RSG INC.
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Documentation for:

STREET GRID EVALUATION FINAL REPORT

Williston, VT

Prepared for:

Town of Williston

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WILLISTON GRID STREET EVALUATION – FINAL REPORT

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EXECUTIVE SUMMARY

This report summarizes the analysis of potential impacts of a new grid street system, as identified in the Town's Comprehensive Plan, which will provide for local circulation and access to existing and future businesses and homes in Taft Corners area. Current traffic conditions are documented (adjusted to the year **2008 as base year**) and then various modeling techniques are used to determine traffic condition for future scenarios, assuming they are constructed by the **year 2018**.

The four alternatives considered are described as follows:

- **Alternative A**: the addition of "Depot Street" running east-west between Harvest Lane (near the entrance to Home Depot) and VT 2A (near the State Police barracks)
- **Alternative B**: the extension of Helena Drive south of US 2 to Marshall Avenue, with various connectors to the Hannaford shopping center, VT 2A, and Harvest Lane
- **Alternative A+B**: a network of the roads in both Alternatives A and B
- **Alternative 'No New Roads'**: an alternative which includes necessary improvements to existing roads, but does not add new roads

The **steps taken** in this analysis include:

STEP 1: Documenting existing conditions, such as land use, roadway and traffic conditions in the project area, including:

a. A summary of existing roadway hierarchy, functional class, jurisdictional boundaries, and access management classifications.

b. Zoning district boundaries.

c. Environmental constraints such as wetlands, watercourses, steep slopes and natural habitats.

d. High crash locations were identified, as follows;

    i. US2 / VT2A intersection

    ii. VT2A / Marshall Ave intersection

e. Levels of Service (LOS-see attached description of Level of Service) at the studied intersections at current traffic levels, adjusted to reflect the Design Hour (DHV) in 2008. **Items of interest from the 2008 PM Peak Hour Analysis include**;

i. Overall LOS for all of the study intersections remains at LOS C or better.

ii. The average delay at the VT 2A – Marshall Avenue intersection is just under LOS D.

iii. During the PM Peak hour the longest queues along the US 2 corridor occur in the eastbound direction.

iv. Along VT 2A signal priority is given to the northbound and southbound through movements on VT 2A at the expense of eastbound and westbound turning movements from Connor Way and Marshall Avenue. This signal timing benefits the mobility role of VT 2A at the expense of the accessibility role of VT 2A.

v. At the VT 2A – Marshall Avenue intersection the northbound left turn from VT 2A onto Marshall Avenue experiences significant delay (66 seconds per vehicle, LOS E). The queue from the left turn lane spills back into the northbound travel lanes on VT 2A upstream form the intersection.

vi. The southbound through and right approaches at the VT2A – Exit 12 Southbound Ramps experience long queues (approximately 800 feet) during the PM peak.

The congestion analysis indicates that for the **Saturday Peak Hour Analysis**:

i. Overall LOS for all of the study intersections remains at LOS C or better with the exception of the VT2A-Marshall Avenue and the Marshall Avenue – Four Seasons Garden Center intersections which operate at LOS D

ii. The Eastbound left and through movements at the VT 2A – Marshall Avenue intersection operate at LOS F with delays greater than 100 seconds/vehicle. The Westbound movements operate at LOS D with delays between 37 and 50 seconds/vehicle.

iii. At the VT 2A – Marshall Avenue intersection the queue from the left turn lane spills back into the northbound travel lanes on VT 2A upstream form the intersection. The eastbound left and through queues are also significant at 240 feet and 550 feet respectively.

iv. The delays on the Eastbound and Westbound approaches is a result VTrans giving signal priority to the Northbound and Southbound through movements on VT 2A. This signal timing benefits the mobility role of VT 2A at the expense of the accessibility role of VT 2A.

v. The Westbound left movement at the Marshall Avenue – Trader Lane intersection functions at LOS E with a delay of 71 seconds/vehicle.

vi. The Westbound left movement at the Marshall Avenue – Harvest Lane intersection functions at LOS F with a delay greater than 100 seconds/vehicle.

vii. At the Marshall Avenue – Four Seasons Garden Center intersection the Eastbound through and right movements operate at LOS E with a delay of 60 seconds/vehicle. The Westbound left, through, and right movements operate at LOS D.

STEP 2: Determining what and where new land uses will occur inside and outside the project area. For new developments inside the project area, this was accomplished with the input from the Planning Department. These new land uses were input into the Chittenden Co. transportation model, which also predicts new land uses outside the project area.

Some of the important assumptions made for this model include:

a. Projects planned in the Metropolitan Transportation Plan have been included

b. The network was modeled wit hand without the Chittenden Co Circumferential highway (segments A+B only)

STEP 3: Modeling future alternatives: A sub-area of the county model, to include all of the traffic zones shown in figure 2, was extracted and input into a more detailed model (Paramics) with specific details such as auxiliary lanes and traffic signal control parameters. This model has the capability to determine the shortest path from the zone of origin to a destination zone, for each vehicle. In addition, congestion is considered, such that actual trip time is also a factor. Each of the alternative grid street scenarios was modeled separately in order to determine the like traffic use of each new road and intersection. The smaller Paramics model was calibrated under current geometric conditions for the adjusted 2008 PM Peak Hour volumes, so that when changes were made the difference in flows (intersection turning movements) could be determined and added (or subtracted) from the measured counts to most accurately determine future traffic conditions for each alternative.

Given the projected growth…many of the major intersections would fail under current conditions in 2018.

Note that given the traffic volumes projected by the county model, many of the major intersections such as the interstate ramps and along the Marshall Ave corridor, would fail under current conditions in 2018. Therefore, each alternative included the necessary lane and traffic control improvements sufficient to meet a minimum level of service – i.e. intersections performed at Level of Service D or better, and average queues did not back up into adjacent intersections or block the use of adjacent lanes. These necessary improvements are explained in detail in Step 4 below.

STEP 4: Determine the improvements necessary to make each alternative perform adequately (intersection level of service D or better, and no queues backing into adjacent lanes or intersections). As further illustrated on the diagrams the four alternatives would require the following:

All of the alternatives include:

- Adding an exclusive left-turn lane onto the I-89 North on-ramp from northbound VT 2A (this necessitates widening of the overpasses.)
- Adding an exclusive right-turn lane onto the I-89 South on-ramp from northbound VT 2A
- Adding a second through-lane southbound on VT 2A at both I-89 ramps (this necessitates widening of the overpasses.)
- Adding left-turn lanes to the eastbound, southbound, and westbound approaches at the Marshall – South Brownell intersection.

Alternative 'No New Roads': a no-build alternative which incorporates various lane additions and intersection improvements, but no new roads. Necessary congestion mitigation for this alternative includes:

- Adding a second northbound left-turn lane from VT 2A onto Marshall Avenue with two receiving lanes on Marshall; these double westbound through lanes continue on Marshall to Harvest Lane
- Adding a second eastbound through-lane on Marshall Avenue from Harvest Lane to VT 2A
- Adding a through lane to the westbound approach at Marshall – VT 2A, for a resulting configuration of 2 left-turn lanes, 1 through lane, 1 through-right lane
- Adding a second eastbound right-turn lane from Marshall onto VT 2A

Alternative A: the addition of "Depot Street" running east-west between Harvest Lane and VT 2A; includes:

- a new traffic signal at Depot and VT 2A
- a northbound left-turn lane onto Depot
- a 2-lane eastbound approach

Alternative B: the extension of Helena Drive south of US 2 to Marshall Avenue, with various connectors to the Hannaford shopping center, VT 2A, and Harvest Lane; elements include (see figure 6):

- Adding a second northbound left-turn lane from VT 2A onto Marshall Avenue with two receiving lanes on Marshall; these double westbound through lanes continue on Marshall to Harvest Lane
- Adding a through lane to the westbound approach at Marshall – VT 2A, for a resulting configuration of 2 left-turn lanes, 1 through lane, 1 through-right lane
- Adding a second eastbound right-turn lane from Marshall onto VT 2A
- New traffic signal at Helena – US 2

Alternative A+B: a network of the new roads assuming both Alternatives A and B are constructed together (Figure 7), items of note include;

- does not require adding through-lanes on Marshall Avenue;
- does not require a second NB left turn lane at Marshall – VT 2A;
- includes new traffic signals at Helena – US 2 and Depot – VT 2A.

STEP 5: Determine Expected Levels of Service under these Future Conditions (2018).

After several successful runs in the Paramics model for each alternative, turning movements were determined and the difference from the turning movements for the 2008 model were then added to the known flows in the traffic analysis software SYNCHRO.

The congestion analysis indicates that for the **2018 Weekday PM Peak Hour Analysis**:

- Overall LOS for all of the study intersections in **each of the alternatives is LOS D or better**. (LOS D occurred only twice: in alternatives A and No New Roads, and both at the VT 2A – Marshall intersection.)
- The 2008 delay for the VT 2A – Marshall Avenue intersection is just under LOS D in the 2018 Alternatives A and A+B, the delay increases slightly- just enough to achieve LOS D - while Alternatives B and No New Roads have no effect.
- The southbound through and right movements at the VT2A – Exit 12 Northbound Ramps experience long queues (approximately 800 feet) during the 2008 PM peak. The improvements to the interchange made in each of the 2018 alternatives significantly reduce the average queue.

The **2018 Saturday Peak Hour Analysis** indicated that given the necessary geometric improvements, only one area experiences worse conditions than in the 2008 situation: Exit 12 I-89 NB ramps – VT 2A in Alternative A+B, but the decline was only from LOS A to LOS B.

Additional **network-wide comparisons** reveal the difference in total delay for each alternative, and ranked as follows;

- Alternative A+B 173 hours
- Alternative A 178 hours
- Alternative B 179 hours
- No New Roads 192 hours

STEP 6: Determine any potential impacts to natural resources:

One conflict with wetlands/watercourses is expected where Depot Street (proposed in Alternatives A and A+B) crosses the watercourse at the approach to Harvest Lane (see figure 5).

It is expected that some significant cut and fill will be necessary for the construction of Depot Street, which could affect the final alignment in relation to the adjacent watercourse.

There are no identified threatened species or deer wintering areas that should be in conflict with the proposed street grid roadways.

STEP 7: Determine the likely cost for each alternative:

Costs for each alternative were estimate in detail, including, preliminary and final engineering, construction, construction engineering, stormwater treatment, erosion control, traffic control, and a 15% contingency.

- Feature assumptions:
  - Curbing
  - Bike accessibility
  - Sidewalks (one side only)
  - Lighting – intersections only

All alternatives assume improvements at the interstate (Exit 12) including 2 new overpasses which are estimated $10-15 million, based on similar past projects.

- Alternative Cost Estimate Summary:

No New Roads'	$1,060,860
A	$1,689,399
B	$3,160,301
A+B	$4,149,811

Summary Findings & Conclusions

1. The Proposed Grid Streets relieve current congestion as well as expected additional future congestion;
2. The location of the 2 proposed signals are adequately spaced from adjacent intersections given the VTrans minimum of 500 ft, as well as the expected queuing at future traffic levels.
3. Alternative B alone does not relieve much of the congestion on Marshall Ave;
4. Alternative A alone will help relieve current congestion on Marshall Ave;
5. The Saturday traffic congestion appears to be most acute on Marshall Ave, which is relieved substantially by all of the future alternatives;
6. The cost estimate does not accurately reflect the benefits realized from each alternative, including land access, access management, pedestrian and bicycle access and circulation, and safety.

1.0 INTRODUCTION

The Town's Comprehensive Plan identifies a grid street system to provide for local circulation and access to existing and future businesses and homes in Taft Corners. Major components of the grid street network have been completed for several years and the Town is interested in expanding the network. The existing street system has helped to disperse traffic generated by development around Taft Corners while also providing alternate routes for through traffic between Exit 12 and points east and west along the US 2 corridor. This report summarizes existing conditions within the project area and provides an analysis of future conditions with several alternative grid streets.

2.0 STUDY AREA & NEW GRID STREETS OVERVIEW

2.1 STUDY INTERSECTIONS

The study area is highlighted in Figure 1. Major roads in this study area include US 2, VT 2A, and Marshall Avenue. The following intersections are included in this study:

US 2 Corridor

- US 2 – Harvest Lane;
- US 2 – VT 2A;
- US 2 – Boxwood Street; and
- US 2 – Maple Tree Place.

VT 2A Corridor

- VT 2A – Connor Way;
- VT 2A – Marshall Avenue;
- VT 2A – I-89 Northbound Exit 12 On/Off Ramps; and
- VT 2A – I-89 Southbound Exit 12 On/Off Ramps.

Marshall Avenue Corridor

- Marshall Avenue – Trader Lane;
- Marshall Avenue – Harvest Lane;
- Marshall Avenue – Harvest Lane – Four Seasons Gardner Center; and
- Marshall Avenue – South Brownell Street.

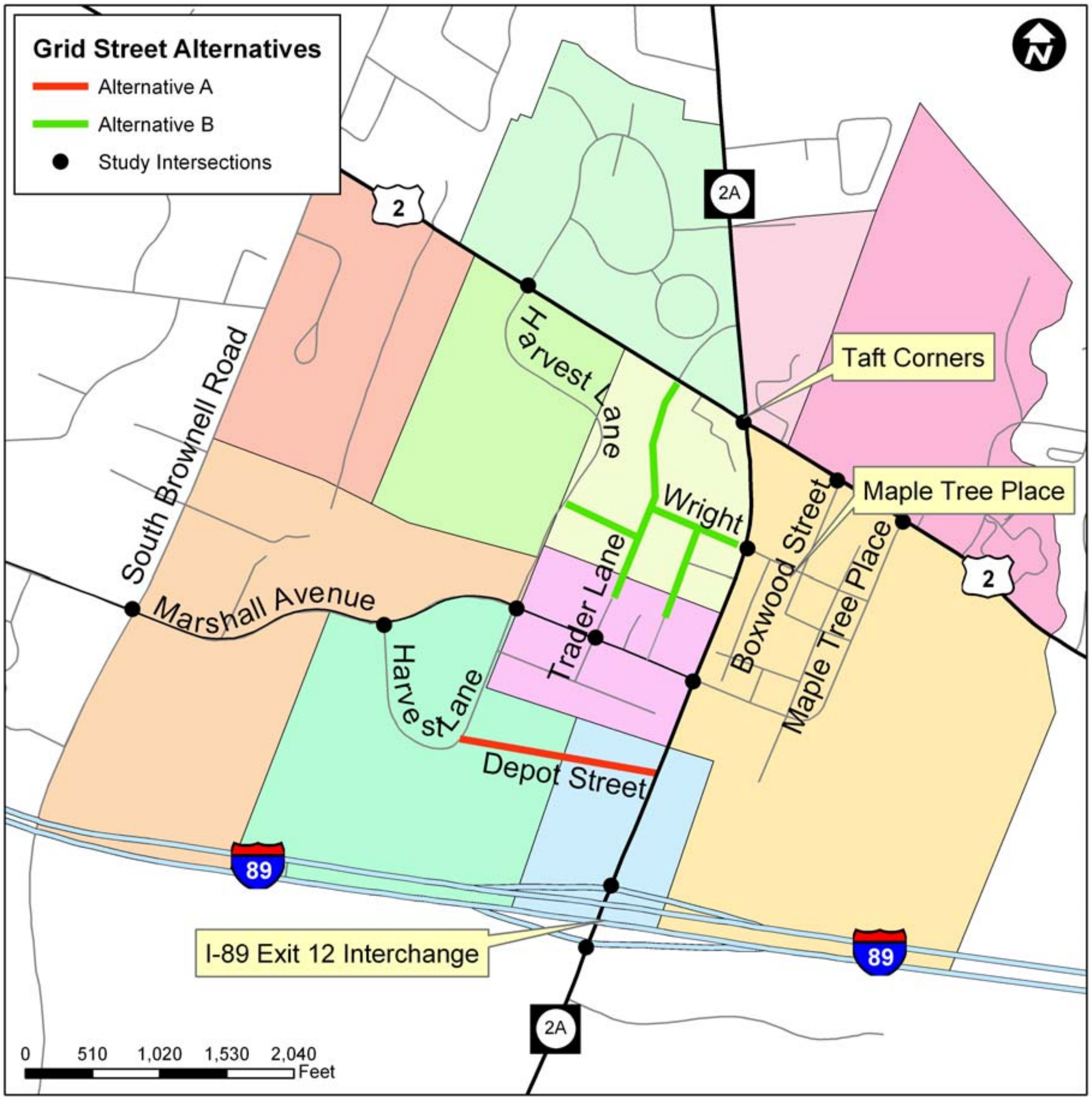
2.2 ALTERNATIVES

The future grid street alternatives analyzed for this report (also shown in Figure 1) include:

- **Alternative A**: the addition of "Depot Street" running east-west between Harvest Lane (near the entrance to Home Depot) and VT 2A (near the State Police barracks)
- **Alternative B**: the extension of Helena Drive south of US 2 to Marshall Avenue, with various connectors to the Hannaford shopping center, VT 2A, and Harvest Lane
- **Alternative A+B**: a network of the roads in both Alternatives A and B
- **Alternative 'No New Roads'**: an alternative which includes necessary improvements to existing roads, but does not add new roads

The most significant area in the analysis is Marshall – VT 2A given that is the intersection of two major corridors at the heart of the study area and is adjacent to the I-89 interchange. This intersection has the longest delay in the 2008 PM Peak as well as in all of the 2018 alternatives.

Figure 1: Study area showing alternatives layouts



The study area involves one of Chittenden County's largest and fastest growing commercial areas. This area is fed by 3 major road arteries – I-89 (via Exit 12), VT 2A and US 2. Traffic from a majority of the County's population centers can reach this area within minutes due to these connections. Additionally, Marshall Avenue provides similar capacity and convenience to the area, with a recent connection to Kimball Avenue in South Burlington.

The Taft Corners Shopping Center, once the commercial center, has been overshadowed by two newer developments – Taft Associates (TA), west of VT 2A, and Maple Tree Place (MTP), east of

VT 2A, each with multiple heavy traffic generators. Other large land uses include Blair Park (BP) and Judge Associates (JA) as well as numerous smaller - but in aggregate - significant developments. Many of these developments are "gated" by relatively few intersections, which allow good access control, but have become saturated with traffic at peak times. While there is relatively little residential use in the project area, zoning allows it, and some significant plans for such development are in the works. (See Section 3).

3.0 GENERAL LAND USE CHARACTERISTICS

3.1 EXISTING ZONING

This section provides a general overview of the zoning districts and existing land use in the study area. A map of current zoning districts and boundaries can be found in Appendix A. Below is a summary of allowable uses both permitted and conditional for each of the zones in the study area:

- Taft Corners – **Multi-family residential**, commercial lodging, health care and rehabilitation facilities, retail and professional services, office use, restaurant, educational, cultural, social, and religious facilities, public facilities, recreation and entertainment facilities, agriculture, storage, and towers.
- Mixed Use – **Single-family and multi-family residential**, commercial lodging, health care and rehabilitation facilities, retail and professional services, office use, restaurant, educational, cultural, social, and religious facilities, recreation and entertainment facilities, agriculture, and towers.
- Business Park – **Multi-family residential**, commercial lodging, health care and rehabilitation facilities, retail and professional services, office use, restaurant, educational, cultural, social, and religious facilities, recreation and entertainment facilities, agriculture, and towers.
- Commercial IA, IB, IIB, IIC - **Multi-family residential**, commercial lodging, health care and rehabilitation facilities, retail and professional services, office use, restaurant, educational, cultural, social, and religious facilities, public facilities, recreation and entertainment facilities, **limited manufacturing**, agriculture, storage, and towers.

The permitted uses for each zone are broad. The bold-faced uses in the bulleted points above highlight the differences between the zones. Multi-family residential units are permitted in all zones, while single family residential units are permitted only in the mixed use zone. Commercial zones are permitted to have limited manufacturing operates.

Table 1 displays the current and potential non-residential development for zones in the study area.

Table 1: Current and potential non-residential development for zones in the study area

Zone	Percent Developed to Date	Not Built Non-Residential Potential (sq.ft.)
Taft Corners	53%	1,965,266
Mixed Use	3%	138,574
Business Park	88%	540,995
Commerical I A	93%	288,379
Commerical I C	83%	203,533
Commerical II B	31%	178,938
Commerical II C	83%	495,999

3.2 FUTURE LAND USE ASSUMPTIONS

After conferring with the Williston Planning Department, the following additional land uses were included in the Land Use Transportation Model (LUTM) for the analysis of the 2018 alternatives. Future land use and demands in external zones were determined by the LUTM. Figure 2 and Table 2 describe the current and projected land uses in the study area.

Figure 2: Land use zones in project area

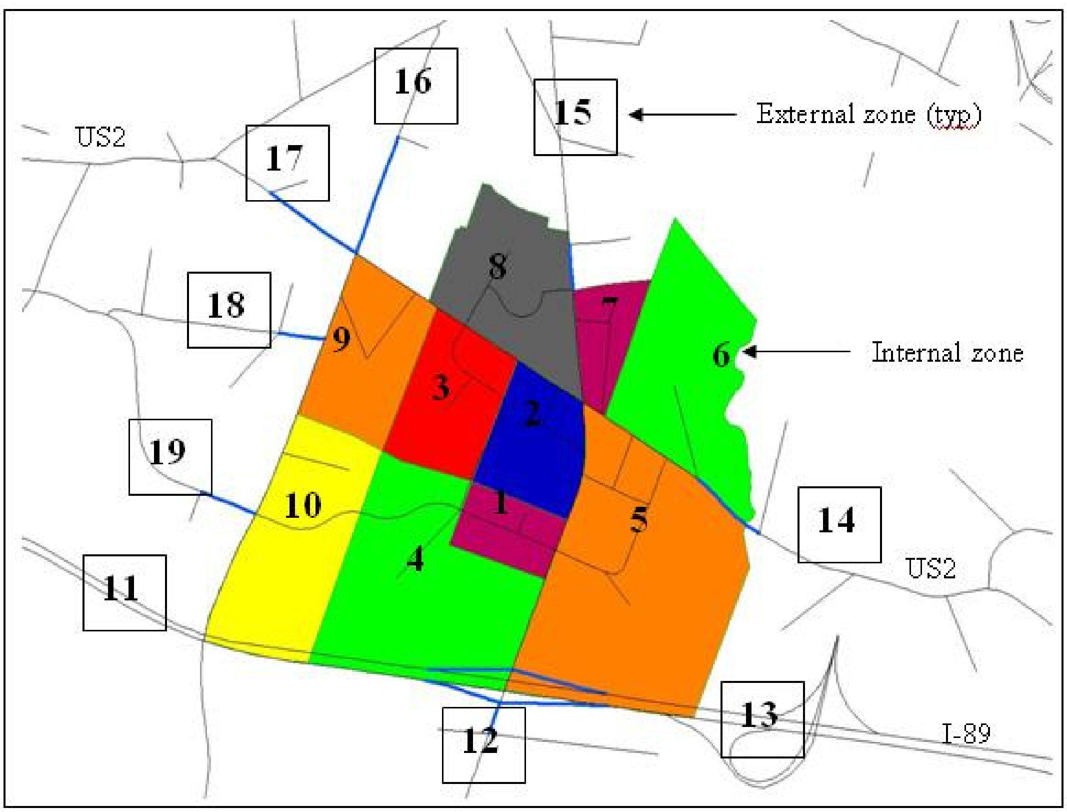


Table 2: Projected land use in project area by 2018

Zone	Area (description)	Retail	Non-retail	Residential
1	Davis/east (general)	35,000		
	(restaurant)		5,000	
	(market expansion)	20,000		
2	Davis/north (drug)	30,000		
5	MTP* (office)		10,000	
	(restaurant)		2,000	
	(general)	10,000		
	Lapierre (residential)			200 units
	(office)		40,000	
6	~Pecor (residential)			360 units
	(general)	25,000		
	(general)		25,000	
7	Judge & north (drug)	30,000		
	(residential)			160 units
8	Blair Park (office)		50,000	
TOTAL		150,000 s.f	132,000 s.f.	720 units

4.0 TRANSPORTATION SYSTEM CHARACTERISTICS

4.1 HIGHWAY SYSTEM CONTEXT

The roadways in the study area are components of a connected local, state, and national highway network. Highway functional class, the National Highway System, the Vermont Truck Network and town highway classification are the foundation for a variety of policies that affect funding eligibility, project prioritization, design requirements, jurisdiction, and maintenance and operation responsibilities for a highway. These various classification systems also provide a big picture view that defines the function of a specific, local highway project within the context of the regional, state, and national transportation systems.

4.1.1 Functional Class

The Federal Highway Administration's roadway functional classification system is organized as a hierarchy of facilities, based on the degree to which the roadway serves mobility and access to adjacent land uses as shown in Figure 3.

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.

Functional classification is used to determine funding eligibility and to establish roadway design standards. In designated urban areas, all collectors, arterials, and freeways are part of the federal aide system and are therefore eligible to receive federal transportation funds.

Figure 3: Conceptual Roadway Functional Hierarchy

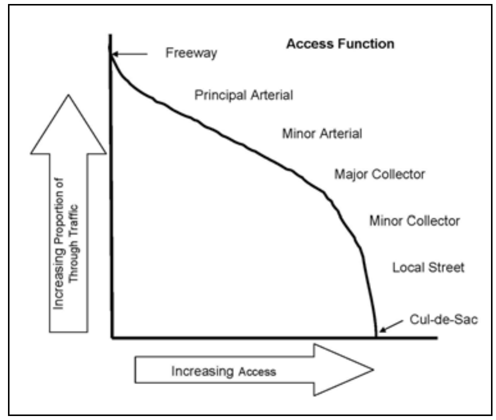


Table 3 summarizes the major roadway design guidelines as published in the *Vermont State Standards*[1] for principal and minor arterials in urban areas. The *Vermont State Standards* provide a significant amount of flexibility in selecting lane and shoulder widths for arterials that pass through built-up urban areas.

Table 3: Roadway Design Standards

Design Feature	Urban Arterials	Urban Collectors	Urban Local Roads
Design Speed	30-55, occasionally 25	25-50 mph	25-50 mph
Lane Widths	10-12 feet	9-11 feet	9-11 feet
Shoulder Widths	Varies from 2 to 8 feet depending on surrounding area	2 feet minimum but can be more or less depending on historic character and on-street parking requirements	2 feet minimum but can be more or less depending on historic character and on-street parking requirements
Bicycle Accomidations	11 feet lanes and 4 feet shoulders	11 feet lanes with 3 feet shoulders	11 feet lanes with 3 feet shoulders

Source: *Vermont State Standards*

Figure 4 displays the roadway functional classifications in the study area. The 2006 Town of Williston Comprehensive Plan defines the following classes of roadways:

- **Arterial**: Links communities and carries major traffic flows within urbanized areas, such as between the central business district and outlying areas or between suburban centers.
- **Major Collector**: Collects traffic from local streets and collectors and channels it to arterials or destinations that are not well served by the arterial system. Provides both land access and traffic circulation in residential, commercial, and industrial areas.

[1] "*Vermont State Standards* for the Design of Transportation Construction and Rehabilitation n on Freeways, Roads and Streets"; State of Vermont, Agency of Transportation; October 22, 1997.

- **Collector**: Collects traffic from local streets and channels it into the arterial system. Provides both land access and traffic circulation in residential, commercial, and industrial areas.
- **Local**: Provides access to land and higher systems (collectors and arterials). Through traffic is discouraged.

Given these definitions, the roads in the study area are designated as follows:

- VT 2A between I-89 and US 2 is classified as an urban principal arterial and as a minor urban arterial north of US 2
- US 2 is classified as an urban principal arterial west of VT 2A and as a minor urban arterial east of VT 2A
- Marshall Avenue is classified as an urban collector road
- all remaining roads in the study area are classified as urban local roads.

All new streets are designed with a typical cross section as shown in Figure 5. These general dimensions coincide with the Williston town specifications and typical sections.

Figure 4: Functional Class

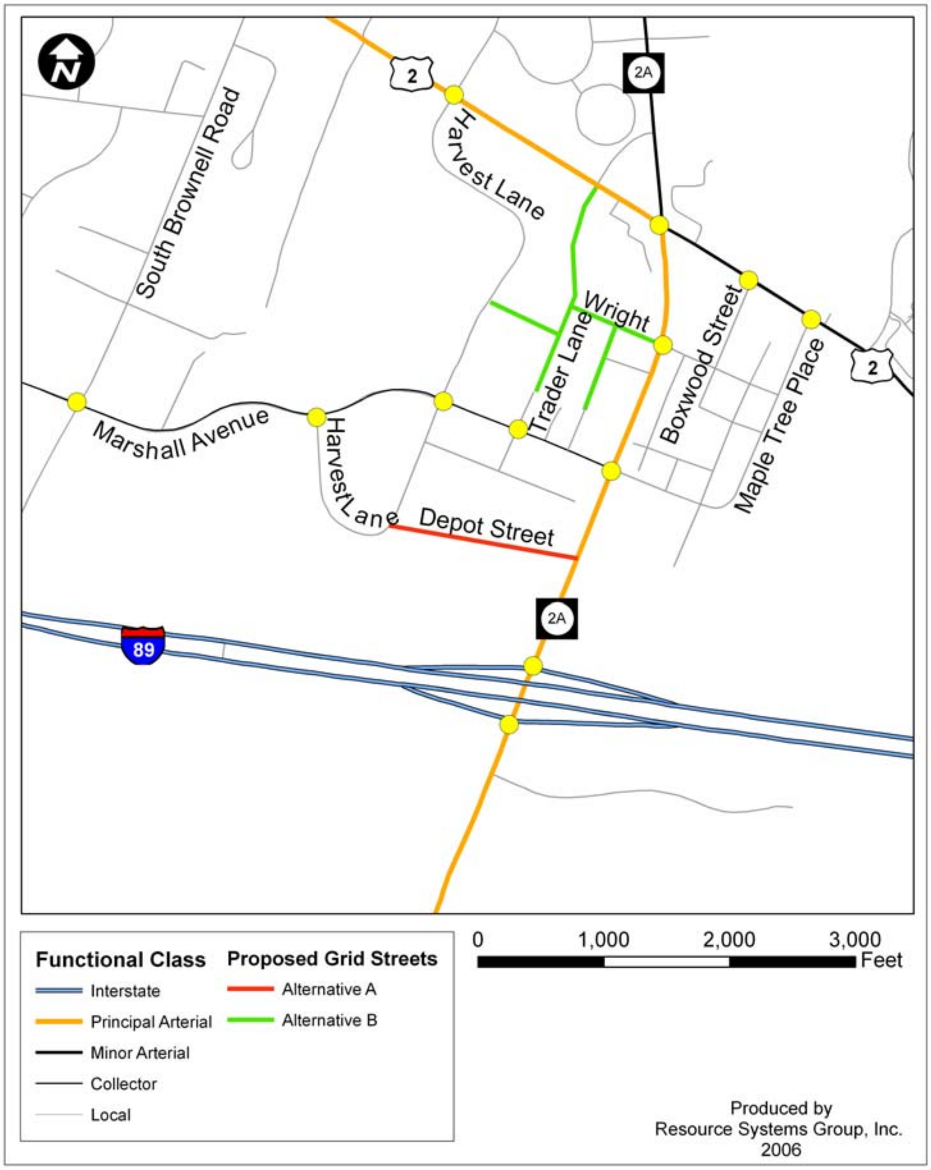
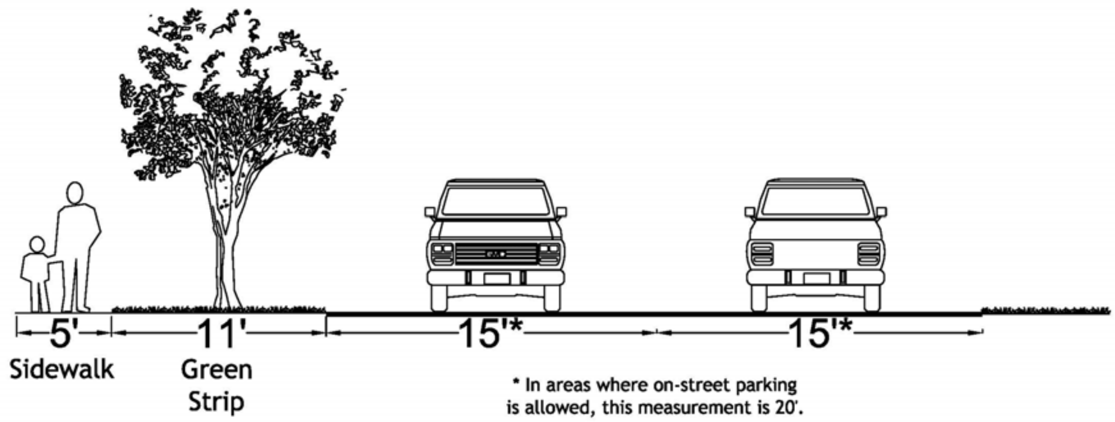


Figure 5: Typical Cross Section of New Streets (source: Williston town specifications)



4.1.2 National Highway System and VT Truck Route

The NHS consists of Interstate and Defense Highways and principal arterial roads essential for interstate and regional commerce, travel, national defense, intermodal transfer facilities, international commerce, and border crossings. NHS routes were designated in the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA). In the study area I-89, VT 2A from the exit 12 interchange to US 2, and US 2 west of VT 2A are part of the NHS.

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. The roads that are not part of the NHS were added to the truck network based on the volume of truck traffic and/or through the legislative decision making process. Inclusion on the truck network does not affect design standards which are governed by functional class, AADT, and truck traffic.

Within the study area, VT 2A north of US 2 and south of the exit 12 interchange is designated as part of the Vermont Truck Network. Because of this designation, recommendations related to the re-design and additions of intersections in the study area that may result from this study should accommodate trucks with overall lengths of 72 feet. This requirement will affect turning radii and should be considered in selecting appropriate lane widths.

4.1.3 Roadway Jurisdiction

The entire public highway network in Vermont is maintained either by the state or a municipality. 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. Roads owned by municipalities are categorized as class 1, 2, 3, or 4 town highways. A class 1 town highway has a VT or US route number and is an important part of the state system. In general, municipalities are responsible for all maintenance and construction costs associated with class 1-4 town highways although some funds are provided by the state to support projects on local roads. VT 2A, US 2, and I-89 in the study area are maintained by the State of Vermont. The town maintains Marshall Avenue, Maple Tree Place, and Harvest Lane.

4.1.4 VTrans Access Management Categories

In the study area, I-89, US 2, and VT 2A are maintained by VTrans which is responsible for issuing access permits. VTrans has established an Access Management Program that assigns all segments of the State's Highway System into one of six access management categories. The standards provide the basis for access permitting on state highways and are used in the planning and development of VTrans roadway construction projects. Existing highways are not required to meet the design standards. However, the standards are applied to all new access permits and construction projects.

The access management categories, which are summarized in Table 4**,** specify whether or not direct access to adjacent property is permitted, the type of driveway design factors to be considered, and type of turning movement allowed (Traffic Operations).

The following access management categories exist in the study area and are also shown in Table 4:

- Class 1: The entire interstate falls within this classification. Access is allowed only through grade separated interchanges;
- Class 4: VT 2A south of I-89. Direct access to abutting land is permitted without approval from the Vermont Transportation Board.
- Class 6: US 2 and VT 2A north of I-89 in the study area fall within this category. Direct access may be denied by VTrans if safe and reasonable alternative locations are possible on a side street. VTrans can limit the number of driveways to one per parcel.

Table 4. VTrans Access Management Categories

Access Category	Functional Class and AADT Characteristics	Direct Property Access	Driveway Design Factors	Traffic Operations and Movements Allowed	Design Features
1	- Interstates	No	Not Applicable	Access only provided at Interchanges with public highways	Grade-Separated Interchanges
2	- Other Principal Arterials - Limited Access Major Collectors	No – Except by Access Rights	Number, Spacing and Locations	Access at intersections with public highways	At-Grade or Grade-Separated intersections at ½ to 1 mile intervals
3	- Other Principal Arterials - Minor Arterials (AADT > 5,000) - Non-limited Access Major Collectors on State Highway and Class 1 Town Highways (AADT greater than 5,000)	Deny, Restrict or Allow	Number, Spacing and Locations	May limit turning movements	- Physical Barriers (Medians or Islands) - Traffic signal spacing requirements - Left and/or Right Turn Lanes Required - Spacing of public highway intersections that are or may be signalized (1/4 to ½ mile)
4	- Minor Collectors - Minor Arterials and Class 1 Town Highways (< 5,000 AADT) - Non-limited Access Major Collectors on State Highway and Class 1 Town Highways (Less than 5,000 AADT)	Yes	Number, Spacing and Locations	All turns in & out May limit turning movements	- Spacing of public highway intersections that are or may be signalized (1/4 to ½ mile)
5	- Frontage or Service Road	Yes	Number and location	All turns in and out	- Traffic signal spacing not less than 500 feet.
6	- May have any functional class but are urban in nature.	Deny, restrict, or allow	Number and location		- Traffic signal spacing not less than 500 feet.

4.2 EXISTING ROADWAY CHARACTERISTICS

Intersection geometries and control types are summarized in Table 5. All study intersections are signal controlled. Some intersections currently have the capability to be coordinated with each other. The entire VT 2A corridor is coordinated by a master controller at Taft Corners. Some of the intersections on US 2 are coordinated from this master as well (Taft Corners to Maple Tree Place).

Marshall Avenue has an interconnect between the 3 local signals, and a master at the Four Seasons Garden Center intersection. No interconnect has been made to the VT 2A intersection, however this could be done relatively easily once jurisdictional issues are addressed.

Table 5: Study Intersection Characteristics

US 2 Corridor	**# of Lanes**	**Lane Configuration Center**	**Middle**	**Curb**	**Control Type**	**Turn Lane Lengths**
US 2 - Harvest Lane						
US 2 EB	3	L	T	R		Left (240') and Right (240')
US 2 WB	2	L		T R	Signal	Left (160')
Harvest Lane NB	2	L T		R		Right (190')
Blair Park Road SB	2	L T		R		Right (95')
US 2 - VT 2A						
US 2 EB	3	L	T	R		Left (680') and Right (302')
US 2 WB	3	L	T	R	Signal	Left (110') and Right (310')
VT 2A NB	3	L	T	R		Left (690') and Right (270')
VT 2A SB	3	L	T	T R		Left (370') and Through, Right (370')
US 2 - Boxwood Street						
US 2 EB	1			T R		
US 2 WB	2	L		T	Signal	Left (155')
Boxwood Street NB	1			L R		
US 2 - Maple Tree Place						
US 2 EB	2	L		T R		Left (127')
US 2 WB	2	L		T R	Signal	Left (216')
Maple Tree Place NB	2	L T		R		Right (130')
Gas Station Driveway	1			L T R		
VT 2A Corridor						
VT2A - Connor Way						
Connor Way EB	1			L T R		
Connor Way WB	1			L T R	Signal	
VT 2A NB	2	L T		R		Left (152')
VT 2A SB	3	L	T	T R		Left (105')
VT 2A - Marshall Aveune						
Marshall Avenue EB	3	L	T	R		Left (273') and Right (273')
Marshall Avenue WB	3	L	L	T R	Signal	Left (263')
VT 2A NB	3	L	T	R		Left (396')
VT 2A SB	3	L	T	R		Left (200')
Exit 12 NB Ramps & VT 2A						
Exit 12 NB Ramps WB	2	L		R		
VT 2A NB	2	L T		T	Signal	
VT 2A NB	2	T		R		
Exit 12 SB Ramps & VT 2A						
Exit 12 SB Ramps EB	3	L	L	R		Right (690')
VT 2A NB	2	T		T R	Signal	Left (295')
VT 2A NB	2	L		T		Left (250')
Marshall Avenue Corridor						
Marshall Avenue - South Brownell Road						
Marshall Avenue EB	1			L T R		
Marshall Avenue WB	1			L T R	Signal	
South Brownell Road NB	2	L T		R		Right (135')
South Brownell Road SB	1			L T R		
Marshall Avenue - Harvest Lane - Four Seasons Garden Center						
Marshall Avenue EB	2	L		T R		Left (155')
Marshall Avenue WB	2	L		T R	Signal	Left (175')
Harvest Lane NB	2	L T		R		Right (170')
Harvest Lane SB	2	L T		R		
Marshall Avenue - Harvest Lane						
Marshall Avenue EB	2	L		T R		Left (100')
Marshall Avenue WB	2	L		T R	Signal	Left (300')
Harvest Lane NB	2	L T		R		Right (150')
Harvest Lane SB	2	L		T R		Left (180')
Marshall Avenue - Trader Lane						
Marshall Avenue EB	2	L		T R		Left (121')
Marshall Avenue WB	2	L		T R	Signal	Left (157')
Trader Lane NB	2	L T		R		Right (82')
Trader Lane SB	2	L T		R		Right (92')

4.3 TRANSIT SERVICE

CCTA operates bus service from the Burlington Central Business District to Williston. The number 23 CCTA bus stops at the following locations in the study area at half an hour to hour intervals depending on the time of day:

- Taft Corners;
- Maple Tree Place;
- Wal-Mart; and
- the South Brownell Street – Marshall Avenue intersection.

5.0 CONGESTION, SAFETY, AND ACCESS MANAGEMENT

5.1 CONGESTION ANALYSIS

This section describes the development of current and future design hour volumes and presents delay, level of service, and queueing results from the analysis of the study intersections.

5.1.1 Development of 2008 and 2018 PM Peak Hour DHV Volumes

Turning movement counts for the study intersections were conducted on the dates shown in Table 6. The majority of intersections experienced the PM peak hour from 4:30 PM to 5:30 PM, which was used as the common analysis hour.

Table 6: Intersection Traffic Count Dates

Intersection	Count Date	CTC used for DHV Adjustment	DHV Adjustment Factor
US 2 Corridor			
US Route 2 - Harvest Lane	6/1/2004	D061	1.11
US Route 2 - VT 2A	6/1/2004	D129	1.12
US Route 2 - Boxwood Street	6/4/2004	D061	1.07
US Route 2 - MTP	6/1/2004	D061	1.11
VT 2A Corridor			
VT2A - Connor Way	6/1/2004	D129	1.12
VT 2A - Marshall Aveune	6/1/2004	D129	1.12
Exit 12 NB Ramps & VT 2A	5/26/2004	D129	1.11
Exit 12 SB Ramps & VT 2A	5/26/2004	D129	1.11
Marshall Avenue Corridor			
Marshall Avenue - South Brownell Road	3/21/2006	D061	1.19
Marshall Avenue - Harvest Lane - Four Seasons Garden Center	3/21/2006	D061	1.19
Marshall Avenue - Harvest Lane	3/21/2006	D061	1.19
Marshall Avenue - Trader Lane	3/28/2006	D061	1.19

The raw traffic counts have been modified to represent the design hour volume (DHV)[1] in 2008 using two adjustment factors:

- The design hour adjustment factors are based on VTrans Continuous Traffic Counters (CTC) D061 (located on US 2 east of Industrial Avenue) and D129 (located on VT2A in Williston). These counters collect traffic volumes 365 days per year, 24 hours per day. These data describe the daily fluctuations in traffic volumes and are used to adjust a ground count conducted on a specific date to the design hour. Table 6 shows the corresponding CTCs and DHV adjustment factors for the study intersections. The DHV factors increased raw traffic volumes between 7% (1.07 DHV adjustment factor) and 19% (1.19 DHV adjustment factor).
- An annual adjustment factor, which represents general background traffic growth, is based on the growth rate for rural primary and secondary roads in the 2004 VTrans Redbook. The base year annual adjustment factor increased the raw 2004 volumes by 3.0% and raw 2006 volumes by 1% to represent 2008 conditions.

The DHV then provides the basis for a model to estimate future volumes in the year 2018 for a PM Weekday. These projections are used for the 2018 congestion analysis.

5.1.2 Development of 2008 and 2018 Saturday Peak Hour Volumes

Turning movement counts for a subset of the intersections studied in the Weekday PM Peak hour were conducted on Saturday 8 April, 2006. (The subset of intersections included all PM peak hour study intersections except US 2-Boxwood Street, US 2 – Maple Tree Place, VT2A – Connor Way, and Marshall Avenue – South Brownell Street). The majority of intersections experienced a peak hour from 11:30 PM to 12:30 PM, which was used as the common analysis hour. Volumes were grown by 1% to represent 2008 volumes based on growth factors for regression group B, Urban areas, in the VTrans Redbook. 2018 Saturday peak hour volumes were estimated for this subset of intersections by proportioning the change in volume for each alternative as modeled in the PM peak hour analysis. These projections provided the basis for the 2018 Saturday congestion analysis.

5.1.3 Analysis Methodology

Each alternative was modeled with the geometries and lane configurations necessary to perform at reasonable levels of congestion (i.e., overall Level of Service (LOS) D or better; movement/lane group LOS E or better; and no queue spillback into adjacent intersections). This minimum level of geometric improvements is shown in Figure 6, Figure 7, Figure 8, and Figure 9.

The general analysis steps include:

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[1] The DHV is the 30th highest hour of traffic for the year and is used as the design standard in Vermont.

1. Future land use assumptions were developed through consultation with the town planning department. (See Section 3.2 for more detail.)
2. The County Land Use & Transportation Model was used to forecast demand within and outside of the project area using assumptions developed in Step 1.
3. Alternatives were modeled in Paramics (a program that predicts likely route choices based on a comparison of travel time and expected delay) using the demand forecasted in Step 2.
4. The output from the Paramics model was then entered into Synchro (v6), a traffic analysis software package from Trafficware, to determine levels of congestion and expected delay.

5.1.4 Alternatives Overview

The resulting grid street alternatives analyzed include:

- **Alternative A** (Figure 6): the addition of "Depot Street" running east-west between Harvest Lane and VT 2A; includes a new traffic signal at Depot and VT 2A with a northbound left-turn lane onto Depot and a 2-lane eastbound approach
- **Alternative B** (Figure 7): the extension of Helena Drive south of US 2 to Marshall Avenue, with various connectors to the Hannaford shopping center, VT 2A, and Harvest Lane; elements include:
    - Adding a second northbound left-turn lane from VT 2A onto Marshall Avenue with two receiving lanes on Marshall; these double westbound through lanes continue on Marshall to Harvest Lane
    - Adding a through lane to the westbound approach at Marshall – VT 2A, for a resulting configuration of 2 left-turn lanes, 1 through lane, 1 through-right lane
    - Adding a second eastbound right-turn lane from Marshall onto VT 2A
    - New traffic signal at Helena – US 2
- **Alternative A+B** (Figure 8): a network of the new roads in both Alternatives A and B; does not require adding through-lanes on Marshall Avenue or a second NB left turn lane at Marshall – VT 2A; includes new traffic signals at Helena – US 2 and Depot – VT 2A
- **Alternative 'No New Roads'** (Figure 9): a no build alternative which incorporates various lane additions and intersection improvements, but no new roads. Necessary congestion mitigation for this alternative includes:
    - Adding a second northbound left-turn lane from VT 2A onto Marshall Avenue with two receiving lanes on Marshall; these double westbound through lanes continue on Marshall to Harvest Lane
    - Adding a second eastbound through-lane on Marshall Avenue from Harvest Lane to VT 2A

  - Adding a through lane to the westbound approach at Marshall – VT 2A, for a resulting configuration of 2 left-turn lanes, 1 through lane, 1 through-right lane
  - Adding a second eastbound right-turn lane from Marshall onto VT 2A

As shown in Figure 9, all of the alternatives include:

- Adding an exclusive left-turn lane onto the I-89 North on-ramp from northbound VT 2A
- Adding an exclusive right-turn lane onto the I-89 South on-ramp from northbound VT 2A
- Adding a second through-lane on southbound VT 2A at both I-89 ramps
- Adding left-turn lanes to the eastbound, southbound, and westbound approaches at Marshall – South Brownell

The most significant area in the analysis is Marshall – VT 2A given that is the intersection of two major corridors at the heart of the study area and is adjacent to the I-89 interchange. This intersection has the longest delay in the 2008 PM Peak as well as in all of the 2018 alternatives.

Figure 6: Alternative A Geometry

Figure 7: Alternative B Geometry

Figure 8: Alternative A+B Geometry

Figure 9: Alternative 'No New Roads' and adjustments to all alternatives

5.1.5 Signalized Intersection Spacing

The new grid street system must provide the necessary distances between intersections so that adequate queuing space is available at traffic signals for through and turning traffic. VTrans design standards set a minimum spacing of 500 feet between signalized intersections. In addition expected queuing should be analyzed. E ach of the future grid street alternatives were analyzed for expected lane queuing to ensure that adjacent lanes or intersections did not become blocked, and that these minimum criteria were met. See Appendix E for spacing distances between intersections along the US2 and VT2A in the project area.

5.1.6 LOS Methodology

Level of Service (LOS) is a qualitative measure describing the operating conditions as perceived by motorists driving in a traffic stream. The 2000 Highway Capacity Manual (HCM) defines six grades to describe the LOS (which is based on the average delay per vehicle) at an intersection.

Table 7 shows the various LOS grades, qualitative descriptions, and quantitative definitions for unsignalized and signalized intersections.

Table 7: LOS Criteria for 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 principal and minor arterials in urban or village areas will generally be designed for LOS C or better. However, in heavily developed urban areas, reduced LOS criteria such as D or E may be appropriate as judged on a case by case basis. For the purpose of this study, the assumed performance target is LOS D or better.

5.1.7 LOS and Queuing Results

Weekday PM Peak Hour

Synchro was used to quantify delay, LOS, and vehicle queues at the study intersections. The software uses procedures that are consistent with those specified in the 2000 Highway Capacity Manual. Traffic signal timings were provided by VTrans and field observations.

The LOS results for the 2008 and 2018 weekday PM peak hour along the US 2, VT 2A, and Marshall Avenue corridors are shown in Table 8, Table 9, and Table 10 respectively; Table 11 shows the results of the new intersections. The LOS and delays are reported for each approach and for the overall intersection. Detailed LOS worksheets will be provided in an appendix submitted with the final report.

Table 8: Weekday PM Peak Hour LOS and Queuing Results for 2008 and 2018 Alternatives – US 2 Corridor

Table 9: Weekday PM Peak Hour LOS and Queuing Results for 2008 and 2018 Alternatives – VT 2A Corridor

Table 10: Weekday PM Peak Hour LOS and Queuing Results for 2008 and 2018 Alternatives – Marshall Avenue Corridor

Table 11: Weekday PM Peak Hour LOS and Queuing Results for 2008 and 2018 Alternatives – New Intersections

2018 Alternative A

Harvest Lane - Depot Street	*Synchro* LOS	*Synchro* Delay (s)	*SimTraffic* Ave. Queue (ft)
WB LTR (Depot Street)	B	14.6	46
SB LTR (Harvest Lane)	A	7.4	25

2018 Alternative AB

Harvest Lane - Depot Street	*Synchro* LOS	*Synchro* Delay (s)	*SimTraffic* Ave. Queue (ft)
WB L T R (Depot Street)	B	13.4	41
SB L T (Harvest Lane)	A	8.6	41

US 2 - Trader Lane	*Synchro* LOS	*Synchro* Delay (s)	*SimTraffic* Ave. Queue (ft)
Overall	**A**	**7.7**	
EB T R (US 2)	A	3.6	328
WB T R (US 2)	A	3.5	159
NB L T (Trader Lane)	B	16.5	54
NB R (Trader Lane)	B	15.3	59
SB T R (Trader Lane)	B	14.8	199

2018 Alternative B

US 2 - Trader Lane	LOS (*Synchro*)	Delay (s) (*Synchro*)	Ave. Queue (ft) (*SimTraffic*)
Overall	**A**	**9.6**	
EB T R (US 2)	A	2.6	106
WB T R (US 2)	A	3.4	88
NB L T (Trader Lane)	C	25.7	54
NB R (Trader Lane)	C	20.3	85
SB T R (Trader Lane)	B	19.8	84

Marshall Avenue - Hannaford Dri	LOS (*Synchro*)	Delay (s) (*Synchro*)	Ave. Queue (ft) (*SimTraffic*)
EB T L (Marshall Avenue)	A	0.4	17
SB L T R (Hannaford Drive)	B	11.1	19

Wright Street - Hannaford Drive	LOS (*Synchro*)	Delay (s) (*Synchro*)	Ave. Queue (ft) (*SimTraffic*)
	A	**8**	
EB L T R (Wright Street)	A	8.2	34
WB L T R (Wright Street)	A	7.9	34
NB L T R (Hannaford Drive)	A	7.8	20

Wright Street - Trader Lane	LOS (*Synchro*)	Delay (s) (*Synchro*)	Ave. Queue (ft) (*SimTraffic*)
Overall	**B**	**12.5**	
EB L T R (Wright Street)	B	12.8	44
WB L T R (Wright Street)	B	10.4	35
NB L T R (Trader Lane)	B	10.8	42
SB L T R (Trader Lane)	B	13.9	63

VT 2A - Helena Drive	LOS (*Synchro*)	Delay (s) (*Synchro*)	Ave. Queue (ft) (*SimTraffic*)
Overall	**A**	**7.9**	
EB L T R (Helena Drive)	D	50.7	44
NB L T R (VT 2A)	A	3.3	41
SB L T R (VT 2A)	A	6.7	118

Harvest Lane - Wright Street	LOS (*Synchro*)	Delay (s) (*Synchro*)	Ave. Queue (ft) (*SimTraffic*)
WB L T R (Wright Street)	B	10.6	33
SB L (Harvest Lane)	A	8.1	12

Figure 10: Alternative A LOS Summary

Figure 11: Alternative B LOS Summary

Figure 12: Alternative A+B LOS Summary

Figure 13: Alternative 'No New Roads' LOS Summary

Key Findings from LOS and Queuing Analysis of the Weekday PM Peak

The congestion analysis indicates that for the 2018 weekday PM peak analysis:

- Overall LOS for all of the study intersections in all of the alternatives is LOS D or better. (Note: LOS D occurred only twice: in alternatives A and No New Roads, and both at the VT 2A – Marshall intersection.)
- If no new roads are built by 2018, congestion on Marshall Avenue will warrant significant widening to Marshall Avenue, as well as added turn lanes at VT 2A.
- In the 2008 analysis, the northbound left turn from VT 2A onto Marshall Avenue experiences significant delay (66 seconds per vehicle, LOS E). The queue from the left turn lane spills back into the northbound travel lanes on VT 2A upstream from the intersection. Alternatives B, A+B and No New Roads improve the LOS of this movement and reduce delay by at least 20 seconds in the future condition. Alternative A does not improve the queue length.
- During the 2008 PM Peak hour the longest queues along the US 2 corridor occur in the eastbound direction; Alternatives A, B and A+B will improve this condition.
- The southbound through and right movements at the VT2A – Exit 12 Northbound Ramps experience long queues (approximately 800 feet) during the 2008 PM peak. The improvements to the interchange made in each of the 2018 alternatives reduced the average queue significantly.

Saturday Peak

The LOS results for the 2008 and 2018 Saturday peak along the US 2, VT 2A, and Marshall Avenue corridors are shown in Table 12, Table 13, and Table 14 respectively.

Table 12: Saturday Peak LOS and Queuing Results for 2008 and 2018 Alternatives – US 2 Corridor

Table 13: Saturday Peak LOS and Queuing Results for 2008 and 2018 Alternatives – VT 2A Corridor

Table 14: Saturday Peak Hour LOS and Queuing Results for 2008 and 2018 Alternatives – Marshall Avenue Corridor

Key Findings from LOS and Queuing Analysis of the Saturday Peak

The congestion analysis indicates that for the Saturday peak analysis:

- In 2008, congestion was less on state routes but significantly worse on Marshall Avenue compared to the weekday PM peak analysis.
- For each of the 2018 alternatives, this apparent difference was mitigated by the addition of new streets and/or lanes.
- Overall LOS of the Saturday subset of intersections is LOS C or better in all of the 2018 alternatives.
- The overall LOS of the VT 2A – Marshall Avenue intersection improves to C (from D in 2008) in all of the alternatives.
- At the VT 2A – Marshall Avenue intersection, the queue from the northbound left-turn lane spills back into the through lanes on VT 2A in the 2008 analysis. This spillback is eliminated in each of the 2018 alternatives.
- In the 2008 analysis, the westbound left movement at the Marshall Avenue – Harvest Lane intersection functions at LOS F with a delay greater than 100 seconds/vehicle. This situation improves to at least LOS D in Alternatives B and No New Roads, and even higher in the remaining alternatives.
- Overall, only one intersection (Exit 12 I-89 NB ramps – VT 2A) declined in LOS from the 2008 condition (from LOS A to LOS B). The LOS of the remaining intersections either improved or did not change in the 2018 Saturday analysis.

5.2 SAFETY ANALYSIS – EXISTING CONDITIONS

2000-2004 crash data were obtained from VTrans for the US 2, VT2A, and Marshall Avenue roadway segments. It is VTrans policy to report crashes involving injuries, fatalities, or those that exceed $1,000 in property damage. Figure 14 shows the locations of crashes reported to VTrans from 1999-2003 in the study area.

In order to be classified as a High Crash Location (HCL), an intersection or road section (0.3 mile section) must meet two conditions: 1) it must have at least 5 crashes over a 5-year period; and 2) the actual crash rate must exceed the critical crash rate[1].

[1] The most recently published state wide crash rates, which were used in this study to calculate critical crash rates, are based on 1998-2002 data. In 2002 VTrans improved the crash reporting procedures, which increased the number of crashes reported. It is

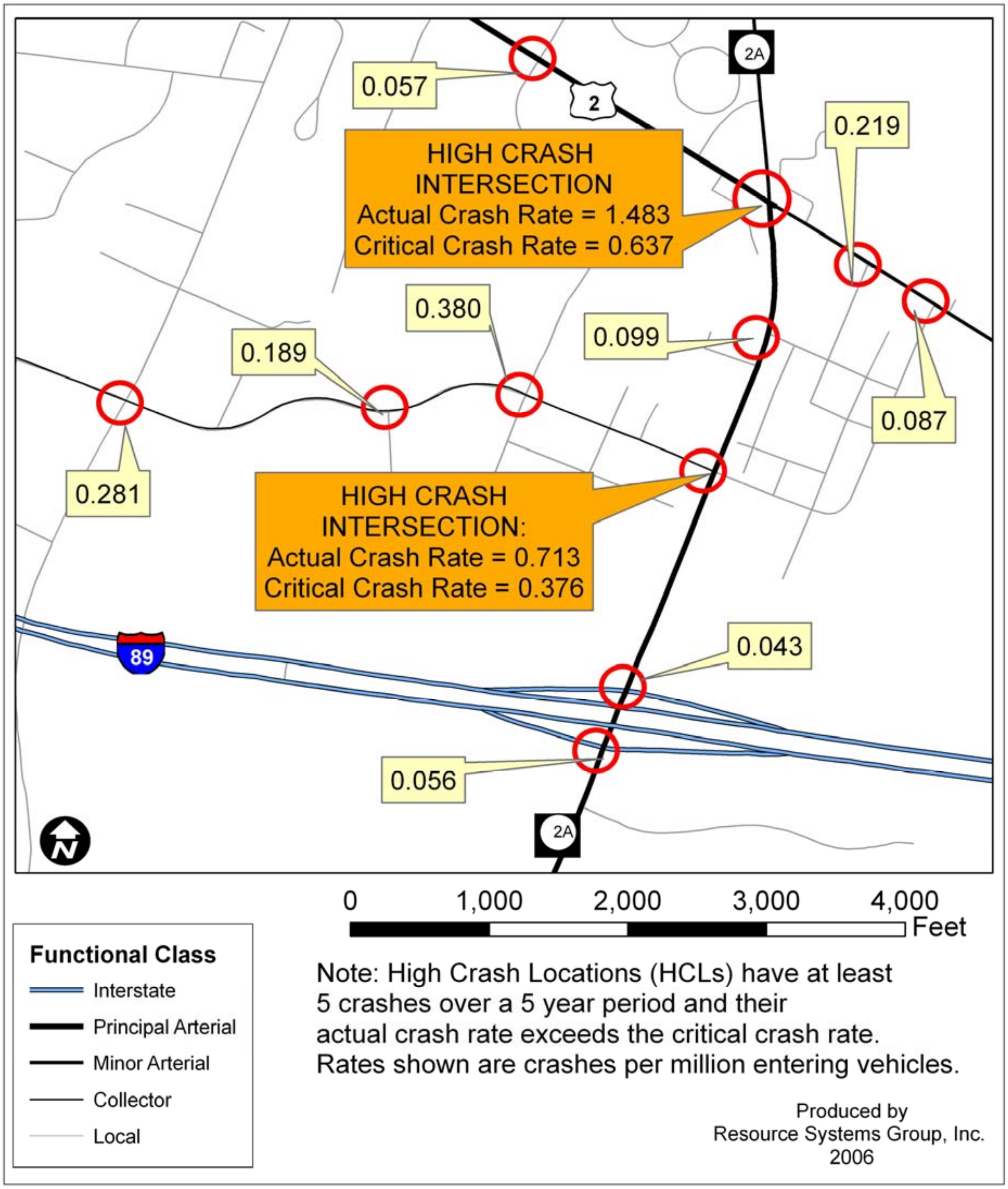
The following locations satisfy the HCL criteria based on 2000-2004 crash data:

- The US 2-VT 2A intersection.
- The VT2A – Marshall Avenue Intersection.

Crash data are provided in Appendix C.

likely that the state wide crash rates derived from 1998-2002 crash data are lower than the actual state-wide crash rates. These lower crash rates would tend to classify more intersections as high crash locations than there actually exists.

Figure 14: Actual Crash Rates (crashes per million entering vehicles) and High Crash Intersections from 2000-2004



6.0 NATURAL AND CULTURAL RESOURCES

This section provides a screening of the following natural and cultural resources adjacent to the study area using GIS data:

- Wetlands, Streams/Watercourses, and Ponds;
- Steep Slopes; and
- Endangered Species and Deer Wintering Areas.

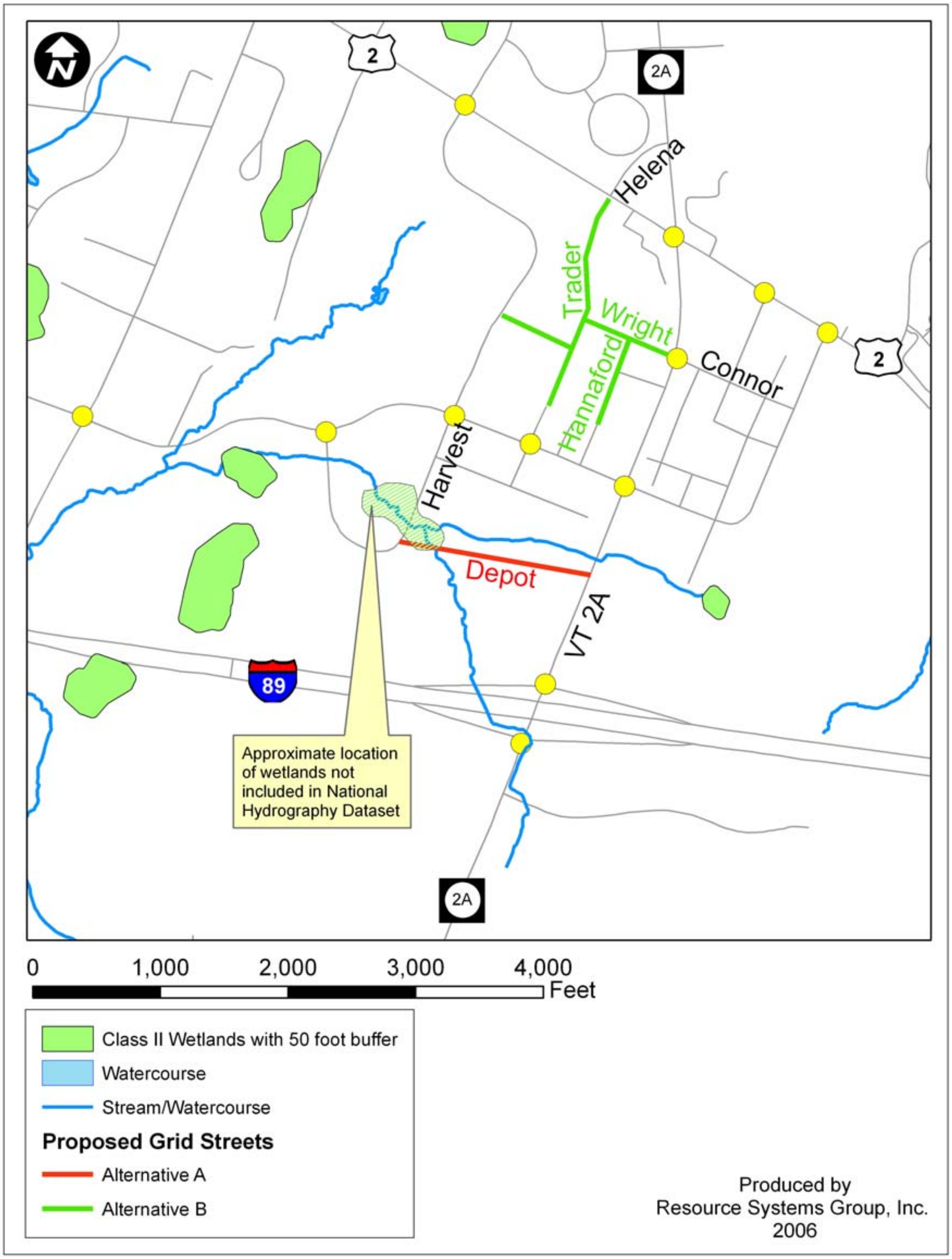
This screening is useful in identifying potential physical and regulatory constraints that could affect selection of alternatives in latter phases of this study.

6.1 WETLANDS, STREAMS, AND PONDS

Figure 15 shows the extent of identified Class II wetlands adjacent to the study corridor. The wetland boundaries are based on the Vermont Significant Wetlands Inventory developed by the Vermont Agency of Natural Resources. All 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 Determination from the Water Quality Division of the Department of Environmental Conservation. Figure 15 also shows the locations of watercourses and ponds based on the National Hydrography Dataset.

One conflict with wetlands/watercourses is expected where Depot Street crosses the watercourse at the approach to Harvest Lane.

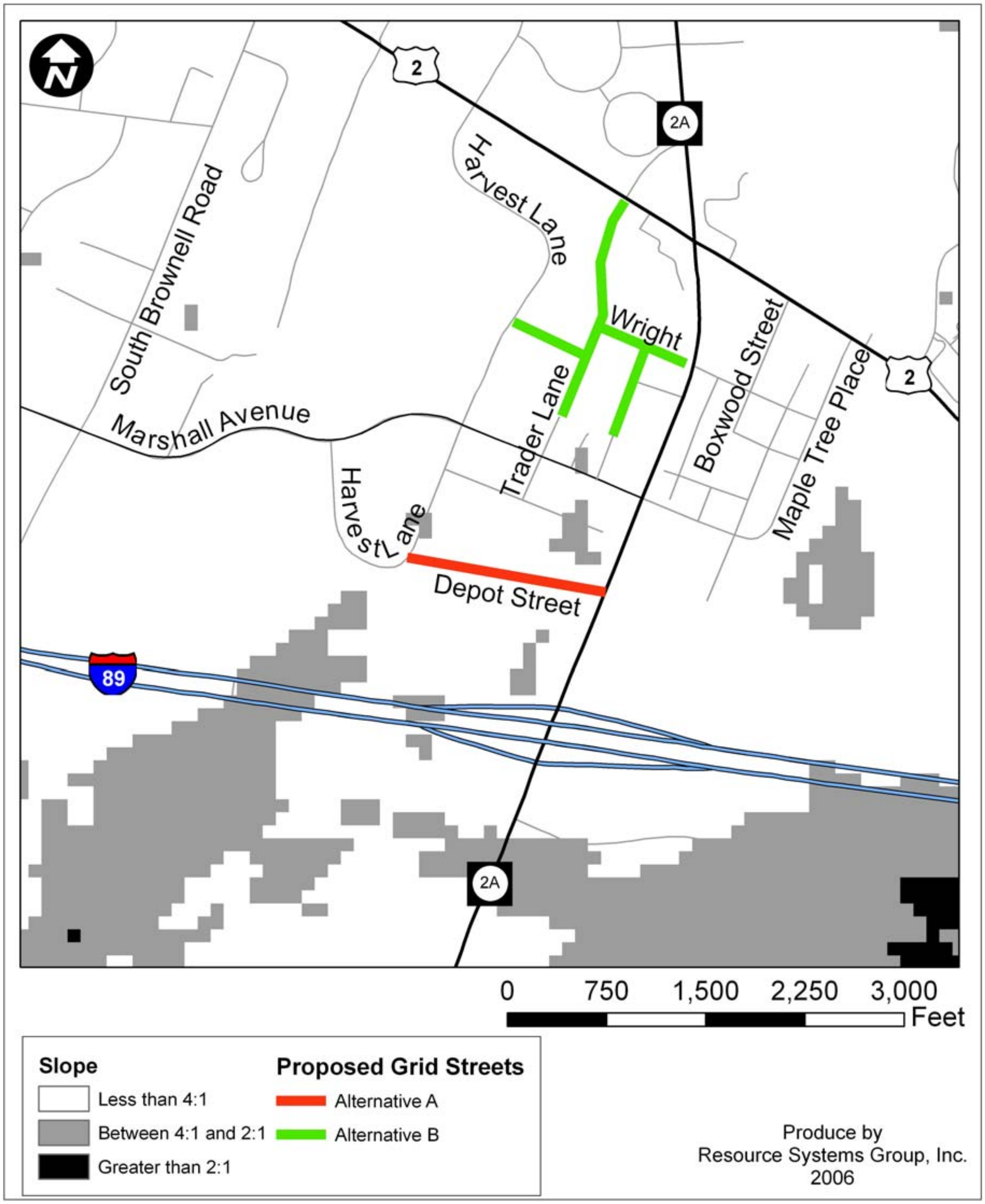
Figure 15: Wetlands & Watercourses In or Near the Study Area



6.2 STEEP SLOPES

Figure 16 shows a composite image of estimated slopes in and near the study area. Most of the study area has slopes less than 4:1. The significant areas of steeper slopes (greater than 4:1) are located south of I-89. At one location on Depot Street (proposed in Alternatives A and A+B), it is expected that some cut and fill will be necessary.

Figure 16: Steep Slopes

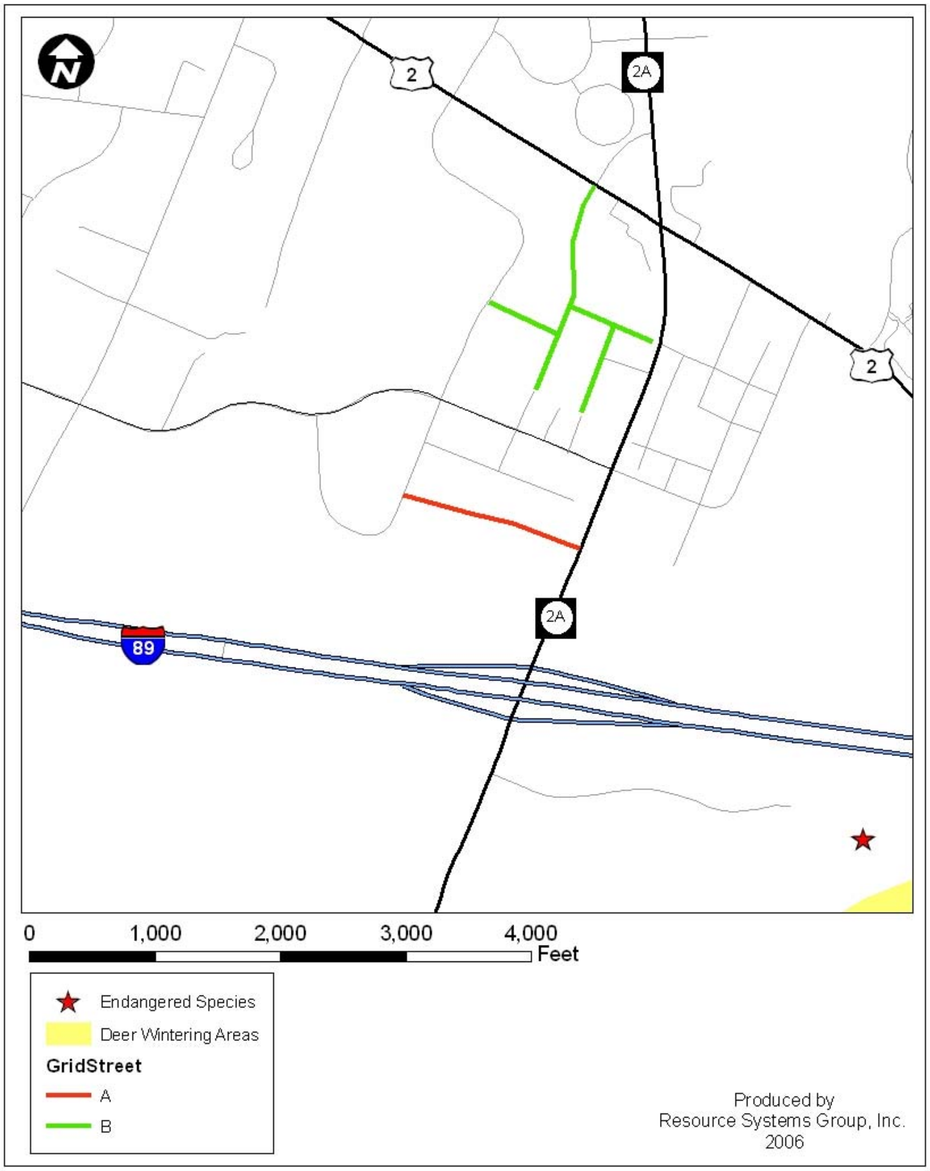


6.3 RARE, THREATENED AND ENDANGERED SPECIES AND DEER WINTERING AREAS

Figure 17 shows the location of rare, threatened, or endangered species as defined by the Vermont Department of Fish and Wildlife as well as identified deer wintering areas based on boundaries established by the Vermont Agency of Natural Resources. Deer wintering areas generally begin at the edge of mature coniferous tree cover. Any disturbances on either identified endangered species grounds or deer wintering areas may require special permitting and/or mitigation.

As the graphic shows, the proposed street grid roadways are not expected to conflict with any identified threatened species or deer wintering areas.

Figure 17: Endangered Species and Deer Wintering Areas



7.0 COST ANALYSIS

A preliminary cost analysis has been prepared to estimate the expense of constructing each alternative (Table 15, Table 16, Table 17 and Table 18). The Williston Public Works standard cross-sections are the basis for estimating quantities of subsurface material such as drainage, gravel, and sand fill. Sidewalks are assumed to be built on one side of the road only. Lighting estimates are based on two light fixtures per intersection. The improvements to the I-89 interchange involve bridge widening for the additional lanes in that segment. Although a detailed estimate of this work is beyond the scope of this report, a survey of similar projects suggests that widening the bridge and paving the roadway beneath it costs between approximately $10 million and $15 million.

Right-of-Way impacts have been estimated as follows:

- Alternative A: 1.5 acres (65,000 sq. ft.); 4 parcels impacted
- Alternative B: 3.6 acres (160,000 sq. ft.); 16 parcels impacted
- Alternative A+B: 4.9 acres (213,000 sq. ft.); 14 parcels impacted
- Alternative No New Roads: 0.3 acres (11,800 sq. ft.); 2 parcels impacted

Table 15: Preliminary Cost Estimate of Alternative A

Alternative A

ITEM/TASK	QUANTITY	UNITS	$/UNIT	TOTAL
Establish turf	1.88	AC	$10,000.00	$18,840.68
Common excavation (3' depth)	6594	CY	$24.00	$158,266.67
Subbase of crushed gravel (fine graded) (0.5' depth)	1099	CY	$23.34	$25,652.39
Subbase of dense graded crushed stone (1.5' depth)	3297	CY	$19.32	$63,702.33
Sand borrow (1' depth)	2198	CY	$13.35	$29,345.28
Bituminous concrete pavement	725	TON	$80.00	$58,031.11
Cut-fill allowance			TOTAL	$150,000.00
Cast-in-place concrete curb, Type B	3840	LF	$14.59	$56,025.60
Removal of existing curb	1000	LF	$8.00	$8,000.00
5' concrete walk	1420	LF	$87.00	$123,540.00
Topsoil, seed, mulch	1420	LF	$10.00	$14,200.00
Roadway striping			TOTAL	$3,000.00
Removal of existing roadway paint	1350	LF	$1.18	$1,593.00
Signal equipment			TOTAL	$215,000.00
Stream crossing-culvert 66" RCP CL III	54	LF	$188.98	$10,204.92
Lighting	4	EACH	$4,000.00	$16,000.00
Drainage			TOTAL	$80,000.00
Stormwater treatment			TOTAL	$25,000.00
			Subtotal:	*$1,056,402*

15%	Preliminary Engineering	$158,460
2%	Erosion Control	$21,128
15%	Contingency	*$158,460*
8%	Traffic Control (Local)	$78,085
15%	Traffic Control (State and US Routes)	$5,583
7.5%	Mobilization	$79,230
12.5%	Construction Engineering	$132,050
	TOTAL:	**$1,689,399**

Table 16: Preliminary Cost Estimate of Alternative B

Alternative B

ITEM/TASK	QUANTITY	UNITS	$/UNIT	TOTAL
Establish turf	4.26	AC	$10,000.00	$42,607.90
Common excavation (3' depth)	14578	CY	$24.00	$349,866.67
Subbase of crushed gravel (fine graded) (0.5' depth)	2430	CY	$23.34	$56,707.56
Subbase of dense graded crushed stone (1.5' depth)	7478	CY	$19.32	$144,470.67
Sand borrow (1' depth)	4859	CY	$13.35	$64,871.11
Bituminous concrete pavement	1604	TON	$80.00	$128,284.44
Cast-in-place concrete curb, Type B	10760	LF	$14.59	$156,988.40
Removal of existing curb	3960	LF	$8.00	$31,680.00
5' concrete walk	3400	LF	$87.00	$295,800.00
Topsoil, seed, mulch	3400	LF	$10.00	$34,000.00
Roadway striping			TOTAL	$5,100.00
Removal of existing roadway paint	2880	LF	$1.18	$3,398.40
Signal equipment			TOTAL	$305,000.00
Lighting	14	EACH	$4,000.00	$56,000.00
Lighting-resetting pole	5	EACH	$1,221.03	$6,105.15
Drainage			TOTAL	$189,200.00
Sidewalk Impacts			TOTAL	$25,480.00
Median Impacts			TOTAL	$22,226.40
Stormwater treatment			TOTAL	$50,000.00
			Subtotal:	*$1,967,787*

15%	Preliminary Engineering	$295,168
2%	Erosion Control	$39,356
15%	Contingency	$295,168
8%	Traffic Control (Local)	$135,318
15%	Traffic Control (State and US Routes)	$33,947
7.5%	Mobilization	$147,584
12.5%	Construction Engineering	$245,973
	TOTAL:	**$3,160,301**

Table 17: Preliminary Cost Estimate of Alternative A+B

Alternative A+B

ITEM/TASK	QUANTITY	UNITS	$/UNIT	TOTAL
Establish turf	5.60	AC	$10,000.00	$55,996.33
Common excavation (3' depth)	18533	CY	$24.00	$444,800.00
Subbase of crushed gravel (fine graded) (0.5' depth)	3089	CY	$23.34	$72,094.67
Subbase of dense graded crushed stone (1.5' depth)	9456	CY	$19.32	$182,681.33
Sand borrow (1' depth)	6178	CY	$13.35	$82,473.33
Bituminous concrete pavement	2039	TON	$80.00	$163,093.33
Cut-fill allowance			TOTAL	$150,000.00
Cast-in-place concrete curb, Type B	10640	LF	$14.59	$155,237.60
Removal of existing curb	1000	LF	$8.00	$8,000.00
5' concrete walk	4820	LF	$87.00	$419,340.00
Topsoil, seed, mulch	4820	LF	$10.00	$48,200.00
Roadway striping			TOTAL	$5,500.00
Removal of existing roadway paint	1950	LF	$1.18	$2,301.00
Signal equipment			TOTAL	$360,000.00
Stream crossing-culvert 66" RCP CL III	54	LF	$188.98	$10,204.92
Lighting	18	EACH	$4,000.00	$72,000.00
Drainage			TOTAL	$254,000.00
Stormwater treatment			TOTAL	$75,000.00
			Subtotal:	*$2,560,923*
		15%	Preliminary Engineering	$385,494
		2%	Erosion Control	$51,399
		15%	Contingency	$385,494
		8%	Traffic Control (Local)	$203,944
		15%	Traffic Control (State and US Routes)	$39,530
		7.5%	Mobilization	$192,747
		12.5%	Construction Engineering	$321,245
			TOTAL:	**$4,149,811**

Table 18: Preliminary Cost Estimate of Alternative 'No New Roads'

Alternative 'No New Roads'

ITEM/TASK	QUANTITY	UNITS	$/UNIT	TOTAL
Establish turf	0.79	AC	$10,000.00	$7,874.20
Common excavation (3' depth)	3811	CY	$24.00	$91,466.67
Subbase of crushed gravel (fine graded) (0.5' depth)	635	CY	$23.34	$14,825.22
Subbase of dense graded crushed stone (1.5' depth)	1906	CY	$19.32	$36,815.33
Sand borrow (1' depth)	1270	CY	$13.35	$16,959.44
Bituminous concrete pavement	419	TON	$80.00	$33,537.78
Cast-in-place concrete curb, Type B	5500	LF	$14.59	$80,245.00
Removal of existing curb	5500	LF	$8.00	$44,000.00
Roadway striping			TOTAL	$3,000.00
Removal of existing roadway paint	3250	LF	$1.18	$3,835.00
Signal equipment			TOTAL	$240,000.00
Lighting-resetting pole	2	EACH	$1,221.03	$2,442.06
Drainage			TOTAL	$21,666.67
Sidewalk Impacts			TOTAL	$25,480.00
Median Impacts			TOTAL	$26,214.90
Stormwater treatment			TOTAL	$10,000.00
			Subtotal:	*$658,362*
		15%	Preliminary Engineering	$98,754
		2%	Erosion Control	$13,167
		15%	Contingency	$98,754
		8%	Traffic Control (Local)	$42,406
		15%	Traffic Control (State and US Routes)	$17,743
		7.5%	Mobilization	$49,377
		12.5%	Construction Engineering	$82,295
			TOTAL:	**$1,060,860**

Costs for each alternative are also presented by intersection in the appendix of this report.

8.0 SUMMARY

The Town's Comprehensive Plan identifies a grid street system to provide for local circulation and access to existing and future businesses and homes in Taft Corners. Major components of the grid street network have been completed for several years and the Town is interested in expanding the network. The existing street system has helped to disperse traffic generated by development around Taft Corners while also providing alternate routes for through traffic between Exit 12 and points east and west along the US 2 corridor. This report summarized existing conditions within the project area and provided an analysis of future conditions with several alternative grid streets.

Key findings of each section are summarized below:

8.1 LAND USE

The zoning regulations in the study area are defined by the Taft Corners, Mixed Uses, Business Park, and Commercial IA, IB, IIB, and IIC zones. Zoning regulations permit a wide variety of uses to be developed in these zones including residential, commercial, educational, recreational, and light industrial.

8.2 TRANSPORTATION SYSTEM CHARATERISTICS

- US 2 and VT 2A are classified as urban arterials. The *Vermont State Standards* provide a significant amount of flexibility in selecting lane and shoulder widths for arterials that pass through built-up urban and village areas.
- VT 2A is designated as part of the Vermont Truck Network. Because of this designation, recommendations related to the re-design or addition of intersections that may result from this study should accommodate trucks with overall lengths of 72 feet. This requirement will affect turning radii and should be considered in selecting appropriate lane widths.

8.3 CONGESTION AND SAFETY

8.3.1 Existing Conditions - Safety

The following locations satisfy the High Crash Location criteria based on 2000-2004 crash data:

- The US 2 – VT2A intersection; and
- The VT 2A – Marshall Avenue intersection

8.3.2 Future Conditions - Congestion

The congestion analysis indicates that for the 2018 Weekday PM Peak Analysis:

- Overall LOS for all of the study intersections in each of the alternatives is LOS D or better. (LOS D occurred only twice: in alternatives A and No New Roads, and both at the VT 2A – Marshall intersection.)
- The 2008 delay for the VT 2A – Marshall Avenue intersection is just under the 35.1 seconds required for classification as LOS D; in the 2018 Alternatives A and A+B, the delay increases slightly- just enough to achieve LOS D- while Alternatives B and No New Roads have no effect.
- The southbound through and right movements at the VT2A – Exit 12 Northbound Ramps experience long queues (approximately 800 feet) during the 2008 PM peak. The improvements to the interchange made in each of the 2018 alternatives prove helpful for these movements (particularly in Alternatives A and A+B), reducing the average queue by at least 237 feet.

Table 19 summarizes whether the alternative improves the intersection LOS over the 2008 condition, degrades the LOS, or does not change it either way.

Table 19: Overall Weekday PM LOS of 2018 alternatives compared to 2008 conditions

Intersection (2008 LOS)	Alternative A	Alternative B	Alternative A+B	Alternative 'No New Roads'
US 2 Corridor				
US 2-Harvest Lane (B)	—	↑ (A)	—	—
US 2-VT 2A (C)	—	—	—	—
US 2-Boxwood (B)	↑ (A)	↑ (A)	↑ (A)	↑ (A)
US 2-Maple Tree Place (C)	↑ (B)	—	↑ (B)	↑ (B)
VT 2A Corridor				
VT2A-Conner (A)	—	↓ (B)	—	—
VT2A-Marshall (C)	↓ (D)	—	—	↓ (D)
Exit 12 NB Ramps (C)	↑ (B)	↑ (B)	—	—
Exit 12 SB Ramps (C)	—	—	—	—
Marshall Corridor				
Marshall-Trader (C)	↑ (B)	↑ (B)	↑ (B)	↑ (B)
Marshall-Harvest (B)	—	—	↑ (A)	—
Marshall-Four Seasons (C)	↑ (A)	↑ (A)	↑ (A)	↑ (B)
Marshall-South Brownell (B)	—	↓ (C)	—	↓ (C)
↑ = improvement over 2008 LOS ↓ = decline from 2008 LOS — = no change				

The Saturday peak analysis indicated that given the necessary geometric improvements, only one area experiences worse conditions than in the 2008 situation: Exit 12 I-89 NB ramps – VT 2A in Alternative A+B, but the decline was only from LOS A to LOS B.

8.4 NATURAL RESOURCES

One conflict with wetlands/watercourses is expected where Depot Street (proposed in Alternatives A and A+B) crosses the watercourse at the approach to Harvest Lane.

It is expected that some cut and fill will be necessary at one location on Depot Street.

There are no identified threatened species or deer wintering areas that should be in conflict with the proposed street grid roadways.

8.5 POTENTIAL COST

Potential costs including materials, preliminary and construction engineering, construction, drainage, water pollution control, traffic control, and a 15% contingency have been estimated as follows:

All Alternatives

- Marshall/Brownell: included in all estimates
- I-89 Exit 12 overpass and VT 2A widening: $10-15M (based on similar projects)

Alternative A	
Depot Street	$875,951
NB L at VT 2A/Depot	$37,221
Marshall/Brownell	$118,229
SUBTOTAL	$1,031,402
Stormwater Treatment	$25,000
Preliminary Engineering	$158,460
Erosion Control	$21,128
Contingency	$158,460
Traffic Control (Local)	$78,085
Traffic Control (State and US Routes)	$5,583
Mobilization	$79,230
Construction Engineering	$132,050
GRAND TOTAL	**$1,689,399**

Alternative B	
New Roads (Trader, Wright, Hannaford ext., Trader-Harvest)	$1,463,557
VT 2A/Marshall improvements (NB L, EB R, WB TR)	$180,055
WB T lane on Marshall from VT 2A to Harvest	$155,946
Marshall/Brownell	$118,229
SUBTOTAL	$1,917,787
Stormwater Treatment	$50,000
Preliminary Engineering	$295,168
Erosion Control	$39,356
Contingency	$295,168
Traffic Control (Local)	$135,318
Traffic Control (State and US Routes)	$33,947
Mobilization	$147,584
Construction Engineering	$245,973
GRAND TOTAL	**$3,160,301**

Alternative A+B	
Depot Street	$875,951
NB L at VT 2A/Depot	$37,221
New Roads (Trader, Wright, Hannaford ext., Trader-Harvest)	$1,463,557
Marshall/Brownell	$118,229
SUBTOTAL	$2,494,959
Stormwater Treatment	$75,000
Preliminary Engineering	$385,494
Erosion Control	$51,399
Contingency	$385,494
Traffic Control (Local)	$203,944
Traffic Control (State and US Routes)	$39,530
Mobilization	$192,747
Construction Engineering	$321,245
GRAND TOTAL	**$4,149,811**

'No New Roads' Alternative	
VT 2A/Marshall improvements (NB L, EB R, WB TR)	$375,408
WB T lane on Marshall from VT 2A to Harvest	$154,725
Marshall/Brownell	$118,229
SUBTOTAL	$648,362
Stormwater Treatment	$10,000
Preliminary Engineering	$98,754
Erosion Control	$13,167
Contingency	$98,754
Traffic Control (Local)	$42,406
Traffic Control (State and US Routes)	$17,743
Mobilization	$49,377
Construction Engineering	$82,295
GRAND TOTAL	**$1,060,860**

APPENDIX A - ZONE AND PARCEL MAPS

APPENDIX B - VOLUME WORKSHEETS

APPENDIX C - CRASH DATA

INTERSECTION NAME	Number of Years (2000-2004)	Total Crashes	Average Rate	Actual Rate	Critical Rate	Actual/ Critical Ratio	High Crash Location
US Route 2 - Harvest Lane	5	2	0.232	0.057	0.427	**0.133**	**No**
US Route 2 - VT 2A	5	79	0.418	1.483	0.637	**2.327**	**Yes**
US Route 2 - Boxwood Street	5	5	0.232	0.219	0.470	**0.465**	**No**
US Route 2 - MTP	5	3	0.232	0.087	0.429	**0.202**	**No**
VT2A - Connor Way	5	4	0.232	0.099	0.415	**0.238**	**No**
VT 2A - Marshall Aveune	5	48	0.232	0.713	0.376	**1.896**	**Yes**
Exit 12 NB Ramps - VT 2A	5	3	0.205	0.043	0.338	**0.127**	**No**
Exit 12 SB Ramps - VT 2A	5	3	0.205	0.056	0.355	**0.157**	**No**
Marshall Avenue - South Brownell Road	5	9	0.266	0.281	0.577	**0.487**	**No**
Marshall Avenue - Harvest Lane - Gardener's Supply	5	4	0.266	0.189	0.756	**0.250**	**No**
Marshall Avenue - Harvest Lane	5	12	0.266	0.380	0.670	**0.566**	**No**
	5	3	0.266				

AVERAGE CRASH RATES

Source:
http://www.aot.state.vt.us/TechServices/Documents/HighResearch/Publications/StatewideCrashRates1998-2002.pdf

Summary Statewide Average Crash Rates, 1998-2002

Functional Classification	Rate (Crashes/MVM)*
RURAL	
1) Interstate	0.1395
2) Principal Arterial	0.3438
6) Minor Arterial	0.6072
7) Major Collector	0.5766
8) Minor Collector	0.6296
9) Local	0.6296
URBAN	
11) Interstate	0.1071
12) Other Freeways and Expressways	0.3453
14) Principal Arterial	1.7787
16) Minor Arterial	1.4338
17) Urban Collector	1.4265
19) Local	0.3817

* Crashes per million vehicle miles

Summary Statewide Average Crash Rates, 1998-2002

Functional Classification	Rate (Crashes/MV)*
Principal Arterial (r)/ Minor Arterial (r)	0.181
Principal Arterial (r)/Major Collector (r)	0.143
Freeway/Expressway (u)/Principal Arterial (u)	0.205
Principal Arterial (u)/Urban Collector (u)	0.232
Freeway/Expressway (u)/Minor Arterial (u)	0.285
Principal Arterial (u)/Minor Arterial (u)	0.418
Principal Arterial (u)/ Principal Arterial (u)	0.258
Major Collector (r)/Major Collector (r)	0.144
Minor Arterial (u)/Minor Arterial (u)	0.310
Minor Arterial (u)/Urban Collector (u)	0.240
Minor Arterial (r)/Major Collector (r)	0.314
Principal Arterial (r)/Principal Arterial (r)	0.115
Urban Collector (u)/Urban Collector (u)	0.266
Minor Arterial (r) / Minor Arterial (r)	0.193
Interstate, Rural (r)/Principal Arterial (r)	0.115
Major Collector (r)/Non-Federal Aid Collectors (r)	0.144
Interstate, Urban (u)/Principal Arterial (u)	0.205
Minor Arterial (r)/Non-Federal Aid Collectors (r)	0.314
Freeway/Expressway (u)/ Urban Collector (u)	0.285
Non-Federal Aid Collectors (r)	0.144

* Crashes per Million Vehicles
(r) = Rural
(u) = Urban

EQUATIONS

Source:
VTrans, Program Development Division, Highway Research Unit, *High Crash Location Report, 1998-2002* (September 2004).

Critical Crash Rate

R_C = R_A + K * ?(R_A/M) - 1/(2*M)

R_C = Critical Crash Rate
R_A = vehicle miles (sections) or million vehicles (intersections). This is the Statewide
M = consideration
$M_{section}$ = (AADT*L*365*Number of Years)/1,000,000
$M_{intersection}$ = (AADT all legs/2)(365)(Number of Years)/1,000,000
K = is currently used by this program which gives a 99.5% confidence level.

Actual Rate - Section

RMVM = (C * 1,000,000) / (AADT * L * 365 * N)

RMVM = Actual Crash Rate in crashes per million vehicle miles.
C = Total Number of crashes for this Section.
AADT = Current AADT for this Section
N = Number of years being analyzed.
L = Section Lenth.

Actual Rate - Intersection

AR = # Crashes / (Incoming ADT * 365 * Number of Years / 1,000,000)

AR = Actual Crash Rate in crashes per million vehicles
# Crashes = Total number of crashes
Incoming ADT = The sum of the AADT for all legs of the Intersection divided by 2
Number of Years = where Roadway Imiprovements have occurred).

APPENDIX D – COST ESTIMATE - BY INTERSECTION

APPENDIX E – DISTANCES BETWEEN SIGNALIZED INTERSECTIONS

The following distance between intersections (feet, center to center) were measured to ensure that the proposed grid street traffic signals meet VTrans minimum requirements.for signalized intersection spacing. In addition expected queuing must be analyzed to ensure adequate space is available (see section 5.1)

<u>VT2A Corridor (south to north)</u>

from Hurricane Lane	---
to I89 SB Ramps	460
to I89 NB Ramps	425
to Depot Drive (alt A)	**864**
to Marshall	686
to Connor/Wright	998
to US2	885

<u>US2Corridor (west to east)</u>

from Harvest Lane	---
to Helena/Trader (alt B)	**1,220**
to VT2A	548
to Boxwood	792
to Simons/MTP	506