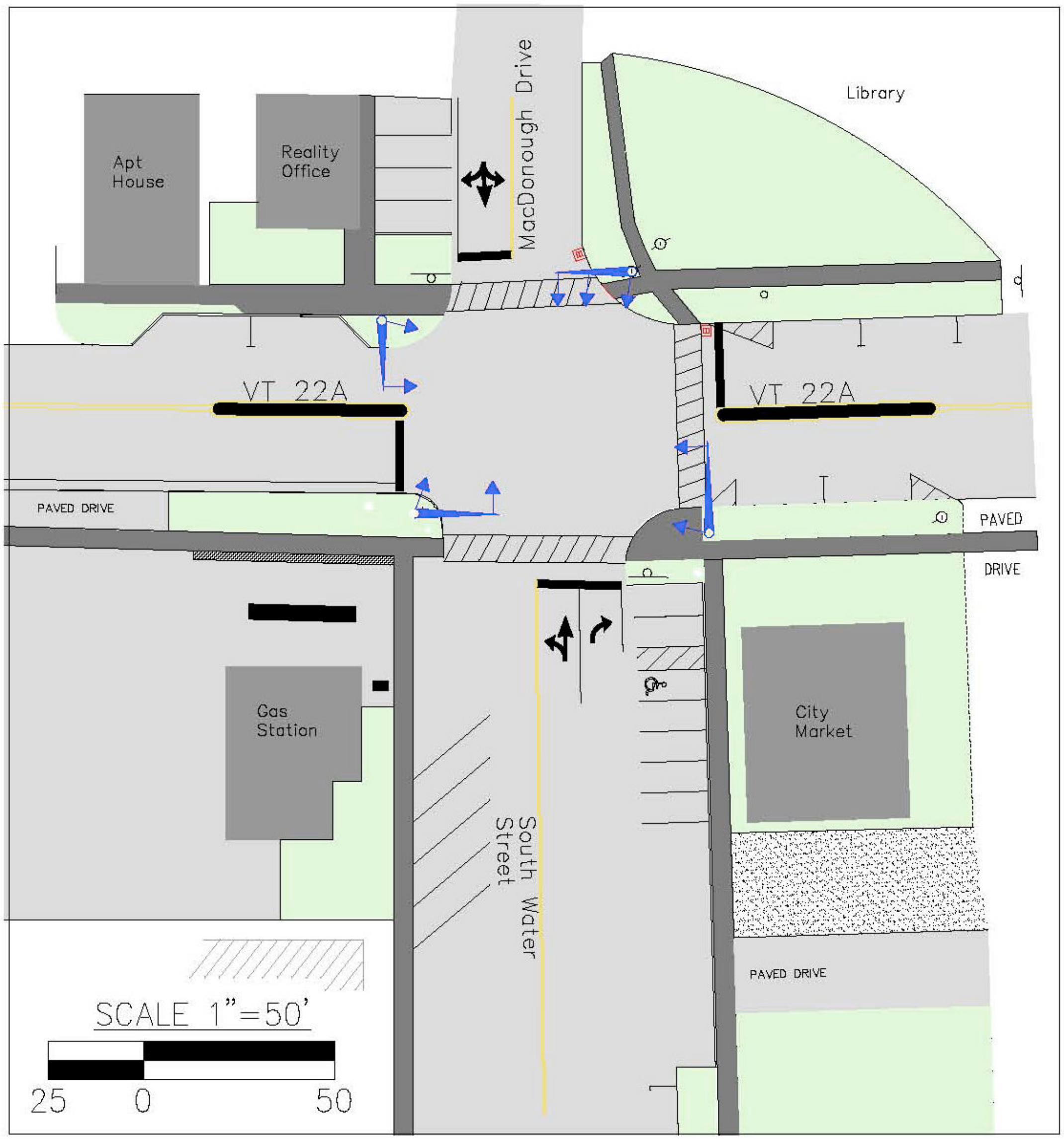
Figure 28 presents a fourth alternative based on the comments from the land owners. It includes raised medians on the VT 22A approaches that would be approximately three feet wide, additional on-street parking in front of the real estate office, and maintains the existing configuration and number of parking spaces in front of the Small City Market on South Water Street. The two exiting lanes on South Water Street are maintained and a traffic signal is assumed for the long-term.

This alternative is similar to Alternative 3, except that raised medians are provided on VT 22A. The medians will add approximately $10,000 to the cost. Therefore, the estimated cost for Alternative 4 is $240,000.

Alternative 4 provides an economic advantage over Alternative 1 because it does not change the existing parking situation and provides un-fettered access to the Small City Market. It does not however address the conflicts caused by the head-in parking at the Small City Market and the tendency of vehicles to cut across South Water Street as they enter the parking spaces from VT 22A northbound. At the same time, the medians on VT 22A will encourage vehicles to slow as they turn from VT 22A into South Water Street and MacDonough Drive. The medians will also help to slow vehicles as they approach the intersection from both directions on VT 22A and emphasize a gateway into the downtown.

In order to maintain the on-street parking along VT 22A, the medians are only three feet wide. This width is less than ideal and could be problematic for general maintenance and snow plowing.

Figure 28: Alternative 4 - Median on VT 22A



5.0 RECOMMENDATION

A traffic signal should be installed at the intersection of VT 22A, South Water Street, and MacDonough Drive. The traffic signal will eliminate projected congestion, will improve accessibility and safety for pedestrians, and will improve safety for vehicular traffic by providing a protected exit from the side streets. To accommodate the operational needs of large trucks, installing a video detector upstream, south on VT 22A that would only be activated by large vehicles is recommended.

The modifications proposed in Alternative 4 to the southwest corner of the intersection at the real estate office should be pursued. The modifications provide adequate parking for the building, accommodate the proposed sidewalk extension from MacDonough Drive to Canal Street, provide more green space, and eliminate a poorly defined, continuous curb cut.

The median proposed in Alternative 2 on South Water Street should not be constructed because it has a negative impact on the two businesses located near the corner.

The medians proposed on VT 22A should be considered further by the City. The City needs to weigh the maintenance requirements relative to the benefits of creating a gateway and slowing traffic. If the City chooses to construct the medians, it should consider the option of eliminating the on-street parking spaces to allow for wider medians.

6.0 IMPLEMENTATION

These recommendations can be implemented in the phases identified in Table 8. The access changes proposed for the southwest corner of MacDonough Drive and VT 22A could be incorporated into the sidewalk project planned from MacDonough Drive to the bridge.

Installation of the traffic signal and medians (if desired) would have immediate benefits. However, given the cost, the City should consider implementing the project using state and federal funds. The process for accessing state and federal funds will take at least five years and consists of:

1. Support from the Addison County Regional Planning Commission by identifying the project in its long range transportation plan. The project may also need to be prioritized relative to other transportation projects in Addison County. VTrans considers regional prioritization of projects in its funding decisions.
2. Completion of a VTrans project definition study. Any project that uses federal transportation funds must satisfy the requirements of the National Environmental Policy Act (NEPA). These requirements are evaluated through the Federal Highway Administration's NEPA project development process which is designed to balance the public's need for safe and efficient transportation while accounting for potential impacts on the human and natural environment. Given the limited scope and impacts associated with this project, a categorical exclusion is the recommended level of environmental documentation.

   This study has provided the background information necessary to screen alternatives. More detail will be necessary based on a land survey and assessment of cultural and natural resources. The

VTrans project definition and scoping study will provide the level of detail necessary to complete a categorical exclusion and will also include additional public meetings and selection of the preferred alternative by the City Council. The VTrans project definition team (PDT) will then vote to approve the recommendation or may ask for additional information.

3. Inclusion of the project on the VTrans Capital Program. Once the PDT has granted its approval, the project can move forward through design and construction. Funding for these phases is identified in the annual VTrans Capital Program. The Capital Program is prepared by VTrans and approved by the legislature.

Table 8: Implementation Plan

Phase	Time-Frame	Cost	Potential Funding Source	Next Steps	Project Lead
Access and parking modifications on the southwest corner	Less Than 5 Years	$ 18,000	Municipal capital budget or incorporate in sidewalk project	Include in design for sidewalk project	City
Traffic Signal and Medians	5-10 Years	$ 222,000	State/Federal Funds	Include in ACRPC Long Range Plan, Conduct Project Definition Study, place in VTrans Capital Program under Development and Evaluation	City and ACRPC

7.0 SUMMARY

The purpose of this study is to identify, evaluate, and recommend short and long range improvements to the intersection of VT 22A, South Water Street, and MacDonough Drive in the City of Vergennes, VT. Existing conditions satisfy warrants for the installation of a traffic signal. However a more comprehensive analysis and public outreach was desired by the City and the Addison County Regional Planning Commission before moving forward with installation of a traffic signal.

A project purpose and need statement was developed based on an assessment of existing and future conditions and public comments. It provides a comprehensive list of issues at the intersection which include congestion, operational requirements for large trucks, safety, natural and cultural resources, and access for pedestrians and cyclists.

Three initial alternatives were developed and evaluated relative to the purpose and need statement. The alternatives were developed by combining seven different components. All three alternatives include access and parking modifications to the southwest corner of MacDonough Drive and VT 22A at the real estate office, modifications to the parking in front of Small City Market, and parking changes in front of the gas station.

Alternative 1 and Alternative 2 assume that a traffic signal is installed with truck preemption. Alternative 1 includes the median and the reduction from two lanes to one on the South Water Street approach to VT 22A. Alternative 2 does not include a median on South Water Street and maintains two lanes exiting South Water Street. Alternative 3 assumes that the intersection will continue to be controlled by stop signs on the side streets, does not include a median on South Water Street, and maintains two lanes exiting South Water Street.

The three alternatives were presented to landowners of the businesses located directly adjacent to the intersection. To address landowner comments, a fourth alternative was developed. It includes raised medians on the VT 22A approaches that would be approximately three feet wide, additional on-street parking in front of the real estate office, and maintains the existing configuration and number of parking spaces in front of the Small City Market on South Water Street. The two exiting lanes on South Water Street are maintained and a traffic signal is assumed for the long-term.

The report recommends reconfiguration of the southwest corner of VT 22A and MacDonough Drive as presented in Alternative 4 and installation of a traffic signal. It does not recommend installation of a median on South Water Street.

The medians proposed in Alternative 4 on VT 22A should be considered further by the City after weighing the maintenance requirements relative the benefits of creating a gateway and slowing traffic. If the City chooses to construct the medians, it should consider the option of eliminating the on-street parking spaces to allow for wider medians.

The total estimated cost for these recommendations is $240,000. Modifications to the southwest corner will cost approximately $18,000 and could be implemented as part of the new sidewalk project proposed between MacDonough Drive and Canal Street.

The estimated cost of the traffic signal and medians on VT 22A is $222,000 and should be financed using state and federal funds available through the standard VTrans project development process. Given the competition for these funds, and the time necessary to complete the required environmental documentation and design, this component of the recommended alternative will take 5-10 years to complete. The City should start the process as soon as possible by working with the Addison County Regional Planning Commission to include the project in its long range transportation plan and on the regional list of priorities.

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APPENDIX A

TRAFFIC VOLUMES

Table 1: AM Peak Hour Volume Adjustments

06/05/06 09:24 AM

AM Raw Count Data | DHV & Annual Adjustments to 2005 | DESIGN HOUR VOLUME 2005 | ODVs Hopkins/Hillside Residential | ODVs Panton Road Industrial

D061 US 2 Williston
0.4% Annual Growth Rate

ODVs	Enter	Exit	Total
Hopkins/Hillside Residential	10	34	44
Panton Road Industrial	362	49	412

VT22A -MonktonRd, Vergennes, VT, 7/22/2003, 4th Tuesday

AM Raw Count Data

	EB	WB	NB	SB	Total
LT	0	76	0	22	
TH	0	0	268	154	
RT	0	17	69	0	606
Enter	0	93	337	176	606
Exit	91	0	285	230	606
Analysis Hour % Trucks	0.0%	0.0%	0.0%	0.0%	
Analysis Hour PHF	0.93				
Analysis Hour	7:30 - 8:30 peak				

Count Year	2003
Average DHV Adjustment	1.08
Annual Adjustment	1.03
DHV & Annual Adjustment	1.11

Design Hour Volume 2005

	EB	WB	NB	SB	Total
LT	0	84	0	24	
TH	0	0	298	171	
RT	0	19	77	0	673
Enter	0	103	374	195	673
Exit	101	0	316	255	673

ODVs Hopkins/Hillside Residential

	EB	WB	NB	SB	Total
LT		1	0		
TH			9	1	
RT	0		2		14
Enter	0	1	12	1	14
Exit	2	0	9	2	14

ODVs Panton Road Industrial

	EB	WB	NB	SB	Total
LT		26	0		
TH			13	52	
RT	0		3		94
Enter	0	26	16	52	94
Exit	3	0	13	78	94

VT22A -GreenSt, Vergennes, VT, 7/22/2004, 4th Thursday

AM Raw Count Data

	EB	WB	NB	SB	Total
LT	22	86	7	25	
TH	10	16	261	222	
RT	12	45	70	5	781
Enter	44	147	338	252	781
Exit	105	28	328	320	781
Analysis Hour % Trucks	0.0%	0.0%	0.0%	0.0%	
Analysis Hour PHF	0.92				
Analysis Hour	7:30 - 8:30 peak				

Count Year	2004
Average DHV Adjustment	1.04
Annual Adjustment	1.02
DHV & Annual Adjustment	1.06

Design Hour Volume 2005

	EB	WB	NB	SB	Total
LT	23	91	7	26	
TH	11	17	276	235	
RT	13	48	74	5	826
Enter	47	155	357	266	826
Exit	111	30	347	338	826

ODVs Hopkins/Hillside Residential

	EB	WB	NB	SB	Total
LT		1	0		
TH			12	2	
RT	0		3		18
Enter	0	1	15	2	18
Exit	3	0	12	3	18

ODVs Panton Road Industrial

	EB	WB	NB	SB	Total
LT		30	0		
TH			16	78	
RT	4		4		133
Enter	4	30	20	78	133
Exit	4	0	16	113	133

VT22A -Water, Vergennes, VT, 9/2/2004, 1st Thursday

AM Raw Count Data

	EB	WB	NB	SB	Total
LT	10	34	26	20	
TH	18	13	355	330	
RT	15	39	41	32	933
Enter	43	86	422	382	933
Exit	79	71	404	379	933
Analysis Hour % Trucks	0.0%	0.0%	0.0%	0.0%	
Analysis Hour PHF	0.92				
Analysis Hour	7:30 - 8:30 peak				

Count Year	2004
Average DHV Adjustment	0.96
Annual Adjustment	1.02
DHV & Annual Adjustment	0.98

Design Hour Volume 2005

	EB	WB	NB	SB	Total
LT	10	33	26	20	
TH	18	13	349	325	
RT	15	38	40	31	918
Enter	42	85	415	376	918
Exit	78	70	397	373	918

ODVs Hopkins/Hillside Residential

	EB	WB	NB	SB	Total
LT		0	1		
TH			15	3	
RT	0		2		21
Enter	0	0	18	3	21
Exit	2	1	15	3	21

ODVs Panton Road Industrial

	EB	WB	NB	SB	Total
LT		12	1		
TH			20	113	
RT	5		2		154
Enter	5	12	24	113	154
Exit	2	1	20	129	154

VT22A -PantonRd, Vergennes, VT, 7/21/2003, 3rd Monday

AM Raw Count Data

	EB	WB	NB	SB	Total
LT	118	1	29	1	
TH	2	0	161	108	
RT	6	5	2	86	519
Enter	126	6	192	195	519
Exit	5	115	284	115	519
Analysis Hour % Trucks	0.0%	0.0%	0.0%	0.0%	
Analysis Hour PHF	0.88				
Analysis Hour	7:30 - 8:30 peak				

Count Year	2003
Average DHV Adjustment	1.06
Annual Adjustment	1.03
DHV & Annual Adjustment	1.09

Design Hour Volume 2005

	EB	WB	NB	SB	Total
LT	129	1	32	1	
TH	2	0	176	118	
RT	7	5	2	94	566
Enter	137	7	209	213	566
Exit	5	125	310	125	566

ODVs Hopkins/Hillside Residential

	EB	WB	NB	SB	Total
LT			3		
TH			18	3	
RT	0				25
Enter	0	0	21	3	25
Exit	0	3	18	4	25

ODVs Panton Road Industrial

	EB	WB	NB	SB	Total
LT	24		44		
TH	0	0			
RT	1			129	199
Enter	26	0	44	129	199
Exit	0	173	24	1	199

Table 2: AM Peak Hour Volume Adjustments Continued

ODVs – Shade Roller

Enter	Exit	Total
10	3	13

	EB	WB	NB	SB	
LT		1	0		
TH			1	1	
RT	0		0		3
Enter	0	1	1	1	3
Exit	0	0	1	2	3

	EB	WB	NB	SB	
LT		1	0		
TH			1	2	
RT	0		0		4
Enter	0	1	1	2	4
Exit	0	0	1	3	4

	EB	WB	NB	SB	
LT		0	0		
TH			1	3	
RT	0		0		5
Enter	0	0	1	3	5
Exit	0	0	1	4	5

	EB	WB	NB	SB	
LT	1		1		
TH	0	0			
RT	0			4	7
Enter	2	0	1	4	7
Exit	0	5	1	0	7

ODVs – Retail Across from Shade Roller

Enter	Exit	Total
0	0	0

	EB	WB	NB	SB	
LT		0	0		
TH			0	0	
RT	0		0		0
Enter	0	0	0	0	0
Exit	0	0	0	0	0

	EB	WB	NB	SB	
LT		0	0		
TH			0	0	
RT	0		0		0
Enter	0	0	0	0	0
Exit	0	0	0	0	0

	EB	WB	NB	SB	
LT		0	0		
TH			0	0	
RT	0		0		0
Enter	0	0	0	0	0
Exit	0	0	0	0	0

	EB	WB	NB	SB	
LT		0		0	
TH	0	0			
RT		0	0		0
Enter	0	0	0	0	0
Exit	0	0	0	0	0

ODVs – Total

	EB	WB	NB	SB	
LT	0	27	0	0	
TH	0	0	23	55	
RT	0	0	6	0	111
Enter	0	27	28	55	111
Exit	6	0	23	82	111

	EB	WB	NB	SB	
LT	0	32	1	0	
TH	0	0	28	82	
RT	4	0	8	0	156
Enter	4	32	37	82	156
Exit	8	1	28	119	156

	EB	WB	NB	SB	
LT	0	12	3	0	
TH	0	0	37	119	
RT	5	0	4	0	180
Enter	5	12	44	119	180
Exit	4	3	37	136	180

	EB	WB	NB	SB	
LT	26	0	48	0	
TH	0	0	18	3	
RT	1	0	0	133	230
Enter	28	0	66	136	230
Exit	0	181	44	5	230

DHV WITH OTHER DEVELOPMENTS – 2005

	EB	WB	NB	SB	
LT	0	112	0	24	
TH	0	0	320	226	
RT	0	19	82	0	784
Enter	0	131	403	251	784
Exit	107	0	339	338	784

	EB	WB	NB	SB	
LT	23	123	8	26	
TH	11	17	304	317	
RT	17	48	82	5	981
Enter	51	187	394	349	981
Exit	119	30	375	457	981

	EB	WB	NB	SB	
LT	10	46	28	20	
TH	18	13	386	443	
RT	20	38	45	31	1098
Enter	48	97	459	495	1098
Exit	82	73	434	509	1098

	EB	WB	NB	SB	
LT	154	1	80	1	
TH	3	0	194	121	
RT	8	5	2	227	796
Enter	165	7	276	349	796
Exit	6	307	354	130	796

DHV – 2015

1.161 Annual Adjustment

	EB	WB	NB	SB	
LT	0	98	0	28	
TH	0	0	345	198	
RT	0	22	89	0	781
Enter	0	120	434	227	781
Exit	117	0	367	296	781

	EB	WB	NB	SB	
LT	27	106	9	31	
TH	12	20	320	272	
RT	15	55	86	6	958
Enter	54	180	415	309	958
Exit	129	34	402	393	958

	EB	WB	NB	SB	
LT	11	39	30	23	
TH	21	15	405	377	
RT	17	45	47	37	1065
Enter	49	98	482	436	1065
Exit	90	81	461	433	1065

	EB	WB	NB	SB	
LT	149	1	37	1	
TH	3	0	204	137	
RT	8	6	3	109	657
Enter	160	8	243	247	657
Exit	6	146	360	146	657

DHV WITH OTHER DEVELOPMENTS – 2015

	EB	WB	NB	SB	
LT	0	125	0	28	
TH	0	0	368	254	
RT	0	22	95	0	892
Enter	0	147	463	282	892
Exit	123	0	390	379	892

	EB	WB	NB	SB	
LT	27	137	9	31	
TH	12	20	349	355	
RT	19	55	94	6	1114
Enter	58	212	452	392	1114
Exit	136	35	431	511	1114

	EB	WB	NB	SB	
LT	11	51	32	23	
TH	21	15	442	496	
RT	23	45	51	37	1245
Enter	54	110	526	555	1245
Exit	94	84	498	569	1245

	EB	WB	NB	SB	
LT	175	1	85	1	
TH	3	0	222	140	
RT	9	6	3	242	887
Enter	187	8	309	383	887
Exit	7	327	403	150	887

Table 3: PM Peak Hour Volume Adjustments

06/05/06 09:30 AM

DHV & Annual Adjustments to 2005

	2005	2004	Source
2002	1.04	1.02	Rural Primary & Secondary 2004 Red Book
2003	1.03	1.01	
2004	1.02	1	

DESIGN HOUR VOLUME 2005

ODVs Hopkins/Hillside Residential

Enter	Exit	Total
32	18	50

ODVs Panton Road Industrial

Enter	Exit	Total
53	391	444

VT22A -MonktonRd, Vergennes, VT, 7/22/2003, 4th Tuesday

PM Raw Count Data

	EB	WB	NB	SB	
LT	0	232	0	39	
TH	0	0	309	265	
RT	0	40	189	0	1074
Enter	0	272	498	304	1074
Exit	228	0	349	497	1074
% Trucks	0.0%	0.0%	0.0%	0.0%	
PHF	0.88				
Peak Hour	3:30 - 4:30 peak				

DHV & Annual Adjustments

Count Year	DHV	Corr. Count	DHV Adj.
2003	1170	490	1.08
	995	500	1.03
DHV & Annual Adjustment			1.11
	1.176	0.98	

Design Hour Volume

	EB	WB	NB	SB	
LT	0	258	0	43	
TH	0	0	343	294	
RT	0	44	210	0	1193
Enter	0	302	553	338	1193
Exit	253	0	388	552	1193

ODVs Hopkins/Hillside Residential

	EB	WB	NB	SB	
LT		5	0		
TH			3	6	
RT	0		2		15
Enter	0	5	5	6	15
Exit	2	0	3	11	15

ODVs Panton Road Industrial

	EB	WB	NB	SB	
LT		7	0		
TH			76	8	
RT	0		46		138
Enter	0	7	122	8	138
Exit	46	0	76	15	138

VT22A -GreenSt, Vergennes, VT, 7/22/2004, 4th Thursday

PM Raw Count Data

	EB	WB	NB	SB	
LT	52	133	14	35	
TH	38	25	412	411	
RT	35	64	88	16	1323
Enter	125	222	514	462	1323
Exit	161	55	528	579	1323
% Trucks	0.0%	0.0%	0.0%	0.0%	
PHF	0.94				
Peak Hour	3:45 - 4:45 peak				

DHV & Annual Adjustments

Count Year	DHV	Corr. Count	DHV Adj.
2004	397	383	1.04
Annual Adjustment			1.02
DHV & Annual Adjustment			1.06

Design Hour Volume

	EB	WB	NB	SB	
LT	55	141	15	37	
TH	40	26	436	435	
RT	37	68	93	17	1399
Enter	132	235	543	488	1399
Exit	170	58	558	612	1399

ODVs Hopkins/Hillside Residential

	EB	WB	NB	SB	
LT		3	0		
TH			5	11	
RT	1		1		21
Enter	1	3	6	11	21
Exit	1	0	5	15	21

ODVs Panton Road Industrial

	EB	WB	NB	SB	
LT		5	4		
TH			122	15	
RT	1		26		174
Enter	1	5	152	15	174
Exit	26	4	122	22	174

VT22A -Water, Vergennes, VT, 9/2/2004, 1st Thursday

PM Raw Count Data

	EB	WB	NB	SB	
LT	15	35	22	42	
TH	11	14	453	478	
RT	40	42	24	37	1213
Enter	66	91	499	557	1213
Exit	77	73	510	553	1213
% Trucks	0.0%	0.0%	0.0%	0.0%	
PHF	0.95				
Peak Hour	3:45 - 4:45 peak				

DHV & Annual Adjustments

Count Year	DHV	Corr. Count	DHV Adj.
2004	115	173	0.96
	168	139	1.02
DHV & Annual Adjustment			0.98
	0.68	1.24	

Design Hour Volume

	EB	WB	NB	SB	
LT	15	34	22	41	
TH	11	14	446	470	
RT	39	41	24	36	1193
Enter	65	90	491	548	1193
Exit	76	72	502	544	1193

ODVs Hopkins/Hillside Residential

	EB	WB	NB	SB	
LT		1	0		
TH			6	15	
RT	1		0		24
Enter	1	1	7	15	24
Exit	0	0	6	17	24

ODVs Panton Road Industrial

	EB	WB	NB	SB	
LT		2	7		
TH			152	22	
RT	2		8		193
Enter	2	2	168	22	193
Exit	8	7	152	25	193

VT22A -PantonRd, Vergennes, VT, 7/21/2003, 3rd Monday

PM Raw Count Data

	EB	WB	NB	SB	
LT	211	0	14	8	
TH	1	1	205	285	
RT	33	5	1	231	995
Enter	245	6	220	524	995
Exit	10	246	421	318	995
% Trucks	0.0%	0.0%	0.0%	0.0%	
PHF	0.94				
Peak Hour	4:00 - 5:00 peak				

DHV & Annual Adjustments

Count Year	DHV	Corr. Count	DHV Adj.
2003	520	491	1.06
Annual Adjustment			1.03
DHV & Annual Adjustment			1.09

Design Hour Volume

	EB	WB	NB	SB	
LT	230	0	15	9	
TH	1	1	224	311	
RT	36	5	1	252	1086
Enter	267	7	240	572	1086
Exit	11	268	459	347	1086

ODVs Hopkins/Hillside Residential

	EB	WB	NB	SB	
LT			0		
TH			7	17	
RT	2				26
Enter	2	0	7	17	26
Exit	0	0	7	19	26

ODVs Panton Road Industrial

	EB	WB	NB	SB	
LT	168		2		
TH	1	0			
RT	26			25	222
Enter	195	0	2	25	222
Exit	1	27	168	26	222

AADT

	Year	AADT	2004	2005	DHV	Year
VT 22A - mm 1.9	2002	8100	8262	8427.24		10908
VT 22A - mm 1.4	2002	10800	11016	11236.3	1170	2003
VT 22A - mm 0.9	2002	9300	9486	9675.72		
Monkton Road	2003	4200	4242	4326.84	490	2003
Green Street	2002	3200	3264	3329.28	397	2004
Water Street	2002	480	489.6	499.392	115	2004
MacDonough Drive	2002	1100	1122	1144.44	173	2004
Panton Road	2003	4500	4545	4635.9	520	2003

Table 4: PM Peak Hour Volume Adjustments Continued

ODVs — Shade Roller

Enter	Exit	Total
41	57	97

	EB	WB	NB	SB	Total
LT		6	0		
TH			11	6	
RT	0		7		29
Enter	0	6	18	6	29
Exit	7	0	11	12	29

	EB	WB	NB	SB	Total
LT		4	1		
TH			18	12	
RT	1		4		39
Enter	1	4	22	12	39
Exit	4	1	18	17	39

	EB	WB	NB	SB	Total
LT		1	1		
TH			22	17	
RT	1		1		44
Enter	1	1	24	17	44
Exit	1	1	22	19	44

	EB	WB	NB	SB	Total
LT	24		1		
TH	0	0			
RT	4			19	49
Enter	28	0	1	19	49
Exit	0	21	24	4	49

ODVs — Retail Across from Shade Roller

Enter	Exit	Total
16	20	36

	EB	WB	NB	SB	Total
LT		4	0		
TH			8	4	
RT	0		5		20
Enter	0	4	12	4	20
Exit	5	0	8	8	20

	EB	WB	NB	SB	Total
LT		3	0		
TH			12	8	
RT	1		3		27
Enter	1	3	15	8	27
Exit	3	0	12	11	27

	EB	WB	NB	SB	Total
LT		1	1		
TH			15	11	
RT	1		1		30
Enter	1	1	17	11	30
Exit	1	1	15	13	30

	EB	WB	NB	SB	Total
LT		0		13	
TH	2	3			
RT		17	2		36
Enter	2	20	2	13	36
Exit	16	3	17	0	36

ODVs — Total

	EB	WB	NB	SB	Total
LT	0	21	0	0	
TH	0	0	98	24	
RT	0	0	60	0	203
Enter	0	21	157	24	203
Exit	60	0	98	46	203

	EB	WB	NB	SB	Total
LT	0	15	5	0	
TH	0	0	157	46	
RT	4	0	34	0	260
Enter	4	15	196	46	260
Exit	34	5	157	64	260

	EB	WB	NB	SB	Total
LT	0	5	10	0	
TH	0	0	196	64	
RT	5	0	10	0	290
Enter	5	5	216	64	290
Exit	10	10	196	74	290

	EB	WB	NB	SB	Total
LT	192	0	3	13	
TH	3	4	7	17	
RT	32	17	2	44	333
Enter	227	21	12	74	333
Exit	17	51	216	49	333

DHV WITH OTHER DEVELOPMENTS — 2005

	EB	WB	NB	SB	Total
LT	0	279	0	43	
TH	0	0	441	319	
RT	0	44	270	0	1395
Enter	0	323	710	362	1395
Exit	313	0	485	597	1395

	EB	WB	NB	SB	Total
LT	55	155	20	37	
TH	40	26	593	480	
RT	41	68	127	17	1659
Enter	136	249	739	534	1659
Exit	204	63	715	676	1659

	EB	WB	NB	SB	Total
LT	15	39	31	41	
TH	11	14	642	534	
RT	45	41	34	36	1484
Enter	70	94	707	612	1484
Exit	86	81	698	618	1484

	EB	WB	NB	SB	Total
LT	422	0	18	22	
TH	4	5	230	328	
RT	68	22	3	296	1419
Enter	494	27	252	646	1419
Exit	28	319	675	396	1419

DHV — 2015

1.161 Annual Adjustment

	EB	WB	NB	SB	Total
LT	0	299	0	50	
TH	0	0	398	342	
RT	0	52	244	0	1384
Enter	0	351	642	392	1384
Exit	294	0	450	641	1384

	EB	WB	NB	SB	Total
LT	64	163	17	43	
TH	47	31	506	504	
RT	43	79	108	20	1623
Enter	153	272	631	567	1623
Exit	198	67	648	710	1623

	EB	WB	NB	SB	Total
LT	17	40	25	48	
TH	13	16	517	546	
RT	46	48	27	42	1385
Enter	75	104	570	636	1385
Exit	88	83	582	631	1385

	EB	WB	NB	SB	Total
LT	267	0	18	10	
TH	1	1	260	361	
RT	42	6	1	292	1260
Enter	310	8	279	663	1260
Exit	13	311	533	403	1260

DHV WITH OTHER DEVELOPMENTS — 2015

	EB	WB	NB	SB	Total
LT	0	320	0	50	
TH	0	0	496	366	
RT	0	52	303	0	1587
Enter	0	372	799	416	1587
Exit	353	0	547	686	1587

	EB	WB	NB	SB	Total
LT	64	178	23	43	
TH	47	31	663	550	
RT	47	79	142	20	1884
Enter	157	287	827	612	1884
Exit	231	73	805	775	1884

	EB	WB	NB	SB	Total
LT	17	45	35	48	
TH	13	16	713	610	
RT	51	48	38	42	1675
Enter	81	109	786	700	1675
Exit	98	93	778	706	1675

	EB	WB	NB	SB	Total
LT	459	0	21	23	
TH	4	5	266	378	
RT	74	23	3	337	1593
Enter	537	28	290	738	1593
Exit	30	363	749	452	1593

Table 5: Trip Generation for Assumed Development

Development Project	ITE Land Use Description	ITE Land Use Code	Size	Weekday AM (Veh/Hour)		Weekday PM (Veh/Hour)	
				Enter	Exit	Enter	Exit
Panton Road Industrial	General Light Industrial	110	424,710 sq ft	362	49	53	391
Hopkins / Hillside Residential	Single-Family Detached Housing	210	25 units	7	20	19	11
	Residential Condominium/Townhouse	230	25 units	3	14	13	6
Shade Roller	Residential Condominium/Townhouse	230	5 units	0	2	3	2
	Single Tenant Office Building	715	6,250 sq ft	10	1	2	9
	Speciality Retail Center	814	6,250 sq ft	0	0	36	46
Retail across from Shade Roller	Speciality Retail Center	814	25,000 sq ft	0	0	16	20
			Total Other Development	382	87	143	485

APPENDIX B

LEVEL OF SERVICE WORKSHEETS

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		9%			0%			8%			10%	
Volume (veh/h)	10	18	20	46	13	38	28	386	45	20	443	31
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	10	18	20	46	13	38	28	386	45	20	443	31
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1008	986	458	992	978	408	474			431		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1008	986	458	992	978	408	474			431		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	95	92	97	77	95	94	97			98		
cM capacity (veh/h)	190	236	602	198	240	643	1088			1129		

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1
Volume Total	48	59	38	459	494
Volume Left	10	46	0	28	20
Volume Right	20	0	38	45	31
cSH	296	206	643	1088	1129
Volume to Capacity	0.16	0.29	0.06	0.03	0.02
Queue Length 95th (ft)	14	30	5	2	1
Control Delay (s)	19.5	29.5	11.0	0.8	0.5
Lane LOS	C	D	B	A	A
Approach Delay (s)	19.5	22.2		0.8	0.5
Approach LOS	C	C			

Intersection Summary			
Average Delay	3.4		
Intersection Capacity Utilization	50.2%	ICU Level of Service	A
Analysis Period (min)	60		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		9%			0%			8%			10%	
Volume (veh/h)	11	21	23	51	15	45	32	442	51	23	496	37
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	11	21	23	51	15	45	32	442	51	23	496	37
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1144	1118	514	1126	1110	468	533			493		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1144	1118	514	1126	1110	468	533			493		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	93	89	96	67	92	92	97			98		
cM capacity (veh/h)	147	195	559	154	198	595	1035			1071		

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1
Volume Total	55	66	45	525	556
Volume Left	11	51	0	32	23
Volume Right	23	0	45	51	37
cSH	246	162	595	1035	1071
Volume to Capacity	0.22	0.41	0.08	0.03	0.02
Queue Length 95th (ft)	21	49	6	2	2
Control Delay (s)	23.8	42.2	11.5	0.9	0.6
Lane LOS	C	E	B	A	A
Approach Delay (s)	23.8	29.8		0.9	0.6
Approach LOS	C	D			

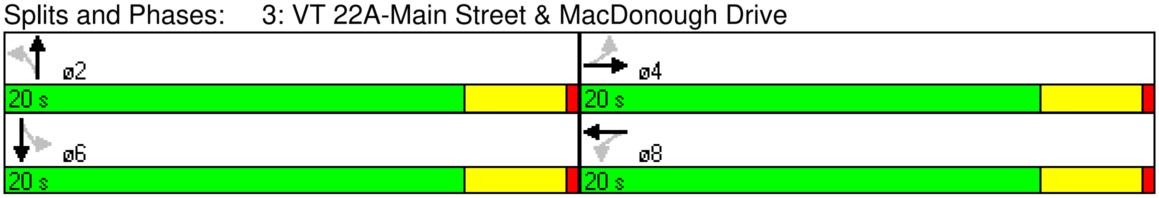
Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	55.6%	ICU Level of Service	B
Analysis Period (min)	60		

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Volume (vph)	11	21	51	15	32	442	23	496
Turn Type	Perm		Perm		Perm		Perm	
Protected Phases		4		8		2		6
Permitted Phases	4		8		2		6	
Detector Phases	4	4	8	8	2	2	6	6
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Total Split (s)	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Total Split (%)	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lead/Lag								
Lead-Lag Optimize?								
Recall Mode	None	None	None	None	C-Min	C-Min	C-Min	C-Min
Act Effct Green (s)		7.2		7.2		30.2		30.2
Actuated g/C Ratio		0.18		0.18		0.76		0.76
v/c Ratio		0.18		0.35		0.41		0.43
Control Delay		9.5		9.8		5.2		5.5
Queue Delay		0.0		0.0		0.0		0.0
Total Delay		9.5		9.8		5.2		5.5
LOS		A		A		A		A
Approach Delay		9.5		9.8		5.2		5.5
Approach LOS		A		A		A		A

Intersection Summary

Cycle Length: 40
Actuated Cycle Length: 40
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
Natural Cycle: 45
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.43
Intersection Signal Delay: 5.9 Intersection LOS: A
Intersection Capacity Utilization 58.2% ICU Level of Service B
Analysis Period (min) 60

Splits and Phases: 3: VT 22A-Main Street & MacDonough Drive



	→	←	↑	↓
Lane Group	EBT	WBT	NBT	SBT
Lane Group Flow (vph)	55	111	525	556
v/c Ratio	0.18	0.35	0.41	0.43
Control Delay	9.5	9.8	5.2	5.5
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	9.5	9.8	5.2	5.5
Queue Length 50th (ft)	6	13	45	50
Queue Length 95th (ft)	27	45	149	165
Internal Link Dist (ft)	722	258	469	362
Turn Bay Length (ft)				
Base Capacity (vph)	655	645	1283	1288
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.08	0.17	0.41	0.43

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		9%			0%			8%			10%	
Total Lost time (s)		4.0			4.0			4.0			4.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.94			0.95			0.99			0.99	
Flt Protected		0.99			0.98			1.00			1.00	
Satd. Flow (prot)		1662			1721			1759			1750	
Flt Permitted		0.94			0.83			0.96			0.98	
Satd. Flow (perm)		1578			1454			1693			1711	
Volume (vph)	11	21	23	51	15	45	32	442	51	23	496	37
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	11	21	23	51	15	45	32	442	51	23	496	37
RTOR Reduction (vph)	0	20	0	0	39	0	0	5	0	0	4	0
Lane Group Flow (vph)	0	35	0	0	72	0	0	520	0	0	552	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		5.0			5.0			27.0			27.0	
Effective Green, g (s)		5.0			5.0			27.0			27.0	
Actuated g/C Ratio		0.12			0.12			0.68			0.68	
Clearance Time (s)		4.0			4.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		197			182			1143			1155	
v/s Ratio Prot												
v/s Ratio Perm		0.02			c0.05			0.31			c0.32	
v/c Ratio		0.18			0.39			0.45			0.48	
Uniform Delay, d1		15.7			16.1			3.0			3.1	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.4			1.4			1.3			1.4	
Delay (s)		16.1			17.5			4.4			4.5	
Level of Service		B			B			A			A	
Approach Delay (s)		16.1			17.5			4.4			4.5	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM Average Control Delay	6.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	58.2%	ICU Level of Service	B
Analysis Period (min)	60		

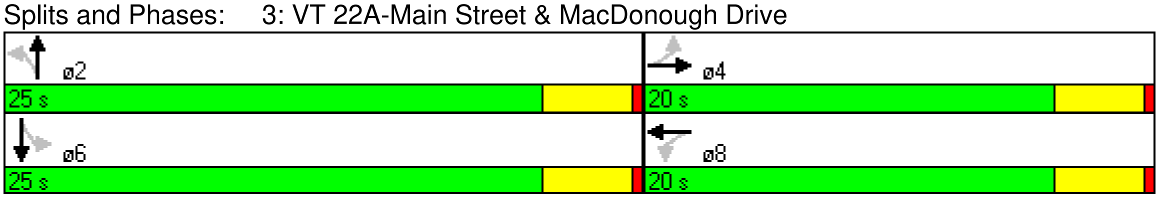
c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Volume (vph)	11	21	51	15	32	442	23	496
Turn Type	Perm		Perm		Perm		Perm	
Protected Phases		4		8		2		6
Permitted Phases	4		8		2		6	
Detector Phases	4	4	8	8	2	2	6	6
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Total Split (s)	20.0	20.0	20.0	20.0	25.0	25.0	25.0	25.0
Total Split (%)	44.4%	44.4%	44.4%	44.4%	55.6%	55.6%	55.6%	55.6%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lead/Lag								
Lead-Lag Optimize?								
Recall Mode	None	None	None	None	C-Min	C-Min	C-Min	C-Min
Act Effct Green (s)		7.0	7.0	7.0		35.4		35.4
Actuated g/C Ratio		0.16	0.16	0.16		0.79		0.79
v/c Ratio		0.20	0.24	0.20		0.40		0.41
Control Delay		11.4	16.6	8.3		4.4		4.6
Queue Delay		0.0	0.0	0.0		0.0		0.0
Total Delay		11.4	16.6	8.3		4.4		4.6
LOS		B	B	A		A		A
Approach Delay		11.4		12.1		4.4		4.6
Approach LOS		B		B		A		A

Intersection Summary

Cycle Length: 45
Actuated Cycle Length: 45
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
Natural Cycle: 45
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.41
Intersection Signal Delay: 5.5 Intersection LOS: A
Intersection Capacity Utilization 55.1% ICU Level of Service B
Analysis Period (min) 60

Splits and Phases: 3: VT 22A-Main Street & MacDonough Drive



Lane Group	EBT	WBL	WBT	NBT	SBT
Lane Group Flow (vph)	55	51	60	525	556
v/c Ratio	0.20	0.24	0.20	0.40	0.41
Control Delay	11.4	16.6	8.3	4.4	4.6
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	11.4	16.6	8.3	4.4	4.6
Queue Length 50th (ft)	7	12	3	45	50
Queue Length 95th (ft)	32	36	29	135	148
Internal Link Dist (ft)	722		258	469	362
Turn Bay Length (ft)					
Base Capacity (vph)	588	478	617	1328	1344
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.09	0.11	0.10	0.40	0.41

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		9%			0%			8%			10%	
Total Lost time (s)		4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor		1.00		1.00	1.00			1.00			1.00	
Frt		0.94		1.00	0.89			0.99			0.99	
Flt Protected		0.99		0.95	1.00			1.00			1.00	
Satd. Flow (prot)		1662		1770	1653			1759			1750	
Flt Permitted		0.91		0.83	1.00			0.96			0.98	
Satd. Flow (perm)		1535		1552	1653			1693			1712	
Volume (vph)	11	21	23	51	15	45	32	442	51	23	496	37
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	11	21	23	51	15	45	32	442	51	23	496	37
RTOR Reduction (vph)	0	21	0	0	40	0	0	5	0	0	3	0
Lane Group Flow (vph)	0	34	0	51	20	0	0	520	0	0	553	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		4.8		4.8	4.8			32.2			32.2	
Effective Green, g (s)		4.8		4.8	4.8			32.2			32.2	
Actuated g/C Ratio		0.11		0.11	0.11			0.72			0.72	
Clearance Time (s)		4.0		4.0	4.0			4.0			4.0	
Vehicle Extension (s)		3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)		164		166	176			1211			1225	
v/s Ratio Prot					0.01							
v/s Ratio Perm		0.02		c0.03				0.31			c0.32	
v/c Ratio		0.21		0.31	0.11			0.43			0.45	
Uniform Delay, d1		18.4		18.6	18.2			2.6			2.7	
Progression Factor		1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2		0.6		1.1	0.3			1.1			1.2	
Delay (s)		19.0		19.6	18.5			3.7			3.9	
Level of Service		B		B	B			A			A	
Approach Delay (s)		19.0			19.0			3.7			3.9	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM Average Control Delay	5.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	45.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	55.1%	ICU Level of Service	B
Analysis Period (min)	60		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		9%			0%			8%			10%	
Volume (veh/h)	15	11	45	39	14	41	31	642	34	41	534	36
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	15	11	45	39	14	41	31	642	34	41	534	36
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1403	1372	552	1406	1373	659	570			676		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1403	1372	552	1406	1373	659	570			676		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	84	92	92	59	90	91	97			96		
cM capacity (veh/h)	92	134	533	95	135	464	1002			915		

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1
Volume Total	71	53	41	707	611
Volume Left	15	39	0	31	41
Volume Right	45	0	41	34	36
cSH	216	103	464	1002	915
Volume to Capacity	0.33	0.52	0.09	0.03	0.04
Queue Length 95th (ft)	36	72	7	2	4
Control Delay (s)	29.8	76.0	13.5	0.8	1.2
Lane LOS	D	F	B	A	A
Approach Delay (s)	29.8	48.7		0.8	1.2
Approach LOS	D	E			

Intersection Summary			
Average Delay	5.4		
Intersection Capacity Utilization	63.1%	ICU Level of Service	B
Analysis Period (min)	60		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		9%			0%			8%			10%	
Volume (veh/h)	17	13	51	45	16	48	35	713	38	48	610	42
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	17	13	51	45	16	48	35	713	38	48	610	42
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1585	1548	631	1586	1550	732	652			751		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1585	1548	631	1586	1550	732	652			751		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	73	87	89	32	85	89	96			94		
cM capacity (veh/h)	63	103	480	66	103	421	935			858		

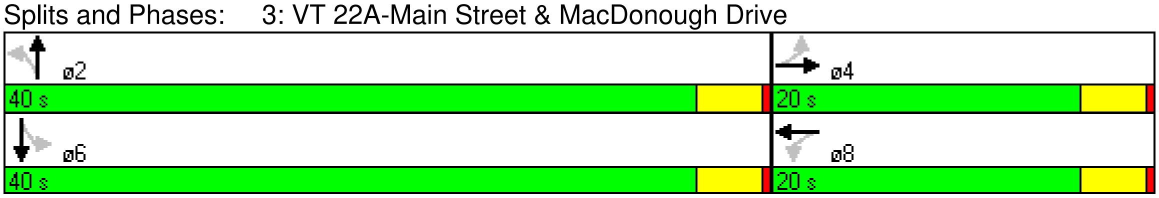
Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1
Volume Total	81	61	48	786	700
Volume Left	17	45	0	35	48
Volume Right	51	0	48	38	42
cSH	162	73	421	935	858
Volume to Capacity	0.50	0.84	0.11	0.04	0.06
Queue Length 95th (ft)	71	177	10	3	4
Control Delay (s)	49.2	219.7	14.6	1.0	1.4
Lane LOS	E	F	B	A	A
Approach Delay (s)	49.2	129.4		1.0	1.4
Approach LOS	E	F			

Intersection Summary			
Average Delay	11.9		
Intersection Capacity Utilization	70.5%	ICU Level of Service	C
Analysis Period (min)	60		

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Volume (vph)	17	13	45	16	35	713	48	610
Turn Type	Perm		Perm		Perm		Perm	
Protected Phases		4		8		2		6
Permitted Phases	4		8		2		6	
Detector Phases	4	4	8	8	2	2	6	6
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Total Split (s)	20.0	20.0	20.0	20.0	40.0	40.0	40.0	40.0
Total Split (%)	33.3%	33.3%	33.3%	33.3%	66.7%	66.7%	66.7%	66.7%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lead/Lag								
Lead-Lag Optimize?								
Recall Mode	None	None	None	None	C-Min	C-Min	C-Min	C-Min
Act Effct Green (s)		8.0		8.0		46.7		46.7
Actuated g/C Ratio		0.13		0.13		0.78		0.78
v/c Ratio		0.33		0.44		0.59		0.55
Control Delay		12.4		15.9		6.6		6.2
Queue Delay		0.0		0.0		0.0		0.0
Total Delay		12.4		15.9		6.6		6.2
LOS		B		B		A		A
Approach Delay		12.4		15.9		6.6		6.2
Approach LOS		B		B		A		A

Intersection Summary	
Cycle Length: 60	
Actuated Cycle Length: 60	
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green	
Natural Cycle: 60	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.59	
Intersection Signal Delay: 7.3	Intersection LOS: A
Intersection Capacity Utilization 70.6%	ICU Level of Service C
Analysis Period (min) 60	

Splits and Phases: 3: VT 22A-Main Street & MacDonough Drive



Lane Group	EBT	WBT	NBT	SBT
Lane Group Flow (vph)	81	109	786	700
v/c Ratio	0.33	0.44	0.59	0.55
Control Delay	12.4	15.9	6.6	6.2
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	12.4	15.9	6.6	6.2
Queue Length 50th (ft)	10	21	96	81
Queue Length 95th (ft)	47	66	327	269
Internal Link Dist (ft)	722	258	469	362
Turn Bay Length (ft)				
Base Capacity (vph)	446	442	1326	1262
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.18	0.25	0.59	0.55

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		9%			0%			8%			10%	
Total Lost time (s)		4.0			4.0			4.0			4.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.92			0.94			0.99			0.99	
Flt Protected		0.99			0.98			1.00			1.00	
Satd. Flow (prot)		1611			1717			1773			1749	
Flt Permitted		0.94			0.89			0.96			0.92	
Satd. Flow (perm)		1523			1558			1705			1623	
Volume (vph)	17	13	51	45	16	48	35	713	38	48	610	42
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	17	13	51	45	16	48	35	713	38	48	610	42
RTOR Reduction (vph)	0	45	0	0	42	0	0	2	0	0	2	0
Lane Group Flow (vph)	0	36	0	0	67	0	0	784	0	0	698	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		6.9			6.9			45.1			45.1	
Effective Green, g (s)		6.9			6.9			45.1			45.1	
Actuated g/C Ratio		0.12			0.12			0.75			0.75	
Clearance Time (s)		4.0			4.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		175			179			1282			1220	
v/s Ratio Prot												
v/s Ratio Perm		0.02			c0.04			c0.46			0.43	
v/c Ratio		0.20			0.37			0.61			0.57	
Uniform Delay, d1		24.1			24.5			3.4			3.2	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.6			1.3			2.2			2.0	
Delay (s)		24.6			25.9			5.6			5.2	
Level of Service		C			C			A			A	
Approach Delay (s)		24.6			25.9			5.6			5.2	
Approach LOS		C			C			A			A	

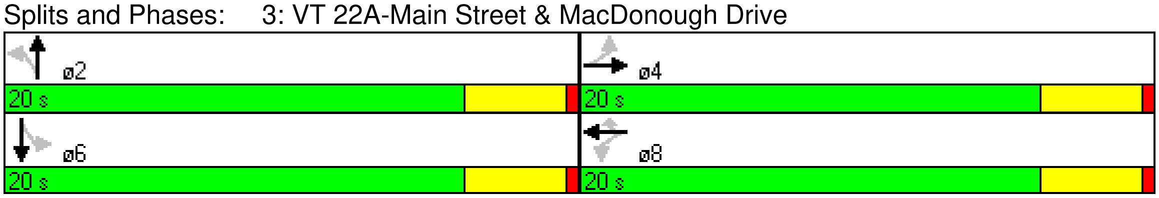
Intersection Summary			
HCM Average Control Delay	7.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	70.6%	ICU Level of Service	C
Analysis Period (min)	60		

c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	17	13	45	16	48	35	713	48	610
Turn Type	Perm		Perm		Perm	Perm		Perm	
Protected Phases		4		8			2		6
Permitted Phases	4		8		8	2		6	
Detector Phases	4	4	8	8	8	2	2	6	6
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Total Split (s)	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Total Split (%)	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lead/Lag									
Lead-Lag Optimize?									
Recall Mode	None	None	None	None	None	C-Min	C-Min	C-Min	C-Min
Act Effct Green (s)		6.9		6.9	6.9		30.5		30.5
Actuated g/C Ratio		0.17		0.17	0.17		0.76		0.76
v/c Ratio		0.26		0.23	0.15		0.60		0.57
Control Delay		8.0		14.2	5.8		8.8		8.0
Queue Delay		0.0		0.0	0.0		0.0		0.0
Total Delay		8.0		14.2	5.8		8.8		8.0
LOS		A		B	A		A		A
Approach Delay		8.0		10.5			8.8		8.0
Approach LOS		A		B			A		A

Intersection Summary	
Cycle Length: 40	
Actuated Cycle Length: 40	
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green	
Natural Cycle: 60	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.60	
Intersection Signal Delay: 8.5	Intersection LOS: A
Intersection Capacity Utilization 70.5%	ICU Level of Service C
Analysis Period (min) 60	

Splits and Phases: 3: VT 22A-Main Street & MacDonough Drive



Lane Group	EBT	WBT	WBR	NBT	SBT
Lane Group Flow (vph)	81	61	48	786	700
v/c Ratio	0.26	0.23	0.15	0.60	0.57
Control Delay	8.0	14.2	5.8	8.8	8.0
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	8.0	14.2	5.8	8.8	8.0
Queue Length 50th (ft)	6	12	0	88	74
Queue Length 95th (ft)	33	36	20	#370	#327
Internal Link Dist (ft)	722	258		469	362
Turn Bay Length (ft)					
Base Capacity (vph)	652	610	662	1307	1234
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.12	0.10	0.07	0.60	0.57

Intersection Summary

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

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		9%			0%			8%			10%	
Total Lost time (s)		4.0			4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00			1.00	1.00		1.00			1.00	
Frt		0.92			1.00	0.85		0.99			0.99	
Flt Protected		0.99			0.96	1.00		1.00			1.00	
Satd. Flow (prot)		1611			1796	1583		1773			1749	
Flt Permitted		0.91			0.74	1.00		0.96			0.93	
Satd. Flow (perm)		1482			1377	1583		1708			1629	
Volume (vph)	17	13	51	45	16	48	35	713	38	48	610	42
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	17	13	51	45	16	48	35	713	38	48	610	42
RTOR Reduction (vph)	0	45	0	0	0	42	0	3	0	0	3	0
Lane Group Flow (vph)	0	36	0	0	61	6	0	783	0	0	697	0
Turn Type	Perm			Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		
Actuated Green, G (s)		4.7			4.7	4.7		27.3			27.3	
Effective Green, g (s)		4.7			4.7	4.7		27.3			27.3	
Actuated g/C Ratio		0.12			0.12	0.12		0.68			0.68	
Clearance Time (s)		4.0			4.0	4.0		4.0			4.0	
Vehicle Extension (s)		3.0			3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)		174			162	186		1166			1112	
v/s Ratio Prot												
v/s Ratio Perm		0.02			c0.04	0.00		c0.46			0.43	
v/c Ratio		0.21			0.38	0.03		0.67			0.63	
Uniform Delay, d1		16.0			16.3	15.6		3.7			3.5	
Progression Factor		1.00			1.00	1.00		1.00			1.00	
Incremental Delay, d2		0.6			1.5	0.1		3.1			2.7	
Delay (s)		16.6			17.8	15.7		6.9			6.2	
Level of Service		B			B	B		A			A	
Approach Delay (s)		16.6			16.9			6.9			6.2	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM Average Control Delay	7.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	70.5%	ICU Level of Service	C
Analysis Period (min)	60		

c Critical Lane Group

APPENDIX C

TRAFFIC SIGNAL WARRANT ANALYSIS

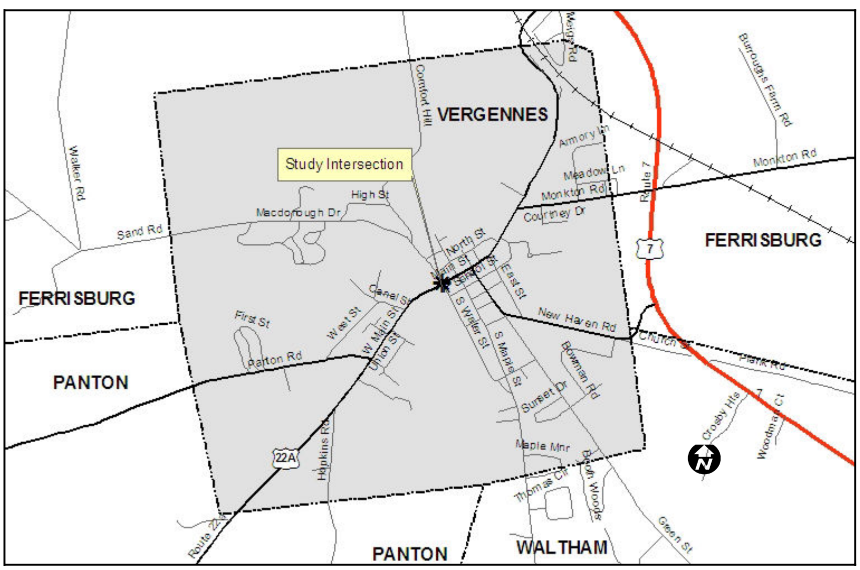
MEMORANDUM

To: Adam Lougee, Executive Director
Addison County Regional Planning Commission
From: Joe Segale, P.E., Charley Mark, EIT
Subject: VT 22A-South Water Street Traffic Signal Warrant Analysis
Date: 15 March 2005

INTRODUCTION

This memorandum provides a traffic signal warrant analysis for the intersection of Main Street (VT 22A) with Water Street and MacDonough Drive in the City of Vergennes, VT. It describes the characteristics of the study intersection, describes the procedure for conducting a traffic signal warrant analysis, identifies the warrants applicable to the study intersection, and determines whether or not existing conditions satisfy the need for a traffic signal. The intersection is located on the southern end of downtown Vergennes as shown in Figure 1.

Figure 1: Intersection Location



INTERSECTION CHARATERISTICS

The intersection has the following characteristics:

- It is owned and maintained by the City of Vergennes. Main Street (VT 22A) is a class one town highway. South Water Street and MacDonough Drive are class two town highways;
- Main Street is the "major" approach. Vehicles traveling through the intersection do not need to stop. South Water Street and MacDonough Drive are the "minor" approaches and are controlled by stop signs;
- All approaches have one lane that serve vehicles traveling through and vehicles turning left or right;
- The intersection is located on the southern end of downtown. On-street parking is permitted along all of the streets and cross-walks are provided across the Main Street southbound approach, South Water Street, and MacDonough Drive;
- As shown in Figure 2, VT 22A from the south and MacDonough Street from the west approach the intersection on steep uphill grades. South Water Street also approaches the intersection on an uphill grade, although it is not as steep; and
- A flashing warning beacon is located over the center of the intersection. This beacon provides a supplemental emphasis for stop signs and alerts drivers traveling northbound on VT 22A that special conditions exist at the intersection.
- Main Street carries approximately 11,000 vehicles per day. South Water Street and MacDonough Drive carry between 1,500 and 1,750 vehicles per day;
- VT 22A is a major truck route along the western side of Vermont. Based on VTrans data, approximately 4.5% (almost 500 trucks/day) of the traffic passing along Main Street are large trucks (separate tractor and trailer). VT 22A is designated as part of the Vermont Truck Network. Trucks with 53 foot trailers (total length up to 72 feet) are allowed to travel on the VT Truck Network without a permit;

Figure 2: Intersection Characteristics


Looking southbound towards the intersection from Main Street (VT 22A)


Looking eastbound towards the intersection from MacDonough Drive.


Looking southbound across the intersection down the hill towards Otter Creek


Looking westbound towards the intersection from South Water Street.

TRAFFIC SIGNAL WARRANT ANALYSIS DESCRIPTION AND APPLICABLITY

A signal warrant analysis is a set of tests that are run to determine whether a traffic signal would significantly improve operations, mobility, and safety at an intersection. The analysis is conducted in accordance with the procedures in the 2003 Manual on Uniform Traffic Control Devices (MUTCD). There are a total of 8 warrants in the MUTCD. Following is a description of each warrant and a discussion of whether or not the warrant is applicable for the Main-South Water-MacDonough Drive intersection. Warrants that are applicable are analyzed in the next section of this memorandum.

Warrant 1 - Eight-Hour Vehicular Traffic Warrant: Applicable when a large amount of intersecting traffic occurs for any eight hours of a typical day is the principal reason for installing a traffic signal, or where excessive delays occur on minor approaches to an intersection due to a large amount of traffic on the major street. ***Warrant 1 is applicable*** at this location because the traffic volumes entering the intersection and the delay experienced on the minor street approaches are significant.

Warrant 2 - Four-Hour Vehicular Traffic Warrant: Applicable when a large amount of intersecting traffic occurring over any four hours of a typical day is the principal reason for installing a traffic signal. ***Warrant 2 is applicable*** at this intersection because of the traffic volume entering the intersection is significant.

Warrant 3 - Peak Hour Warrant: Applicable when the minor-street traffic suffers undue delay when entering or crossing the major-street during the average peak hour is the principal reason for installing a traffic signal. ***Warrant 3 is not applicable.*** It should only be applied in near facilities that generate large traffic volumes over a short amount of time such as an office complex or a manufacturing facility.

Warrant 4 - Pedestrian Volume Warrant: Applicable when the traffic volumes on a major street are so heavy that pedestrians experience excessive delays. ***Warrant 4 is applicable*** due to the location of this intersection in a downtown with higher levels of pedestrian traffic.

Warrant 5 - School Crossing Warrant: Applicable when school children crossing a major street are the principal reason for installing a traffic signal. ***Warrant 5 is not applicable*** at this location because it is not in close proximity to a school.

Warrant 6 - Coordinated Signal System Warrant: Applicable when maintaining proper platooning of vehicles between traffic signals is the principal reason for installing a traffic signal. ***Warrant 6 is not applicable*** because the study intersection is not located between two existing signalized intersections that need to be coordinated.

Warrant 7 - Crash Experience Warrant: Applicable when the severity and frequency of crashes is the principal reason for installing a traffic signal. Crash records should always be examined to determined whether or not a safety issues exists. Therefore, ***Warrant 7 is applicable.***

Warrant 8 - Roadway Network Warrant: Applicable when the concentration and organization of traffic flow is the principal reason for installing a traffic signal. A traffic signal will usually result in increased capacity at an intersection. This warrant should be applied when there is a desire to shift traffic from one street to another. That desire should be established in a city-wide traffic circulation plan that identifies the function and design of each street. We assume that a traffic circulation plan has not been completed. Therefore, ***Warrant 8 is not applicable***.

RESULTS OF TRAFFIC SIGNAL WARRANT ANALYSIS

Warrants 1, 2, 4, and 7 are applicable to the Main-South Water-MacDonough intersection. This section evaluates whether or not existing conditions satisfy the criteria specified by the MUTCD for each of these applicable warrants.

Data Sources

The primary data source for Warrants 1, 2, and 4 is a twelve hour turning movement count conducted at the intersection by VTrans on Thursday, September 2nd 2004. The raw count data are provided in Attachment A and include traffic volumes by the hour for each approach and pedestrian counts. The raw count data have been adjusted in two ways. Traffic signal warrants are based upon traffic volumes for an average day. Therefore, the raw count data collected in September was adjusted for seasonal variation in traffic volumes according to the methodology specified by VTrans[1]. In the second adjustment, the traffic volumes were grown from 2004 to 2005 based on VTrans growth factors for urban areas.

The primary source of data for Warrant 7-Crash Experience, are crash data collected and organized by the VTrans for the year 1997-2001. VTrans collects data on crashes involving injuries, fatalities, or those that exceed $1,000 in property damage.

Warrant 1: Eight-hour Traffic Volume and Warrant 2: Four-hour Traffic Volumes

Warrants 1and 2 both depend on the amount of traffic entering the intersection from the major street (Main Street); and amount of traffic entering from the busier of the two minor streets. Since they each rely on the same data, it is efficient to evaluate each at the same time. Figure 3 presents the analysis of Warrants 1 and 2.

Warrant 1 has two conditions that need to be evaluated. Condition A, is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal. The Interruption of Continuous Traffic, Condition B, is intended for application at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street.

Warrant 1 is satisfied when the volumes on the major street and minor street approaches meet or exceed the threshold volumes indicated in Figure 3 for at least eight hours. Different threshold volumes exist for Condition A and Condition B. The MUTCD allows the threshold volumes to be

[1] "Continuous Traffic Counter Grouping Study and Regression Analysis Based on 2003 Traffic Data"; Vermont Agency of Transportation. http://www.aot.state.vt.us/techservices/Documents/TrafResearch/Publications/2003RedBookText.pdf

reduced to 70% when the intersection is located in an isolated community with a population less than 10,000 people. The estimated 2003 population for the City of Vergennes is 2,789[1].

Figure 3 demonstrates that traffic volumes at the intersection exceed the threshold volumes during nine hours of the day. Therefore, Condition B of Warrant 1 is satisfied.

To satisfy Warrant 2, plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) must all fall above curve in 4C-2 shown in Figure 3 for any four hours of a typical day. The curves vary depending on the number of lanes on each approach. The curves used in the analysis also account for the reduction in threshold volumes due the location of the intersection within an isolated community with a population less than 10,000.

The table in Figure 3 demonstrates that the traffic volumes at the intersection exceed the volume thresholds for six hours of the day. Therefore, Warrant 2 is satisfied.

Warrant 3 – Pedestrian Volume

To satisfy the pedestrian volume warrant a volume of 100 pedestrians an hour must be sustained for 8 hours or a volume of 190 pedestrians per hour must be sustain for 4 hours. The turning movement count conducted in September 2004 by VTrans indicates only a limited number of pedestrian movements of one or two per hour. Given the location of this intersection, the actual pedestrian count is probably much higher. However, it is unlikely the pedestrian volumes required by this warrant are sustained for eight or four hours of a typical day. Therefore, existing conditions do not satisfy this warrant.

[1] Estimate from the US Census Municipal Population Estimates available on the Center for Rural Studies web site arthttp://crs.uvm.edu/census/estimates/town/

Figure 3: Analysis of Warrants One and Two

Estimated Hourly Entering Volume
Scenario: 2005 Average Weekday Traffic

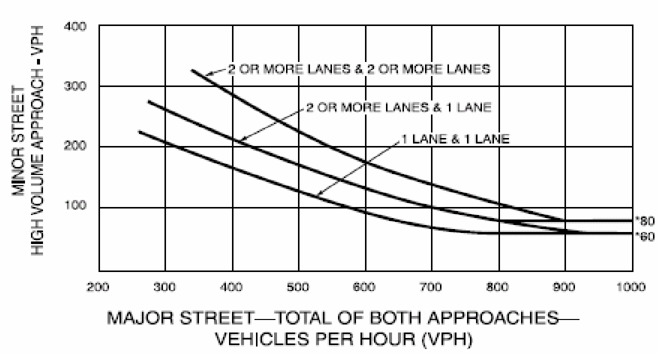
		2005 AAWDT		Warrant 1		Warrant 2
	Beginning Hour	Major Street 22A	Minor Street (Max of Water of MacDonough)	70% 8-HR Condition A	70% 8-HR Condition B	4-HR Warrant
Estimated Hourly Traffic Volumes for Average Weekday	6:00 AM	398	42	No	No	No
	7:00 AM	713	83	No	Yes	Yes
	8:00 AM	677	83	No	Yes	Yes
	9:00 AM	628	60	No	Yes	No
	10:00 AM	568	60	No	Yes	No
	11:00 AM	807	80	No	Yes	Yes
	12:00 PM	713	72	No	Yes	Yes
	1:00 PM	592	49	No	No	No
	2:00 PM	728	67	No	Yes	Yes
	3:00 PM	933	57	No	Yes	No
	4:00 PM	985	94	No	Yes	Yes
	5:00 PM	811	48	No	No	No
	Number of Hours Satisfying Threshold Volumes			0	9	6
	Is Overall Warrant Satisfied?			No	Yes	Yes

Major Street Volume Threshold	350	525	Fig 4C-2
Minor Street Volume	105	53	Fig 4C-2

Traffic Volume Adjustments to Assume:
AAWDT = raw count * (MAWDT to AAWDT Factor for September)
Projected Count to 2005 = AAWDT * (Urban Growth Factor)
MAWDT to AAWDT factor = 0.95 (2003 VTrans Redbook)
Urban Growth Factor = 1.01 (2003 VTrans Redbook)

Volume Thresholds assume:
25 MPH
1 Major Street Lane and 1 Minor Street Lanes
community w/ population < 10,000: As a result, 70% volume thresholds are used for Warrant 1
4-Hr Volume Thresholds from Curve 4C-2

Figure 4C-2. Warrant 2, Four-Hour Vehicular Volume (70% Factor)
(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 70 km/h (40 mph) ON MAJOR STREET)



*Note: 80 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 60 vph applies as the lower threshold volume for a minor-street approach with one lane.

Warrant 7

To satisfy this warrant, there must be at least five crashes occurring within a twelve month period. Crash data collected from VTrans is displayed in Table 1. Between 1997 and 2001 only 3 crashes, highlighted in gray, occurred in the vicinity of the intersection of Main, South Water, and MacDonough Streets. Therefore, existing conditions do not satisfy this warrant.

Table 1. Crash Data for VT 22a in Vergennes. Highlighted rows correspond to study intersection.

ID	Mile Marker	Date	Time	Weather	Cause	Description	Injuries	Fatalities
0120/7194	0.93	11/17/1999	14:50	Clear	Other improper action	Other	1	0
0120/549	1.11	03/06/1998	8:16	Cloudy	Inattention	Rear End	0	0
0120/5455	1.11	06/11/1999	16:14	Clear	Inattention	Other	1	0
0120/5686	1.12	06/21/1999	16:52	Clear	Operating defective equipment	Other	1	0
0120/9514	1.17	06/24/2000	15:05	Clear	Inattention	Rear End	1	0
0120/3519	1.22	11/19/1998	20:15	Cloudy	Other improper action	Other	0	0
0120/548	1.23	01/27/1998	14:30	Cloudy	Not Reported	Rear End	0	0
0120/3518	1.23	11/26/1998	7:40	Rain	Other improper action	Other	1	0
0120/5688	1.29	06/19/1999	11:40	Clear	Followed too closely	Rear End	0	0
0120/1992	1.41	08/03/1998	9:30	Rain	Failed to yield right of way	Other	1	0
0120/6901	UNK	09/09/1999	16:35	Clear	Inattention	Other	1	0

INTERSECTION LEVEL OF SERVICE

A traffic signal should not be installed unless an engineering study demonstrates that it will improve the overall safety and/or operation of the intersection. This section provides a preliminary analysis of how a traffic signal could affect congestion at the intersection.

The analysis uses the concept of Level-of-service (LOS), a qualitative measure describing levels of congestion as perceived by motorists driving in a traffic stream. The 2000 Highway Capacity Manual defines six qualitative grades to describe the level-of-service at an intersection. Level-of-Service is based on the average control delay per vehicle. Table 2 shows the various LOS grades and descriptions for signalized and unsignalized intersections.

Table 2: Level-of-Service Criteria for Signalized and Unsignalized Intersections

LOS	CHARACTERSTICS	SIGNALIZED DELAY (sec)	UNSIGNALIZED DELAY (sec)
A	Little or no delay	< 10.0	< 10.0
B	Short delays	10.1-20.0	10.1-15.0
C	Average delays	20.1-35.0	15.1-25.0
D	Long delays	35.1-55.0	25.1-35.0
E	Very long delays	55.1-80.0	35.1-50.0
F	Extreme delays	80.0<	50.1<

The VTrans policy on LOS states that, "Collectors in urban or village areas will generally be designed for a level of service D or better. However, in heavily developed village or urban areas, level of service E may be appropriate as judged on a case by case basis. Minor Arterials in urban or village areas will generally be designed for a level of service C or better. However, in heavily developed urban areas, reduced level of service criteria such as D or E may be appropriate as judged on a case by case basis."

The LOS at the Main-South Water-MacDonough intersection was calculated for the 2005 design hourly volume (DHV) condition using a software package Synchro V6.6. The complete LOS reports can be found in Attachment B.

Under existing stop-controlled conditions in 2005, the South Water Street and MacDonough Drive approaches operate at LOS of E and D respectively. As traffic increases, the LOS on these approaches will deteriorate over time. The Main Street approaches to the intersection operate at LOS A, which is typical for the major street.

If a traffic signal is installed, all approaches will operate at LOS A, with the exception of South Water St. which will operate at LOS B.

This analysis demonstrates that a traffic signal can improve the overall operation of the intersection without significantly impacting traffic on the major street. However, additional analyses need to be conducted to evaluate the traffic signal under future year traffic volumes. The study must also evaluate in greater detail how the traffic signal would affect large trucks climbing northbound up the hill towards the intersection.

SUMMARY

Existing conditions satisfy the need for a traffic signal at the intersection of Main Street (VT 22A) with South Water Street and MacDonough Drive located in the City of Vergennes, VT. This conclusion is based upon an analysis of applicable traffic signal warrants as specified in the 2003 MUTCD. Existing conditions satisfy Warrant 1: Eight-Hour Vehicular Traffic Warrant and Warrant 2: Four-Hour Vehicular Traffic Warrant.

A signal warrant analysis is considered advisory only. This means that simply meeting any warrant may not be sufficient cause for installing a traffic signal. The LOS analysis demonstrates that a traffic signal will operate at acceptable levels of service. However, other site specific information should be considered. In the case of the study intersection the steep grades on the approaches would present a challenge for trucks to start moving after being stopped at a signal. Traffic signal design should accommodate the frequent truck traffic along VT 22A.

ATTACHMENT A: TRAFFIC VOLUMES

VT22A -Water
Vergennes, VT
9/2/2004
1st Thursday

note:

Source: VTrans

	Eastbound						Westbound						Northbound						Southbound							
	MacDonough Drive						Water						VT22A						VT22A						15 min	hour
	L	(t)	T	(t)	R	(t)	L	(t)	T	(t)	R	(t)	L	(t)	T	(t)	R	(t)	L	(t)	T	(t)	R	(t)	total	total
6:00 AM	2	0	0	0	0	0	5	0	0	0	1	0	1	0	47	0	3	0	0	0	28	0	1	0	88	88
6:15 AM	2	0	3	0	1	0	0	0	1	0	9	0	1	0	41	0	7	0	3	0	22	0	1	0	91	179
6:30 AM	1	0	1	0	4	0	4	0	2	0	12	0	3	0	73	0	3	0	1	0	47	0	2	0	153	332
6:45 AM	0	0	0	0	4	0	5	0	1	0	4	0	3	0	58	0	2	0	3	0	62	0	3	0	145	477
7:00 AM	0	0	2	0	7	0	16	0	2	0	13	0	5	0	76	0	1	0	2	0	80	0	4	0	208	597
7:15 AM	1	0	4	0	1	0	2	0	5	0	9	0	6	0	79	0	1	0	2	0	66	0	2	0	178	684
7:30 AM	2	0	6	0	1	0	8	0	4	0	7	0	5	0	87	0	5	0	5	0	94	0	7	0	231	762
7:45 AM	0	0	6	0	5	0	6	0	2	0	12	0	4	0	117	0	14	0	5	0	67	0	9	0	247	864
8:00 AM	3	0	4	0	4	0	5	0	4	0	9	0	11	0	95	0	10	0	6	0	98	0	5	0	254	910
8:15 AM	5	0	2	0	5	0	15	0	3	0	11	0	6	0	56	0	12	0	4	0	71	0	11	0	201	933
8:30 AM	3	0	2	0	4	0	9	0	3	0	9	0	5	0	70	0	9	0	6	0	63	0	7	0	190	892
8:45 AM	2	0	3	0	3	0	7	0	4	0	8	0	4	0	79	0	8	0	6	0	59	0	5	0	188	833
9:00 AM	3	0	3	0	3	0	9	0	2	0	11	0	4	0	53	0	11	0	3	0	66	0	7	0	175	754
9:15 AM	1	0	2	0	4	0	9	0	2	0	8	0	4	0	63	0	3	0	7	0	76	0	4	0	183	736
9:30 AM	1	0	1	0	2	0	6	0	1	0	5	0	2	0	83	0	8	0	5	0	75	0	4	0	193	739
9:45 AM	4	0	3	0	3	0	4	0	1	0	5	0	4	0	79	0	4	0	3	0	82	0	5	0	197	748
10:00 AM	2	0	4	0	4	0	2	0	1	0	13	0	1	0	69	0	8	0	3	0	73	0	9	0	189	762
10:15 AM	2	0	3	0	3	0	3	0	2	0	11	0	1	0	64	0	6	0	5	0	66	0	6	0	172	751
10:30 AM	1	0	1	0	3	0	4	0	4	0	10	0	1	0	60	0	1	0	7	0	60	0	3	0	155	713
10:45 AM	6	0	1	0	6	0	1	0	0	0	12	0	1	0	74	0	0	0	5	0	64	0	5	0	175	691
11:00 AM	6	0	1	0	2	0	6	0	1	0	8	0	4	0	96	0	10	0	4	0	83	0	10	0	231	733
11:15 AM	5	0	0	0	4	0	8	0	3	0	11	0	3	0	89	0	6	0	4	0	94	0	8	0	235	796
11:30 AM	4	0	1	0	6	0	8	0	1	0	12	0	3	0	103	0	13	0	9	0	68	0	8	0	236	877
11:45 AM	6	0	6	0	8	0	10	0	1	0	14	0	2	0	95	0	11	0	9	0	103	0	6	0	271	973
12:00 PM	2	0	2	0	4	0	4	0	5	0	7	0	1	0	93	0	3	0	7	0	100	0	4	0	232	974
12:15 PM	4	0	3	0	6	0	6	0	6	0	11	0	1	0	70	0	5	0	7	0	81	0	7	0	207	946
12:30 PM	3	0	5	0	5	0	6	0	4	0	4	0	4	0	78	0	13	0	5	0	74	0	10	0	211	921
12:45 PM	1	0	1	0	11	0	9	0	4	0	9	0	4	0	80	0	6	0	8	0	73	0	9	0	215	865
1:00 PM	4	0	2	0	8	0	9	0	5	0	7	0	2	0	68	0	5	0	8	0	77	0	5	0	200	833
1:15 PM	2	0	2	0	7	0	2	0	1	0	8	0	5	0	58	0	5	0	4	0	73	0	9	0	176	802
1:30 PM	6	0	2	0	5	0	5	0	0	0	4	0	2	0	61	0	0	0	5	0	67	0	6	0	163	754
1:45 PM	4	0	1	0	8	0	1	0	0	0	5	0	5	0	66	0	1	0	2	0	76	0	7	0	176	715
2:00 PM	1	0	2	0	6	0	4	0	3	0	7	0	7	0	86	0	5	0	2	0	71	0	6	0	200	715
2:15 PM	5	0	1	0	3	0	3	0	2	0	12	0	3	0	59	0	5	0	8	0	97	0	3	0	201	740
2:30 PM	5	0	1	0	2	0	5	0	2	0	11	0	3	0	70	0	7	0	9	0	98	0	8	0	221	798
2:45 PM	6	0	1	0	4	0	8	0	3	0	10	0	3	0	79	0	9	0	10	0	100	0	11	0	244	866
3:00 PM	0	0	2	0	6	0	4	0	4	0	2	0	5	0	69	0	5	0	8	0	82	0	4	0	191	857
3:15 PM	2	0	3	0	7	0	4	0	2	0	11	0	6	0	108	0	13	0	8	0	124	0	5	0	293	949
3:30 PM	4	0	3	0	8	0	2	0	1	0	9	0	4	0	139	0	12	0	8	0	105	0	11	0	306	1034
3:45 PM	2	0	4	0	7	0	8	0	5	0	7	0	4	0	112	0	9	0	11	0	111	0	9	0	289	1079
4:00 PM	4	0	0	0	10	0	8	0	5	0	8	0	7	0	123	0	5	0	6	0	111	0	10	0	297	1185
4:15 PM	3	0	1	0	11	0	9	0	1	0	11	0	6	0	126	0	6	0	8	0	130	0	6	0	318	1210
4:30 PM	6	0	6	0	12	0	10	0	3	0	16	0	5	0	92	0	4	0	17	0	126	0	12	0	309	1213
4:45 PM	4	0	5	0	16	0	10	0	2	0	15	0	2	0	87	0	5	0	8	0	118	0	7	0	279	1203
5:00 PM	3	0	3	0	6	0	6	0	2	0	7	0	2	0	88	0	1	0	7	0	121	0	10	0	256	1162
5:15 PM	6	0	3	0	5	0	5	0	0	0	8	0	4	0	62	0	2	0	2	0	100	0	7	0	204	1048
5:30 PM	5	0	2	0	9	0	2	0	1	0	7	0	5	0	55	0	5	0	3	0	141	0	10	0	245	984
5:45 PM	4	0	0	0	3	0	3	0	1	0	8	0	2	0	80	0	5	0	8	0	114	0	11	0	239	944
3:45 - 4:45 peak	15	0	11	0	40	0	35	0	14	0	42	0	22	0	453	0	24	0	42	0	478	0	37	0	1213	1213
	15		11		40		35		14		42		22		453		24		42		478		37			

ATTACHMENT B: LOS WORKSHEETS

HCM Unsignalized Intersection Capacity Analysis
3: MacDonough Dr. & VT 22A 3/11/2005

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		5%			0%			3%			0%	
Volume (veh/h)	15	14	40	35	18	42	22	478	24	42	478	37
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	16	15	43	38	20	46	24	520	26	46	520	40
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1267	1224	540	1262	1232	533	560			546		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1267	1224	540	1262	1232	533	560			546		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	86	91	92	68	88	92	98			96		
cM capacity (veh/h)	115	166	542	119	165	547	1011			1024		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	75	103	570	605
Volume Left	16	38	24	46
Volume Right	43	46	26	40
cSH	239	198	1011	1024
Volume to Capacity	0.31	0.52	0.02	0.04
Queue Length 95th (ft)	32	67	2	3
Control Delay (s)	26.8	41.4	0.7	1.2
Lane LOS	D	E	A	A
Approach Delay (s)	26.8	41.4	0.7	1.2
Approach LOS	D	E		

Intersection Summary			
Average Delay	5.5		
Intersection Capacity Utilization	59.4%	ICU Level of Service	B
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
3: MacDonough Dr. & VT 22A 3/11/2005

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		5%			0%			3%			0%	
Total Lost time (s)		4.0			4.0			4.0			4.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.92			0.94			0.99			0.99	
Flt Protected		0.99			0.98			1.00			1.00	
Satd. Flow (prot)		1656			1720			1820			1839	
Flt Permitted		0.94			0.90			0.97			0.94	
Satd. Flow (perm)		1572			1578			1771			1734	
Volume (vph)	15	14	40	35	18	42	22	478	24	42	478	37
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	16	15	43	38	20	46	24	520	26	46	520	40
RTOR Reduction (vph)	0	38	0	0	41	0	0	2	0	0	3	0
Lane Group Flow (vph)	0	36	0	0	63	0	0	568	0	0	603	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		7.0			7.0			45.1			45.1	
Effective Green, g (s)		7.0			7.0			45.1			45.1	
Actuated g/C Ratio		0.12			0.12			0.75			0.75	
Clearance Time (s)		4.0			4.0			4.0			4.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		183			184			1329			1301	
v/s Ratio Prot												
v/s Ratio Perm		0.02			c0.04			0.32			c0.35	
v/c Ratio		0.20			0.34			0.43			0.46	
Uniform Delay, d1		24.0			24.4			2.8			2.9	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		0.5			1.1			1.0			1.2	
Delay (s)		24.5			25.6			3.8			4.1	
Level of Service		C			C			A			A	
Approach Delay (s)		24.5			25.6			3.8			4.1	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM Average Control Delay	6.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	60.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	59.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

APPENDIX D

VIDEO DETECTOR

Autoscope Solo Pro II™

Machine Vision Processor

A high-resolution color video detection and surveillance system with a zoom lens. Featuring simple set-up, configuration, and video compression.

Autoscope®

Features

- Integrated color camera, zoom lens, and machine vision processor in one compact unit.
- 22X zoom lens & color imager.
- Enhanced video compression capability with optional built-in wavelet-technology hardware.
- Direct real-time iris and shutter speed control.
- IP address for Solo network.
- Rugged, environmentally-sealed enclosure.
- Space age faceplate heater.
- Low power consumption.
- Microprocessor technology for reliable long-life performance.
- Fail-safe mode sends outputs to traffic controller.
- Now with an optional 5-year extended warranty package.

Description

The Autoscope Solo Pro II™ (Machine Vision Processor), part of the Autoscope family of high-performance machine vision detection technologies, offers field-proven reliability and the flexibility to meet more detection objectives. New features increase the effectiveness of the world's first integrated wide-area video detection system for traffic management professionals everywhere.

By integrating a color camera, zoom lens, and machine vision processor into a single cost-effective package, the Autoscope Solo Pro II better responds to dynamic lighting changes for more robust performance in all conditions. An optional video compression (VC) card uses a wavelet CODEC for faster streaming video back to the office. Simplified installation and maintenance help keep costs down. At 17 watts, it's a power miser!

The advanced Autoscope Solo® system architecture complements the field-proven Autoscope product suite. The Autoscope Solo Pro is ideal for freeway, intersection, bridge, tunnel, railroad, traffic monitoring, and incident prevention applications.

An Autoscope Solo network can link the traffic management center with each IP-addressable Solo Pro II in the field. With the Solo Communications Server Software Developer's Kit (SDK), a programmer can easily create new client applications for display, incident alarms, and traffic parameter databases.

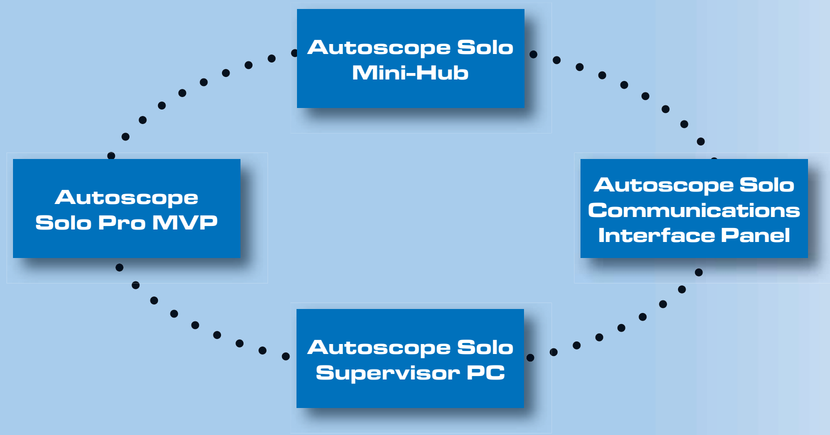
The Autoscope Solo Pro II provides an economic alternative to loops and other detection technologies. Twisted-pair wiring to the Solo Pro II is faster and easier to install than higher-cost coaxial cables. Remote connections as simple as a phone line or wireless radio can bring compressed video and data back to a traffic management center.

Benefits

- Simplicity with Autoscope Wizard™.
- Superior value when compared to other detection systems.
- Flexibility in application.
- Reliable detection performance.
- Ease of installation and cost-effective maintenance.
- Native language support.
- Streaming video with actuations.

www.econolite.com

ECONOLITE CONTROL PRODUCTS, INC.



Applications

- Intersection control detection.
- Freeway management detection.
- Incident detection and verification.
- Traffic survey data collection.
- Temporary, construction, and work zone safety.
- Smart, remote surveillance.

Specifications

Lens
- 22X continuous-focus zoom
- **Horizontal:** 5 to 74 degrees
- **Vertical:** 4 to 59 degrees

Imaging Device
- 1/4" color CCD

Video Formats Supported
- RS170, NTSC, CCIR and PAL

Resolution
- 450 TVL Horizontal

Effective Pixels
- **NTSC**:768(H) x 494(V) [380k]
- **PAL:**752(H) x 582(V) [440k]

Synchronization
- Crystal lock

Sensitivity—at Lens
- Full video, AGC off, 3 lux

Signal to Noise Ratio
- 46 dB

Communications
- **Connector:** MS 14-18P
- RS-485 communications port
- RS-485 detector port
- Differential color video port

Housing & Sunshield
Image sensor and MVP sealed in a waterproof and dust-tight enclosure. Thermostatically controlled faceplate heater. Adjustable weather and sun-shield with drip guard.

Power
- **RS170/NTSC:** 24 VAC 60 Hz
- **CCIR/PAL:** 24 VAC 50 Hz
- 10 to 28 VDC
- 17 watts with heater on (25 watts with optional video compression module)

Dimensions
- **Mounting:** Standard camera bracket tilt top provided
- **Housing Enclosure:** 3.5" diameter, 15.5" long
- **Weather sunshield:** 21.3" long

Weight
- 5 lbs. 14 oz.

Ambient Temperature Limits
- -34°C to +60°C / -29°F to +140°F

Humidity Limits
- Up to 100% relative humidity, non-condensing

Options
- Video output
- Power source
- Sealed or pressurized enclosure
- Enhanced video compression capability for streaming video

Warranty
- Two-year warranty.
- Extended warranty available (5-year warranty package)

Product Support
Product support and training by team of trained Autoscope Technical Support Specialists.

Setup & Operation

Simple mouse and keyboard operations add, delete, or move a number of virtual detectors in the field of view. You can customize detector layouts to match your detection objectives for the site. Any performance monitoring can be on site or remotely over phone lines or other communications infrastructure.

Detection zones include count, presence, and incident detection. Real-time polling, dial out, or stored traffic data include: volume, occupancy, speed, density, headway, and 5 vehicle classifications either by phase or in many time intervals from 1 second to 60 minutes. Extensive Boolean logic capabilities provide flexibility in detector layouts and can help validate an event or incident alarm.

Autoscope Solo Pro II now features the Autoscope Wizard for simplified set-up and configuration of common intersection applications.

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