# COLCHESTER AVENUE/RIVERSIDE AVENUE
## Burlington, Vermont

# Final Scoping Report

Prepared by:

Stantec

Prepared for:

Chittenden County RPC

Burlington, VT Public Works

Vermont Agency of Transportation

April 1, 2019

110 West Canal Street, Suite 202
Winooski, VT 05404
T 802-660-4071
F 802-660-4079
www.ccrpcvt.org

The preparation of this report has been financed in part through grant[s] from the Federal Highway Administration and Federal Transit Administration, U.S. Department of Transportation, under the State Planning and Research Program, Section 505 [or Metropolitan Planning Program, Section 104(f)] of Title 23, U.S. Code. The contents of this report do not necessarily reflect the official views or policy of the U.S. Department of Transportation.

Prepared by:

Stantec Consulting Services Inc.
55 Green Mountain Drive
So. Burlington, VT 05403
(802) 864-0223

Under the direction of:

Chittenden County Regional Planning Commission

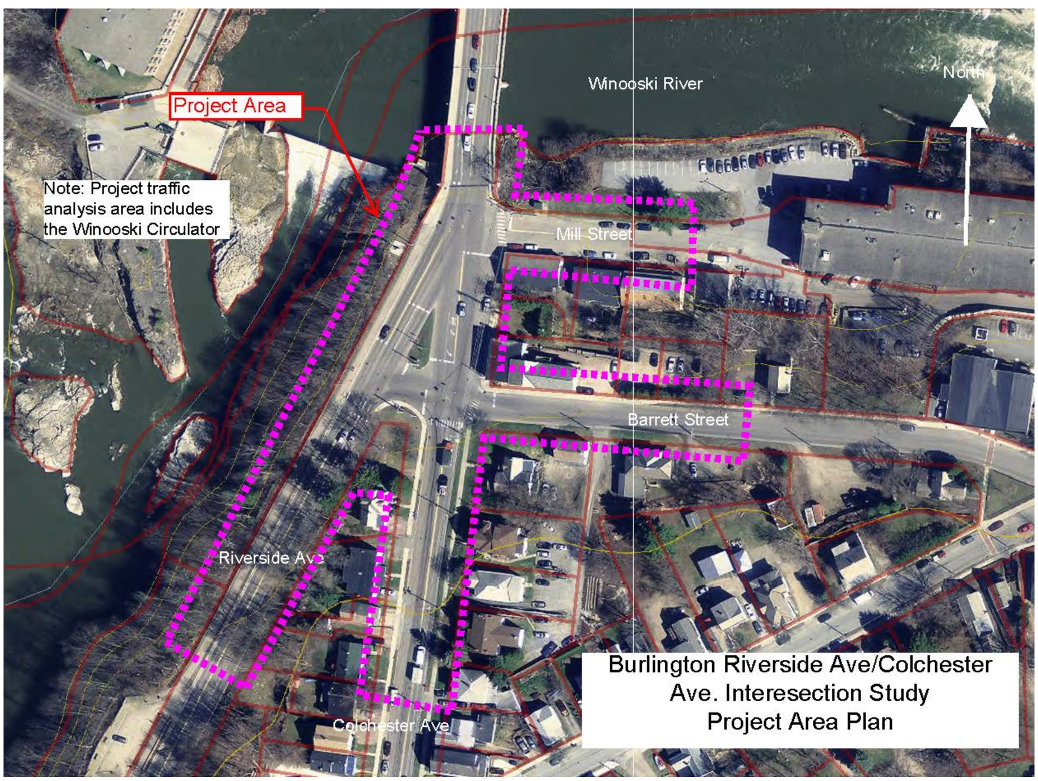
# EXECUTIVE SUMMARY

This scoping report for the intersections of Colchester Avenue, Riverside Avenue, Barrett Street, and Mill Street located in Burlington, Vermont was conducted as part of the Chittenden County Regional Planning Commission's (CCRPC) annual work program at the request of the City of Burlington. The consulting firm Stantec, Inc. was hired by the CCRPC to complete this study. Burlington's request was made to continue the previous planning work conducted during the 2011 Colchester Avenue Corridor Plan that recommended:

> "The complex of three intersections should be consolidated into one signalized intersection between Colchester Avenue, Riverside Avenue and Barrett Street. The traffic signal at the Riverside Avenue-Mill Street intersection would be eliminated and the Mill Street approach would be controlled by a stop sign and widened to include left and right turn lanes. The consolidation has design issues that need to be further evaluated through a more detailed scoping process that would include a land survey and more focused input from adjacent property owners."

The study area is shown below in Figure 1.

*Figure 1 Project Study Area*




The scoping study considered several other studies and plans that were not available when the corridor plan was prepared. This information was reviewed and incorporated throughout the study as appropriate including but not limited to:

- The *Burlington Transportation Plan;*
- *planBTV Walk Bike;*
- A traffic impact assessment for a nearby hotel proposal; and,
- The *Burlington Complete Streets Guidance*.

A "complete street" is one that accommodates all travel modes – driving, walking, biking, etc. One goal of the scoping study was to incorporate complete street elements into the intersection design alternatives.

The study process included working closely with a Project Advisory Committee consisting of community leaders, Burlington & Winooski staff, CCRPC staff, neighborhood representatives and others. PAC members are listed below.

| | |
|---|---|
| Burlington City Staff | Nicole Losch, Meagan Tuttle |
| Burlington City Council | Sharon Bushor |
| Ward 1 NPA | Wayne Senville/Richard Hillyard |
| CCTA | David Armstrong/Rachel Kennedy |
| CATMA & Hill Institutions | Sandy Thibault |
| Winooski City Staff | Alex Sampson/Jon Rauscher |
| Local Motion | Jason Van Driesche/Allegra Williams |
| Redstone/VT Commercial | Linda Letourneau |
| CCRPC | Eleni Churchill/Jason Charest |

The PAC was responsible for reviewing interim work products prepared as part of the study and making final recommendations to City boards.

# EXISTING CONDITIONS

The existing intersection is actually three separate intersections that are all controlled by one traffic signal system. As a main entrance or gateway to Burlington from points north, it processes a considerable amount of vehicle traffic. The combined intersection operates near its theoretical capacity during the PM peak hour and has little or no capacity to process additional vehicles. The intersection of Colchester Avenue and Barrett Street is recognized by VTrans as a High Crash Location. Its configuration is confusing to unfamiliar motorists.

The study area is presently lacking in its non-motorized accommodations. While there are crosswalks, they are not controlled by the signals and leave pedestrians to cross at their discretion. There are no on-road bicyclist facilities. Sidewalks exist around the perimeter of the intersection and there is a multi-use path along Riverside Avenue. Parking is permitted along the eastern side Colchester Avenue between Barrett and Mill Streets but is undefined and vehicles have been observed to park both parallel and angled.

# PURPOSE AND NEED STATEMENT

**Purpose**: The purpose of the Colchester Avenue/Riverside Avenue intersection scoping study is to define a safer intersection that enhances mobility and access for all users while contributing to livable and vibrant communities and ensuring efficient operations.

**Needs:**

1. Improve safety and mobility for all users of the intersection.
2. Simplify the intersection.
3. Enhance the gateway into Burlington.
4. Manage traffic congestion.

# FUTURE CONDITIONS

The future year for this study was 2035 and peak hour traffic volumes were determined by taking into consideration proposed development in the nearby area along with historic traffic growth trends. This resulted in traffic volumes being projected to increase in the future and, absent any improvements, further increase congestion. In the PM peak hour, the combined intersection is expected to be over capacity with significantly longer traffic delays.

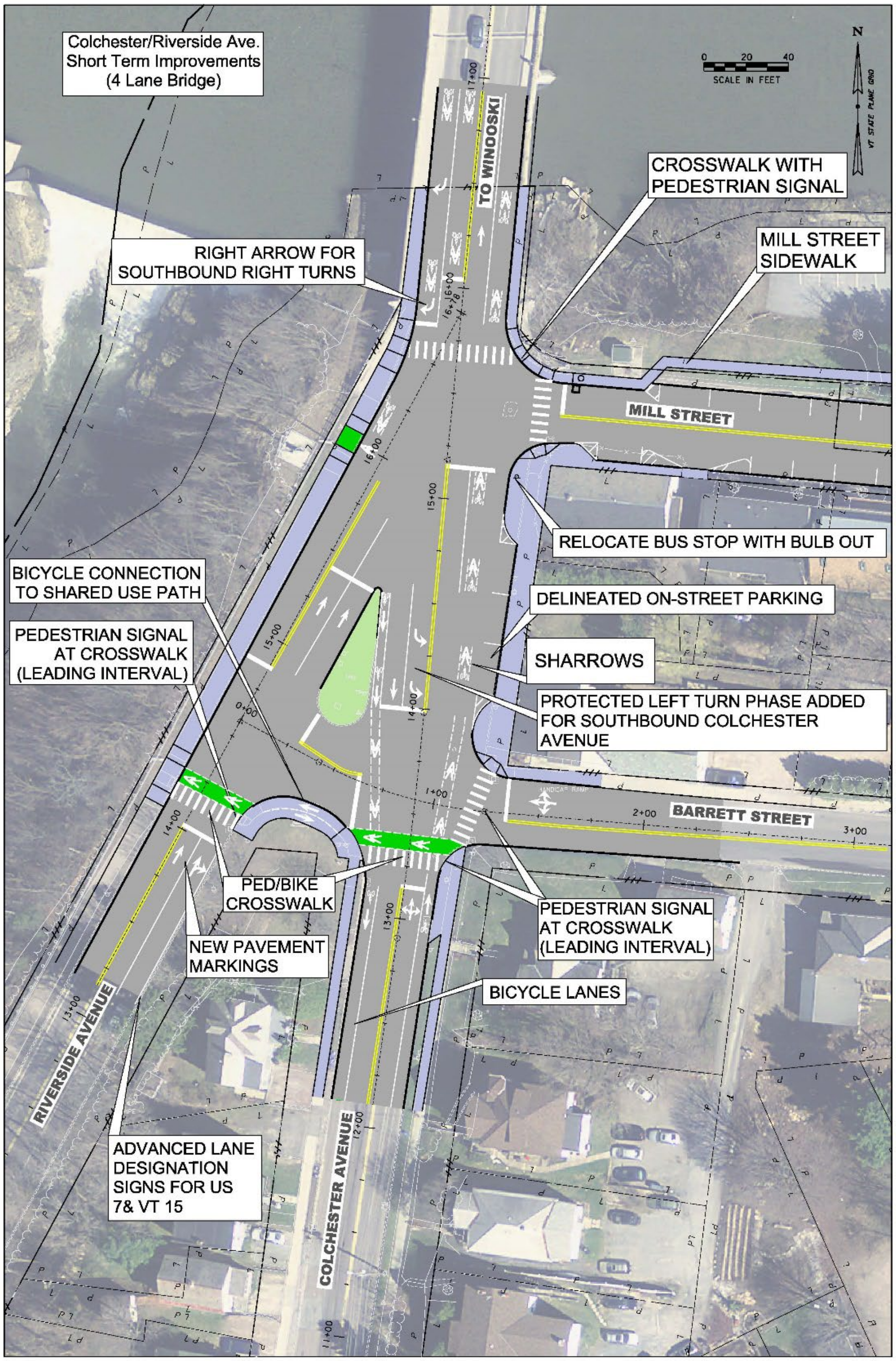
# ALTERNATIVES

The Project Advisory Committee considered a range of transportation improvements to address the project's purpose and need. System improvements that could be constructed in the short (0 to 3 years) and medium terms (3 to 10 years) were developed and evaluated. Since none of the alternatives add significant vehicle capacity, it will be imperative to continue to pursue Transportation Demand Management (TDM) strategies and promote alternative modes that reduce peak hour traffic congestion impacts. Short- and medium-term improvements are described below.

## Short Term Improvements

Short term improvements consist of minor changes to the transportation system that can be easily implemented with limited curb relocations and generally do not require permits, right-of-way acquisition, or extensive drainage system changes. The short-term improvements considered and ultimately adopted by the PAC are shown in Figure 2. As shown, enhanced accommodations for pedestrians and bicyclists are proposed to include a new crosswalk, pedestrian traffic signals, and wider crosswalks. Signal system changes, the addition of a protected left-turn phase for southbound traffic on Colchester Avenue turning into Barrett Street, are also proposed to enhance safety. In recent years a pedestrian was struck and killed by a vehicle making this left turn.

*Figure 2 Recommended Short-Term Improvements*



## Medium Term Improvements

Three medium term improvements were developed and evaluated. A brief synopsis of each of the three is as follows:

- Alternative 1 – 4-way Intersection
  - This alternative reconfigures the existing three intersections most closely to what was called for in the Colchester Avenue Corridor Study. The result is one signalized intersection, 4-wqy intersection at Colchester Avenue and Barrett Street and an unsignalized intersection at Colchester Avenue and Mill Street.
- Alternative 2 – 4-way Intersection with Separate Right Turn Lane
  - Largely similar to Alternative 1, Alternative 2 additionally consists of a separated southbound right turn lane from Colchester Avenue creating a yield condition onto Riverside Avenue.
- Alternative 3 – Roundabout
  - Alternative 3 provides a modern, hybrid roundabout at the existing Colchester Avenue/Barrett Street intersection incorporating Riverside Avenue.

## Comparison of Alternatives

A comparison of the alternatives is outlined according to the study's purpose and need statement in the matrix below. As shown, costs and performance associated with Alternatives 1 and 2 are comparable. Alternative 3 offers the greatest benefits but also at the highest cost. There are also significant challenges associated with implementation of Alternative 3, particularly with respect to right-of-way acquisition and impact to historic properties.

*Figure 3 Alternatives Evaluation Matrix*

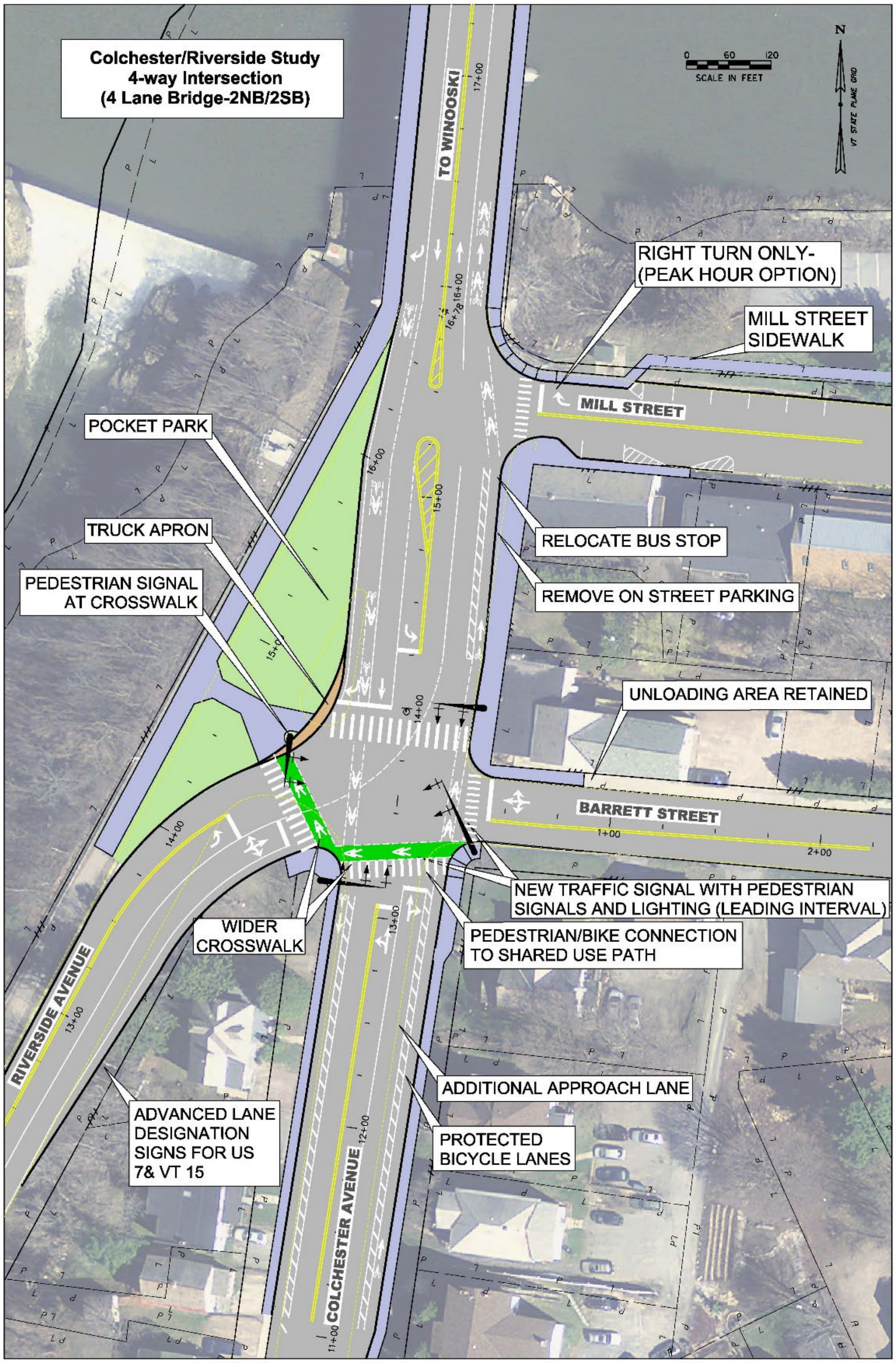
| CRITERIA | No Build | Short Term Improvements | Alternative 1<br>4 Way Intersection | Alternative 2<br>4 Way Intersection w/ Separate Right Lane | Alternative 3<br>Roundabout |
|---|---|---|---|---|---|
| **Project Costs** | **$0** | **$875,000** | **$3,300,000** | **$3,430,000** | **$6,700,000** |
| **PURPOSE AND NEED** | | | | | |
| **Improves Pedestrian Safety** | **No** | **Some** | **Better** | **Better** | **Best** |
| **Provides Safer Bicycle Connectivity Winooski to Burlington** | **No** | **Some (allows safer east/west bicyclist movements)** | **Some (protected bike lanes south of Barrett and south of Mill northbound)** | **Some (protected bike lanes south of Barrett and south of Mill northbound)** | **Some (protected bike lanes south of Barrett)** |
| **Reduces Potential for Crashes** | **No** | **Some** | **Better** | **Better** | **Best** |

| CRITERIA | No Build | Short Term Improvements | Alternative 1<br>4 Way Intersection | Alternative 2<br>4 Way Intersection w/ Separate Right Lane | Alternative 3<br>Roundabout |
|---|---|---|---|---|---|
| Reduces Intersection Complexity | No | No | Best | Best | Better |
| Manages Peak Hour Congestion | No | Some | Some | Better | Best |
| IMPACTS | | | | | |
| ROW Impacts | None | None | Minor (1600 sf) | Minor (1600 sf) | Major (4000 sf/ 1 house) |
| Historic Resources | None | None | None | None | Major (Removes 4(f) resource) |
| Stormwater | No change | No Change | Treatment opportunity | Treatment opportunity | Treatment opportunity |
| Net Change in On-street parking spaces | 0 | Some (-1 – N. of Barrett St.<br>-2 – S. of Barrett St.) | More (-5 – N. of Barrett St.<br>-2 – S. of Barrett St.) | More (-5 – N. of Barrett St.<br>-2 – S. of Barrett St.) | More<br>(-5 – N. of Barrett St.<br>-2 – S. of Barrett St.) |
| Aerial Utilities | 0 | 0 | Some<br>(3 poles relocated along Colchester Ave) | Some<br>(3 poles relocated along Colchester Ave) | Some<br>(3 poles relocated along Colchester Ave) |

## PROJECT ADVISORY COMMITTEE RECOMMENDATIONS

The Project Advisory Committee met five times throughout the study. Three of these meetings were focused on the development and consideration of the short- and medium-term improvements. There was unanimous agreement that the short-term improvements should be pursued as soon as possible with the acknowledgment that certain recommended actions are actively being pursued by the City. The PAC also recommended Alternative 1, shown in Figure 4, be chosen as the municipally preferred alternative. Alternative 3 – Roundabout, was eliminated from consideration due to is cost and level of risk. With Alternative 1 – 4-way Intersection and Alternative 2 – 4-way Intersection with Separate Right Turn Lane being so similar, there was much discussion between the two and finer points of difference. With support from the vast majority, the Project Advisory Committee ultimately recommended Alternative 1 citing the potential to develop a pocket park to the west of the intersection and all crosswalks being controlled by signals.

*Figure 4 Recommend Medium Term Alternative – Alternative 1*



# Table of Contents

# LIST OF TABLES



# LIST OF FIGURES

# 1.0 INTRODUCTION

The City of Burlington obtained transportation planning assistance from the Chittenden County Regional Planning Commission (CCRPC) to complete a scoping study for the Colchester Avenue/Riverside Avenue/Barrett Street/Mill Street intersection. Stantec Consulting Services Inc. was retained by the CCRPC to develop this scoping report. The scoping process involves first quantifying existing roadway and traffic conditions and then defining a purpose and need for the project. Alternative improvement strategies are then identified and evaluated leading to the selections of a preferred alternative.

The scoping process includes working closely with a Project Advisory Committee made up of community leaders, City staff, CCRPC staff, neighborhood representatives and others. Advisory committee members for this project are listed below.

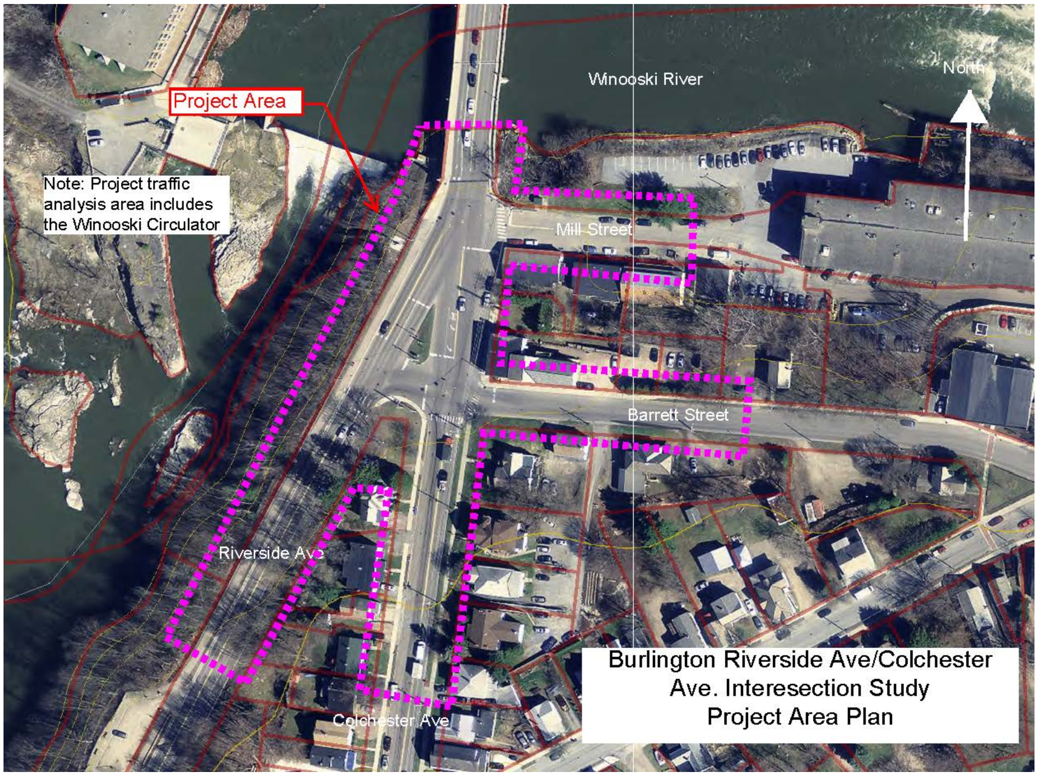
| | |
|---|---|
| Burlington City Staff | Nicole Losch, Meagan Tuttle |
| Burlington City Council | Sharon Bushor |
| Ward 1 NPA | Wayne Senville/Richard Hillyard |
| CCTA | David Armstrong/Rachel Kennedy |
| CATMA & Hill Institutions | Sandy Thibault |
| Winooski City Staff | Alex Sampson/Jon Rauscher |
| Local Motion | Jason Van Driesche/Allegra Williams |
| Redstone/VT Commercial | Linda Letourneau |
| CCRPC | Eleni Churchill/Jason Charest |

The advisory committee is charged with recommending a preferred alternative to the Burlington City Council for their consideration.

# 2.0 PROJECT BACKGROUND

The 2011 *Colchester Avenue Corridor Plan* identified improvements to the Colchester Avenue/Riverside Avenue/Barrett Street/Mill Street intersection that could be developed as a stand-alone project contributing to the overall "Complete Street" vision of Colchester Avenue. The corridor plan identified the challenges associated with the effective operation of three separate, closely-spaced intersections, shown in Figure 5, as a single intersection and recommended geometric changes to consolidate the three intersections. This scoping study builds upon the corridor plan to further evaluate the consolidation plan as well as other possible alternative intersection improvement strategies.

*Figure 5 Project Study Area*




## 2.1 EXISTING PLAN AND STUDY REVIEW

In addition to the corridor plan, several other studies and plans have been developed that considered traffic and pedestrian concerns at the Colchester Avenue/Riverside Avenue intersection. These studies were reviewed in the preparation of this scoping study and are listed below.

- Comprehensive Transportation Plan, 2011 (City of Burlington/CCRPC) and Appendix 2: Street Design Guidelines
- Traffic Impact Study 2013 (RSG Inc.)- Grove Street
- Traffic Impact Study (Trudell Consulting Engineers)- Riverside Avenue (Handy Property Development)
- Burlington Complete Streets Guidance, January 2013 (DPW)
- BTV Walk Bike Plan, 2015
- *Municipal Development Plan*, 2014

The *Comprehensive Transportation Plan,* the *BTV Walk Bike Plan* and the *Burlington Complete Streets Guidance* were also referenced for design guidance in developing conceptual improvement plans for the study intersection. Key elements of three of the above documents are discussed below.

### 2.1.1 Colchester Avenue Corridor Plan

The *Colchester Avenue Corridor Plan* outlines the City's vision, goals, objectives and recommended actions for Colchester Avenue. The goals stated in the corridor plan are applicable to this intersection study. The corridor plan goals are listed below.

| |
|---|
| 1) Design Colchester Avenue consistent with the "Complete Streets" concept. |
| 2) Provide a range of transportation options that are safe, efficient and convenient to serve the diverse needs of residents, businesses, institutions and travelers through the corridor. |
| 3) Enhance safety for vehicular, pedestrian, bicycle and bus travel. |
| 4) Develop strategies that support community character and enhance the built environment. |
| 5) Design and operate transportation projects and services within the corridor to enhance the environment. |
| 6) Develop transportation projects and services cooperatively and implement projects in time to meet immediate and long-term needs. |

Source: *Colchester Avenue Corridor Plan*, RSG, 2011.

### 2.1.2 "Complete Street" Model

The 2013 Burlington Department of Public Works' *Complete Streets Guidance* outlines a new approach to incorporate pedestrian, bicyclist and vehicle needs along Burlington streets. The *Complete Streets Guidance* was developed as a supplement to Burlington's Transportation Plan and to support compliance with Act 34. The Complete Street Model requires consideration of the following features when designing a roadway and incorporating them when feasible.

- Sidewalks
- Transit stops
- Parking
- Vehicle lanes
- Crosswalks
- Median and pedestrian refuge islands
- Curb extensions
- Curb return radii

The Burlington *Complete Streets Guidance* document was considered in developing alternative improvement plans for this study.

### 2.1.3 planBTV Walk Bike Plan

The City of Burlington's *Master Plan* and *The Burlington Transportation Plan* led to the development of a plan targeted for pedestrians and bicyclists, plan*BTV Walk Bike*. The plan includes the following goals:

- "CREATING SAFER STREETS FOR EVERYONE…We will eliminate traffic-related fatalities and serious injuries by 2026," and,
- "MAKING WALKING AND BIKING A VIABLE (AND ENJOYABLE) WAY TO GET AROUND TOWN…By 2026, reliance on drive-alone trips will be low, and alternative modes will make up the majority of commute trips in Burlington".

The plan also includes goals for comprehensive network enhancements and use of active transportation modes for 5, 10 and 20-year milestones. Colchester Avenue and Riverside Avenue are highlighted in the plan as priority zones and indicated as areas in need of immediate attention.

# 3.0 EXISTING CONDITIONS

## 3.1 ROADWAY CHARACTERISTICS

The project study area, identified in Figure 5 above, is located in Burlington, Vermont, south of the Winooski River Bridge and includes three intersections:

- Mill Street/Colchester Avenue/Riverside Avenue
- Barrett Street/Colchester Avenue
- Barrett Street/Riverside Avenue

These closely-spaced, signalized intersections are characterized by high vehicular and pedestrian traffic volumes, un-signalized pedestrian crossings, substandard geometry and substantial crash history. The speed limit through the intersections is 25 mph.

### 3.1.1 Riverside Avenue

Riverside Avenue, a section of U.S. Route 7 and U.S. Route 2, is a Class I Town Highway and Principal Arterial. Route 7 functions as the primary north-south travel corridor for much of western Vermont with Riverside Avenue serving as a direct, two-lane, curbed corridor between Burlington and Winooski. Figures 6 and 7 display Riverside Avenue southwest and northeast of Barrett Street, respectively. Riverside Avenue was reconstructed approximately 13 years ago, and a shared use path was added along the corridor. The shoulders are narrow in the vicinity of the intersection thus limiting on-road bike access.

*Figure 6: Riverside Avenue Southwest of Intersection with Barrett Street*

The 2011 Transportation Plan for the City of Burlington proposed to develop and categorize Riverside Avenue as a Bicycle Street. The Bicycle Street Design incorporates many elements of the Complete Street Model with an extra focus on improving the convenience and safety of bicyclists along the corridor. A variety of improvements to bicycle facilities including proper signage and additional pavement markings could be implemented to make the corridor more aligned with its intended purpose outlined in the Transportation Plan.

*Figure 7: Riverside Avenue Northeast of Intersection with Barrett Street*

### 3.1.2 Colchester Avenue

Colchester Avenue is generally a two-lane curbed Class I Town Highway. It is also a Minor Arterial, providing access to the University of Vermont (UVM) Campus in Burlington and to Burlington's downtown. It continues north over the Winooski Bridge as seen in Figure 8 and carries the U.S. Routes 7 and 2 designations into Winooski.

*Figure 8: Colchester Avenue at Barrett Street Looking Towards Winooski*

Colchester Avenue generally has narrow shoulders with sidewalk available on both sides. Throughout the corridor on-street parallel parking is available on one or both sides of the road. See the following sections for more information on walk/bike facilities and parking accommodations. Figure 9 displays the roads characteristics south of the Mill Street/Riverside Avenue intersection. A green triangular island splits Riverside Avenue and Colchester Avenue on the west side of Colchester Avenue as they both intersect with Barrett Street.

*Figure 9: South Section of Colchester Avenue Heading into Burlington*

In the 2011 Transportation Plan, the City of Burlington proposed to develop and categorize Colchester Avenue as a Complete Street. Currently, Colchester Avenue does not comply with the City's Complete Street guidelines. A variety of improvements to pedestrian and bicycle facilities, as well as aesthetic features, are needed.

### 3.1.3 Mill Street

Mill Street is a Class III Town Highway and Local Road. It provides access to both apartment buildings and the Chace Mill (home to a variety of small businesses). It provides signalized access onto Colchester and Riverside Avenues as seen in Figure 10. The street terminates in the Chace Mill parking area and there is a privately-owned access from the parking area to Chase Street in the rear of the parking area.

*Figure 10: Mill Street*

### 3.1.4 Barrett Street

*Figure 11: Barrett Street*

Barrett Street is a Class II Town Highway and Major Collector. It provides access to Burlington and South Burlington via Chase Street, Grove Street, and Patchen Road. An alternate private access to the Chace Mill is provided from lower Chase Street. Figure 11 displays Barrett Street's approach from the east at its intersection with Colchester Avenue.

The 2011 Transportation Plan proposed that Mill Street and Barrett Street as well as their intersections with Riverside Avenue and Colchester Avenue be categorized as a Neighborhood Center. This model goes beyond the City's Complete Street guidelines to provide a mixture of properties and features that would complement the surrounding neighborhood.

## 3.2 INTERSECTION CHARACTERISTICS

### 3.2.1 Colchester Avenue/Riverside Avenue/Mill Street

The Colchester Avenue/Riverside Avenue/Mill Street intersection is a skewed four-way signalized intersection as seen in Figure 12. The intersection's lane configurations are shown in Figure 14. Note that the northbound Colchester Avenue approach is marked as one lane but functions as two.

See Section 3.8 Walk and Bike Facilities for further description of the intersection's features.

*Figure 12: South Perspective of Riverside Avenue/Mill Street Intersection*

### 3.2.2 Riverside Avenue/Barrett Street

The Riverside Avenue/Barrett Street Intersection functions as a three-way signalized intersection with Riverside Avenue being the major roadway and Barrett Street teeing up to it from the east. The intersection's lane configurations are displayed in Figure 14. The intersection can be seen in Figure 13.

*Figure 13: Southwest Perspective of Riverside Avenue/Barrett Street Intersection*

*Figure 14: Project Area's Lane Configuration*

### 3.2.3 Colchester Avenue/Barrett Street

The Colchester Avenue/Barrett Street Intersection is a four-way signalized intersection with Colchester Avenue being the major roadway. The intersection's lane configuration is displayed in Figure 14 and is shown in Figure 15.

*Figure 15: North Perspective of Colchester Avenue/Barrett Street Intersection*

## 3.3 INTERSECTION AESTHETIC SUMMARY

This intersection forms the northerly gateway to the City of Burlington. The *2014 Municipal Development Plan,* includes a Built Environment Policy to "enhance the City's gateways and streetscapes". Consequently, one study goal is to consider the redesign of roadway elements that help define this gateway. Lighting, sidewalks, landscape, overhead utilities/visual clutter and bus stops compose the area's character and develop an experience for intersection users. These features can be improved to better meet the needs of the community and to define this as an aesthetically appealing gateway.

The intersection is lit inconsistently by high-pressure sodium lamps with cobra head fixtures. These lights limit the visibility of pedestrians at crosswalks and provide an inconsistent aesthetic look with the ornamental light fixtures on Riverside Avenue. These lights are not cut off, adding light pollution to the area.

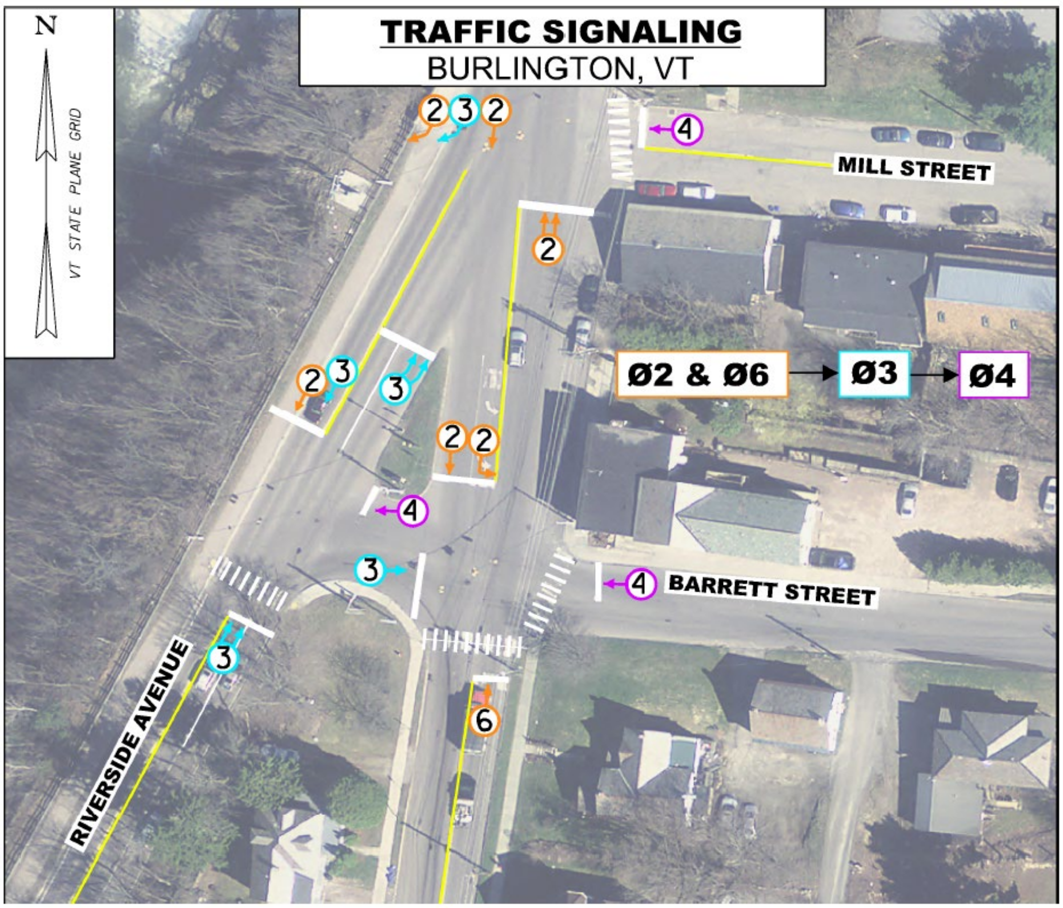
A "green belt", approximately three feet in width, separates the sidewalk on Riverside Avenue from the adjacent vehicular travel lanes. Green belts are also provided on both sides of Colchester Avenue approaching the intersection with a width of approximately five feet on the east side and three feet on the west side. There are no trees planted in any of the green belts. Overhead utilities and posted signs along the approaches contribute to visual clutter. Two sign designated bus stops exist in this project area, but a lack of bus turnouts produce additional delays for through traffic.

The "Complete Street" model proposes to offer a complete experience to pedestrians, bicyclists and cars as they use the intersection. Current aesthetic alterations would enhance the users' experience and create an entrance to the City.

## 3.4 TRAFFIC SIGNAL PHASING

Currently, Colchester Avenue, Riverside Avenue, Barrett Street and Mill Street phasing operates on a single traffic signal controller. The cycle begins with phases two and six allowing north and south movement along Colchester Avenue as noted in Figure 16. Phase three allows northbound and southbound movement along Riverside Avenue including northbound right turns across Colchester Avenue onto Barrett Street. Phase four allows westbound movement on both Barrett Street and Mill Street. Refer to Appendix A for Phasing Diagrams provided from the City of Burlington.

*Figure 16: Traffic Phasing Diagram*




In 2010 this system was upgraded from a mechanical pre-timed controller box in the median between Colchester Avenue and Barrett Street to a digital controller with video vehicle detection. The digital controller allows the signal system to respond to traffic demand thereby significantly increasing the efficiency of the intersection.

Future plans for the project area include adding pedestrian signals, upgrading existing equipment such as traffic signal heads and street lights, and adding a fifth vehicle detection camera to the system with the intent of increasing pedestrian safety and the intersection's efficiency.

## 3.5 TRAFFIC VOLUMES

Traffic volume data for the study area, including Annual Average Daily Traffic (AADT) volumes and peak hour volumes, were available from VTrans. VTrans' 2012 and 2013 AADT volumes for the study area roadways, minus Mill Street, are displayed in Table 1.

*Table 1: Current (2012) AADT Volumes*

| Location | AADT | Count Years |
|---|---|---|
| Riverside Ave. | 15600 | 2012 |
| Colchester Ave.- North of Riverside Ave. | 30600 | 2012 |
| Colchester Ave.- South of Riverside Ave. | 13000 | 2013 |
| Barrett Street | 4200 | 2012 |

VTrans conducted a 12-hour vehicle turning movement count at the Colchester Avenue/Riverside Avenue/Mill Street intersection on July 23, 2014. Figures 17-19 display hourly volumes by direction on the Colchester Avenue and Riverside Avenue approaches. As shown, there are defined morning commuter peaks and midday peaks however the highest volume levels occur during the afternoon commuter peak period. During the afternoon commuter peak period the heaviest volumes are leaving Burlington headed eastbound on Riverside Avenue or northbound on Colchester Avenue. The raw count data can be found in Appendix B.

The raw count data also displays pedestrian volumes. Seven pedestrian movements were recorded at three interconnected intersections during the AM peak hour. Another 29 pedestrian movements were recorded during the PM peak hour. For both peak hours most of the pedestrian activity was reported at the Barrett Street/Colchester Avenue intersection. Bicycle movements were not reported. Field visits conducted by Stantec indicate that most of the bike activity in the area occurs along the Riverside Avenue shared-use path.

*Figure 17: Riverside Avenue Hourly Volumes*

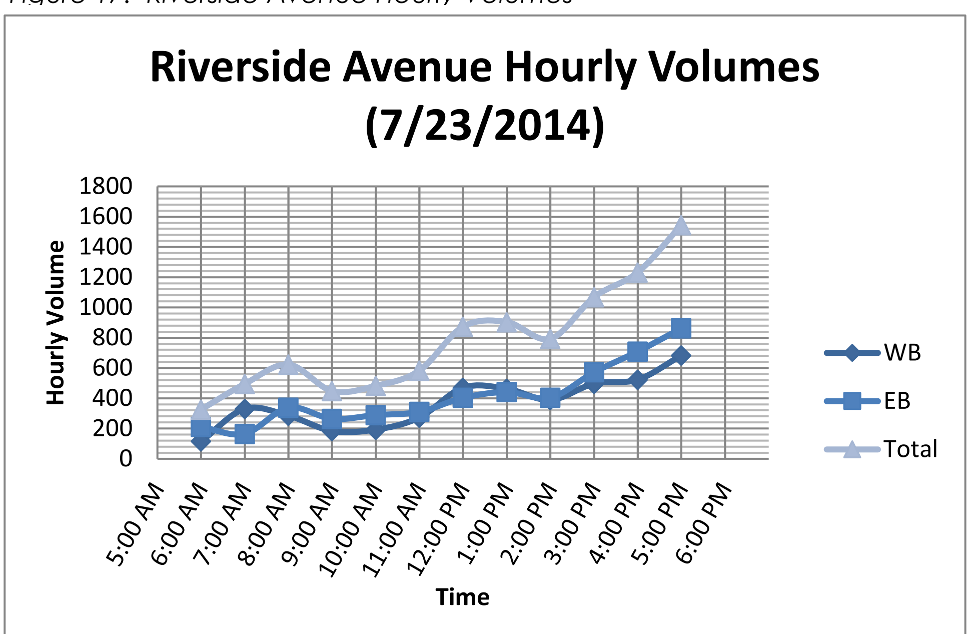


*Figure 18: Colchester Avenue Hourly Volumes - South of Riverside Avenue*

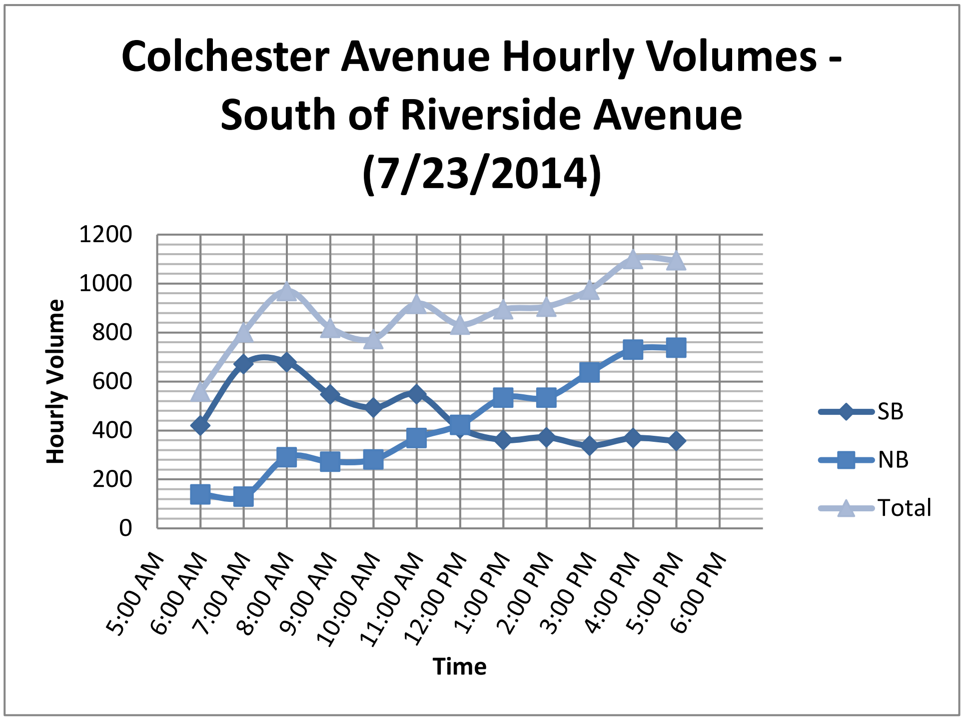
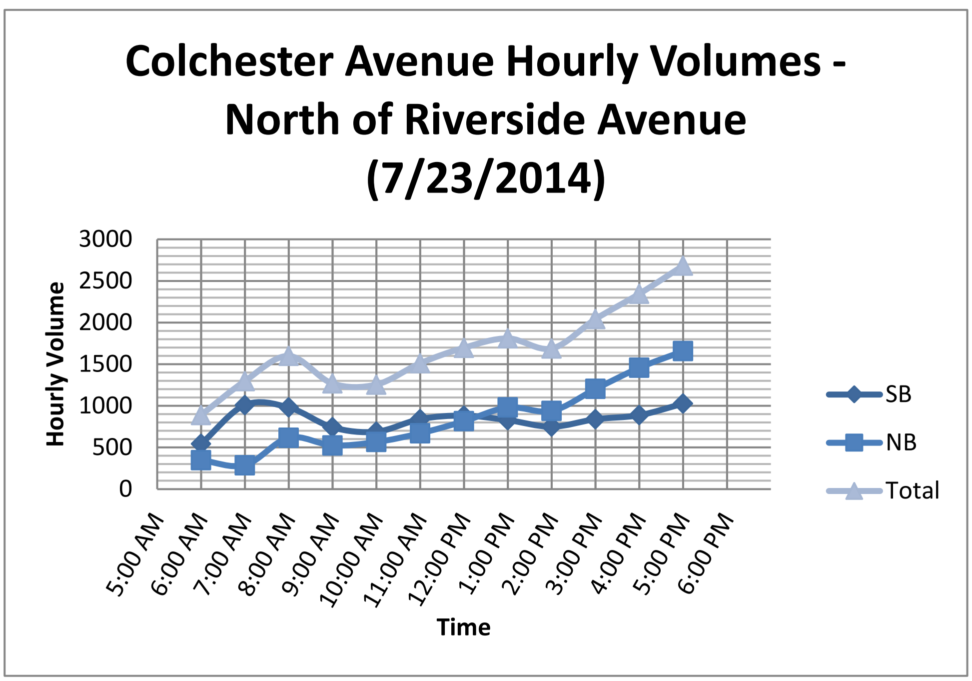



*Figure 19: Colchester Avenue Hourly Volumes - North of Riverside Avenue*



Following VTrans' methodology, recorded traffic volumes were increased four percent to yield existing AM and PM Design Hourly Volumes (DHVs). The DHV's are shown in Figures 20 and 21. The DHV calculations for these can be found in Appendix C along with the documents explaining the calculation processes.

*Figure 20: AM Existing Design Hourly Volumes*

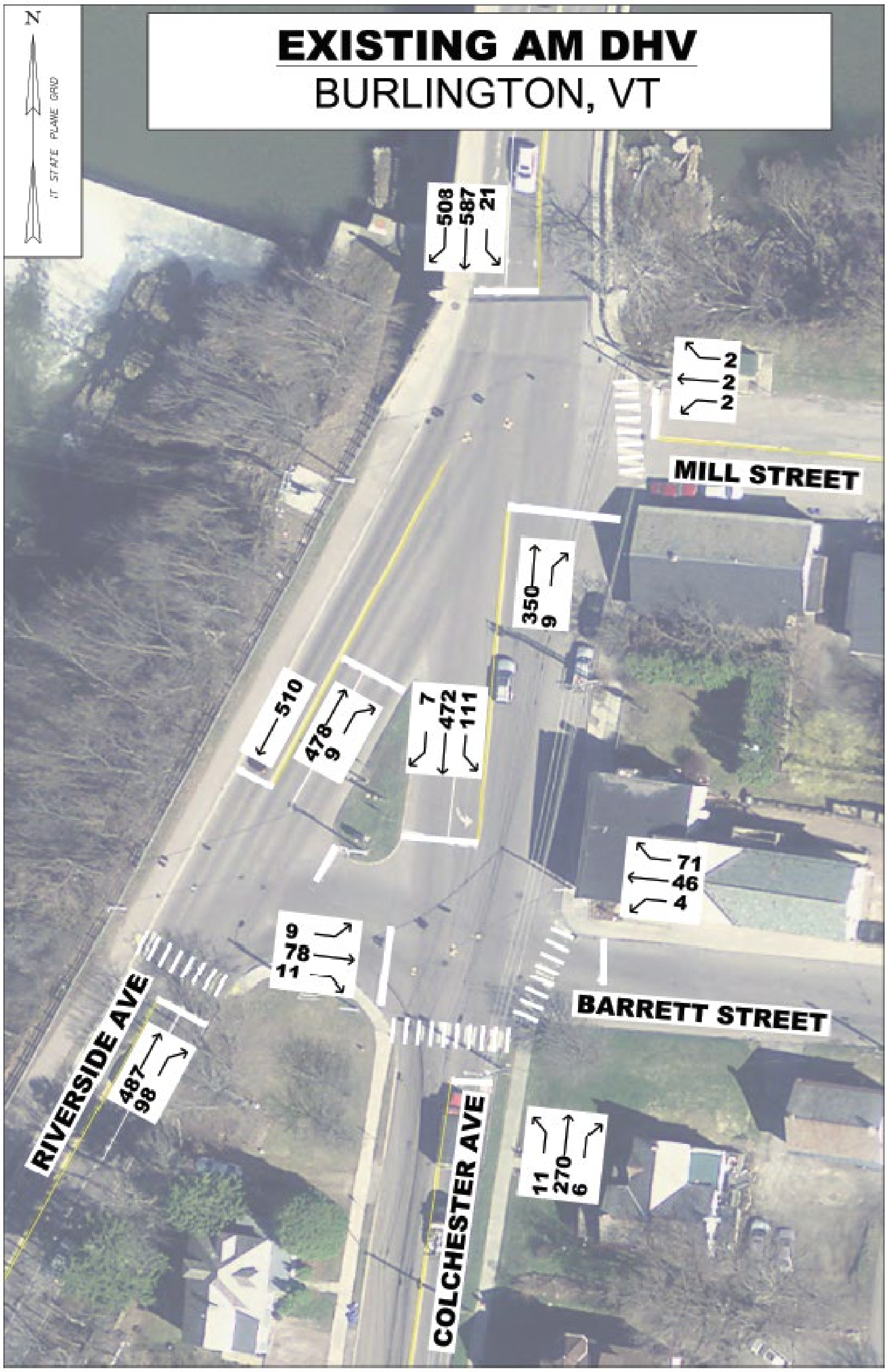
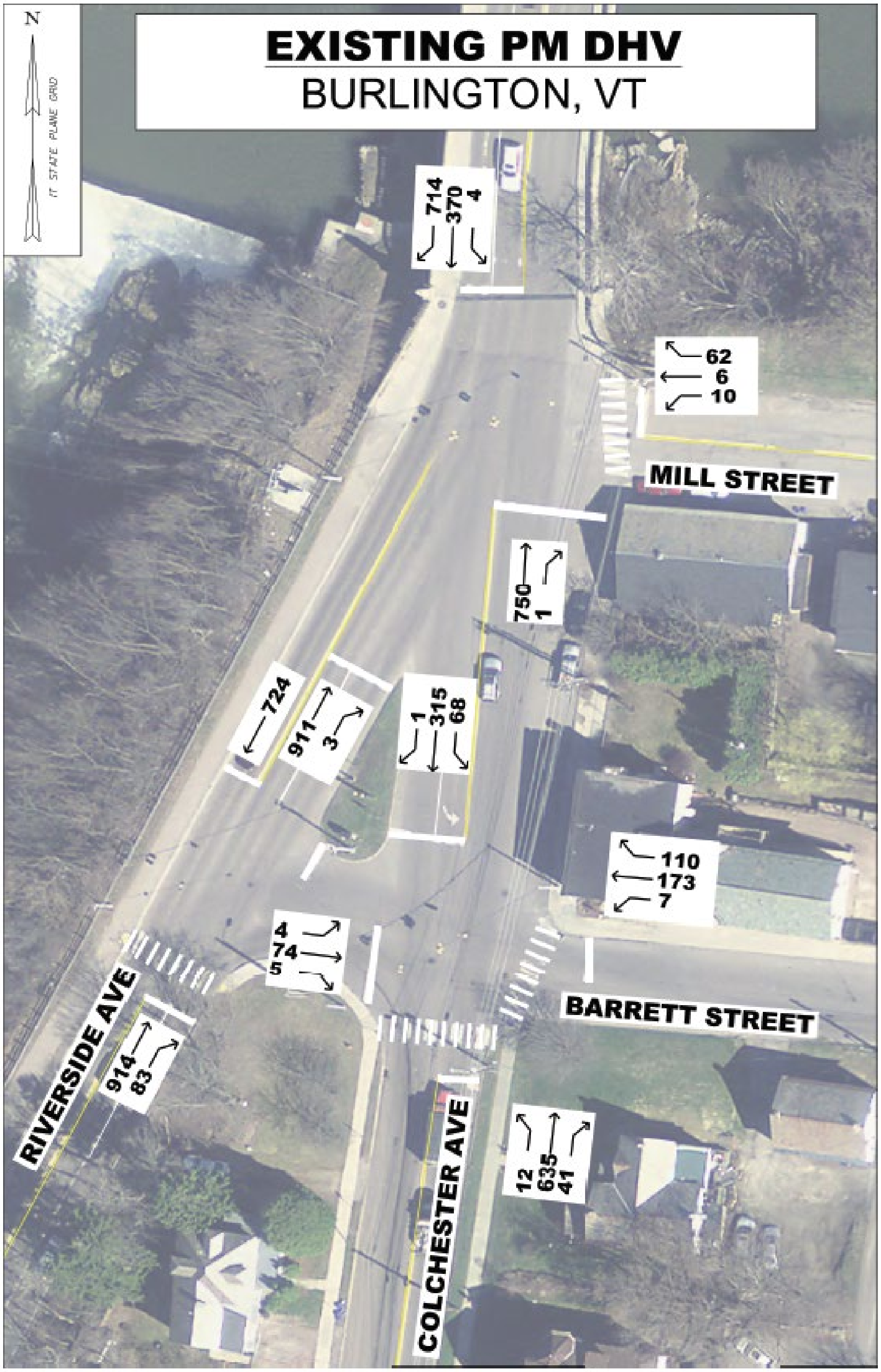


*Figure 21: PM Existing Design Hourly Volumes*



## 3.6 INTERSECTION OPERATIONS

Intersection and roadway operating levels of service (LOS) have been calculated for the study area intersections based on the traffic volume, geometry, and traffic control type previously mentioned. The results of these calculations, which are intended to quantify intersection operations, are presented below.

### 3.6.1 Level of Service Criteria

Level of service (LOS) is a term used to describe the quality of the traffic flow on a roadway facility at a particular point in time. It is an aggregate measure of travel delay, travel speed, congestion, driver discomfort, convenience, and safety based on a comparison of roadway system capacity to roadway system travel demand. Operating levels of service are reported on a scale of A to F, with A representing operating conditions with little or no delay to motorists, and F representing operating conditions with long delays and traffic demands sometimes exceeding roadway capacity.

Intersection operating levels of service are calculated in accordance with procedures defined in the *Highway Capacity Manual*, published by the Transportation Research Board. For unsignalized and signalized intersections the operating level of service is based on travel delays. Delays can be measured in the field but generally are calculated as a function of the following: traffic volume; peaking characteristic of traffic flow; percentage of heavy vehicles in the traffic stream; type of traffic control; number of travel lanes and lane use; intersection approach grades; and pedestrian activity. Through this analysis, volume-to-capacity ratios can be calculated for individual movements or for the intersection as a whole. A volume-to-capacity ratio of 1.0 indicates that a movement or intersection is operating at its theoretical capacity. The specific delay criteria applied per the *2010 Highway Capacity Manual* to determine operating levels of service are summarized in Table 2.

*Table 2: Intersection Level of Service Criteria*

| | Average Delay per Vehicle (Seconds) | |
|---|---|---|
| **Level of Service** | **Signalized Intersections** | **Unsignalized Intersections** |
| A | ≤10.0 | ≤10.0 |
| B | 10.1 to 20.0 | 10.1 to 15.0 |
| C | 20.1 to 35.0 | 15.1 to 25.0 |
| D | 35.1 to 55.0 | 25.1 to 35.0 |
| E | 55.1 to 80.0 | 35.1 to 50.0 |
| F[1] | >80.0 | >50.0 |

[1]Level of Service F is also assigned if the volume-to-capacity ratio exceeds 1.0 for a specific movement or lane group. For approach-based and intersection assessments, LOS is defined solely by delay. (Source: *HCM 2010 Highway Capacity Manual*, Transportation Research Board, National Academy of Sciences, Washington, DC, 2010.)

For two-way stop-controlled intersections, the major approaches have the right-of-way and experience little to no delay aside from impeding left or right-turning vehicles. Generally, the delays at two-way stop-controlled intersections are experienced on the minor approaches. As a result, there is no methodology for calculating an overall intersection LOS at two-way stop-controlled intersections.

### 3.6.2 Calculated Operating Levels of Service

Capacity analysis results for the study area intersections are presented in Table 3 below. All three intersections are interconnected and are operated by a single traffic signal controller. Consequently, each intersection was first analyzed separately and then the critical movements at each location were considered to define operating conditions for the combined intersection. When considered separately, each intersection operates at 73 percent capacity or less. When all three intersections are considered as a single location, the overall intersection volume-to-capacity ratio approaches 1.0 for the PM peak commuter hour. As previously explained, this means the intersection is at its theoretical capacity limit and cannot process more traffic. Field observations confirm these findings with long vehicle queues observed on Barrett Street westbound and Colchester Avenue northbound during the PM peak hour. Capacity analysis worksheets for existing and future analysis conditions are presented in Appendix D.

*Table 3: Existing Intersection Capacity Analysis Results*

| | | Existing DHV (2015) | | |
|---|---|---|---|---|
| | Peak Hour | LOS[1] | Delay[2] | V/C[3] |
| ***Signalized Intersection*** | | | | |
| **Colchester Ave / Riverside Ave / Mill St** | | | | |
| | AM | B | 10.6 | 0.60 |
| | PM | B | 12.6 | 0.59 |
| **Colchester Ave / Barrett St** | | | | |
| | AM | B | 10.4 | 0.44 |
| | PM | D | 49.1 | 0.69 |
| **Riverside Ave / Barrett St** | | | | |
| | AM | C | 22.2 | 0.49 |
| | PM | D | 38.5 | 0.73 |
| **Combined Intersection** | | | | |
| | AM | C | 21.9 | 0.69 |
| | PM | D | 50.8 | 0.98 |

[1] LOS= Level of Service
[2] Delay = Average delay expressed in seconds per vehicle
[3] V/C = Volume-to-capacity ratio for critical movements

## 3.7 LAND USE AND ZONING

Colchester Avenue and Riverside Avenue are major routes for access into and out of Burlington from the east/northeast, Downtown Winooski, The University of Vermont (UVM), and UVM Medical Center. The intersection immediately serves employees and customers at Chace Mill, Champlain

Mill, Dominos, stores along the Winooski Circulator and visitors to the Winooski River's nature trails. This intersection serves residents, employees, and students and must be designed to accommodate substantial fluxes in vehicle, pedestrian, and bicycle traffic.

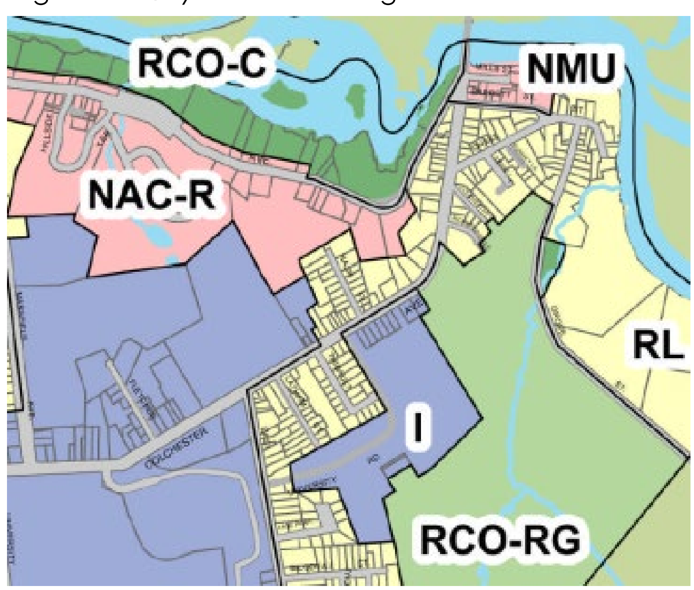
All roads leading up to the intersection have mixed land uses including residential, commercial, institutional, and government/public. To understand the current land uses leading up to and through the project area as well as the City of Burlington's expectations for land development in this area, the City's Municipal Development Plan (planBTV) and the Burlington Comprehensive Development Ordinance must be observed.

planBTV is a plan developed by the City of Burlington, readopted on March 31, 2014, which presents the long-range vision and goals for land use and land development. This plan emphasizes dense residential, mixed-use, and institutional development that preserves and prioritizes nearby open spaces and natural areas. Near this intersection, and other Neighborhood Activity Center (NAC) and Neighborhood Mixed Use (NMU) areas, the City aims to cultivate existing under-utilized commercial developments and transform them into neighborhood-serving mixed-use areas, while maintaining the scale and character of nearby neighborhoods. One concept introduced and explained in planBTV is different "built environments" which emphasizes the variety of existing structures and buildings and how they influence the environment surrounding it. This could be interpreted in terms of services provided, its involvement in community development, or its historical significance.

Another highly interwoven topic throughout the Plan is the relationship of land use and transportation. To foster the culture of Burlington, the plan encourages a multi-modal transportation approach to minimize vehicular traffic loads. The plan, along with plans that are incorporated by reference, prioritize and underscore the importance of the pedestrian experience, improved bicycle routes, and an efficient and effective public transportation system to establish a safe and healthy alternative to vehicular travel.

The Burlington Comprehensive Development Ordinance, readopted on January 7, 2008, with subsequent updates through January 2018, defines six zoning districts around the project area including (RCO-C) Recreation /Conservation, (RCO-RG) Recreation/Greenspace, (RL) Residential Low Density, (NMU) Neighborhood Mixed Use, (NAC) Neighborhood Activity Center, and (I) Institutional. Parcels immediately adjacent to the project area are zoned NMU, RCO-C and RL. This is shown in Figure 22 at right.

*Figure 22: City-defined Zoning Districts*



Neighborhood Mixed Use Districts are defined in the Burlington Zoning Ordinance as areas of land "intended to preserve and enhance historically commercial areas while reinforcing the compact scale and development patterns within the city's older neighborhoods" (p. 4-26). This includes the parcel of land on the east side of Colchester Avenue between Barrett Street and the Winooski River as well as all the parcels surrounding Mill Street. The Ordinance allows 80% land coverage in the area and no setbacks.

The Residential Low-Density District includes all the residential developments along the hill-section of Colchester Avenue, the eastern side of Riverside Avenue and the southern side of Barrett Street. The Zoning Ordinance protects and limits development in these residential neighborhoods. The front yard setbacks are up to 20 feet. The city holds the right to place infill developments and convert homes to neighborhood multi-use developments if necessary.

The Recreation/Conservation Districts are described as areas for active and passive recreational opportunities. The Zoning Ordinance prevents development in these areas. This includes property along the Winooski River, specifically the green space west of the shared use path on Riverside Avenue.

## 3.8 WALK AND BIKE FACILITIES

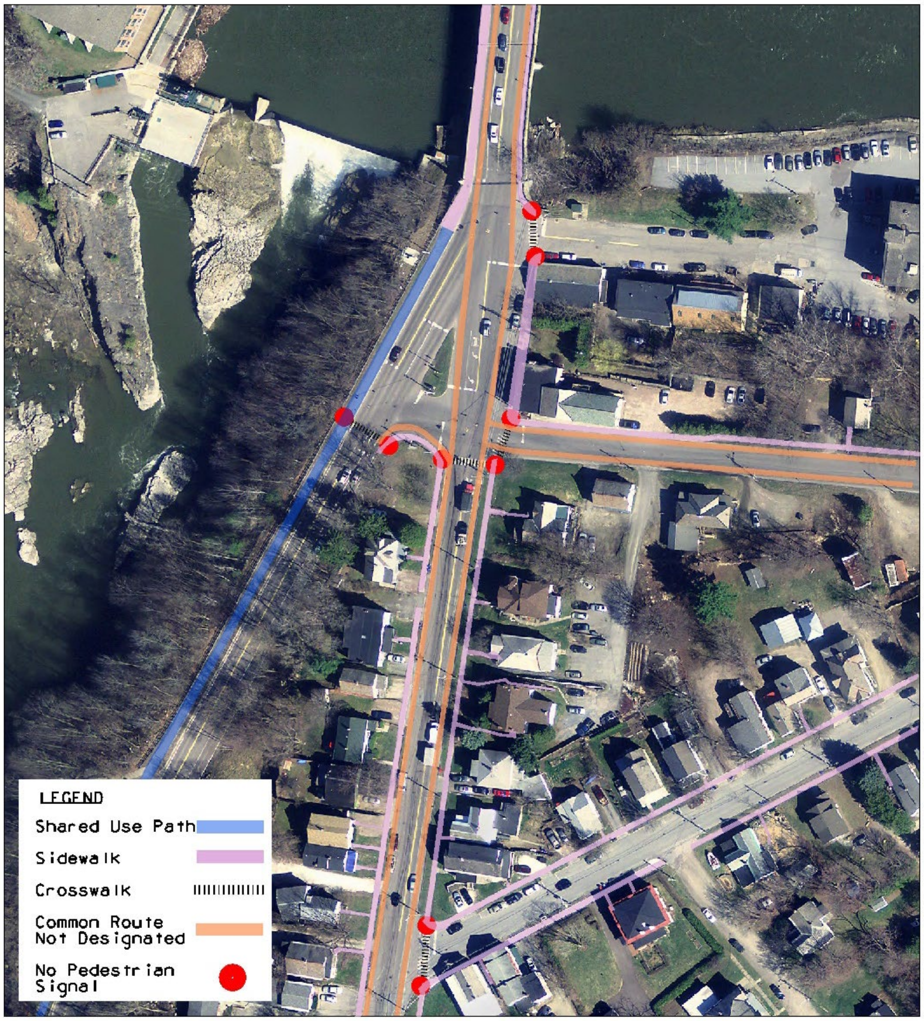
A network of sidewalks and a shared use path are provided within the project area. The project area has four unsignalized painted crosswalks that connect the existing network of sidewalks on Colchester Avenue to the Riverside Avenue shared use path. The pedestrian facilities can be seen in Figure 23.

With the exception of the Riverside Avenue shared use path, the project area is lacking designated facilities for bicycle travel. The CCRPC's 2017 Active Transportation Plan identifies Colchester Avenue extending north to VT 15 in Winooski, along with Burlington's Grove, Chase and Barrett Streets, as high priority road segments recommended for walk/bike facility improvements. The existing bicycle facilities can also be seen in Figure 23 on the following page.

This intersection's walking and biking facilities fail to meet all ADA standards. Sidewalks do not provide detectable warning surfaces at crossings. In addition, there are no signalized ADA accessible crossings in this project area and curb cuts are not provided in all locations necessary.

planBTV Walk Bike 20-year plan proposes additional features within the project area to improve the safety and efficiency of the intersection. In addition to upgrading the crossing facilities, providing a protected bike lane along Colchester Avenue and over the Winooski Bridge is proposed. Road markings will establish a buffered/conventional bicycle lane on Riverside Avenue and the existing shared use path provided on Riverside Avenue will remain. A variety of steps in their 5 and 10-year goals allow for the complete network to be established by 2036.

*Figure 23: Pedestrian and Bicycle Facilities*




## 3.9 TRANSIT SERVICE

Green Mountain Transit (GMT) has two local bus routes and one LINK Express route through the project area. These routes include:

- Route #2: Essex Junction
- Route #9 Riverside/Winooski
- Route #96: St. Albans LINK Express

GMT additionally provides "School Tripper" routes, offering services to school children. Two School Trippers Routes pass through this project area:

- Route #33 BHS/Hunt/HO Wheeler in the AM
- Route #43 Riverside/Wheeler in the PM except on Wednesdays

There are three designated bus stops in the project area with their locations labeled in Figure 24. Two are on Colchester Avenue and one is on Riverside Avenue. Table 4 summarizes bus route schedule and fare information.

*Figure 24: CCTA Bus Stops*

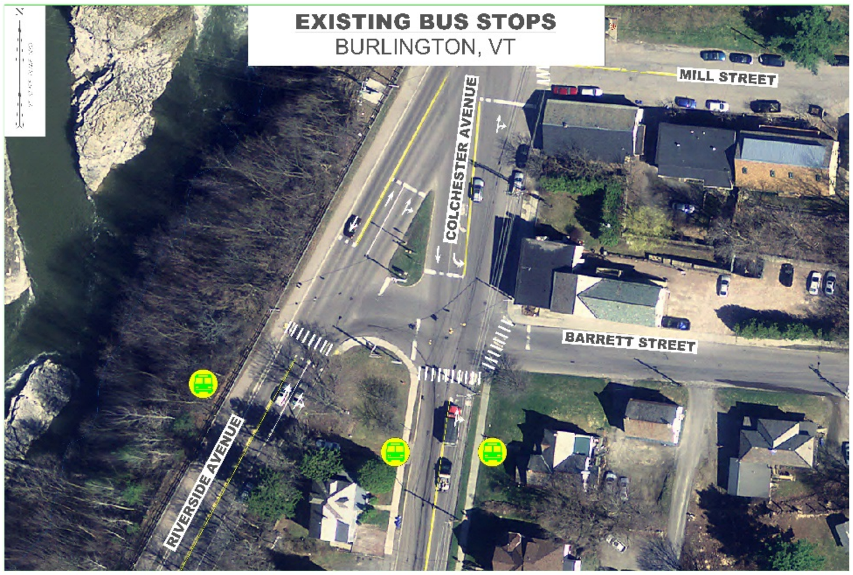



*Table 4: GMT Bus Schedule*

| Route | Start Location | End Location | Cost* | Schedule | Frequency |
|---|---|---|---|---|---|
| #2: Essex Junction | Downtown Burlington | Essex Junction | $1.25 | M-F 5:45AM-9:30PM<br>SAT 6:10AM-7:15PM | M-F: 15 min (on peak); 30min (off-peak); SAT: 30 min (on peak), 1hr (off peak) |
| #9: Riverside/ Winooski | Downtown Burlington | Downtown Burlington | $1.25 | M-F 6:45AM-11:25PM<br>SAT 6:15AM-6:15PM | M-F: 15 min (on peak); 30min (off-peak); SAT: 1hr |
| #96: St. Albans LINK Express | Highgate | Downtown Burlington | $4 | M-F 6:30AM, 7:30AM, 5:47PM and 6:21PM to Burlington<br>M-F 5:45AM, 6:40AM, 4:50 PM and 5:30 to St. Albans | only scheduled times |

*Fare for one-way ride

GMT and the Chittenden Area Transportation Management Association (CATMA) are actively working to promote the use of alternative travel modes in the area and thereby minimize the number of vehicle trips through the study intersections.

GMT is currently preparing its *Next Gen Transit Plan*. Draft recommendations from this plan recommend simplifying the Riverside/Winooski bus route, Route 9, and increased service frequency during evening hours on this route.

### 3.9.1 Transit Ridership

Ridership rates are recorded annually and are shown to be representative of the average daily ridership. GMT's ridership counts are provided below in Table 5.

*Table 5: CCTA Annual Ridership Count*

| Location | Route | On Count | Off Count |
|---|---|---|---|
| Riverside OPPOSITE Barrett St | Weekday, #9 Riverside/Winooski bus | 8 | 3 |
| | Saturday, #9 Riverside/Winooski | 1 | 2 |
| Colchester Ave OPPOSITE Barrett St | Weekday, #2 Essex Junction bus | 13 | 4 |
| | Saturday, #2 Essex Jct bus | 5 | 0 |
| Colchester Ave @ Barrett St | Weekday, #2 Essex Junction bus | 0 | 8 |
| | Saturday, #2 Essex Jct bus | 0 | 10 |

## 3.10 CRASH HISTORY

The crash history for the study area was investigated using the VTrans crash database. VTrans keeps records of reported crashes by milepost along State and Federal Aid Highways in Vermont. General Yearly Summaries can be requested from VTrans for given roadway segments. The summaries note the location (mile marker), date, time of day, weather conditions, contributing circumstances, and severity for reported crashes. Crash reports for 2010 through 2014 (included in Appendix E) were reviewed for U.S. Route 7 (Riverside Avenue) between mile marker 4.00 and mile marker 4.19 including the Barrett Street intersection at 4.10 and the Colchester Avenue/Mill Street intersection at 4.14. The Burlington/Winooski municipal boundary is at mile marker 4.19. In addition, reports for Colchester Avenue between mile markers 0.94 and 1.04 were reviewed. Within these reports were Colchester Avenue's intersection with Barrett Street (mile marker 1.00) and with Riverside Avenue (mile marker 1.04).

Table 6 provides a summary of the crash data. Riverside Avenue experienced the greatest number of crashes with 58 reported over a four-year period (2010-2014). The most prominent crash types at both intersections were rear-end collisions. Crashes were most often observed during the midday and afternoon commuter peak hours. Thirteen crashes involved injuries and one involved a fatality.

*Table 6: Crash Summary (2010-2014)*

| Year | Riverside Avenue | Colchester Avenue | TOTAL |
|---|---|---|---|
| 2010 | 13 | 4 | **17** |
| 2011 | 8 | 8 | **16** |
| 2012 | 7 | 11 | **18** |
| 2013 | 18 | 13 | **31** |
| 2014 | 12 | 6 | **18** |
| **Total** | **58** | **42** | **100** |
| **Type** | | | |
| Angle | 6 | 5 | **11** |
| Rear-end | 32 | 20 | **52** |
| Head-on | 0 | 2 | **2** |
| Single Vehicle | 7 | 1 | **8** |
| Sideswipe | 7 | 9 | **16** |
| Unknown-other | 6 | 5 | **11** |
| **Total** | **58** | **42** | **100** |
| **Severity** | | | |
| Property Damage | 48 | 38 | **86** |
| Personal Injury | 10 | 3 | **13** |
| Fatality | 0 | 1 | **1** |
| Other | 0 | 0 | **0** |
| **Total** | **58** | **42** | **100** |
| **Year** | **Riverside Avenue** | **Colchester Avenue** | **TOTAL** |
| **Weather** | | | |
| Clear | 30 | 23 | **53** |
| Cloudy | 11 | 11 | **22** |
| Rain | 8 | 0 | **8** |
| Snow/Ice | 2 | 4 | **6** |
| Fog | 0 | 0 | **0** |
| Unknown | 7 | 4 | **11** |
| **Total** | **58** | **42** | **100** |
| **Time of Day** | | | |
| 7:00AM to 9:00AM | 9 | 2 | **11** |
| 9:00AM to 4:00PM | 20 | 22 | **42** |
| 4:00PM to 6:00PM | 11 | 6 | **17** |
| 6:00PM to 7:00AM | 18 | 2 | **20** |
| Unknown | 0 | 0 | 0 |
| **Total** | **58** | **42** | **100** |

Three pedestrian/bicyclist related crashes involved vehicles turning left onto Barrett Street from Colchester Avenue. These crashes are described below.

1. On February 6, 2012 at 1:03 PM a pedestrian was hit and killed at the intersection of Barrett Street and Colchester Avenue. It was a clear day and the pedestrian was hit while crossing at the unsignalized Barrett Street crosswalk. The driver was southbound on Colchester Avenue turning left onto Barrett Street under a green light. The driver did not see and hit the pedestrian in the crosswalk.

2. On June 8, 2012 at 1:33 PM a person in a wheelchair was hit and injured at the same intersection. It was a cloudy day. The person in the wheelchair was in the unsignalized Barrett Street crosswalk and the driver under a green light turned left and hit the person in the wheel chair causing an injury. The driver said they did not see the person in the wheelchair.

3. On May 25, 2012 at 6:57 AM a vehicle traveling southbound turning left into Barrett Street struck a bicyclist traveling northbound. The bicyclist was injured.

Appendix F includes a Collision Diagram to document the reported crashes by location over a three-year period.

VTrans maintains a High Crash Location (HCL) list for State and Federal Aid Highways. High Crash Locations experience at least five crashes over a five-year period and a crash rate that exceeds the statewide average crash rate for similar roadway facilities by a factor defined by VTrans. This list was most recently updated to include crashes experienced between 2010 and 2014. The intersection of Colchester Avenue and Barrett Street was included in the HCL list which can be found in Appendix G. This intersection reportedly has the $22^{nd}$ highest crash intersection in the State of Vermont. Further examination by Stantec of the crash rate calculation suggests that the actual crash rate is much lower than the rate reported by VTrans. However, the Stantec derived rate is still above the statewide average for similar intersections.

## 3.11 PARKING

Parking is generally prohibited within the subject intersection except on the east side of Colchester Avenue between Barrett Street and Mill Street. On-street parallel parking is permitted at the northern end of this street segment to support area businesses. Due to lack of delineation and ample available space, some drivers park diagonally in this area. The southern end of this segment is used as a loading zone. A Domino's pizza shop is located on the corner of Barrett Street and Colchester Avenue. The loading zone is used by delivery trucks and pizza delivery drivers. A variety of parking and loading/unloading zones are available through the project area. Additional on-street and off-street parking near the subject intersection is shown in Figure 25.

*Figure 25: Project Area's Existing Parking*


## 3.12 NATURAL RESOURCES

Stantec conducted a preliminary review of the natural resources present within the Colchester/Riverside project area in Burlington, VT. Specifically, as part of this investigation, Stantec identified and characterized wetlands, streams, rare, threatened or endangered (RTE) species, wildlife habitat, agricultural land, 4(f) and 6(f) public lands, and hazardous waste sites. Refer to Appendix H for complete summary of the study's findings.

According to the ANR program, there are no Vermont Significant Wetland Inventory (VSWI) wetlands within the Project Area. The Winooski River flows from east to west to the north and west of the Project Area. The Winooski River has a floodway and Special Flood Hazard Area associated with it, located outside of the Project Area. The Winooski River, in this vicinity, is considered impaired and stressed as indicated in Figure 26.

*Figure 26: River Flood Zones and Impaired*

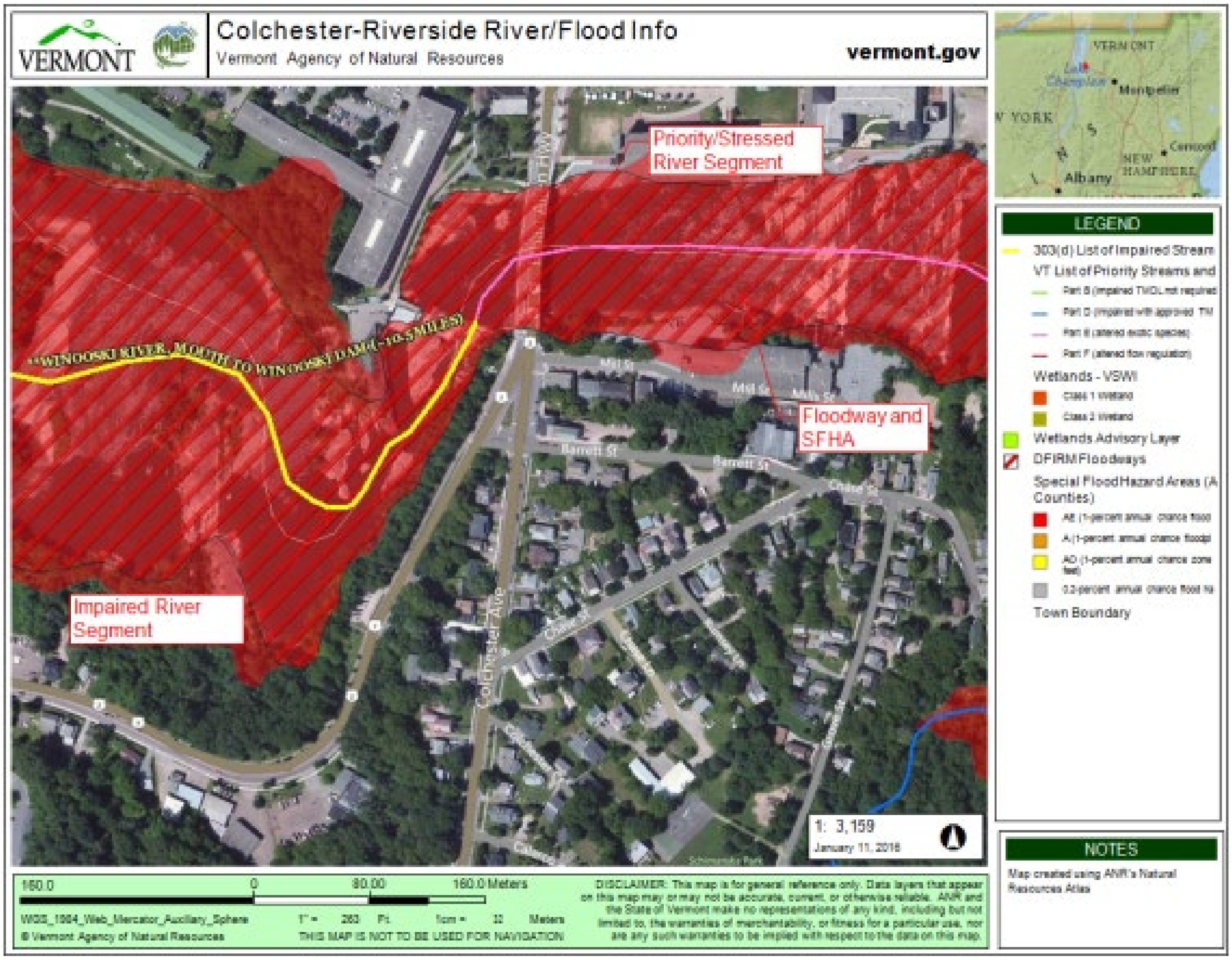
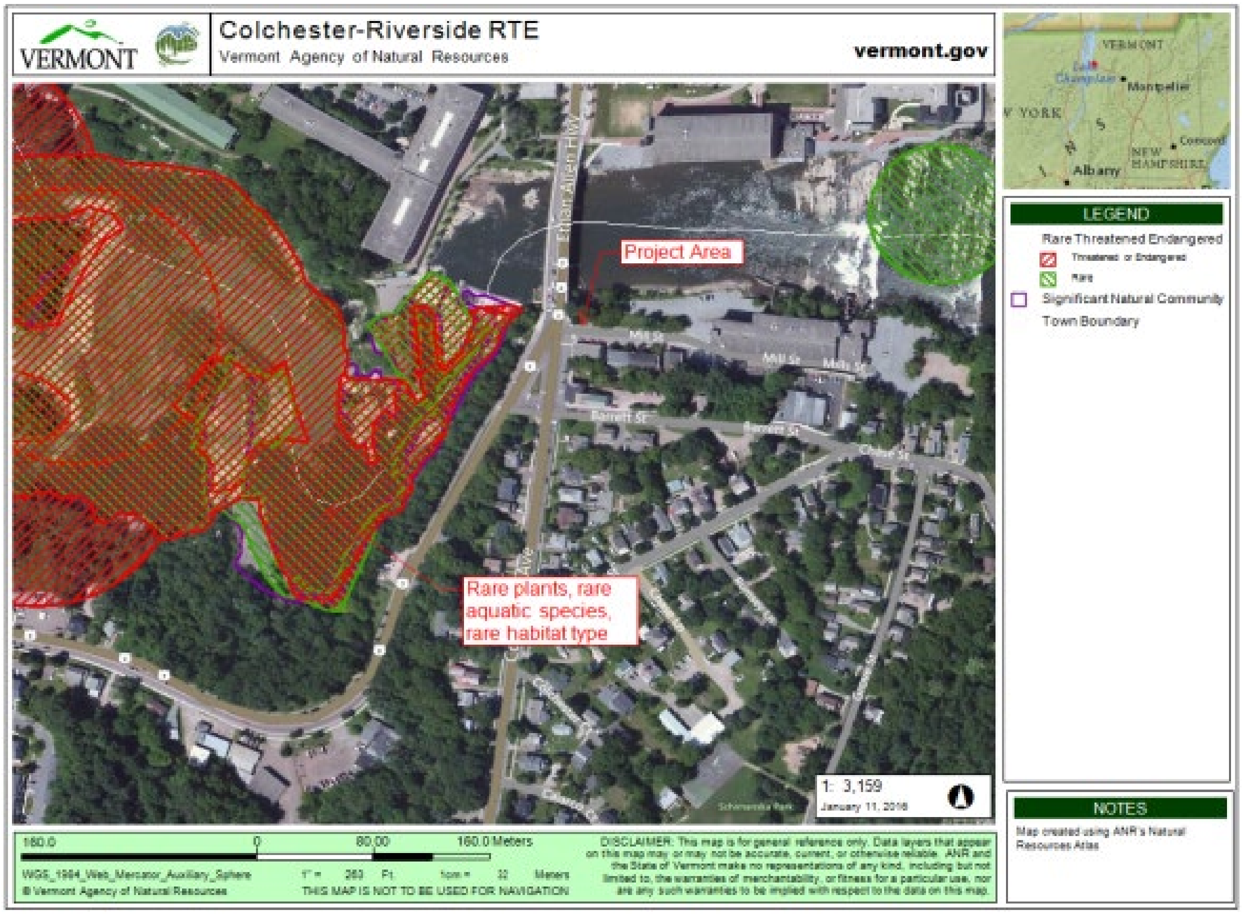


Figure 27 displays the presence of rare plants, rare aquatic species and a rare habitat type located in these wetlands and streams outside of the existing road's ROW, west of the project area.

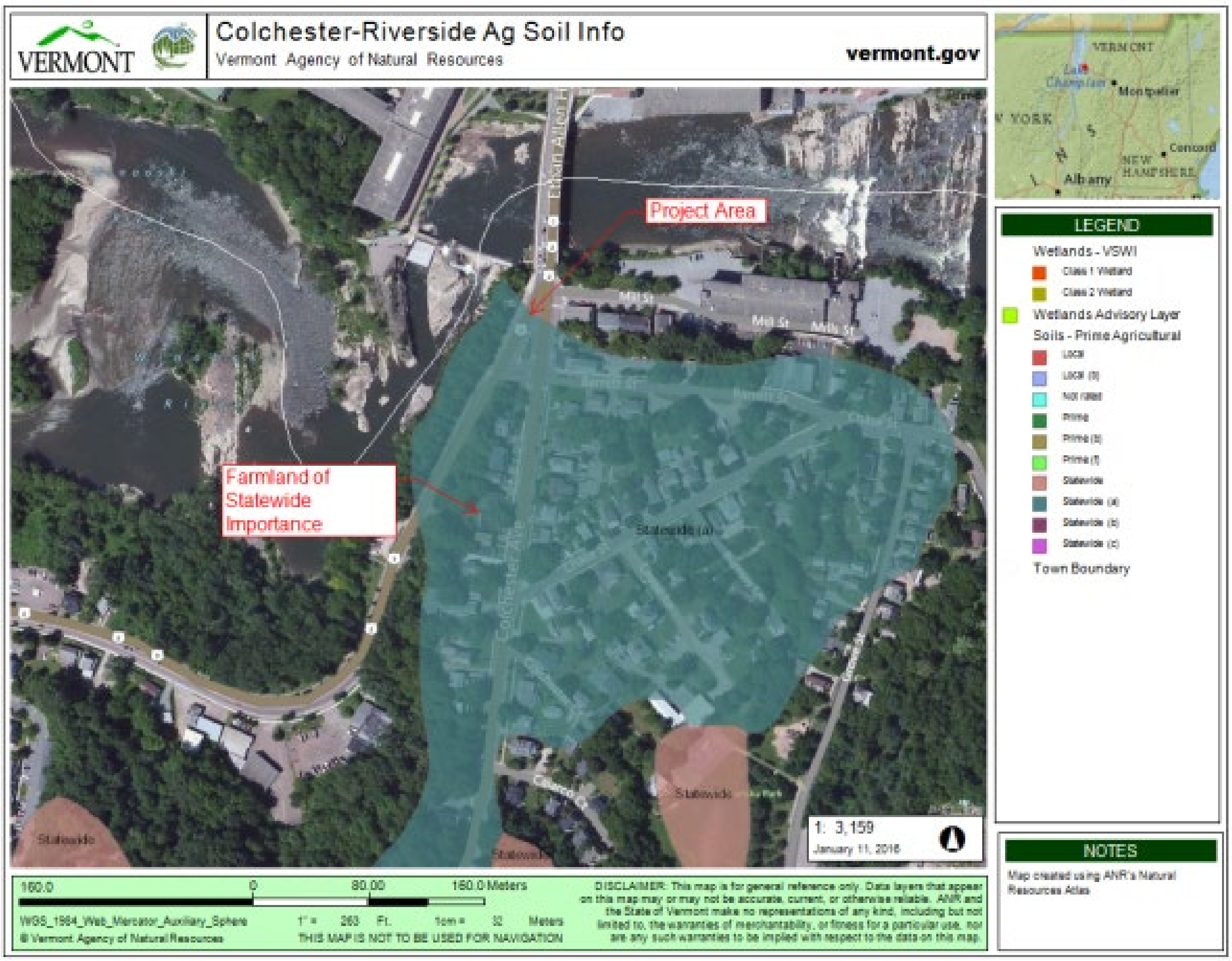
*Figure 27: Rare Threatened Endangered Species*



The soils in this area include Adams and Windsor loamy sands, 5-12% (considered Farmlands of Statewide Importance) and fill soils. These soils are not classified hydric. No soils in the project area are currently or planned to be in active agriculture. The Farmland Policy Protection Program Act does not apply to project's existing ROW.

Refer to Figure 28 for map of the project areas agricultural soil classification.

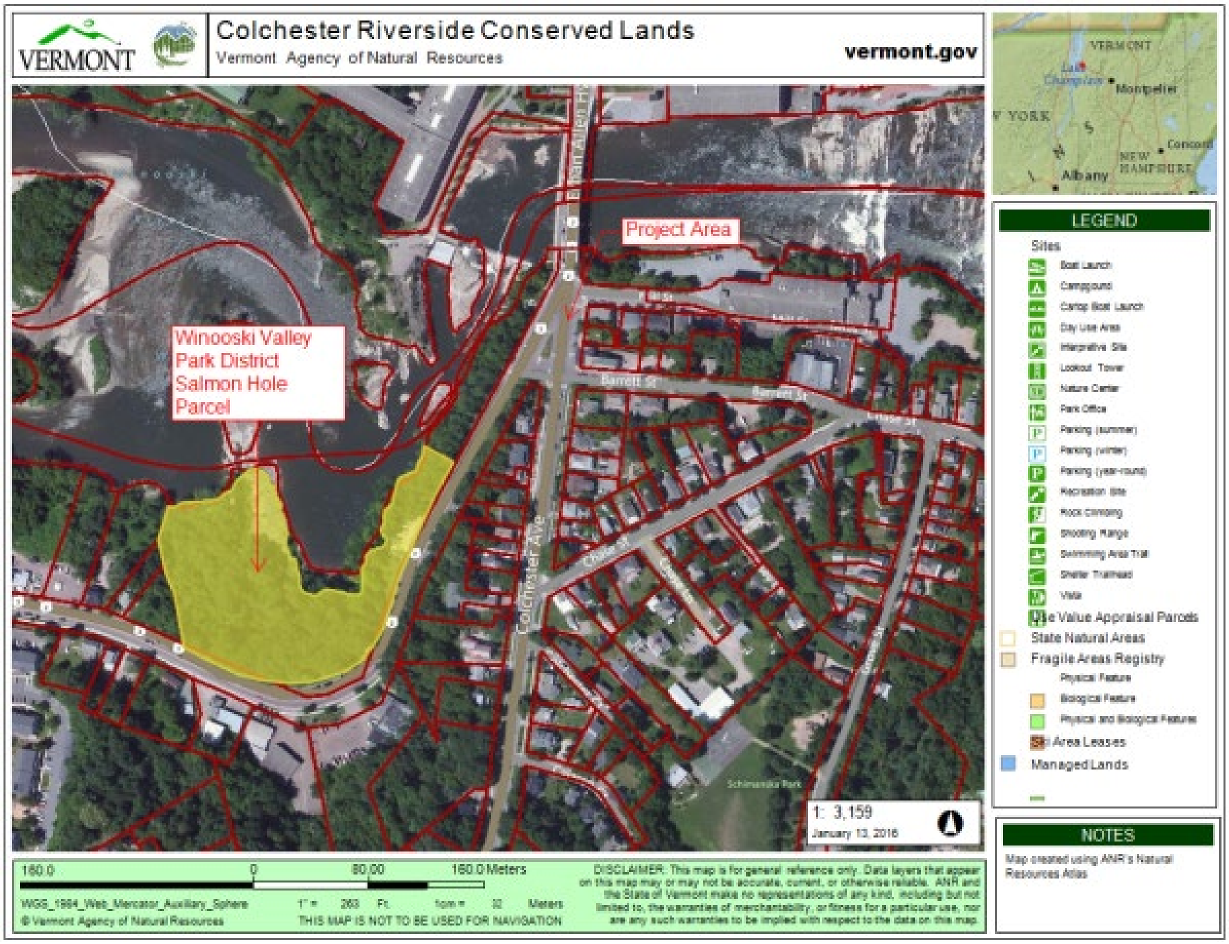
*Figure 28: Riverside Agricultural Soil*



No public recreation lands or public lands developed under Land and Water Conservation Funds exist in the project ROW. Salmon Hole, adjacent to the project, is owned by the Winooski Valley Park District.

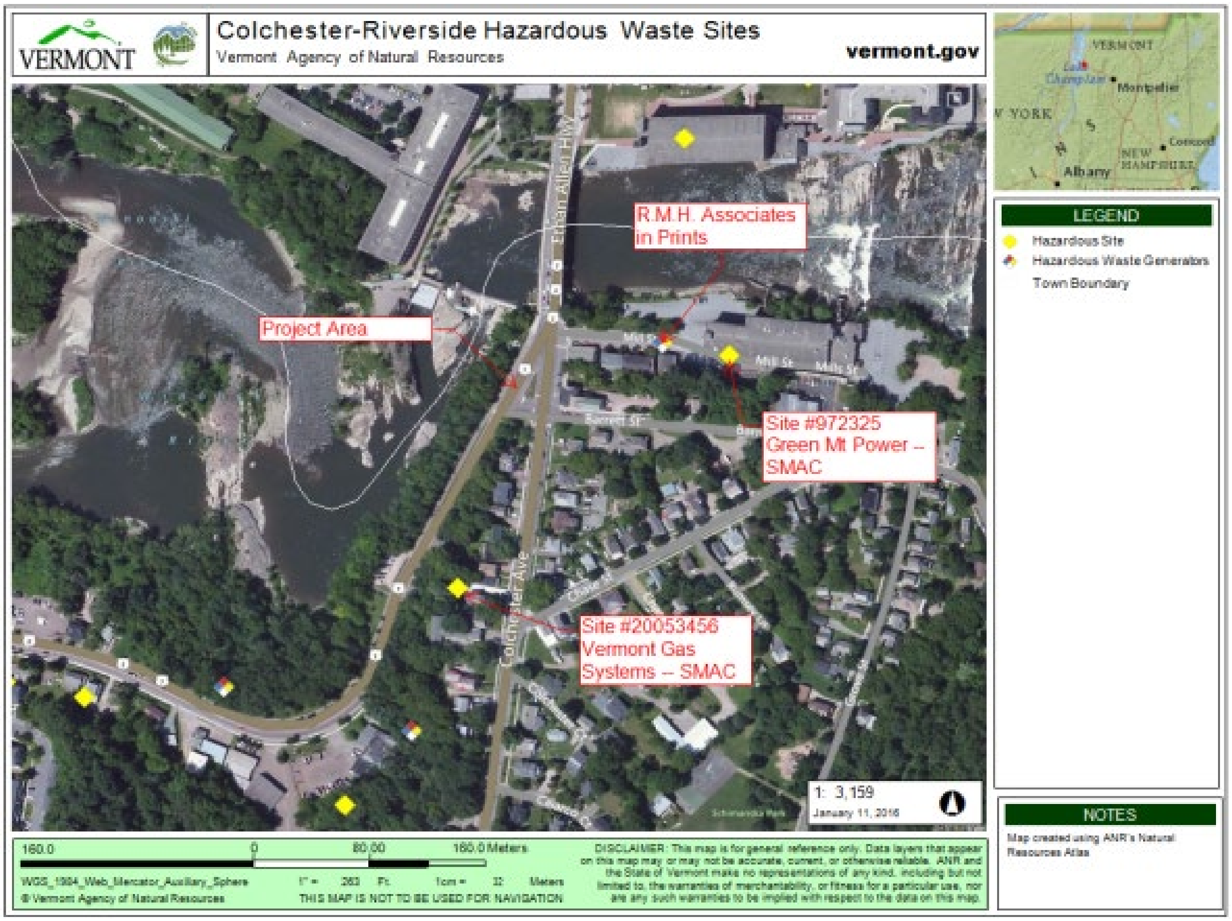
Refer to Figure 29 for a map of conserved lands.

*Figure 29: Conserved Lands*



No active Hazardous Waste sites or generators are located on the project area. Figure 30 indicates the location of Hazardous Sites nearby.

*Figure 30: Hazardous Waste Sites*



# 4.0 PURPOSE AND NEED STATEMENT

The following statement was developed based on the existing conditions assessment, public input and Project Advisory Committee discussions.

**Purpose**: The purpose of the Colchester Avenue/Riverside Avenue intersection scoping study is to define a safer intersection that enhances mobility and access for all users while contributing to livable and vibrant communities and ensuring efficient operations.

**Need:**

1. Improve safety and mobility for all users of the intersection:

   - There is a need to address **pedestrian safety** in the project area. Over a five-year period (2010 - 2014) two pedestrians and one bicyclist were struck while crossing Barrett Street. One of these crashes resulted in a fatality. Deficiencies with respect to the existing infrastructure may be partially to blame for these crashes. Crosswalks are not equipped with pedestrian signals leaving pedestrians to determine when crossing may be safest. Signal heads and their indicating colors are difficult for pedestrians to see. Some sidewalks are in poor condition. Not all crossings are marked well, and many do not have detectable warning surfaces. Mill Street has no sidewalk.

   - There is a need to provide a **safer bicycle connection** between Winooski and Burlington. There are no dedicated bicycle facilities in the project area aside from the Riverside Avenue multi-use path. On-road bicyclists are required to share travel lanes with vehicles as many of the existing shoulders are two feet wide or less. The existing four-lane bridge over the Winooski River has no shoulders. The planBTV Walk Bike proposes protected bike lanes on Colchester Avenue. The CCRPC has nearly completed a scoping study for the bridge over the Winooski River that retains four vehicle travel lanes on the bridge with available space for shared use paths on both sides of the bridge.

   - There is a need to address the reported **High Crash Location** status of the intersection: The most recent VTrans High Crash Location (HCL) report (2010-2014) lists the Colchester/Barrett St intersection as the #22 ranked intersection in Vermont out of 132 High Crash Locations. There were 55 total crashes in this time period with the majority being rear end collisions. Most of the rear end collisions occurred on Colchester Avenue southbound approaching Mill Street. There are no back plates present on the majority of signal indications that would serve to enhance their visibility. There are no protected left turn signal phases and a yellow interval for southbound right turns onto Riverside Avenue is missing.

2. Simplify the intersection:

- There is a need to **reduce the complexity of the intersection**. The existing unique configuration easily confuses newcomers to the area. It includes three signalized intersections that operate as one complex intersection. Motorists are challenged in selecting the proper lane at the intersection approaches due to its complexity and poor signage. Likewise, the safest routes for pedestrians and cyclists to traverse the intersection are not clearly evident. Access to Mill Street businesses will need to be maintained.

- If the **on-street parking** on the east side of Colchester Avenue between Barrett and Mill Streets is to remain, there is a need for organize this parking. Parking stalls are not delineated, and vehicles have been observed parked both parallel and perpendicular to the roadway.

3. Enhance the gateway to Burlington:

- As a **gateway into Burlington**, the intersection does not serve to welcome visitors and assist them in reaching their destination.

4. Manage traffic congestion:

- There is a need to manage peak hour congestion. During the PM peak hour, delays and queues occur on Barrett Street, the Colchester Avenue northbound approach and the Riverside Avenue northbound approach. These queues indicate that the approaches operate at or near capacity.

- Capacity restrictions occurring during any single signal cycle from stopped left turning vehicles or stopped buses have a lasting effect throughout the commuter peak periods.

# 5.0 FUTURE CONDITIONS

Roadway and traffic conditions in the study area were projected to a future design year of 2035. Estimated peak hour traffic volumes were determined based on proposed land development projects in the area and historic traffic growth trends. Intersection operations were then analyzed for the future travel demands.

## 5.1 FUTURE TRAFFIC VOLUMES

This study assumes that traffic volumes will increase at the subject intersection over the next twenty years due to a combination of background traffic growth and approved land development projects. First, existing volumes were increased by five percent. This reflects potential increases in travel demand associated with unforeseen development projects, changes in demographics and changes in travel behaviors. Second, traffic volume increases associated with approved development projects within or adjacent to the study area were accounted for in the traffic forecasts. Specific developments considered include the proposed Grove Street project and redevelopment of the M&M Auto sales site on Riverside Ave. The Grove Street project, to be located at the former S.D. Ireland plant just east of the study area, will include 232 apartment units. The M&M Auto sales site, located just south of the study area, is permitted to be redeveloped into 57 apartment units. The S.D. Ireland and M&M Auto projects are expected to add 27 and 21 PM peak hour trips through the study area, respectively.

A third project was identified late in the study process. There is a proposal to develop a 97-room hotel in Winooski. Detailed traffic information regarding this project was not available at the time that future traffic forecasts were being prepared for this project. Consequently, anticipated traffic associated with this development is not specifically considered in this study. It is assumed that its traffic is part of the "background growth" traffic increase described above. Stantec estimates that the hotel would add 23 PM peak hour trips to traffic flows on the bridge over the Winooski River.

The resulting 2035 AM and PM peak hour traffic flow networks that consider background traffic growth and site-specific developments are shown in Figures 31 and 32, respectively.

## 5.2 FUTURE TRAFFIC OPERATIONS

The traffic operations analysis conducted for existing traffic conditions were repeated for the future conditions based on the traffic growth assumptions described above. The analysis again examined the three individual intersections separately to then calculate operating conditions for the combined intersection. As shown in Table 7 below, new traffic growth will increase utilization of the intersection during the AM peak hour to 74 percent (V/C of 0.74) of capacity from 69 percent with the intersection continuing to operate at LOS C. There is little reserve capacity in the intersection for the PM peak hour under existing conditions such that the assumed traffic growth will cause demands to exceed capacity and the operating level of service will drop from LOS D to LOS E.

*Table 7: Existing and Future Colchester/Barrett Performance*

| Location | Peak Hour | Existing (2015) | | | Future (2035) No Build | | |
|---|---|---|---|---|---|---|---|
| | | V/C[1] | Delay[2] | LOS[3] | V/C[1] | Delay[2] | LOS[3] |
| **Combined Intersection** | | | | | | | |
| | AM | 0.69 | 21.9 | C | 0.74 | 24.4 | C |
| | PM | 0.98 | 50.8 | D | 1.05 | 64.2 | E |

**Notes**

[1] LOS= Level of Service
[2] Delay = Average delay expressed in seconds per vehicle
[3] V/C = Volume-to-capacity ratio for critical movements

*Figure 31: 2035 AM Peak Hour Traffic Flow*

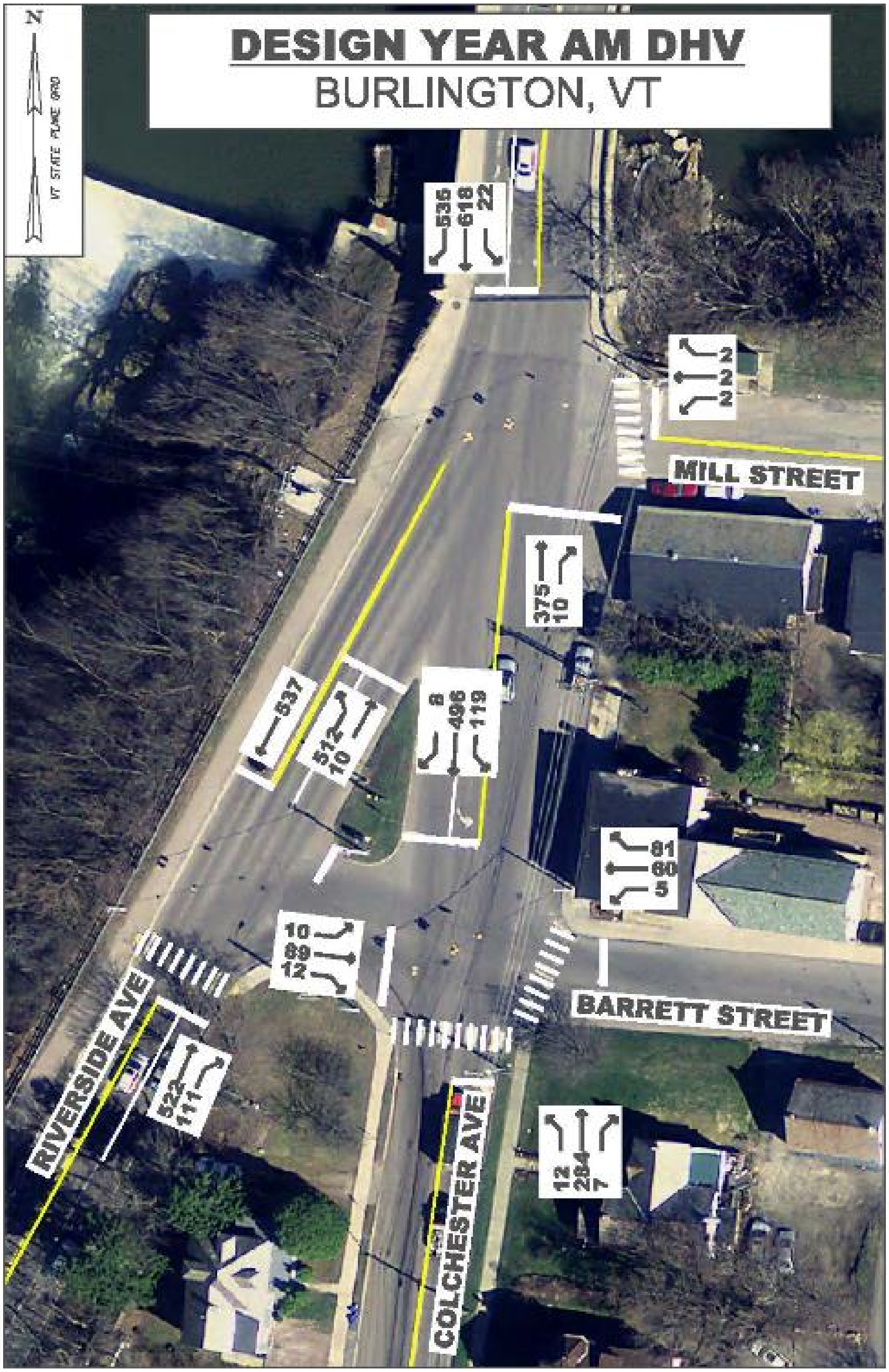
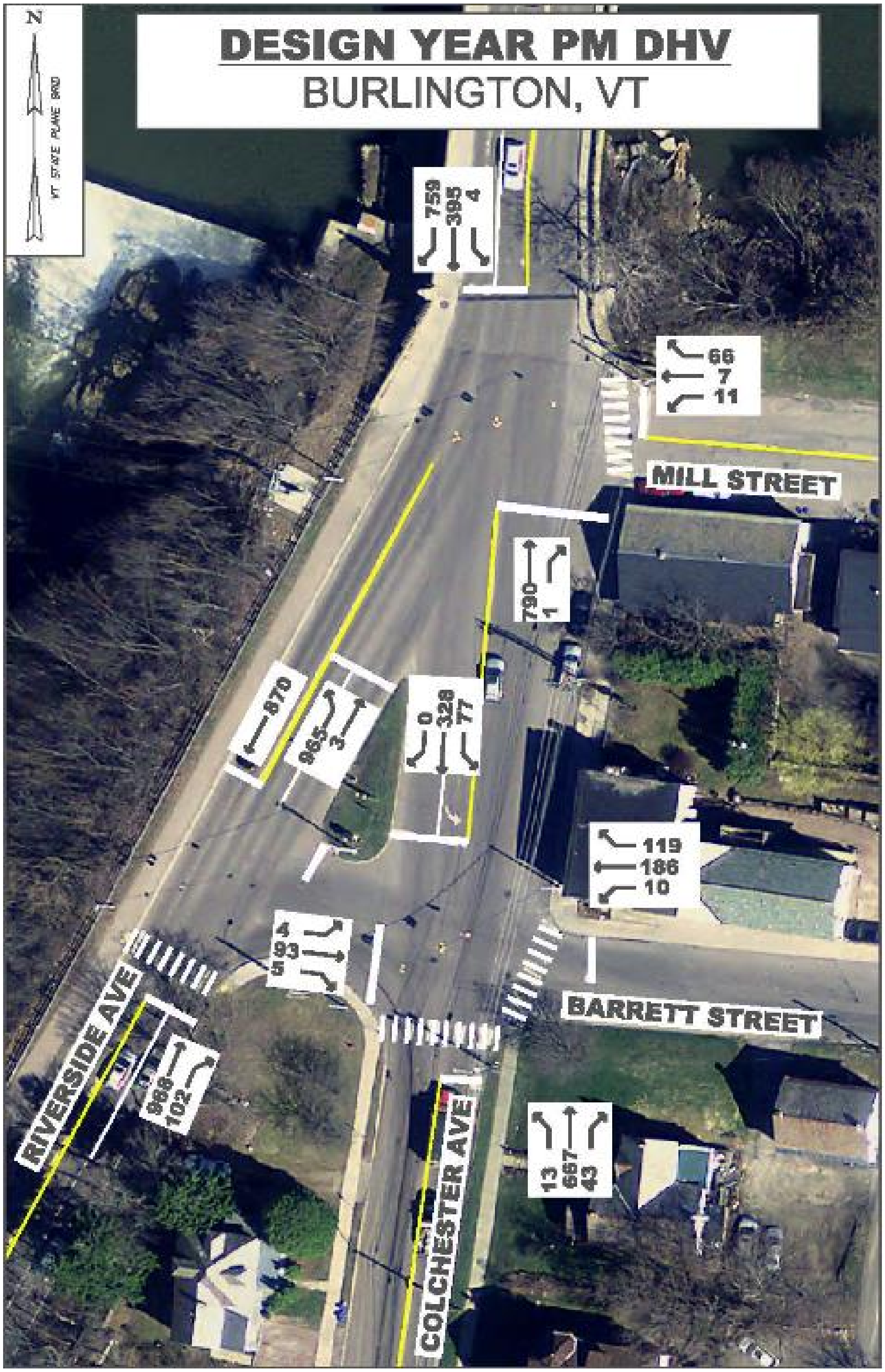


*Figure 32: 2035 PM Peak Hour Traffic Flow*



# 6.0 ALTERNATIVES

The Project Advisory Committee considered a wide range of transportation system improvements to address the project's purpose and need. This scoping study is intended to define system improvements that can be constructed in the short term (0 to 3 years) and medium term (3 to 10 years). Transportation Demand Management (TDM) strategies, strategies that do not require significant physical changes to the transportation system, were also discussed with the advisory committee. An overview of area-wide TDM strategies is provided below followed by a more rigorous investigation of short term and near-term transportation system improvements.

## 6.1 TRANSPORTATION DEMAND MANAGEMENT STRATEGY

Transportation Demand Management (TDM) strategies can be applied on an area-wide basis to reduce peak period vehicular travel demands. Many such strategies are already in place and could be expanded or enhanced to further minimize vehicular travel. TDM is the application of strategies and policies to reduce travel demand (typically single occupancy vehicle trips) or to redistribute this demand in space or time. A variety of TDM strategies that promote walking, biking, carpooling, using public transit, vanpooling, working from home, and compressed work weeks can reduce the number of single occupancy vehicles (SOV's) on the road at peak times. Much has and is being done locally and regionally on this front. For example, in recent years the local transit system, (CCTA, now GMT), has expanded both routes and service frequency resulting in increased ridership. Among the service additions is the Link Express, which provides a convenient alternative for inter-city commuters. The CCRPC and VTrans have and continue to work with communities on education, development of park and ride facilities, car share programs (such as http://www.carsharevt.org/), carpooling programs (such as http://www.connectingcommuters.org/), transit promotions, complete streets, and Safe Routes to School programs. Websites and apps such as http://www.travelsmartervt.org/ or http://www.gochittendencounty.org provide a resource for promoting and choosing alternatives to driving alone while the increasing amount of readily accessible real time travel information provides for better travel decisions.

The City of Burlington and Local Motion have made strides along this front as well. Pedestrian and bicycle facilities have been expanded in recent years, and new land use policies have been adopted to promote more dense urban development. The efforts have led to more residents and students walking and biking to school, work, and businesses in the urban area.

Another local leader in promoting the use of alternative travel modes to reduce traffic congestion is the Chittenden Area Transportation Management Association (CATMA). CATMA has been managing and administering commute programs, incentives, and services for the Hill institutions for almost 25 years, which has reduced congestion and influenced commuters sustainable travel options and choices. In 2015 CATMA transitioned to a Countywide TMA offering membership and its services to businesses, developers and residential sites. Their turn-key TDM programs include Unlimited Access, subsidized bus passes, Bike/Walk Rewards, Guaranteed Ride

Home, off-site parking and shuttles. In addition to programs, they offer commuters TDM tools, resources and an array of educational services. Local to the project area, this is a vital resource to UVM and Champlain College students living in Winooski and Champlain Mill businesses/patrons when considering their limited available parking.

It is anticipated that these local and regional programs will grow and expand over the years. CATMA should be encouraged to work with new employers and developers in the area as well as existing employers who are not yet members. Likewise, the City should encourage membership in CATMA when reviewing permit applications for new development in the City. Increased participation in the CATMA programs however, is not expected to fully address the area's congestion issues and will not result in the physical changes to the study area intersections necessary to provide safer pedestrian, bike and vehicle accommodations. Still, TDM programs are worth pursuing for other reasons such as reduced fuel consumption and carbon emissions.

## 6.2 SHORT TERM IMPROVEMENTS

Short term improvements are physical and operational changes to the intersection that can be readily accomplished with limited if any relocations of existing curbs and generally do not require permits, right-of-way acquisition, or extensive drainage system changes. For the purpose of this study, Short Term Improvements are actions that can be completed within three years. Recommended short term improvements to address the project's needs are shown in Figure 33 and described below. The improvements incorporate recommendations offered by the Project Advisory Committee and Local Motion to enhance bike lane markings and tighten curb radii.

**Pedestrian Safety:**

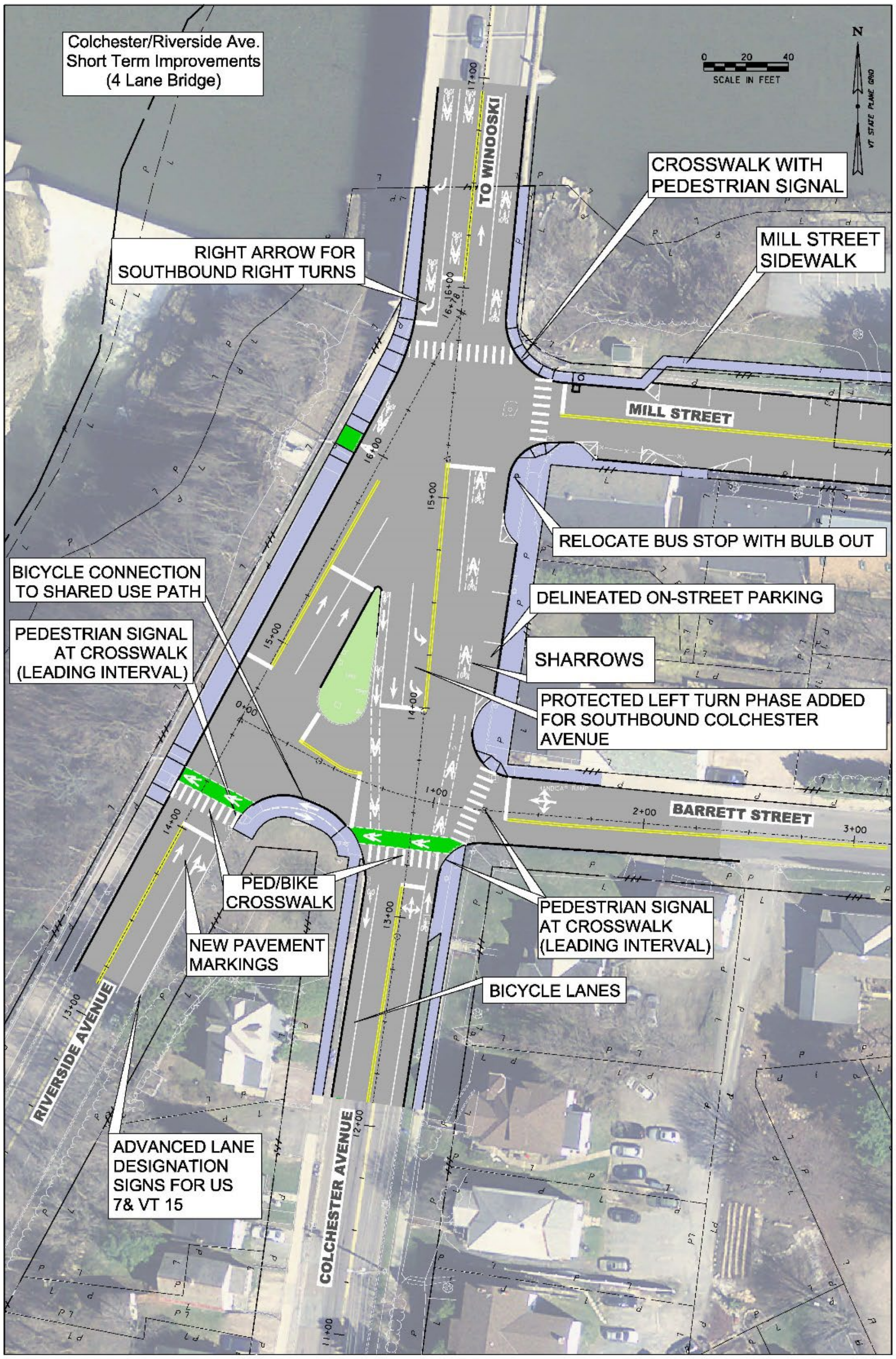
1. Install pedestrian signals at the three existing crosswalks at Colchester Avenue, Riverside Avenue and Barrett Street. Provide a leading pedestrian interval at each location.
2. Add a protected left-turn phase and signal arrow for southbound Colchester Avenue approach to the Colchester/Barrett intersection to provide a gap for left turning vehicles. Signal pedestrians to not cross Barrett Street concurrent with the left-turn phase.
3. Add a crosswalk and pedestrian signal at the end of the bridge on the southbound approach to the Colchester/Riverside/Mill intersection.
4. Add a five-foot wide sidewalk along Mill Street to the Chase Mill.
5. Reconstruct the sidewalk along Colchester Avenue from Barrett Street to Mill Street to include bulb outs that:
    a. Support a relocating a bus stop to the Colchester/Mill intersection from the more congested Colchester/Barrett intersection; and,
    b. Protect and define on-street parking stalls.

**Bicycle Safety:**

1. Include a 5-foot wide bicycle lane with markings and signs along both sides of the Colchester Avenue northbound approach where parking is prohibited. Narrow travel lanes to 11 feet where needed to accommodate the bike lanes.

2. Create a bicycle connection from the Riverside Avenue shared use path to the Colchester Avenue bicycle lanes with bicycle ramps, 10-foot wide sidewalks and 12-foot wide crosswalk markings.

*Figure 33: Short Term Improvements*



**Vehicle Crashes:**

1. Add a yellow turn arrow on the signal head for southbound right turns to alert drivers of the upcoming red light.
2. Add backplates to signal heads to increase signal visibility.
3. Add advance lane designation signs on Riverside Avenue northbound indicating "US 7/I-89 North left lane" and "VT 15/I-89 South right lane".

**Intersection Complexity:**

1. Add durable pavement markings to improve visibility.

**Rejected Actions**

Other improvements were considered, discussed and ultimately rejected as short-term improvements. From a traffic congestion perspective these proposals included:

1. Restricting left turns during peak hours at the northbound Colchester Avenue approach and/or at the westbound Barrett Street approach to the Colchester/Barrett intersection;
2. Providing a right-turn lane on the westbound Barrett Street approach during peak hours by restricting use of the existing loading zone and by widening the roadway three feet to the south; and,
3. Converting the four-lane bridge to three lanes and using the reclaimed space to add a cycle path to the west side of the bridge.

The first proposal was rejected as it would likely result in traffic diversions on to residential streets. The second proposal was rejected due to its expected negative impacts on the business operating at this intersection and the challenges associated with enforcing the suggested parking restrictions. The third proposal would provide an important bicycle connection between downtown Winooski and the Riverside Avenue shared use path. However, the proposed change would restrict the bridge approach to the Colchester/Riverside/Mill intersection to a single lane resulting in long vehicle queues under existing conditions. (The analysis of this proposal indicated that during the AM peak southbound traffic would queue over 600 feet northward into the Winooski circulator.) Consequently, this proposal was deferred for consideration as part of the longer range alternatives that eliminate the signal at Mill Street.

## Operational Impacts

The addition of a protected left-turn signal phase and arrow for the southbound Colchester Avenue approach to the Colchester/Barrett intersection is the only proposed short term action that would potentially impact intersection operations to a measurable degree. The added phase should allow safer left-turn movements however, the clearance time associated with this new phase reduces the overall operational efficiency of the intersection. As shown in Table 8, this action would increase delays during both peak hours by three to five seconds. These impacts are relatively minor and do not change the overall intersection operating level of service.

*Table 8: Colchester/Barrett Intersection Performance with Short Term Improvements*

| | Existing (2015) | | | Future (2035) | | | Future with Short Term Improvements | | |
|---|---|---|---|---|---|---|---|---|---|
| Peak Hour | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C | Delay | LOS |
| AM | 0.69 | 21.9 | C | 0.74 | 24.4 | C | 0.83 | 27.6 | C |
| PM | 0.98 | 50.8 | D | 1.05 | 64.2 | E | 1.10 | 68.9 | E |

[1] V/C = Volume-to-capacity ratio for critical movements
[2] Delay = Average delay expressed in seconds per vehicle
[3] LOS= Level of Service

### Safety Impacts

The addition of a protected left-turn signal phase and arrow for the southbound Colchester Avenue approach to the Colchester/Barrett intersection should improve safety at this location. An analysis was conducted based on crash data for the study area for the years 2012 through 2016 and procedures described in the Highway Safety Manual (HSM) published by the American Association of State Highway and Transportation Officials (AASHTO) in Washington, D.C., 2000. The HSM provides formulas to estimate crash rates and average cost per crash for various intersection configurations and traffic volume conditions. It also offers Crash Modification Factors (CMF) to predict changes in crash rates and/or average crash costs associated with specific intersection design and operational changes.

Calculations provided in the Appendix indicate a net present value of $12,761,000 for crashes in the study area projected over the next 20 years assuming no changes in the current intersection geometry and traffic control. The proposed left turn phasing changes are expected to reduce the frequency and severity of crashes at the Colchester/Barrett intersection. Factors provided in the HSM indicated a six percent reduction in crash frequency and 67 percent reduction in crash severity. Making the adjustments indicated by the HSM suggests that the net present value of crashes would be reduced to $7,654,000.

## 6.3 MEDIUM TERM IMPROVEMENTS

Three medium term improvement alternatives were developed and evaluated. As noted above, these improvements include more significant, physical changes to the transportation system than the short-term improvements but should be able to be built in a three to ten-year timeframe. The alternatives were also evaluated with the conversion of the existing bridge from four vehicle lanes to three (two northbound lanes and one southbound lane) with the extra space given to the sidewalk on the western (downstream) side of the bridge. This would have effectively converted the sidewalk to a multi-use path. In light of the findings from the Winooski River Bridge Scoping Study that determined a three-lane bridge would yield unacceptable levels of congestion in the Winooski Circulator, these were abandoned in favor of their four-lane counterparts. The three lane versions can be found in Appendix I for reference. Each of the three four-lane alternatives are discussed below. Larger scale versions of both the Short-Term and Medium-Term alternative plans are also provided in Appendix I.

### 6.3.1 Alternative 1 – 4-Way Intersection

Alternative 1 reconfigures the existing three intersections into two intersections as shown in Figure 34. This was a concept developed during the 2011 Colchester Avenue corridor study. It provides a 4-way, signalized Colchester/Barrett intersection by directing all Riverside Avenue traffic through the intersection. It also converts the Colchester/Riverside/Mill intersection into a 3-way intersection that is unsignalized. The low traffic volumes associated with Mill Street do not warrant a traffic signal. Eliminating a signal within 150 feet of another signal reduces the intersection complexity allowing for better management of queues between the intersections. Converting egress from Mill Street to right turns only is called for due to the difficulty and safety concern there will be in making a left turn without a signal. Vehicles exiting Mill Street and desiring to go southbound would first proceed northbound and use the Winooski Circulator to reverse direction. While this may appear to be an inconvenience, the delay associated with attempting to turn left during peak hours is estimated to be more than two minutes (see Table 10) which is comparable to the time it would take to go around the Winooski Circulator. This condition may be able to be limited to the peak hours only and will require further analysis or monitoring once implemented.

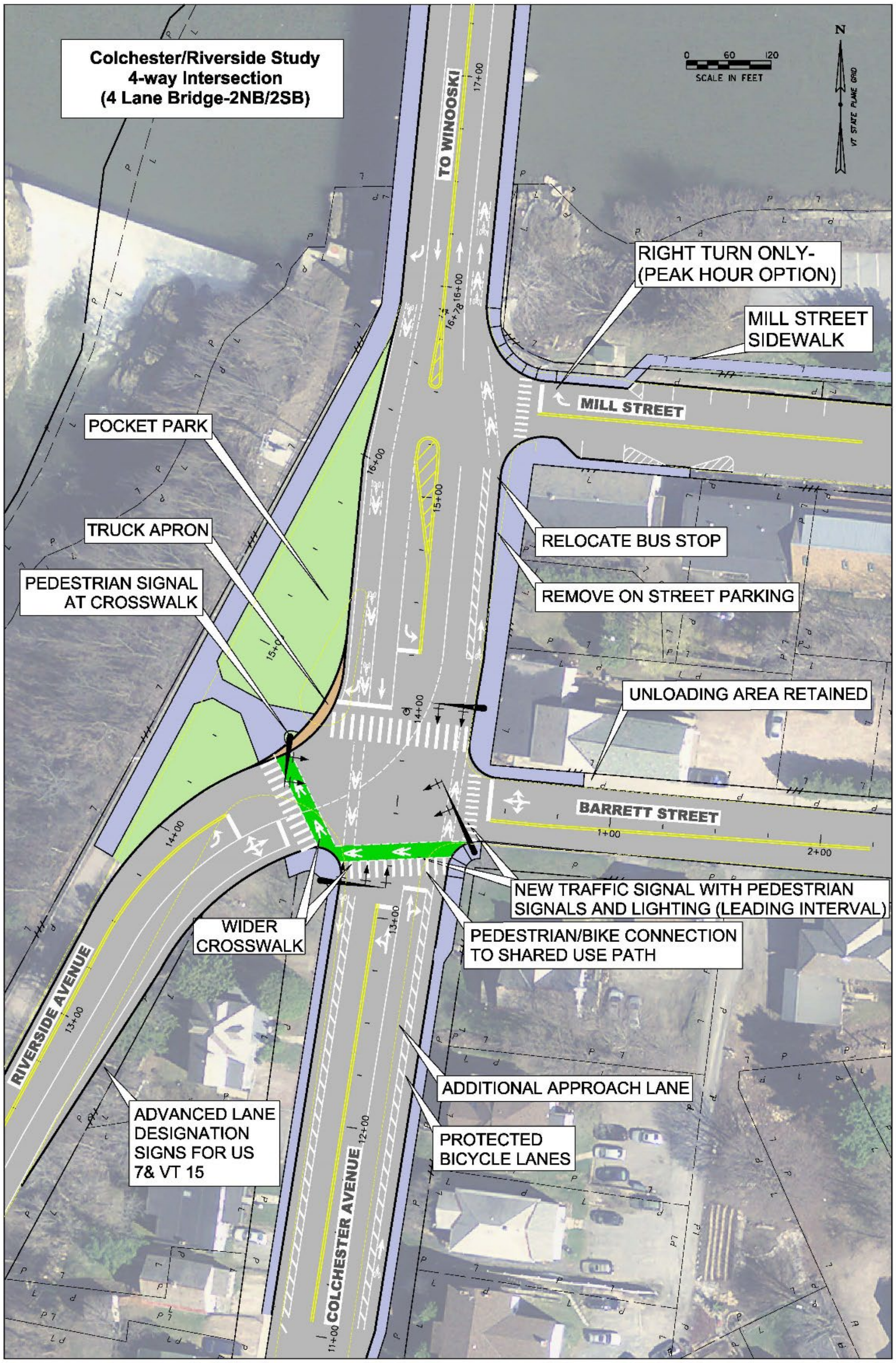
The new 4-way intersection alternative has many of the same pedestrian and bicycle safety features as described in the Short-term improvements. In addition, vehicle capacity is added by providing a second lane on the northbound Colchester Avenue approach. This alternative includes less pavement than the existing configuration. The added green space overlooks the Winooski River and creates an opportunity for a pocket park.

Proposed elements of the plan that address the project's needs are listed below. Proposed actions that are also part of the short-term plan are listed in italics.

**Pedestrian safety:**

1. *Include crosswalks on all four intersection approaches. Install pedestrian signals at the crosswalks at Colchester, Riverside and Barrett.* Remove the crosswalk and pedestrian signal heads proposed under the Short-Term alternative north of Mill Street.
2. *Provide a leading pedestrian signal interval* but allow for a fully protected pedestrian phase. Due to the high volume of southbound Colchester Avenue right turns onto Riverside Avenue, it is proposed these rights turns be prohibited during the conflicting pedestrian crossing ("walk") phase.
3. *Include a protected left turn phase and signal arrow for southbound Colchester Avenue turns into Barrett Street. Signal pedestrians not to cross Barrett Street during this phase.*
4. *Add a five-foot wide sidewalk along Mill Street to the Chase Mill.*
5. *Reconstruct the sidewalk along Colchester Avenue from Barrett Street to Mill Street to support a relocated bus stop.* Remove exiting on-street parking in this area.
6. Add street lights to meet current Burlington Electric Department (BED) lighting requirements.

*Figure 34: Alternative 1 -- 4-Way Intersection*



**Bicycle safety:**

1. Add buffered or protected bike lanes along Colchester Avenue to coincide with planBTV Walk Bike.
2. *Create a bicycle connection from the Riverside Avenue shared use path to the Colchester Avenue protected bicycle lanes with bicycle ramps, ten-foot wide sidewalks and bike crosswalk markings.*
3. Along Colchester Avenue from Barrett Street to Mill Street to provide a buffered or protected bike lane.

**Vehicle Crashes:**

1. Upgrade the existing spanwire supported signals with mast arms and include backplates on signal heads to improve visibility and reduce sunlight impairment.
2. *Add advanced lane designation signs on Riverside Avenue indicating "US 7/I 89 North left lane" and "VT 15/I 89 South right lane".*
3. Provide adequate lane widths on the Riverside Avenue approaches to accommodate left turning trucks.

**Intersection Complexity:**

1. Create a conventional 4-way intersection at the Colchester/Riverside/Barrett intersection and a 3-way intersection at the Colchester/Mill intersection.
2. *Add durable pavement markings to improve visibility.*

**Peak Hour Traffic Congestion:**

1. Provide an additional lane on the northbound Colchester Avenue approach.
2. Permit southbound left turns into Mill Street recognizing that the southbound lane widens to two lanes at this location allowing vehicles to pass when one vehicle is stopped to turn left.
3. Provide for right turns only from Mill Street. This can be adjusted to peak hours only permitting left turns at other hours of the day.
4. *Relocate the bus stop to the Colchester/Mill intersection to eliminate traffic interruptions currently imposed by buses at the Colchester/Barret intersection.*

## Operational Impacts

The capacity analysis results for the Colchester/Riverside/Barrett intersection assuming implementation of Alternative 1 indicates that the proposed four-way intersection will operate at LOS C during the AM peak hour and LOS E during the PM peak hour under projected 2035 traffic conditions. As shown in Table 9 the projected operating conditions with the improvements are slightly better than calculated future operations without any improvements for both peak hours. The capacity increases associated with the proposed geometric improvements are offset in part by the introduction of a protected left turn signal phase for Colchester Avenue southbound into Barrett Street. Again, this action is proposed as a safety improvement. Operations at this location will be impacted by the short southbound left turn lane proposed on Colchester Avenue. At times, vehicle queues forming in the southbound through lane may block entry to the southbound left turn lane.

*Table 9: Colchester/Barrett Intersection Performance with Alternative 1 Improvements*

| | Existing (2015) No Build | | | Future (2035) No Build | | | Future with Alternative 1 Improvements | | |
|---|---|---|---|---|---|---|---|---|---|
| Peak Hour | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C | Delay | LOS |
| AM | 0.69 | 21.9 | C | 0.74 | 24.4 | C | 0.69 | 21.7 | C |
| PM | 0.98 | 50.8 | D | 1.05 | 64.2 | E | 0.98 | 62.1 | E |

[1] V/C = Volume-to-capacity ratio for critical movements
[2] Delay = Average delay expressed in seconds per vehicle
[3] LOS= Level of Service

The proposed Alternative 1 improvements remove the existing signal at the Mill Street and Colchester Avenue intersection and prohibit left turns from Mill Street. Mill Street would be under STOP sign control with this alternative as well as under Alternatives 2 and 3 (described below). Operations at the Colchester/Mill intersection under Alternative 1 conditions are summarized in Table 10. Calculated delays for right turns from Mill Street will be in the LOS B range. Delays for left-turns into Mill Street are expected to be in the LOS A range. If left turns were permitted from Mill Street they would experience long delays in the LOS F range. Since Mill Street operates with a single-lane approach, right turning vehicles caught behind a left turning vehicle would also experience very long delays. The findings presented here for Alternative 1 will be similar for Alternatives 2 and 3.

*Table 10: Colchester/Mill Intersection Performance with Alternative 1 Improvements*

| Peak Hour | Movement | V/C[1] | Delay[2] | LOS[3] |
|---|---|---|---|---|
| AM | Westbound Left[4] | 0.19 | 120+ | F |
| | Westbound Right | 0.00 | 11.6 | B |
| | Southbound Left | 0.03 | 1.2 | A |
| | | | | |
| PM | Westbound Left[4] | 6.53 | 120+ | F |
| | Westbound Right | 0.15 | 13.9 | B |
| | Southbound Left | 0.01 | 0.7 | A |

[1] V/C = Volume-to-capacity ratio for movements
[2] Delay = Average delay expressed in seconds per vehicle
[3] LOS= Level of Service
[4] If permitted. Proposed plan prohibits left turns during peak hours.
120+ =Calculated delay is greater than 120 seconds.

### 6.3.2 Alternative 2 – 4-Way Intersection with Separate Right Turn Lane

Alternative 2, shown in Figure 35, is much like Alternative 1 with one key difference. Unlike Alternative 1, it provides a separated right turn lane for Colchester Avenue southbound traffic turning right onto Riverside Avenue. Separating the right-turn volume from the signalized Barrett Street/Colchester Avenue/Riverside intersection would improve operations but remove the opportunity for a pocket park at the intersection. The separated right turn lane's curving geometry and its direct angle approach to Riverside Avenue encourages slow speeds. A proposed 12-foot wide yield controlled crosswalk and bike crosswalk markings would allow pedestrians and bicyclists to safely cross the right turn lane.

As with Alternative 1, vehicle capacity is added by providing a second lane on the northbound Colchester Avenue approach.

Proposed elements of the plan that address the project's needs are listed below. Proposed actions that are also part of the short-term plan are listed in italics.

**Pedestrian safety:**

1. *Include crosswalks on all four intersection approaches. Install pedestrian signals at the crosswalks at Colchester, Riverside and Barrett.* Remove the crosswalk and pedestrian signal heads proposed under the Short-Term alternative north of Mill Street.
2. *Provide a leading pedestrian interval* but allow for a fully protected pedestrian phase. The separated right turn lane crosswalk proposed would be signed and marked as a yield controlled. If needed in the future a raised crosswalk or rapid flashing beacon could be added in accordance with applicable state standards.
3. *Include protected left turn phase and signal arrow for the southbound Colchester Avenue approach to the Colchester/Riverside/Barrett intersection to provide a gap for left turning vehicles. Signal pedestrians not to cross Barrett Street during this phase.*
4. *Add a five-foot wide sidewalk along Mill Street to the Chase Mill.*
5. *Reconstruct the sidewalk along Colchester Avenue from Barrett Street to Mill Street to support a relocated bus stop.*
6. Add street lights to meet current BED lighting requirements.

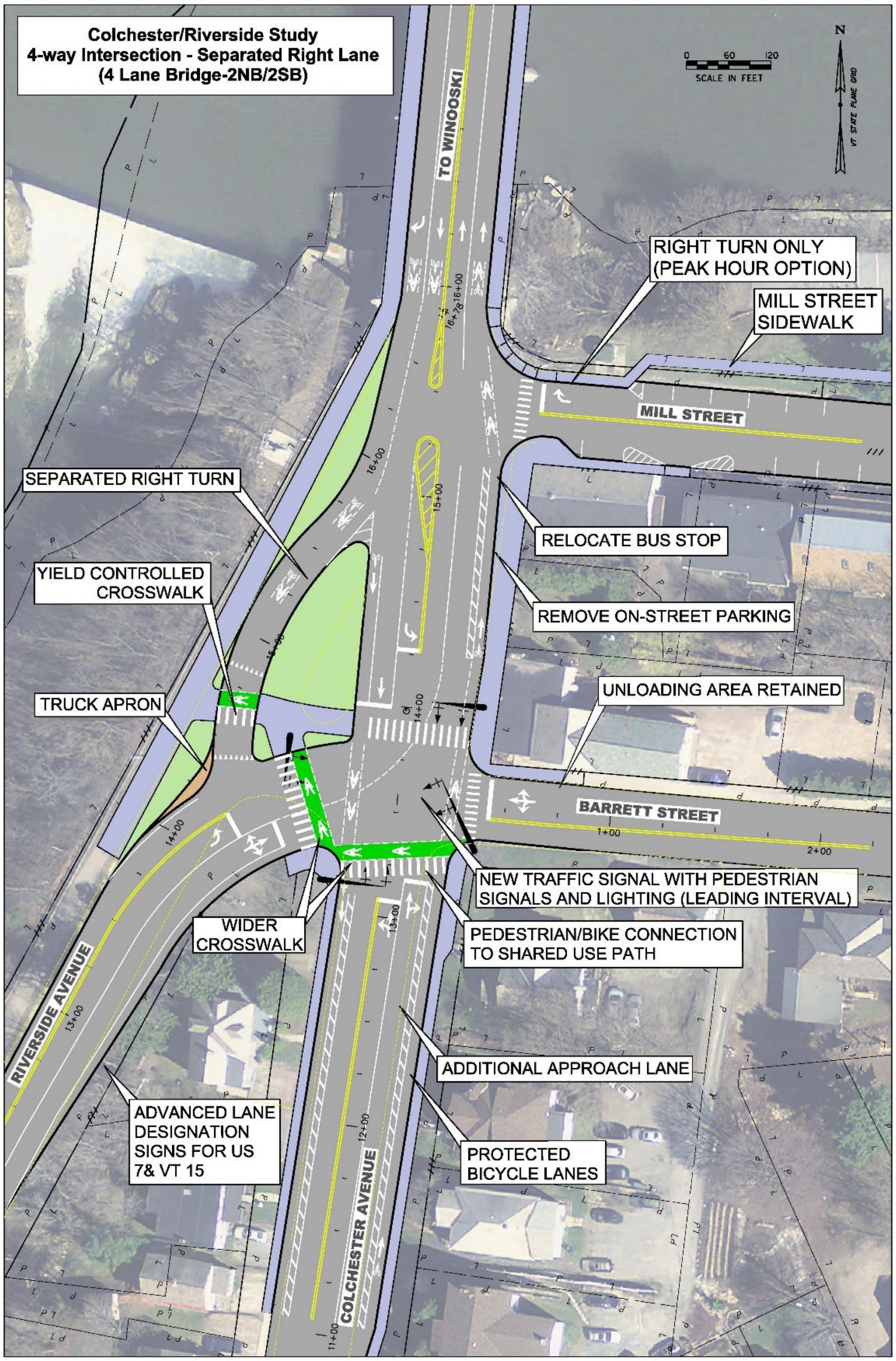
**Bicycle safety:**

1. Add buffered or protected bike lanes along Colchester Avenue to coincide with planBTV Walk Bike.
2. *Create a bicycle connection from the Riverside Avenue shared use path to the Colchester Avenue protected bicycle lanes with bicycle ramps, ten-foot wide sidewalks and bike crosswalk markings.*
3. Eliminate parking along long Colchester Avenue from Barrett Street to Mill Street to provide a buffered bike lane.

**Vehicle Crashes:**

1. Upgrade the existing spanwire supported signals with mast arms and include backplates on signal heads to improve visibility and reduce sunlight impairment.
2. *Add advanced lane designation signs on Riverside Avenue indicating "US 7/I 89 North left lane" and "VT 15 East/I 89 South right lane".*
3. Provide wider lane widths on the Riverside Avenue approach to accommodate left turning trucks.

*Figure 35: Alternative 2 – 4-way Intersection with Separate Right Turn Lane*



**Intersection Complexity:**

1. Create a conventional 4-way intersection at Colchester/Riverside/Barrett intersection and a 3-way intersection at Colchester/Mill intersection.
2. *Add durable pavement markings to improve visibility.*

**Peak Hour Traffic Congestion:**

1. Provide an additional lane on the northbound Colchester Avenue approach.
2. Permit southbound left turns into Mill Street recognizing that the southbound lane widens to two lanes at this location allowing vehicles to pass when one vehicle is stopped to turn left.
3. Provide for right turns only from Mill Street. This can be adjusted to peak hours only permitting left turns at other hours of the day.
4. *Relocate the bus stop to the Colchester/Mill intersection to eliminate traffic interruptions currently caused by buses at the Colchester/Barrett intersection.*

## Operational Impacts

The capacity analysis results for the Colchester/Riverside/Barrett intersection assuming implementation of Alternative 2 indicates that the proposed four-way intersection with a separated southbound right-turn lane will operate at LOS C during the AM peak hour and LOS E during the PM peak hour under projected 2035 traffic conditions. As shown in Table 11, the projected operating conditions with the improvements are comparable to calculated future operations without any improvements for the AM peak hour. During the PM peak hour intersection capacity is increased as reflected in the drop in the intersection volume-to-capacity from 105 percent to 99 percent. The calculated PM peak hour delay increases slightly relative to the unimproved condition only because the southbound right-turn movement is eliminated from the calculation for Alternative 2 conditions. Since the southbound right-turn movement is in a separate lane and is not controlled by the signal, delays associated with the right-turn are not included in the calculation. Delays for this movement are lower than those for other movements. Consequently, removing this movement from the calculation increases the average delay for all movements.

*Table 11: Colchester/Riverside/Barrett Intersection Performance with Alternative 2 Improvements*

| | Existing (2015) | | | Future (2035) No Build | | | Future with Alternative 2 Improvements | | |
|---|---|---|---|---|---|---|---|---|---|
| Peak Hour | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C | Delay | LOS |
| AM | 0.69 | 21.9 | C | 0.74 | 24.4 | C | 0.75 | 24.0 | C |
| PM | 0.98 | 50.8 | D | 1.05 | 64.2 | E | 0.99 | 70.9 | E |

[1] V/C = Volume-to-capacity ratio for critical movements
[2] Delay = Average delay expressed in seconds per vehicle
[3] LOS= Level of Service

As noted above in Section 3.6.1, removal of the existing signal at the Mill Street/Colchester Avenue intersection will change operations at this location. Calculated peak hour delays for right turns from Mill Street will be in the LOS B range. Delays for left-turns into Mill Street are expected to be in the LOS A range. Left turns from Mill Street will experience long delays in the LOS F range.

### 6.3.3 Alternative 3 - Roundabout

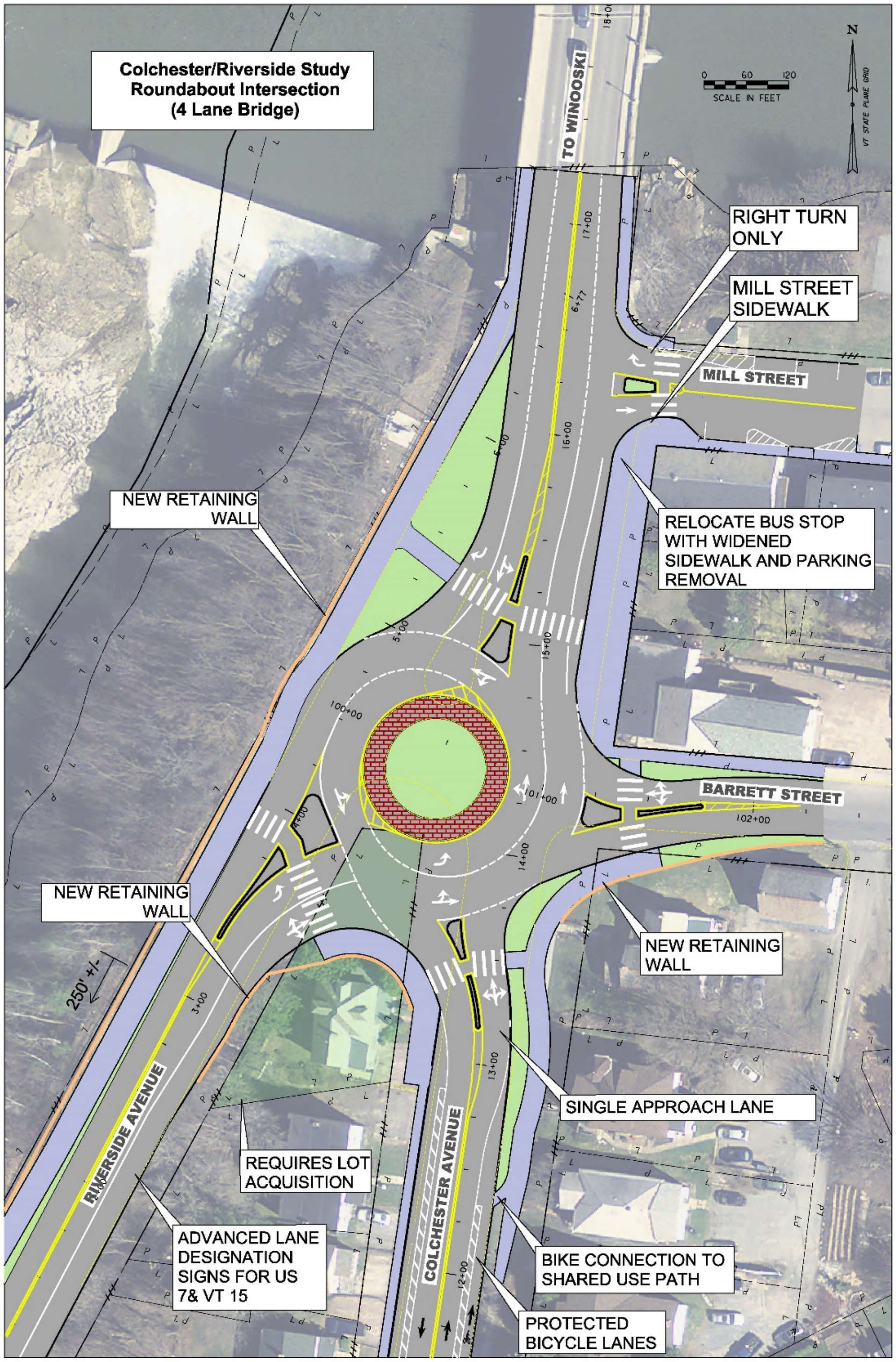
The third alternative intersection improvement considered is a modern roundabout. Roundabouts can provide lasting benefits and value in many ways. They are often safer, more efficient, less costly to maintain and more aesthetically appealing than conventional intersection designs. Furthermore, roundabouts are an excellent choice to complement other transportation objectives – including Complete Streets, multimodal networks, and corridor access management – without compromising the ability to keep people and freight moving. The FHWA Office of Safety identified roundabouts as a Proven Safety Countermeasure because of their ability to substantially reduce the types of crashes that result in injury or loss of life.

In the 2001-2002 Vermont legislative session, Act 141, Section 37 was passed. This provided support for roundabouts by indicating the following, "The general assembly finds that the installation of roundabouts at dangerous intersections in the state has been cost-efficient and has enhanced the safe operation of vehicles at these locations. The Agency of Transportation is directed to carefully examine and pursue the opportunities for construction of roundabouts at intersections determined to pose safety hazards for motorists."

Alternative 3 reconfigures the existing three intersections into two intersections as shown in Figure 36. It provides a hybrid modern roundabout at the Colchester/Barrett intersection and directs all Riverside Avenue traffic through the intersection. It also converts the Colchester/Riverside/Mill intersection into a 3-way intersection that is unsignalized. It is proposed that southbound left turns into Mill Street be prohibited with signs and a channelization island on Mill Street. Southbound access to Mill Street is achieved by circulating the roundabout. Similarly, left turns from Mill Street would be prohibited. Vehicles exiting Mill Street and desiring to go southbound would first proceed northbound and use the Winooski Circulator to reverse direction. Again, while this may appear to be an inconvenience, the delay associated with attempting to turn left out of Mill Street during peak hours is estimated to be more than two minutes (see Table 10) which is comparable to the time it would take to go around the Winooski Circulator.

The proposed roundabout maintains the existing number of approach lanes on each existing intersection approach. There is one approach lane on the Colchester Avenue northbound and Barrett Street westbound approaches while the Colchester Avenue southbound and Riverside Avenue northbound approaches have two lanes. This alternative has limited green space but still provides the opportunity to create a pocket park or gateway treatment overlooking the Winooski River. The roundabout features crosswalks on all four approaches and provides alternative routes for bicycles. Bicyclists can assume a lane through the roundabout or use provided ramps to go onto the widened sidewalk to use crosswalks. The combination of single lane and double lane approaches dictates that adequate signage be provided to direct motorists to the proper lanes when entering the roundabout.

*Figure 36: Alternative 3 – Roundabout*



Implementation of this alternative will require land takings and retaining wall construction. These are required to address the following design challenges: a steep embankment to the west dropping off to the Winooski River; the 11 percent downgrade of Colchester Avenue northbound; the seven percent downgrade though the intersection; the skewed approach of Riverside Avenue; a national registered historic district along Colchester Avenue between Barrett and Mill Streets; and, surrounding structures eligible for the historic register are considered Section 4(f) resources. The proposed roundabout layout and size is optimized to avoid the historic district impacts and minimize encroachment towards the steep embankment. However, the proposed plan still results in a roundabout constructed on a five to seven percent grade with retaining walls on three sides and the taking of the property and dwelling at the southwest corner of the intersection. Wall heights will vary but would be as high as eight feet on the south side of the intersection and up to six feet on the west side.

Proposed elements of the plan that address the project's needs are listed below. Proposed actions that are also part of the short-term plan are listed in italics.

**Pedestrian safety:**

1. Include crosswalks on all four roundabout approaches. Allow for future installation of Rectangular Rapid Flashing Beacons or other controls on the two-lane crossings. Remove the crosswalk and pedestrian signal heads proposed under the Short-Term alternative north of Mill Street.
2. *Add a five-foot wide sidewalk along Mill Street to the Chase Mill.*
3. *Reconstruct the sidewalk along Colchester Avenue from Barrett Street to Mill Street to support a relocated bus stop.*
4. Add street lights to meet current BED lighting requirements.

**Bicycle safety:**

1. Add buffered or protected bike lane markings and signs along Colchester Avenue approach to coincide with planBTV Walk Bike.
2. *Create a bicycle connection from the Riverside Avenue shared use path to the Colchester Avenue protected bicycle lanes with bicycle ramps, ten-foot wide sidewalks and 12-foot wide crosswalk markings.*
3. Provide northbound bicyclists an alternative to riding in the roundabout via a bicycle ramp and shared-use path along Colchester Avenue to the bridge.

**Vehicle Crashes:**

1. Construct a roundabout as a traffic calming measure that will reduce the severity of crashes and reduce the incidence of rear end collisions.
2. *Add advanced lane designation signs on Riverside Avenue indicating "US 7/I 89 North left lane" and "VT 15 East/I 89 South right lane".* Provide appropriate signs and markings for the two-lane roundabout operation.
3. Eliminate parking along long Colchester Avenue from Barrett Street to Mill Street. (Existing parking in this location would be in conflict with the proposed crosswalk on the north leg

of the roundabout. Eliminating parking in this area will also avoid conflicts on the "free flow" departure from the roundabout with vehicles entering or exiting parking stalls.)

**Intersection Complexity:**

1. Create a modern roundabout at the Colchester/Riverside/Barrett intersection and a three-way intersection at the Colchester/Mill intersection with Stop control on the Mill Street approach and right-turns only allowed from Mill Street.
2. Provide appropriate signs and durable markings for the two-lane roundabout operation.

**Peak Hour Traffic Congestion:**

1. Provide two lane approaches to the roundabout on the Colchester Avenue southbound and Riverside Avenue northbound approaches.
2. Southbound left turns into Mill Street are eliminated and southbound vehicles access Mill Street by circulating the roundabout.
3. Provide for right turns only from Mill Street.
4. *Relocate bus stop to the Colchester/Mill intersection to separate the bus stop from the roundabout.*

## Operational Impacts

Performance results for Alternative 3 are provided in Table 12. As shown, the intersection will operate during peak hours at the same levels of service as reported for future conditions without improvements. With the improvements in place however, the expected traffic delays will be notably lower than those reported for the unimproved conditions. The results shown in the table are for the worst performing approach to the roundabout. Operations will be better on the other three approaches to the roundabout. The next section of this report compares the performance of each alternative by intersection approach.

*Table 12: Colchester/Riverside/Barrett Intersection Performance with Alternative 3 Improvements*

| | Existing (2015) No Build | | | Future (2035) No Build | | | Future with Alternative 3 Improvements | | |
|---|---|---|---|---|---|---|---|---|---|
| Peak Hour | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C | Delay | LOS |
| AM | 0.69 | 21.9 | C | 0.74 | 24.4 | C | 0.88 | 20.1 | C |
| PM | 0.98 | 50.8 | D | 1.05 | 64.2 | E | 1.09 | 47.0 | E |

[1] V/C = Volume-to-capacity ratio for critical movements
[2] Delay = Average delay expressed in seconds per vehicle
[3] LOS= Level of Service
Note: For Alternative 3, the results apply to the worst performing intersection approach (Southbound during the AM peak hour and Northbound during the PM peak hour). Performance results are not directly comparable to results shown in Tables 9 and 11.

## 6.4 COMPARISON OF ALTERNATIVES

### 6.4.1 Operational Impacts

The peak hour performance of the three medium term alternatives is illustrated by intersection approach in Table 13 for the Colchester Avenue/Barrett Street intersection. (Results for the short-term improvements were reported above in Section 6.2 indicating Level of Service E operations during the PM peak hour for the combined intersection with a volume-to-capacity ratio of 1.10.) This table also provides information regarding expected vehicle queuing on each approach. This side-by-side comparison helps highlight some of the operational differences between the alternatives that may not be so apparent when only looking at the overall intersection operations results. These differences are most notable for the PM peak hour as projected AM peak hour operations are consistently better than projected PM peak hour operations.

The new information presented in this table includes estimated 95th percentile vehicle queue lengths on the intersection approaches. Vehicle queue lengths are sensitive to traffic signal timings and the signal timings assumed in the analysis are preliminary at best. Consequently, the calculated queue lengths shown are not final estimates but do help to identify issues that may be considered in selecting a preferred alternative.

*Table 13: Colchester/Barrett Intersection Performance by Approach for Each Alternative*

| | | Alternative 1 | | | | Alternative 2 | | | | Alternative 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Peak Hour | Approach and Movement | LOS[1] | Delay[2] | V/C[3] | Queue[4] | LOS[1] | Delay[2] | V/C[3] | Queue[4] | LOS[1] | Delay[2] | V/C[3] | Queue[4] |
| AM | **Northbound-Colchester Avenue** | | | | | | | | | | | | |
| | All | C | 26.8 | 0.56 | 114 | B | 18.7 | 0.39 | 93 | A | 5.5 | 0.36 | 32 |
| | **Southbound-Colchester Avenue** | | | | | | | | | | | | |
| | All | B | 13.0 | - | - | B | 15.8 | - | - | C | 20.1 | 0.88 | 422 |
| | Left | C | 30.6 | 0.49 | **107** | B | 12.1 | 0.30 | **63** | | | | |
| | Through | B | 18.9 | 0.90 | 288 | B | 16.7 | 0.65 | 275 | | | | |
| | Right | A | 3.8 | 0.69 | 119 | - | - | - | - | | | | |
| | **Eastbound-Riverside Avenue** | | | | | | | | | | | | |
| | All | C | 32.6 | - | - | C | 32.0 | - | - | A | 7.9 | 0.61 | 95 |
| | Left | C | 32.5 | 0.76 | 296 | C | 32.0 | 0.78 | 275 | | | | |
| | Through/Right | D | 32.8 | 0.76 | 304 | C | 32.0 | 0.78 | 282 | | | | |
| | **Westbound-Barrett Street** | | | | | | | | | | | | |
| | All | D | 33.6 | 0.54 | 125 | C | 34.7 | 0.58 | 96 | A | 6.6 | 0.42 | 40 |
| | **Overall** | **C** | **21.7** | **0.69** | | **C** | **24.0** | **0.75** | | **NA** | **NA** | **NA** | |
| | | | | | | | | | | | | | |

| | | Alternative 1 | | | | Alternative 2 | | | | Alternative 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Peak Hour** | **Approach and Movement** | **LOS[1]** | **Delay[2]** | **V/C[3]** | **Queue[4]** | **LOS[1]** | **Delay[2]** | **V/C[3]** | **Queue[4]** | **LOS[1]** | **Delay[2]** | **V/C[3]** | **Queue[4]** |
| PM | **Northbound-Colchester Avenue** | | | | | | | | | | | | |
| | All | E | 75.8 | 1.00 | 448 | E | 62.6 | 0.96 | 429 | E | 47.0 | 1.09 | 610 |
| | **Southbound-Colchester Avenue** | | | | | | | | | | | | |
| | All | C | 22.8 | - | - | C | 29.6 | - | - | C | 24.3 | 0.94 | 460 |
| | Left | F | 130.4 | 0.93 | **165** | C | 31.2 | 0.54 | **75** | | | | |
| | Through | C | 29.4 | 0.50 | 294 | C | 29.3 | 0.50 | 290 | | | | |
| | Right | A | 9.1 | 0.67 | 396 | - | - | - | - | | | | |
| | **Eastbound-Riverside Avenue** | | | | | | | | | | | | |
| | All | E | 77.8 | - | - | E | 79.4 | - | - | C | 16.0 | 0.86 | 291 |
| | Left | E | 79.4 | 1.01 | 710 | F | 80.8 | 1.01 | 722 | | | | |
| | Through/Right | E | 76.1 | 0.99 | 705 | E | 77.9 | 1.00 | 717 | | | | |
| | **Westbound-Barrett Street** | | | | | | | | | | | | |
| | All | F | 122.5 | 1.07 | 456 | F | 114.6 | 1.05 | 456 | C | 16.6 | 0.67 | 96 |
| | **Overall** | **E** | **62.1** | **0.98** | | **E** | **70.9** | **0.99** | | **NA** | **NA** | **NA** | |

1 LOS= Level of Service
2 Delay = Average delay expressed in seconds per vehicle
3 V/C = Volume-to-capacity ratio for critical movements
4 95th Percentile Queue in feet. Bold text indicates that the queue exceeds the available storage of: 40 feet in the southbound left-turn lane for Alternatives 1 and 2.
NA-Not Applicable. Overall volume to capacity ratios and delay are not calculated for roundabouts.

The queue analysis results show vehicle queues in the Colchester Avenue southbound left turn lane exceeding the lane length during the PM peak hour for Alternative 1. The 95th percentile queue in the southbound left-turn lane is 165 feet compared to only 40 feet of storage in this lane. Alternative 2 presents similar, although less severe, concerns. For Alternative 2 the projected 95th percentile queue condition in the southbound left turn lane on Colchester Avenue is 75 feet compared to a storage length of 40 feet. Queues in this lane may block the adjacent through lane on occasion. These occasions will be more frequent under Alternative 1 for which a 165-foot queue is projected.

The proposed roundabout operation is not constrained by turn lanes with limited storage capacity. It too however, will generate some long queues with a 95th percentile queue of 610 feet expected on the northbound Colchester Avenue approach during the PM peak hour. This is expected to be a "rolling queue" given the continuous flow conditions typically associated with roundabouts.

### 6.4.2 Safety Analysis

An analysis was completed to assess the potential safety impacts of the alternative improvement strategies proposed and to assign a monetary value to any expected benefits. The analysis is based on crash data for the years 2012 through 2016 and procedures described in the Highway Safety Manual (HSM) published by the American Association of State Highway and Transportation

Officials (AASHTO) in Washington, D.C., 2000. The HSM provides formulas to estimate crash rates and average cost per crash for various intersection configurations and traffic volume conditions. It also offers Crash Modification Factors (CMF) to predict changes in crash rates and/or average crash costs associated with specific intersection design and operational changes.

The HSM formulas were applied to consider the proposed intersection reconfigurations under each alternative and relevant CMF's were also applied. The CMF's included relate to protected left turn phasing (Alternatives 1 and 2) and conversion of a signalized intersection to a roundabout (Alternative 3). The results of the analysis are presented in Table 14. As shown, an annual cost of crashes was calculated for each intersection and a net present value was determined for these costs assuming a 20-year forecast period and a three percent discount rate. The net present value of crashes at the three intersections for existing geometric and traffic control conditions is estimated at $12.7 million. Implementation of Alternatives 1 and 2 reduces the estimated value to $7.1 million and $5.1 million, respectively. Constructing a modern roundabout (Alternative 3) leads to the greatest safety benefit with an estimated crash value of only $3.4 million. As reported above, the estimated value of crashes assuming implementation of the short-term improvements is $7.7 million. The safety analysis is documented in Appendix J.

*Table 14: Key Safety Statistics*

| Location/Performance Measure | Baseline (Existing Conditions) | Alternative 1 (4-way, Signalized Intersection) | Alternative 2 (4-way with Right Lane) | Alternative 3 (Modern Roundabout) |
|---|---|---|---|---|
| **Colchester Avenue/Barrett Street** | | | | |
| Crash Rate (Crashes per MEV) | 1.18 | 1.2 | 0.92 | 0. 62 |
| Cost per Crash | $82,000 | $28,000 | $27,000 | $16,000 |
| Annual Cost of Crashes | $493,000 | $360,000 | $209,000 | $107,000 |
| Present Value of Crashes | $7,340,000 | $5,352,000 | $3,116,000 | $1,585,635 |
| **Riverside Avenue/Barrett Street** | | | | |
| Crash Rate (Crashes per MEV) | 0.60 | NA | 0.23 | NA |
| Cost per Crash | $29,000 | NA | $25,000 | NA |
| Annual Cost of Crashes | $117,000 | NA | $39,000 | NA |
| Present Value of Crashes | $1,744,000 | $0 | $576,000 | $0 |
| **Riverside Ave/Colchester Ave/Mill Street** | | | | |
| Crash Rate (Crashes per MEV) | 0.84 | 0.34 | 0.34 | 0.34 |
| Cost per Crash | $29,000 | $35,000 | $35,000 | $35,000 |
| Annual Cost of Crashes | $244,000 | $120,000 | $120,000 | $120,000 |
| Present Value of Crashes | $3,633,000 | $1,787,000 | $1,787,000 | $1,787,000 |

| Location/Performance Measure | Baseline (Existing Conditions) | Alternative 1 (4-way, Signalized Intersection) | Alternative 2 (4-way with Right Lane) | Alternative 3 (Modern Roundabout) |
|---|---|---|---|---|
| **Combined (three locations)** | | | | |
| Present Value of Crashes | $12,717,000 | $7,139,000 | $5,480,000 | $3,373,000 |
| Savings Relative to Existing | - | $5,578,000 | $7,237,000 | $9,344,000 |

MEV-Million Entering Vehicles

NA-Not Applicable. Intersection does not exist for this Alternative.

### 6.4.3 Physical Impacts

**Right-of-Way (ROW) Impacts**

The Short-Term improvements are located within the existing highway ROW and do not require the acquisition of property. Sidewalk construction along Colchester Avenue and Mill Street will require construction easements as the construction is at the assumed limit of the highway ROW.

The 4-way Intersection alternative and 4-way Intersection with a Separated Right Lane alternative have similar ROW impacts. A permanent ROW acquisition is needed, approximately 1600 square feet, to realign the Riverside Avenue northbound intersection approach to meet Colchester Avenue opposite Barrett Street. The taking would occur between Riverside Avenue and Colchester Avenue. Construction easements will be needed in two locations. Widening the Colchester Avenue northbound approach to Barrett Street will require relocation of the eastern sidewalk on this approach by approximately five feet to the east. This relocation would in turn require reconstructing the stairs accessing the four residential properties closest to the intersection. Similarly, proposed new sidewalk construction along Mill Street will require construction easements as the proposed construction is at the assumed limit of the highway ROW.

The Roundabout proposal results in the greatest ROW takings. Approximately 4000 square feet of taking is required for construction in the southwest quadrant of the intersection. The impact of this taking on the existing home on the impacted parcel are such that the entire residential parcel and the home on the parcel would be taken. Other takings would be required in the southeast quadrant of the intersection. Construction easements would be needed for proposed new sidewalk construction along Mill Street.

**Environmental Resource Impacts**

Based on research and a field review there are no wetlands, streams, rare, threatened or endangered (RTE) species, 6(f) public lands, or hazardous waste sites in the project area. Therefore, impact to environmental resources is not a concern with any of the proposed alternatives.

### Cultural Resource Impacts

Based on research and a field review, historic resources include a national registered historic district along Colchester Avenue between Barrett and Mill Streets and surrounding structures eligible for the historic register. These are considered Section 4(f) resources. The Short-Term Improvements, the 4-way Intersection alternative and 4-way Intersection with a Separated Right Lane alternative avoid these resources. The roundabout alternative avoids the national registered historic district but does require the taking of the property and dwelling at the southwest corner of the intersection. This structure is likely to be considered an eligible historic structure and therefore its removal is considered an Adverse Effect on Section 106 and Section 4(f) resources. Historic and Archeologic information is compiled in Appendix M.

### On-Street Parking Impacts

There is on-street parking along the east side of Colchester Avenue between Barrett and Mill Streets. Typically, this area is intended for parallel parking, but diagonal parking occurs there as well. Although currently the spaces are unmarked, there is room for five parallel parking spaces. The Short-Term Improvements include the relocation of the bus stop in this area to the corner of Colchester Avenue and Mill Street and the construction of a sidewalk bulb-out. This bulb-out removes one parking space. The medium-term alternatives remove all five parking spaces in this area.

The on-street loading zone on the north side of Barrett Street in front of Domino's remains for the signalized alternatives. The Roundabout alternative removes the loading zone.

There is existing on-street parking along the west side of the Colchester Avenue south of Barrett Street. It begins at the northernmost driveway prior to the intersection. Improvements proposed as part of the Short Term and all Medium-Term alternatives remove two on-street parking spaces in the area.

The addition of bike lanes for the Short-Term Improvements removes two on-street parking spaces in the area. For the 4-way Intersection alternative and 4-way Intersection with a Separated Right Lane alternative, the addition of a lane on the Colchester Avenue northbound approach and the addition of separated bike lanes, removes two on-street parking spaces in this area. The Roundabout alternative also removes two on-street parking spaces in this area.

### Utility Impacts

Exiting utilities in the project area includes aerial electric distribution and communication lines, underground sewer, water, gas, electric and communications. The Short-Term Improvements should not significantly impact these utilities although investigations should be done during final design to ensure the proposed pedestrian signal pole foundations do not conflict with underground utilities. The 4-way Intersection alternative, 4-way Intersection with a Separated Right Lane alternative and the Roundabout alternative do include the construction of a new stormwater system. This system although typically designed to avoid existing utilities will likely require some relocation of the underground utilities. Depending on the condition and capacity of the underground utilities, the utility owner may desire to replace or upgrade their existing facilities either prior to or during construction.

There are aerial utilities are along the east side of Colchester Avenue. There are two poles between the bridge and Barrett Street. These two poles remain for all alternatives. On the Colchester Avenue northbound approach, three utility poles will need to be relocated with all the alternatives. Any proposed utility work should also consider the plan bridge replacement project and required utility connections to the new bridge.

### 6.4.4 Project Costs

The following, Table 15, is a summary of the project costs for all alternatives. As noted, the Roundabout alternative cost is approximately double the cost of Alternatives 1 and 2. A complete breakdown is included in Appendix K.

*Table 15: Summary of Project Costs*

| Item | Short Term Improvements | Alternative 1 (4-way, Intersection) | Alternative 2 (4-way, Intersection w/Right Lane | Alternative 3 (Modern Roundabout) |
|---|---|---|---|---|
| Construction Costs | $700,000 | $2,600,0000 | $2,700,000 | $4,300,000 |
| Right-of-Way Costs | - | $50,000 | $50,000 | $700,000 |
| Design Engineering | $100,000 | $390,000 | $390,000 | $720,000 |
| Construction Engineering | $70,000 | $260,000 | $260,000 | $480,000 |
| **Total Project Costs** | **$875,000** | **$3,300,000** | **$3,430,000** | **$6,700,000** |

### 6.4.5 Evaluation Matrix

Table 16 provides an evaluation matrix summarizing the above information by the purpose and need statement and resource impacts. As shown, there are trade-offs between project cost and performance. The roundabout alternative is most effective in relieving congestion and improving safety, but it is also the most expensive alternative to build. It requires the most additional right-of-way and poses the greatest risk. Implementation of the roundabout proposal would require the removal of an eligible historic structure. There is no certainty that required federal approvals would be granted for the removal of this structure.

*Table 16: Evaluation Matrix*

| CRITERIA | No Build | Short Term Improvements | Alternative 1<br>4 Way Intersection | Alternative 2<br>4 Way Intersection w/ Separate Right Lane | Alternative 3<br>Roundabout |
|---|---|---|---|---|---|
| Project Costs | $0 | $875,000 | $3,300,000 | $3,430,000 | $6,700,000 |
| **PURPOSE AND NEED** | | | | | |
| Improves Pedestrian Safety | No | Some | Better | Better | Best |
| Provides Safer Bicycle Connectivity Winooski to Burlington | No | Some (allows cyclists safer east/west movements) | Some (protected bike lanes south of Barrett and south of Mill northbound) | Some (protected bike lanes south of Barrett and south of Mill northbound) | Some (protected bike lanes south of Barrett) |
| Reduces Potential for Crashes | No | Some | Better | Better | Best |
| Reduces Intersection Complexity | No | No | Best | Best | Better |
| Manages Peak Hour Congestion | No | Some | Some | Better | Best |
| **IMPACTS** | | | | | |
| ROW Impacts | None | None | Minor (1600 sf) | Minor (1600 sf) | Major (4000 sf/ 1 house) |
| Historic Resources | None | None | None | None | Major (Removes 4(f) resource) |
| Stormwater | No change | No Change | Treatment opportunity | Treatment opportunity | Treatment opportunity |
| Net Change in On-street parking spaces | 0 | Some (-1 – N. of Barrett St. -2 – S. of Barrett St.) | More (-5 – N. of Barrett St. -2 – S. of Barrett St.) | More (-5 – N. of Barrett St. -2 – S. of Barrett St.) | More (-5 – N. of Barrett St. -2 – S. of Barrett St.) |
| Aerial Utilities | 0 | 0 | Some (3 poles relocated along Colchester Ave) | Some (3 poles relocated along Colchester Ave) | Some (3 poles relocated along Colchester Ave) |

# 7.0 PROJECT ADVISORY COMMITTEE INPUT AND RECOMMENDATIONS

A series of meetings were held with the Project Advisory Committee to discuss the proposed alternatives. Minutes from these meetings are in Appendix L. Additional documents made available to the advisory committee are also provided in Appendix L. These include a walk audit for the area prepared by the AARP and written comments on the Short-Term plan provided by Local Motion. The principal findings and recommendations from the committee are listed below.

Short Term Alternative

**Findings:**

- The existing pedestrian and bicyclist safety issues are critical and should be addressed immediately.
- The City of Burlington has programmed funding for safety improvements at this location.
- Installation of a crosswalk and pedestrian signals for a new crossing of Colchester Avenue just north of Mill Street would be challenging and is not included in any of the longer range alternatives. There is very limited space available within the existing, narrow sidewalks to install necessary ramps and signal pole foundations without impeding pedestrian flow.

**Recommendations:**

- Implement the recommended short-term improvements as soon as possible except for the proposed new pedestrian crossing north of Mill Street.
- Further evaluate the proposed new pedestrian crossing north of Mill Street to determine its actual cost and feasibility.

Medium Term Alternatives

**Findings:**

- The roundabout alternative is a risky alternative to pursue. Right-of-Way issues and historic property impacts could derail the project wasting time and resources.
- The anticipated safety benefits of the roundabout alternative may be overstated given its hybrid configuration and grade conditions on Colchester Avenue.
- Alternative 2, the four-way intersection with a separated southbound right-turn lane, operates better than Alternative 1. Alternative 1 would likely result more frequent vehicle queues extending northerly from the four-way intersection onto the bridge.
- The Chace Mill connection to Chase St is not suitable for two-way traffic flow and often closed to all traffic.

**Recommendations:**

- Eliminate the roundabout alternative, Alternative 3, from further consideration.

- Advance a "hybrid" alternative should the significant delays be encountered pursuing Alternative 1 or 2. The hybrid alternative consists of the short-term alternative plus the addition of a second northbound lane on Colchester Avenue.
- Consider incorporating recommendations offered by Local Motion to enhance bike lane markings and tighten curb radii in the final design of the preferred alternative.
- Consider maintaining full access to Colchester Avenue at Mill Street in the final design of the preferred alternative.

Final Project Advisory Committee Recommendations and Concerns

In May of 2018, preliminary findings and recommendations of the Winooski River Bridge Scoping Study were made available to CCRPC staff and Stantec. The bridge study recommends maintaining four travel lanes on the bridge. This report was updated accordingly and shared with the Project Advisory Committee (PAC). A PAC meeting was convened on June 19, 2018. At this meeting Medium Term Alternatives 1 and 2 were compared and the vast majority selected Alternative 1 as the preferred alternative. Notes from this meeting are found in Appendix L.

Additional recommendations or concerns as part of selecting Alternative 1 to be revisited or further addressed as part of the design development are as follows:

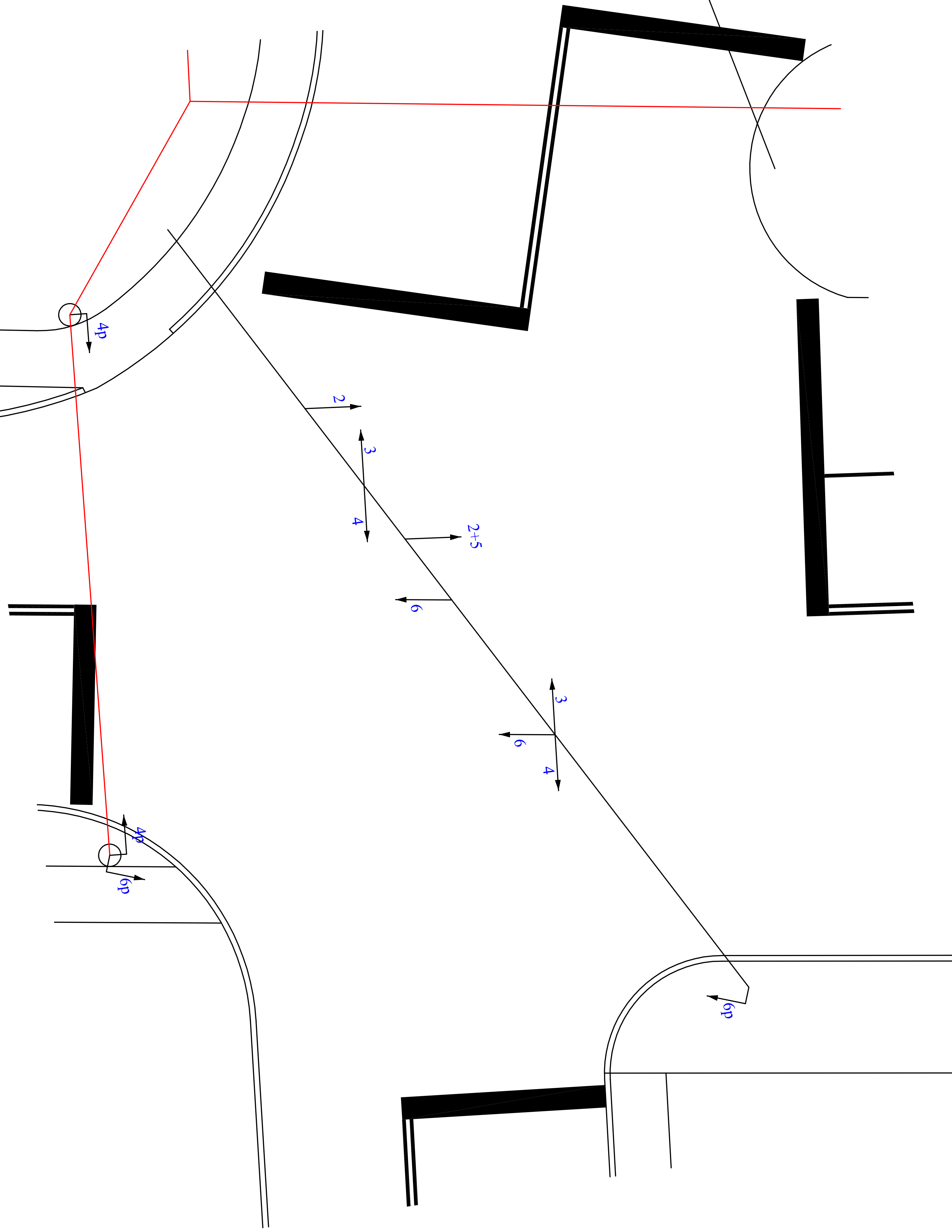
- A few members while in favor of Alternative 1 were dissatisfied with the loss of the traffic signal at Mill Street. It was explained that the intersection would no longer meet signal warrants without Riverside Avenue traffic and that its removal aligns with the project's need for reducing the complexity of the intersection.
- Loss of parking on the east side of Colchester Avenue between Barrett and Mill was brought up as a concern for the nearby businesses. It is noted that this sort of change would need to be approved by the Burlington Public Works Commission.
- There are impacts to the immediate four easterly properties on Colchester Ave just south of Barrett St associated with a widened Colchester Ave. Retaining walls and modifications to their stairways will be required due to the steep slopes.

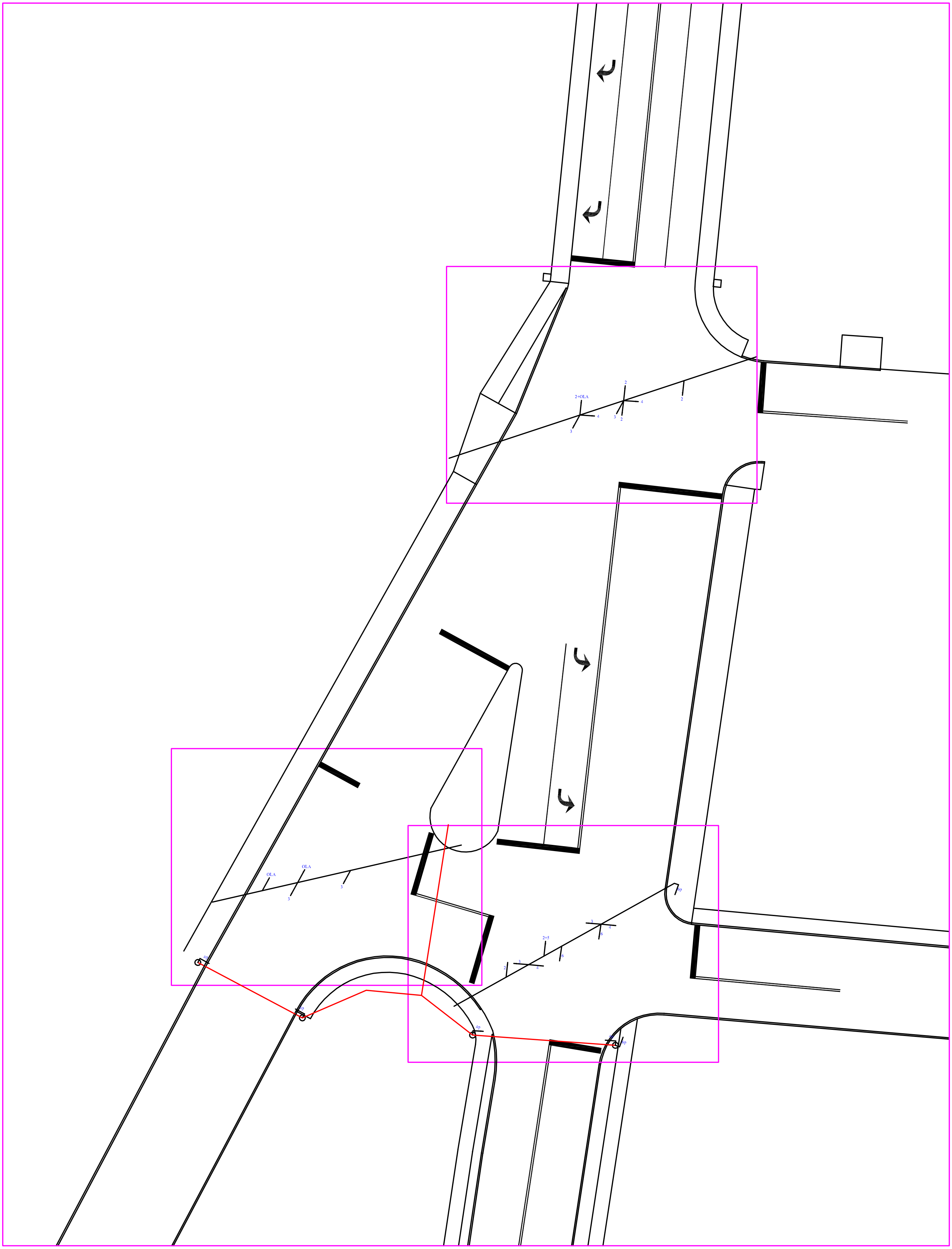
# 8.0 MUNICIPAL PREFERRED ALTERNATIVE

At their meeting on Monday, March 25, 2019 the Burlington City Council was presented with the Project Advisory Committee (PAC) and Transportation Energy and Utilities Commission (TEUC) recommendations for endorsement as the municipally preferred alternative (Short Term Alternative and Medium Term Alternative 1 – 4-way Intersection). At this meeting the City Council unanimously approved the resolution before them which directed the Department of Public Works to pursue the implementation of the Short Term Alternative and Medium Term Alternative 1. A copy of the TEUC memo along with the City Council memo, resolution, and relevant minutes can be found in Appendix L.

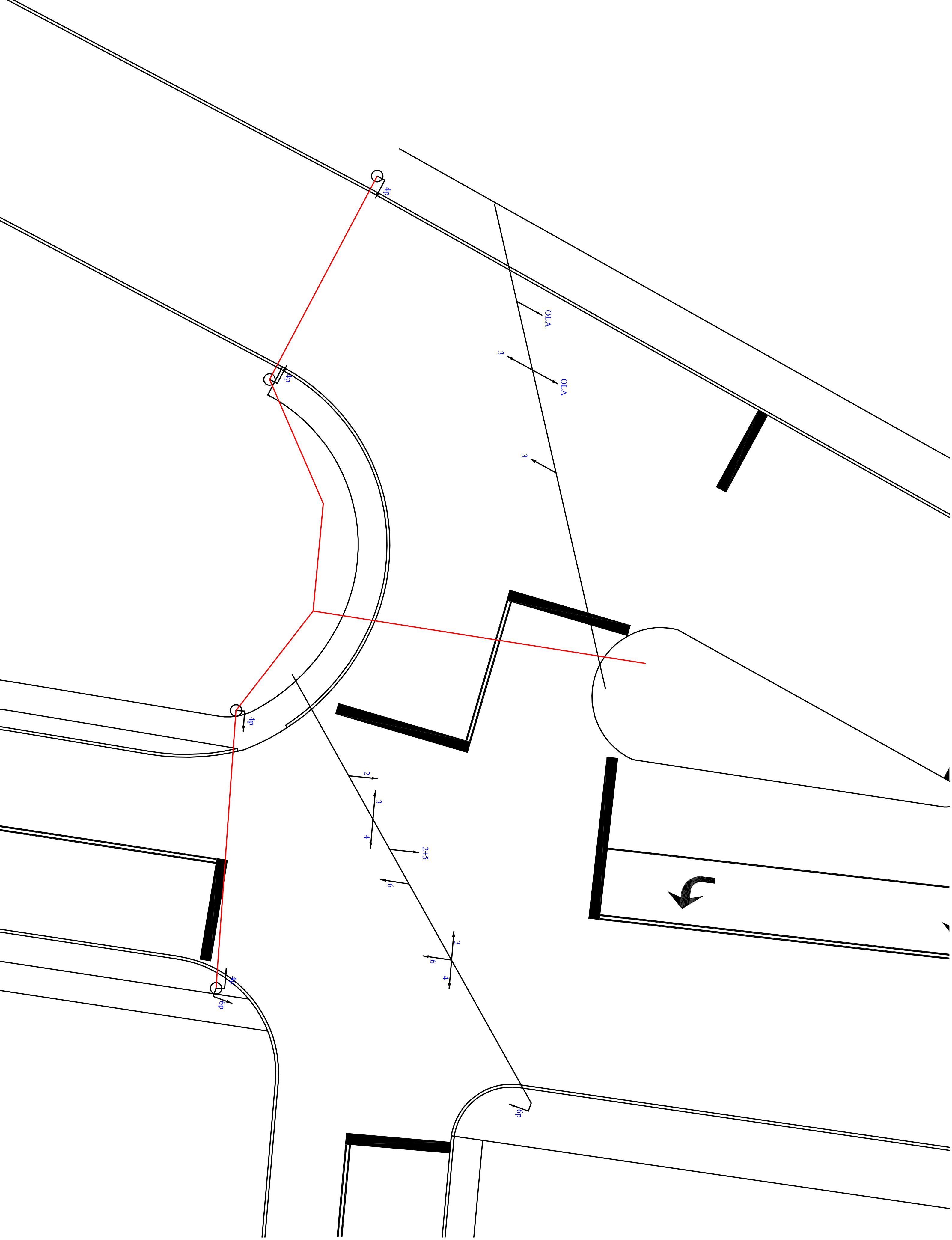
# APPENDIX A

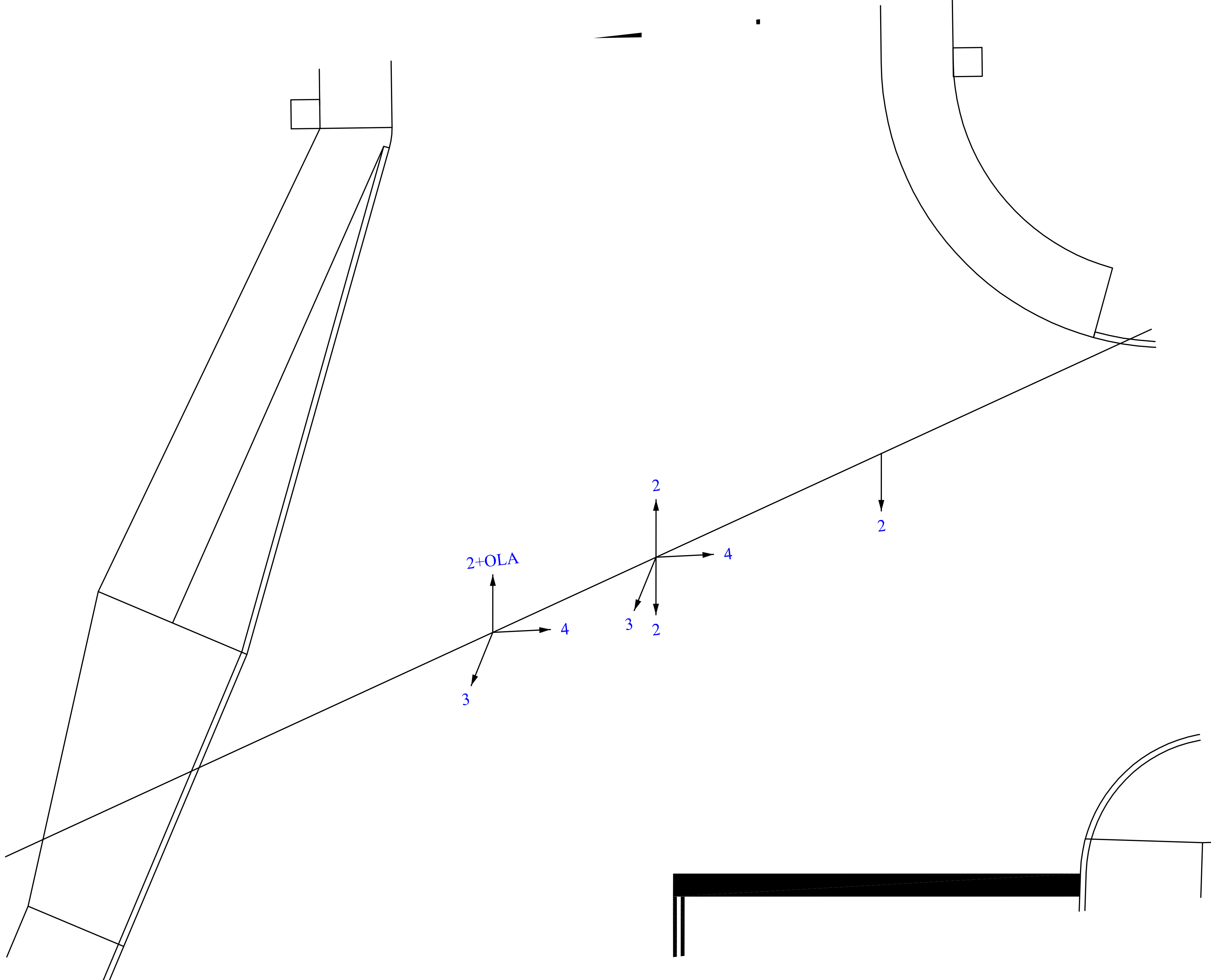
## Signal Phasing Diagrams


4p
2
3
4
2+5
6
3
6
4
4p
6p
6p

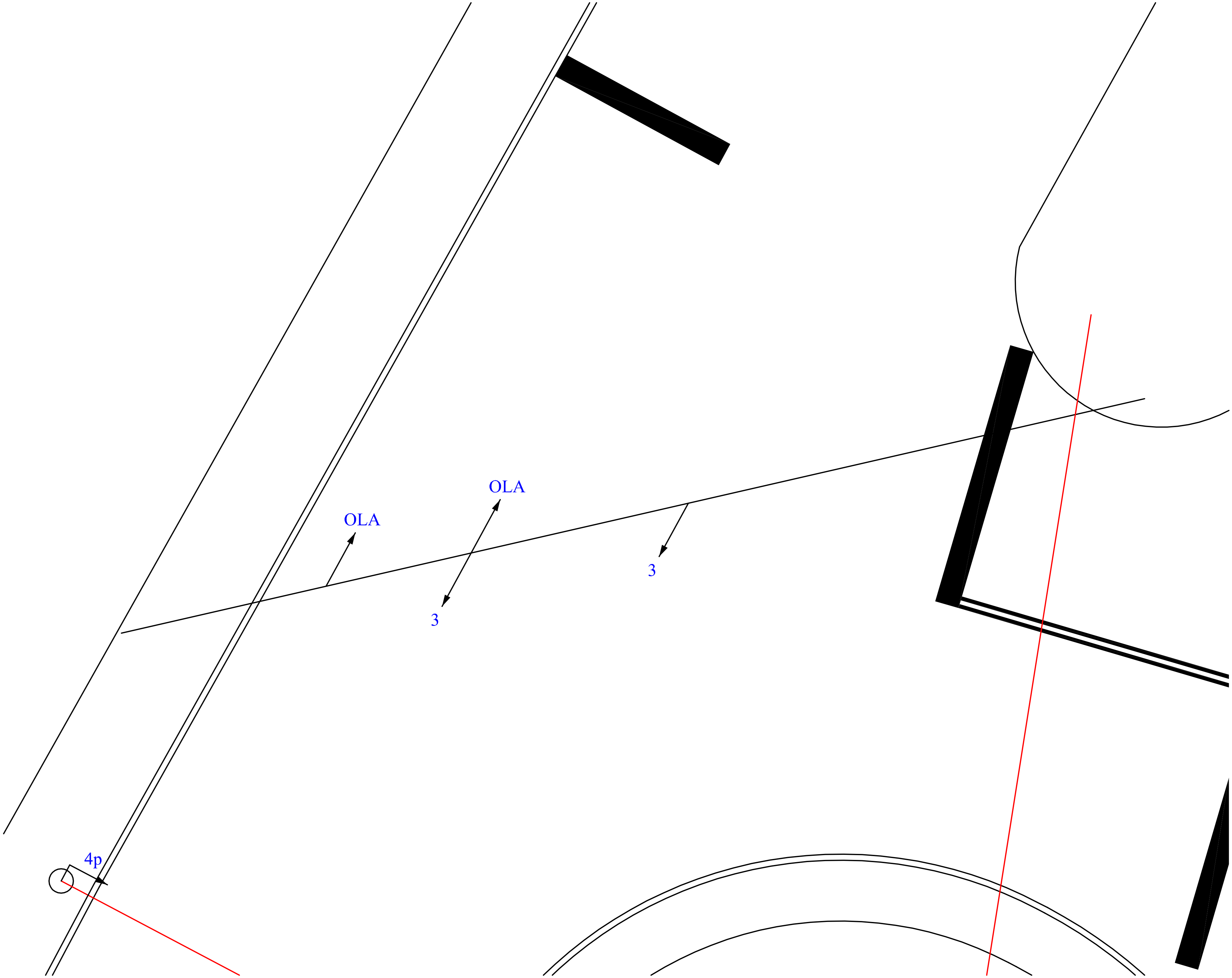


2+OLA
3
4
2
3
2
4
2
OLA
OLA
3
3
2+5
3
4
6
2
3
4
6
6p
4p
4p
6p


4p
4p
OLA
3
OLA
3
4p
2
3
4
2+5
6
3
6
4
4p
6p
6p



2
2
2+OLA
4
4
3
2
3


OLA
OLA
3
3
4p

# APPENDIX B

## Turning Movement Counts

## Riverside Ave and Colchester Ave Hourly Volumes ( 7/23/2014)

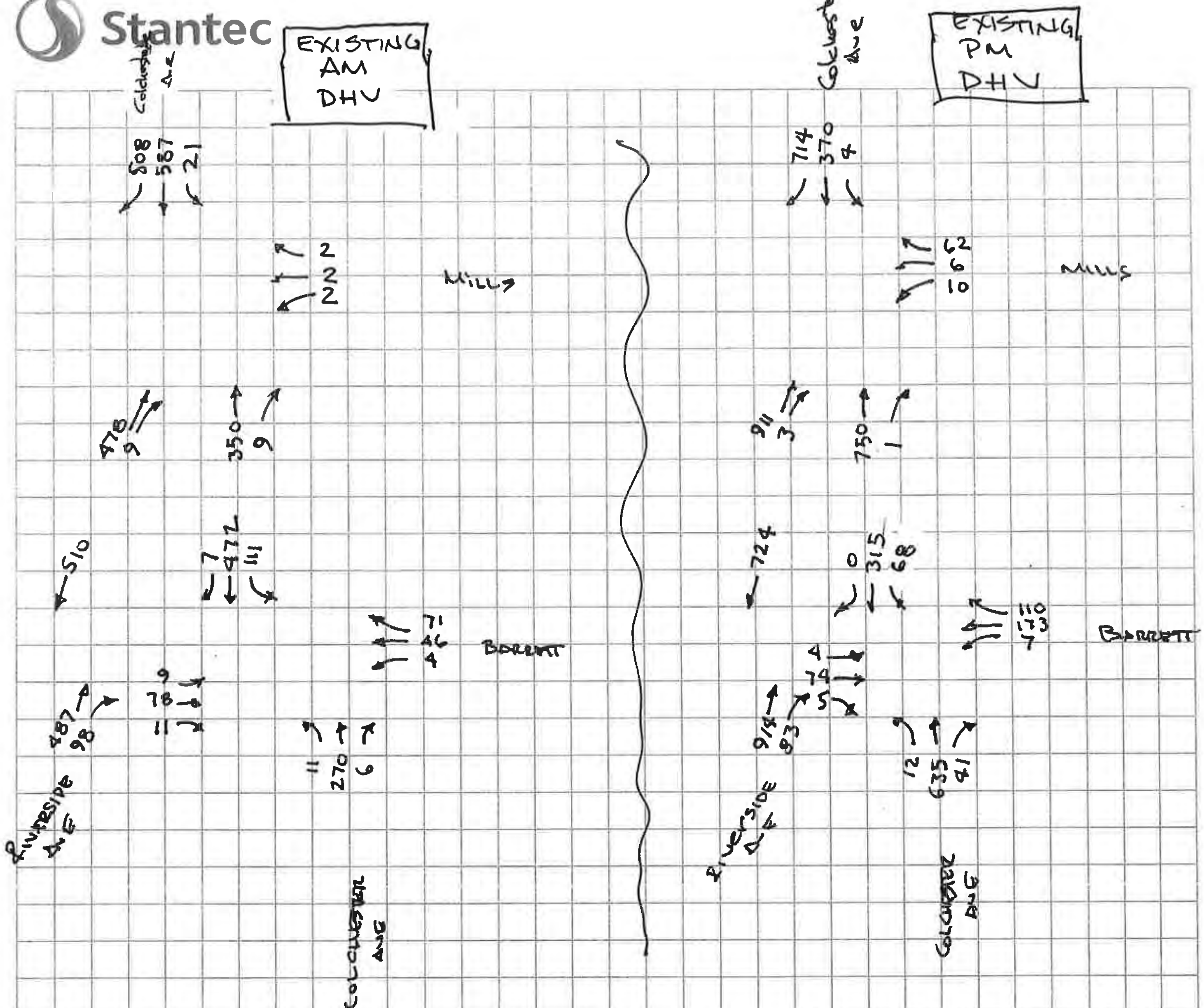
| | Riverside Ave W of Colchester Ave | | | Colchester Ave S of Riverside Ave | | | Colchester Ave N of Riverside Ave | | |
|---|---|---|---|---|---|---|---|---|---|
| | WB | EB | Total | SB | NB | Total | SB | NB | Total |
| 6-7 AM | 115 | 211 | 326 | 420 | 139 | 559 | 542 | 348 | 890 |
| 7-8 AM | 330 | 165 | 495 | 671 | 130 | 801 | 1010 | 288 | 1298 |
| 8-9 AM | 285 | 338 | 623 | 679 | 291 | 970 | 981 | 618 | 1599 |
| 9-10 AM | 184 | 264 | 448 | 547 | 272 | 819 | 742 | 526 | 1268 |
| 10-11 AM | 193 | 289 | 482 | 493 | 281 | 774 | 690 | 566 | 1256 |
| 11-12 PM | 273 | 310 | 583 | 549 | 369 | 918 | 841 | 671 | 1512 |
| 12-1 PM | 470 | 403 | 873 | 409 | 423 | 832 | 883 | 815 | 1698 |
| 1-2 PM | 463 | 441 | 904 | 361 | 534 | 895 | 829 | 981 | 1810 |
| 2-3 PM | 389 | 404 | 793 | 372 | 534 | 906 | 750 | 939 | 1689 |
| 3-4 PM | 497 | 572 | 1069 | 338 | 637 | 975 | 840 | 1203 | 2043 |
| 4-5 PM | 523 | 709 | 1232 | 369 | 731 | 1100 | 888 | 1458 | 2346 |
| 5-6 PM | 683 | 862 | 1545 | 357 | 738 | 1095 | 1027 | 1657 | 2684 |

AADT (2012) 15,600 ( Estimated) 30,600 ( Estimated)

# APPENDIX C

## Design Hour Volume (DHV) Calculations

Stantec

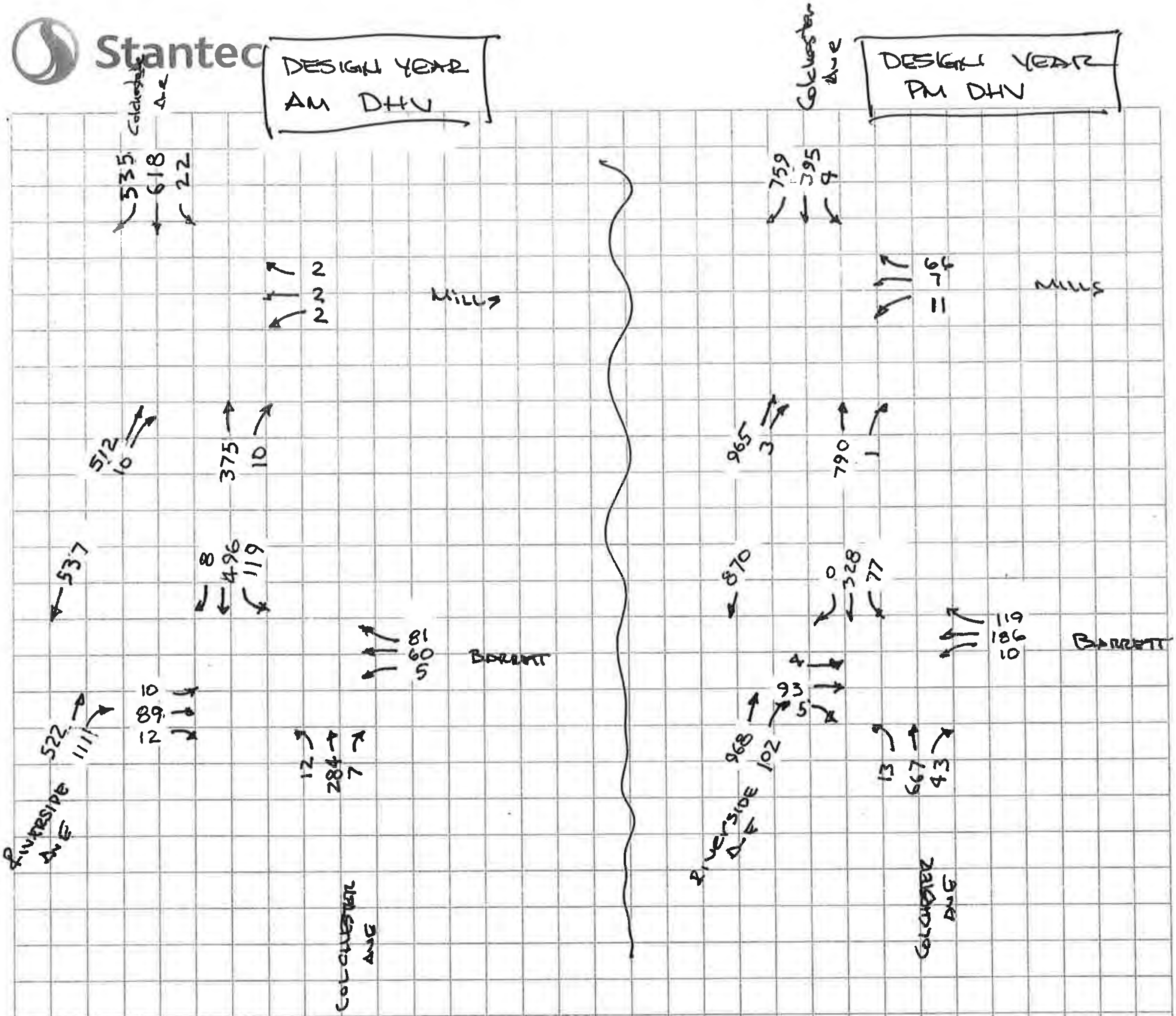



NOTE
EXISTING VOLUMES (1.04) = EXISTING DHV
(SEE DHV CALCULATION)

EXISTING DESIGN HOUR VOLUMES (DHV)

Designed by: DJD 1/28/16 Checked by:

Stantec




NOTE

EXISTING DHV (1.05) = FUTURE DHV + SPECIFIC BACKGROUND GROWTH = DESIGN YEAR DHV
(SEE CCRPC Directive (1/27/16))

| DHV METHOD | VALIDATION | CALCULATION |
|---|---|---|

**a. DHV from CTC**

**Recorded DHV Available ?**

| CTC | Route | Town | Location | 20 Yr Growth* | Annual growth | 2014 AADT | DHV |
|---|---|---|---|---|---|---|---|
| | | Nearest CTC | | | | | |
| P6D001 | VT 127 | Burlington | 0.4 mi. N of Manhattan Dr | 0.72 | 0.96 | 14,100 | 1,578 |
| P6D040 | US 7 | Colchester | 0.6 mi S of Blakely Rd | 1.16 | 1.01 | 15,400 | 1,780 |
| | * 2014 to 2034 Group B: Urban | | | 0.93 | 1.00 | NA | |

**b. % K from a CTC [ % K ( AADT) ]**

| CTC | Route | Town | Location | CTC along Project Roadway ? | Estimated 2012 AADT | % K | AADT | DHV |
|---|---|---|---|---|---|---|---|---|
| | | Nearest CTC | | | | | | |
| P6D001 | VT 127 | Burlington | 0.4 mi. N of Manhattan Dr | No | Riverside Ave | 11.2% | | 1,750 |
| P6D040 | US 7 | Colchester | 0.6 mi S of Blakely Rd | No | 15,600 | 11.6% | 15,600 | 1,810 |
| | | Urban Group | | No | | 10.4% | | 1,625 |
| | | | | | Colchester Ave* | 11.2% | | 3,430 |
| | | | | | 30,600 | 11.6% | 30,600 | 3,550 |
| | | | | | * Winooski City Line | 10.4% | | 3,180 |

No CTC on a project roadway so consider DHV resulting from Urban Group K factor and Vtrans estimated AADT

**c. Alternate DHV determination [ % K ( AADT)]**

| by Poll Group | K Factor |
|---|---|
| 1. Rural Interstate | 0.1243 |
| 2. Rural Non - Interstate | 0.1127 |
| 3. Urban | 0.104 |
| 4. Summer Recreational | 0.1326 |
| 5. Summer / Winter Recreational (US & VT) | 0.1436 |

| Roadway Type | Roadway Number | Town | Available AADT Beginning Reference | End Reference | ATR Station | Year | AADT | Actual |
|---|---|---|---|---|---|---|---|---|

Applicable Poll Group / AADT

| K Factor | AADT | DHV |
|---|---|---|

NOT USED

**d. CTC Method using Red Book Report**

Is CTC along Route? NO
Is TMC along Route? YES

Step 1. CTC near w/o traffic breaks
Step 2. DHV for CTC that year
Step 3. PHV at CTC for date of TMC count
Step 4. Calc DHV Factor
Step 5. Apply DHV factor to TMC

CTC:
DHV ctc =
PHV ctc =
DHV ctc / PHV ctc =
PHV tmc =
DHV tmc =

NOT USED

**e. DHV based on AADT and Highway Class**

NOT USED

**INTERSECTION DHV's**

| Riverside/Colchester/Mills AM PH Count Data 7:30 - 8:30 AM 6/14/2014 | |
|---|---|
| WB | 490 |
| EB Left | 460 |
| EB Thru | 9 |
| EB Right | 0 |
| Total | 959 |
| WB right | 2 |
| WB Thru | 2 |
| WB Left | 2 |
| EB | 38 |
| Total | 44 |
| NB Left | 0 |
| NB Thru | 337 |
| NB Right | 9 |
| SB | 566 |
| Total | 912 |
| NB | 799 |
| SB Right | 488 |
| SB Thru | 564 |
| SB Left | 20 |
| Total | 1871 |

NOTES
DHV Factor Calculation

June is peak month per CTC P6D001 and P6D040

PM Riverside Ave ( USED)
1,557< estimated DHV (1,625)
(DHV Factor 1625/1557=1.04)

PM Colchester Ave ( NOT USED)
2,704 < estimated DHV (3,180)
( DHV Factor 3180/2704 =1.18)

Riverside/Colchester/Mills

| Existing AM DHV with 1.04 factor | | Future AM DHV with addt'l 1.05 factor | | Specific Future Developments | Design Year PM DHV |
|---|---|---|---|---|---|
| EB Left | 478 | EB Left | 502 | 10 | 512 |
| EB Thru | 9 | EB Thru | 10 | | 10 |
| EB Right | 0 | EB Right | 0 | | 0 |
| Total | 487 | Total | 512 | | 522 |
| WB right | 2 | WB right | 2 | | 2 |
| WB Thru | 2 | WB Thru | 2 | | 2 |
| WB Left | 2 | WB Left | 2 | | 2 |
| Total | 6 | Total | 6 | | 6 |
| NB Left | 0 | NB Left | 0 | | 0 |
| NB Thru | 350 | NB Thru | 368 | 7 | 375 |
| NB Right | 9 | NB Right | 10 | | 10 |
| Total | 359 | Total | 378 | | 385 |
| SB Right | 508 | SB Right | 533 | 2 | 535 |
| SB Thru | 587 | SB Thru | 616 | 2 | 618 |
| SB Left | 21 | SB Left | 22 | | 22 |
| Total | 1116 | Total | 1171 | | 1175 |

Burlington Vermont

Riverside & Colchester
Barrett and Mills

195311163 2/2/2016

# DHV Calculation (Existing & Future)

Colchester Ave at Riverside Ave **AM**

**Stantec Consulting Services Inc.**
55 Green Mountain Drive.
South Burlington, VT U.S.A.
05403
Tel. 802.864.0223
Fax. 802.864.0165
www.stantec.com

| DHV METHOD | VALIDATION | CALCULATION |
|---|---|---|

**a. DHV from CTC**

**Recorded DHV Available ?**

| CTC | Route | Town | Location | 20 Yr Growth* | Annual growth | 2014 AADT | DHV |
|---|---|---|---|---|---|---|---|
| P6D001 | VT 127 | Burlington | 0.4 mi. N of Manhattan Dr | 0.72 | 0.96 | 14,100 | 1,578 |
| P6D040 | US 7 | Colchester | 0.6 mi S of Blakely Rd | 1.16 | 1.01 | 15,400 | 1,780 |
| | * 2014 to 2034 Group B: Urban | | | 0.93 | 1.00 | NA | |

(Nearest CTC)

**b. % K from a CTC [ % K ( AADT) ]**

| CTC | Route | Town | Location | CTC along Project Roadway ? | Estimated 2012 AADT | % K | AADT | DHV |
|---|---|---|---|---|---|---|---|---|
| P6D001 | VT 127 | Burlington | 0.4 mi. N of Manhattan Dr | No | Riverside Ave | 11.2% | | 1,750 |
| P6D040 | US 7 | Colchester | 0.6 mi S of Blakely Rd | No | 15,600 | 11.6% | 15,600 | 1,810 |
| | | Urban Group | | No | | 10.4% | | 1,625 |
| | | | | | Colchester Ave* | 11.2% | | 3,430 |
| | | | | | 30,600 | 11.6% | 30,600 | 3,550 |
| | | | | | * Winooski City Line | 10.4% | | 3,180 |

No CTC on a project roadway so consider DHV resulting from Urban Group K factor and Vtrans estimated AADT

**c. Alternate DHV determination [ % K ( AADT)]**

| by Poll Group | K Factor |
|---|---|
| 1. Rural Interstate | 0.1243 |
| 2. Rural Non - Interstate | 0.1127 |
| 3. Urban | 0.104 |
| 4. Summer Recreational | 0.1326 |
| 5. Summer / Winter Recreational (US & VT) | 0.1436 |

| Roadway Type | Roadway Number | Town | Available AADT Beginning Reference | End Reference | ATR Station | Year | AADT | Actual |
|---|---|---|---|---|---|---|---|---|

Applicable Poll Group / AADT

| K Factor | AADT | DHV |
|---|---|---|

**NOT USED**

**d. CTC Method using Red Book Report**

Is CTC along Route? NO

Is TMC along Route? YES

Step 1. CTC near w/o traffic breaks
Step 2. DHV for CTC that year
Step 3. PHV at CTC for date of TMC count
Step 4. Calc DHV Factor
Step 5. Apply DHV factor to TMC

CTC:
DHV ctc =
PHV ctc =
DHV ctc / PHV ctc =
PHV tmc =
DHV tmc =

**NOT USED**

**e. DHV based on AADT and Highway Class**

**NOT USED**

**INTERSECTION DHV's**

**Riverside/Colchester/Mills**

| PM PH Count Data | |
|---|---|
| 4:30 - 5:30 PM | |
| 7/23/2014 | |
| WB | 678 |
| EB Left | 876 |
| EB Thru | 3 |
| EB Right | 0 |
| Total | 1557 |
| WB right | 60 |
| WB Thru | 6 |
| WB Left | 10 |
| EB | 8 |
| Total | 84 |
| NB Left | 0 |
| NB Thru | 721 |
| NB Right | 1 |
| SB | 466 |
| Total | 1188 |
| NB | 1657 |
| SB Right | 687 |
| SB Thru | 356 |
| SB Left | 4 |
| Total | 2704 |

NOTES
DHV Factor Calculation

July < peak month per CTC P6D001 & P6D040

Riverside Ave ( USED)
1,557< estimated DHV (1,625)
(DHV Factor 1625/1557=1.04)

Colchester Ave ( NOT USED)
2,704 < estimated DHV (3,180)
( DHV Factor 3180/2704 =1.18)

**Riverside/Colchester/Mills**

| Movement | Existing PM DHV with 1.04 factor | Future PM DHV with addt'l 1.05 factor | Specific Future Developments | Design Year PM DHV |
|---|---|---|---|---|
| EB Left | 911 | 957 | 8 | 965 |
| EB Thru | 3 | 3 | | 3 |
| EB Right | 0 | 0 | | 0 |
| Total | 914 | 960 | | 968 |
| WB right | 62 | 66 | | 66 |
| WB Thru | 6 | 7 | | 7 |
| WB Left | 10 | 11 | | 11 |
| Total | 86 | 149 | | 149 |
| NB Left | 0 | 0 | | 0 |
| NB Thru | 750 | 787 | 3 | 790 |
| NB Right | 1 | 1 | | 1 |
| Total | 751 | 788 | | 791 |
| SB Right | 714 | 750 | 9 | 759 |
| SB Thru | 370 | 389 | 6 | 395 |
| SB Left | 4 | 4 | | 4 |
| Total | 2811 | 1143 | | 1158 |

Burlington Vermont

Riverside & Colchester
Barrett and Mills

195311163 2/2/2016

# DHV Calculation (Existing & Future)

Colchester Ave at Riverside Ave **PM**

**Stantec Consulting Services Inc.**
55 Green Mountain Drive.
South Burlington, VT U.S.A.
05403
Tel. 802.864.0223
Fax. 802.864.0165
www.stantec.com

5/18

| DHV METHOD | VALIDATION | CALCULATION |
|---|---|---|

**a. DHV from CTC**

**Recorded DHV Available ?**

| CTC | Route | Town | Location | 20 Yr Growth* | Annual growth | 2014 AADT | DHV |
|---|---|---|---|---|---|---|---|
| P6D001 | VT 127 | Burlington | 0.4 mi. N of Manhattan Dr | 0.72 | 0.96 | 14,100 | 1,578 |
| P6D040 | US 7 | Colchester | 0.6 mi S of Blakely Rd | 1.16 | 1.01 | 15,400 | 1,780 |
| | * 2014 to 2034 Group B: Urban | | | 0.93 | 1.00 | NA | |

(Nearest CTC)

**b. % K from a CTC** **[ % K ( AADT) ]**

| CTC | Route | Town | Location | CTC along Project Roadway ? | Estimated 2012 AADT | % K | AADT | DHV |
|---|---|---|---|---|---|---|---|---|
| P6D001 | VT 127 | Burlington | 0.4 mi. N of Manhattan Dr | No | Riverside Ave | 11.2% | | 1,750 |
| P6D040 | US 7 | Colchester | 0.6 mi S of Blakely Rd | No | 15,600 | 11.6% | 15,600 | 1,810 |
| | | Urban Group | | No | | 10.4% | | 1,625 |
| | | | | | Colchester Ave* | 11.2% | | 3,430 |
| | | | | | 30,600 | 11.6% | 30,600 | 3,550 |
| | | | | | * Winooski City Line | 10.4% | | 3,180 |

No CTC on a project roadway so consider DHV resulting from Urban Group K factor and Vtrans estimated AADT

**c. Alternate DHV determination [ % K ( AADT)]**

| by Poll Group | K Factor |
|---|---|
| 1. Rural Interstate | 0.1243 |
| 2. Rural Non - Interstate | 0.1127 |
| 3. Urban | 0.104 |
| 4. Summer Recreational | 0.1326 |
| 5. Summer / Winter Recreational (US & VT) | 0.1436 |

| Roadway Type | Roadway Number | Town | Available AADT Beginning Reference | End Reference | ATR Station | Year | AADT | Actual |
|---|---|---|---|---|---|---|---|---|

Applicable Poll Group / AADT

| K Factor | AADT | DHV |
|---|---|---|

NOT USED

**d. CTC Method using Red Book Report**

Is CTC along Route? NO
Is TMC along Route? YES

Step 1. CTC near w/o traffic breaks
Step 2. DHV for CTC that year
Step 3. PHV at CTC for date of TMC count
Step 4. Calc DHV Factor
Step 5. Apply DHV factor to TMC

CTC:
DHV ctc =
PHV ctc =
DHV ctc / PHV ctc =
PHV tmc =
DHV tmc =

NOT USED

**e. DHV based on AADT and Highway Class**

NOT USED

**INTERSECTION DHV's**

| Colchester/ Barrett AM PH Count Data 7:30 - 8:30 AM 6/24/2013 | | NOTES DHV Factor Calculation |
|---|---|---|
| WB | 62 | June is peak month per CTC P6D001 and P6D040 DHV factor may not be needed but PM factor applied > |
| EB Left | 9 | |
| EB Thru | 75 | |
| EB Right | 11 | See PM Riverside Ave (USED) |
| Total | 157 | 1,557< estimated DHV (1,625) ( PM DHV Factor 1625/1557=1.04) |
| WB right | 68 | |
| WB Thru | 44 | |
| WB Left | 4 | |
| EB | 188 | |
| Total | 304 | |
| NB Left | 11 | |
| NB Thru | 260 | Balancing holding NB at Mills |
| NB Right | 6 | |
| SB | 469 | |
| Total | 746 | |
| NB | 721 | Balanced |
| SB Right | 7 | |
| SB Thru | 454 | Balanced |
| SB Left | 107 | PM Colchester Ave ( NOT USED) |
| Total | 1289 | 2,704 < estimated DHV (3,180) ( DHV Factor 3180/2704 =1.18) |

Colchester/Barrett

| Existing AM DHV with 1.04 factor (PM) | | Future DHV (AM) with addt'l 1.05 factor | | Specific Future Developments | Design Year AM DHV |
|---|---|---|---|---|---|
| EB Left | 9 | EB Left | 10 | | 10 |
| EB Thru | 78 | EB Thru | 82 | 7 | 89 |
| EB Right | 11 | EB Right | 12 | | 12 |
| Total | 98 | Total | 104 | | 111 |
| WB right | 71 | WB right | 74 | 7 | 81 |
| WB Thru | 46 | WB Thru | 48 | 12 | 60 |
| WB Left | 4 | WB Left | 4 | 1 | 5 |
| Total | 121 | Total | 126 | | 146 |
| NB Left | 11 | NB Left | 12 | | 12 |
| NB Thru | 270 | NB Thru | 284 | | 284 |
| NB Right | 6 | NB Right | 7 | | 7 |
| Total | 287 | Total | 303 | | 303 |
| SB Right | 7 | SB Right | 8 | | 8 |
| SB Thru | 472 | SB Thru | 496 | | 496 |
| SB Left | 111 | SB Left | 117 | 2 | 119 |
| Total | 590 | Total | 621 | | 623 |

Burlington Vermont

Riverside & Colchester
Barrett and Mills

195311163 2/2/2016

# DHV Calculation (Existing & Future)

Colchester Ave at Barrett Street **AM**

Stantec

**Stantec Consulting Services Inc.**
55 Green Mountain Drive.
South Burlington, VT U.S.A.
05403
Tel. 802.864.0223
Fax. 802.864.0165
www.stantec.com

| DHV METHOD | VALIDATION | CALCULATION |
|---|---|---|

**a. DHV from CTC**

Recorded DHV Available ?

| CTC | Route | Town | Location | 20 Yr Growth* | Annual growth | 2014 AADT | DHV |
|---|---|---|---|---|---|---|---|
| P6D001 | VT 127 | Burlington | 0.4 mi. N of Manhattan Dr | 0.72 | 0.96 | 14,100 | 1,578 |
| P6D040 | US 7 | Colchester | 0.6 mi S of Blakely Rd | 1.16 | 1.01 | 15,400 | 1,780 |
| * 2014 to 2034 Group B: Urban | | | | 0.93 | 1.00 | NA | |

(Nearest CTC)

**b. % K from a CTC [ % K ( AADT) ]**

| CTC | Route | Town | Location | CTC along Project Roadway ? | Estimated 2012 AADT | % K | AADT | DHV |
|---|---|---|---|---|---|---|---|---|
| P6D001 | VT 127 | Burlington | 0.4 mi. N of Manhattan Dr | No | Riverside Ave | 11.2% | | 1,750 |
| P6D040 | US 7 | Colchester | 0.6 mi S of Blakely Rd | No | 15,600 | 11.6% | 15,600 | 1,810 |
| | | Urban Group | | No | | 10.4% | | 1,625 |
| | | | | | Colchester Ave* | 11.2% | | 3,430 |
| | | | | | 30,600 | 11.6% | 30,600 | 3,550 |
| | | | | | * Winooski City Line | 10.4% | | 3,180 |

No CTC on a project roadway so consider DHV resulting from Urban Group K factor and Vtrans estimated AADT

**c. Alternate DHV determination [ % K ( AADT)]**

| by Poll Group | K Factor |
|---|---|
| 1. Rural Interstate | 0.1243 |
| 2. Rural Non - Interstate | 0.1127 |
| 3. Urban | 0.104 |
| 4. Summer Recreational | 0.1326 |
| 5. Summer / Winter Recreational (US & VT) | 0.1436 |

Available AADT

| Roadway Type | Roadway Number | Town | Beginning Reference | End Reference | ATR Station | Year | AADT | Actual |
|---|---|---|---|---|---|---|---|---|

Applicable Poll Group / AADT

| K Factor | AADT | DHV |
|---|---|---|

NOT USED

**d. CTC Method using Red Book Report**

Is CTC along Route? NO
Is TMC along Route? YES

Step 1. CTC near w/o traffic breaks
Step 2. DHV for CTC that year
Step 3. PHV at CTC for date of TMC count
Step 4. Calc DHV Factor
Step 5. Apply DHV factor to TMC

CTC:
DHV ctc =
PHV ctc =
DHV ctc / PHV ctc =
PHV tmc =
DHV tmc =

NOT USED

**e. DHV based on AADT and Highway Class**

NOT USED

**INTERSECTION DHV's**

Colchester/Barrett
PM PH Count Data
5:00 - 6:00 PM
6/24/2013

| Movement | Count |
|---|---|
| WB | 178 |
| EB Left | 4 |
| EB Thru | 71 |
| EB Right | 5 |
| Total | 258 |
| WB right | 106 |
| WB Thru | 166 |
| WB Left | 7 |
| EB | 108 |
| Total | 387 |
| NB Left | 12 |
| NB Thru | 611 |
| NB Right | 39 |
| SB | 312 |
| Total | 974 |
| NB | 721 |
| SB Right | 0 |
| SB Thru | 300 |
| SB Left | 65 |
| Total | 1086 |

NOTES
DHV Factor Calculation
Volumes balanced with 7/23/2014 at Mills
June is peak month per CTC P6D001 and P6D040

See PM Riverside Ave (USED)
1,557< estimated DHV (1,625)
(DHV Factor 1625/1557=1.04)

Balanced (NB)

Balanced (SB)

PM Colchester Ave ( NOT USED)
2,704 < estimated DHV (3,180)
( DHV Factor 3180/2704 =1.18)

Colchester/Barrett

| Movement | Existing PM DHV with 1.04 factor (7/23/2014 Riverside) | Movement | Future PM DHV with addt'l 1.05 factor | Specific Future Developments | Design Year DHV |
|---|---|---|---|---|---|
| EB Left | 4 | EB Left | 4 | | 4 |
| EB Thru | 74 | EB Thru | 78 | 15 | 93 |
| EB Right | 5 | EB Right | 5 | | 5 |
| Total | 83 | Total | 87 | | 102 |
| WB right | 110 | WB right | 116 | 3 | 119 |
| WB Thru | 173 | WB Thru | 181 | 5 | 186 |
| WB Left | 7 | WB Left | 8 | 2 | 10 |
| Total | 290 | Total | 305 | | 315 |
| NB Left | 12 | NB Left | 13 | | 13 |
| NB Thru | 635 | NB Thru | 667 | | 667 |
| NB Right | 41 | NB Right | 43 | | 43 |
| Total | 788 | Total | 723 | | 723 |
| SB Right | 0 | SB Right | 0 | | 0 |
| SB Thru | 312 | SB Thru | 328 | | 328 |
| SB Left | 68 | SB Left | 71 | 6 | 77 |
| Total | 380 | Total | 399 | | 405 |

Burlington Vermont

Riverside & Colchester
Barrett and Mills

195311163 2/2/2016

# DHV Calculation (Existing & Future)

Colchester Ave at Barrett Street **PM**

Stantec

**Stantec Consulting Services Inc.**
55 Green Mountain Drive.
South Burlington, VT U.S.A.
05403
Tel. 802.864.0223
Fax. 802.864.0165
www.stantec.com

## DeBaie, Dave

**From:** Jason Charest <jcharest@ccrpcvt.org>
**Sent:** Wednesday, January 27, 2016 4:57 PM
**To:** Edwards, Greg
**Cc:** Luther, Thad; DeBaie, Dave; Eleni Churchill
**Subject:** RE: Colchester Riverside Barret Mill design criteria

Hi Greg,

Growth was discussed thoroughly as part of the Colchester Avenue Corridor Study (see Section 4. Future Conditions for background and rationale). The corridor study used 5% over 20 years. This was again discussed during the more recent Colchester Ave/Pearl St/Prospect St scoping which used 2.5% over 10 years. I've checked the meeting minutes as to why a future horizon of 10 years vs 20 was used but came up empty handed. We will do some additional digging but for now please plan on using 5% over 20 years and we'll run this by the advisory committee at our next meeting.

Thanks,

Jason

****************************************************

Jason Charest, P.E. | Senior Transportation Planning Engineer

Chittenden County Regional Planning Commission
110 West Canal Street, Suite 202 ; Winooski, VT 05404-2109

Phone: 802-861-0127 | Fax: 802-846-4494
Email: jcharest@ccrpcvt.org | Web: www.ccrpcvt.org

**From:** Edwards, Greg [mailto:greg.edwards@stantec.com]
**Sent:** Wednesday, January 20, 2016 12:42 PM
**To:** Jason Charest <jcharest@ccrpcvt.org>
**Cc:** Luther, Thad <thad.luther@stantec.com>; DeBaie, Dave <dave.debaie@stantec.com>
**Subject:** Colchester Riverside Barret Mill design criteria

Hi Jason,

We would like you thoughts on the design year and growth rates to use for traffic volume projections.

The following is what we are considering:

Construction year: 2020
Design year: 2040
20 year growth: 10%

We understand the local urban growth rates have been negative, but on past projects he have accounted for some additional capacity since some alternative may be significant investment. Curious what you might be seeing used on other projects.

Senior Principal, Transportation
Stantec
55 Green Mountain Drive South Burlington VT 05403-7824
Phone: (802) 497-6398
Cell: (603) 289-0025

**2014 Growth Factors by Regression Analysis Group**

**A: Interstate Highways**

| Site ID | Route No | Town | Regression Analysis Year | 20 Year GF 2014 to 2034 | Short term GF 2009 to 2014 |
|---|---|---|---|---|---|
| P6C002 | I91 | Sheffield | 1995 | 1.12 | 1.06 |
| P6C015 | I93 | Waterford | 1995 | 1.35 | 1.08 |
| P6D091 | I89 | South Burlington | 1995 | 1.17 | 0.98 |
| P6D092 | I89 | Colchester | 1995 | 1.20 | 1.03 |
| P6F096 | I89 | Swanton | 1995 | 1.16 | 1.08 |
| P6N001 | I91 | Fairlee | 1995 | 1.15 | 0.84 |
| P6N002 | I91 | Bradford | 1995 | 1.13 | 0.98 |
| P6P082 | I91 | Derby | 1995 | 0.85 | 1.00 |
| P6R001 | US4 | Fair Haven | 1995 | 1.06 | 0.90 |
| P6W089 | I89 | Waterbury | 1995 | 1.17 | 1.05 |
| P6X071 | I91 | Vernon | 1995 | 0.91 | 0.98 |
| P6X072 | I91 | Brattleboro | 1995 | 0.93 | 0.89 |
| P6X073 | I91 | Putney | 1995 | 0.93 | 0.97 |
| P6X074 | I91 | Rockingham | 1995 | 1.02 | 0.97 |
| P6Y001 | I89 | Bethel | 1995 | 1.16 | 1.03 |
| P6Y002 | I91 | Norwich | 1995 | 1.12 | 0.97 |
| | | | **GROUP AVG** | 1.09 | 0.99 |

**B: Urban**

| Site ID | Route No | Town | Regression Analysis Year | 20 Year GF 2014 to 2034 | Short term GF 2009 to 2014 |
|---|---|---|---|---|---|
| P6D001 | VT127 | Burlington | 1995 | 0.72 | 0.96 |
| P6D040 | US7 | Colchester | 1995 | 1.16 | 1.01 |
| P6D129 | VT2A | Williston | 1995 | 0.92 | 0.99 |
| P6R022 | US7 | Rutland Town | 1995 | 0.89 | 0.98 |
| P6W004 | VT62 | Barre City | 1995 | 1.02 | 0.94 |
| P6W006 | US302 | Berlin | 1995 | 0.87 | 0.99 |
| P6W014 | US302 | Barre City | 1995 | 0.86 | |
| P6W024 | US2 | Montpelier | 1995 | 1.00 | 1.07 |
| P6X011 | US5 | Brattleboro | 1995 | 0.90 | 1.04 |
| | | | **GROUP AVG** | 0.93 | 1.00 |

**Continued on Next Page...**

**Continuous Traffic Counter-2014 Daily Adjustment Factors By Site**

**Site ID:** P6D001 — **AADT:** 14100
**Town:** Burlington — **Route No:** VT127
**Location:** Burlington: VT127 0.40miNof ManhattanDr

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.59 | 1.07 | 1.12 | 0.91 | 0.95 | 1.19 | 0.89 | 0.88 | 1.31 | 0.91 | 1.08 | 0.88 |
| 2 | 1.11 | 1.29 | 1.39 | 0.91 | 0.88 | 0.93 | 0.91 | 1.17 | 0.92 | 0.90 | 1.31 | 0.86 |
| 3 | 1.06 | 0.91 | 0.98 | 0.90 | 1.15 | 0.97 | 0.87 | 1.31 | 0.92 | 0.85 | 0.91 | 0.88 |
| 4 | 1.25 | 0.86 | 0.95 | 0.91 | 1.39 | 0.90 | 1.35 | 0.95 | 0.90 | 1.23 | 0.89 | 0.85 |
| 5 | 1.43 | 1.27 | 0.94 | 1.18 | 0.99 | 0.92 | 1.23 | 0.96 | 0.90 | 1.31 | 0.88 | 0.84 |
| 6 | 0.96 | 0.93 | 0.90 | 1.32 | 0.95 | 0.89 | 1.32 | 0.92 | 1.24 | 0.94 | 0.88 | 1.12 |
| 7 | 0.91 | 0.87 | 0.85 | 0.95 | 0.96 | 1.06 | 0.96 | 0.92 | 1.34 | 0.92 | 0.87 | 1.25 |
| 8 | 0.88 | 1.10 | 1.14 | 0.95 | 0.93 | 1.24 | 0.91 | 0.92 | 0.95 | 0.91 | 1.11 | 0.87 |
| 9 | 0.87 | 1.36 | 1.29 | 0.92 | 0.92 | 0.95 | 0.92 | 1.13 | 0.93 | 0.91 | 1.31 | 1.02 |
| 10 | 0.86 | 0.93 | 0.92 | 0.91 | 1.01 | 0.93 | 0.88 | 1.27 | 0.94 | 0.88 | 0.92 | 1.37 |
| 11 | 1.21 | 0.89 | 0.88 | 0.88 | 1.23 | 0.95 | 0.89 | 0.93 | 0.92 | 1.13 | 0.88 | 1.01 |
| 12 | 1.31 | 0.86 | 1.42 | 1.08 | 0.97 | 0.97 | 1.12 | 0.94 | 0.89 | 1.33 | 0.88 | 0.88 |
| 13 | 0.89 | 0.95 | 1.66 | 1.33 | 0.95 | 0.94 | 1.41 | 0.99 | 1.16 | 0.99 | 0.88 | 1.06 |
| 14 | 0.89 | 1.30 | 0.93 | 0.93 | 0.93 | 1.17 | 0.93 | 0.91 | 1.34 | 0.91 | 0.86 | 1.27 |
| 15 | 0.86 | 1.06 | 1.18 | 0.97 | 0.91 | 1.33 | 0.91 | 0.94 | 0.95 | 0.90 | 1.08 | 0.90 |
| 16 | 0.88 | 1.24 | 1.32 | 0.92 | 0.93 | 0.97 | 0.89 | 1.25 | 0.93 | 0.93 | 1.29 | 0.87 |
| 17 | 0.83 | 0.96 | 0.90 | 0.88 | 1.10 | 0.93 | 0.88 | 1.37 | 0.91 | 0.91 | 0.97 | 0.86 |
| 18 | 1.07 | 0.92 | 0.87 | 0.87 | 1.26 | 0.97 | 0.87 | 0.96 | 0.90 | 1.21 | 0.88 | 0.85 |
| 19 | 1.46 | 0.89 | 0.87 | 1.17 | 0.94 | 0.91 | 1.13 | 0.92 | 0.88 | 1.37 | 0.88 | 0.82 |
| 20 | 1.15 | 0.87 | 0.88 | 1.39 | 0.91 | 0.91 | 1.24 | 0.90 | 1.17 | 0.96 | 0.87 | 1.07 |
| 21 | 0.93 | 0.91 | 0.84 | 1.00 | 0.89 | 1.20 | 0.94 | 0.92 | 1.39 | 0.97 | 0.86 | 1.23 |
| 22 | 0.91 | 1.15 | 1.15 | 1.00 | 0.92 | 1.33 | 0.91 | 0.92 | 0.96 | 0.95 | 1.13 | 0.88 |
| 23 | 0.90 | 1.32 | 1.30 | 0.98 | 0.93 | 0.97 | 0.95 | 1.15 | 0.92 | 0.95 | 1.33 | 0.91 |
| 24 | 0.85 | 0.96 | 0.88 | 0.94 | 1.12 | 0.96 | 0.90 | 1.26 | 0.90 | 0.92 | 0.89 | 0.99 |
| 25 | 1.14 | 0.95 | 0.87 | 0.94 | | 1.02 | 0.90 | 0.94 | 0.90 | 1.16 | 0.86 | 1.75 |
| 26 | 1.31 | 0.94 | 0.88 | 1.24 | 1.42 | 0.93 | 1.18 | 0.92 | 0.89 | 1.36 | 1.06 | 1.13 |
| 27 | 0.90 | 0.96 | 0.86 | 1.37 | 0.92 | 0.90 | 1.37 | 0.92 | 1.12 | 0.97 | 1.79 | 1.24 |
| 28 | 0.88 | 0.90 | 0.89 | 0.94 | 0.92 | 1.13 | 1.02 | 0.91 | 1.25 | 0.94 | 1.23 | 1.33 |
| 29 | 0.87 | | 1.12 | 0.91 | 0.88 | 1.26 | 0.91 | 0.89 | 0.92 | 0.94 | 1.33 | 0.96 |
| 30 | 0.86 | | 1.45 | 0.91 | 0.87 | 0.93 | 0.92 | 1.18 | 0.93 | 0.91 | 1.44 | 0.92 |
| 31 | 0.84 | | 0.89 | | 1.08 | | 0.92 | 1.43 | | 0.85 | | 0.96 |
| **MADT to AADT** | **1.11** | **1.10** | **1.08** | **1.00** | **0.93** | **0.92** | **0.95** | **0.95** | **0.97** | **0.96** | **1.03** | **1.06** |

**Site ID:** P6D040 — **AADT:** 15400
**Town:** Colchester — **Route No:** US7
**Location:** Colchester: US7 0.6 mi S of Blakely Rd

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.03 | 1.10 | 1.23 | 0.94 | 0.95 | 1.32 | | 0.86 | 1.49 | 0.92 | 1.15 | 0.86 |
| 2 | 1.01 | 1.40 | 1.47 | 0.94 | 0.88 | 0.94 | | 1.19 | 0.89 | 0.89 | 1.36 | 0.84 |
| 3 | 0.94 | 0.91 | 0.95 | 0.92 | 1.18 | 0.94 | 0.83 | 1.40 | 0.90 | 0.82 | 0.90 | 0.88 |
| 4 | 1.14 | 0.86 | 0.91 | 0.88 | 1.44 | 0.93 | 1.47 | 0.97 | 0.87 | 1.20 | 0.86 | 0.83 |
| 5 | 1.43 | 1.23 | 0.91 | 1.16 | 0.99 | 0.90 | 1.27 | 0.94 | 0.84 | 1.35 | 0.90 | 0.79 |
| 6 | 1.00 | 0.90 | 0.88 | 1.40 | 0.95 | 0.88 | 1.42 | 0.92 | 1.22 | 0.94 | 0.88 | 1.22 |
| 7 | 0.90 | 0.83 | 0.83 | 0.96 | 0.95 | 1.19 | 0.95 | 0.91 | 1.35 | 0.93 | 0.79 | 1.34 |
| 8 | 0.90 | 1.16 | 1.13 | 0.97 | 0.92 | | 0.92 | 0.87 | 0.93 | 0.92 | 1.15 | 0.85 |
| 9 | 0.86 | 1.42 | 1.35 | 0.93 | 0.87 | | 0.90 | 1.18 | 0.92 | 0.89 | 1.41 | 0.98 |
| 10 | 0.87 | 0.92 | 0.93 | 0.90 | 1.07 | | 0.88 | 1.32 | 0.90 | 0.86 | 0.89 | 1.53 |
| 11 | 1.22 | 0.91 | 0.85 | 0.86 | 1.32 | | 0.84 | 0.95 | 0.90 | 1.16 | 0.90 | 0.96 |
| 12 | 1.41 | 0.88 | 1.29 | 1.13 | 0.97 | | 1.16 | 0.94 | 0.87 | 1.30 | 0.87 | 0.83 |
| 13 | 0.90 | 0.88 | 1.50 | 1.34 | 0.98 | | 1.41 | 0.96 | 1.20 | 1.00 | 0.88 | 1.12 |
| 14 | 0.91 | 1.30 | 0.85 | 0.91 | 0.92 | | 0.93 | 0.89 | 1.43 | 0.94 | 0.83 | 1.34 |
| 15 | 0.85 | 1.11 | 1.15 | 0.96 | 0.90 | | 0.91 | 0.90 | 0.95 | 0.91 | 1.16 | 0.86 |
| 16 | 0.88 | 1.30 | 1.42 | 0.91 | 0.85 | 1.06 | 0.88 | 1.22 | 0.93 | 0.90 | 1.42 | 0.84 |
| 17 | 0.84 | 0.96 | 0.92 | 0.86 | 1.10 | 0.93 | 0.87 | 1.42 | 0.93 | 0.83 | 0.95 | 0.84 |
| 18 | 1.04 | 0.92 | 0.92 | 0.82 | 1.22 | 0.91 | 0.86 | 0.96 | 0.91 | 1.18 | 0.91 | 0.82 |
| 19 | 1.57 | 0.89 | 0.90 | 1.14 | 0.92 | 0.91 | 1.15 | 0.92 | 0.86 | 1.39 | 0.88 | 0.77 |
| 20 | 1.05 | 0.86 | 0.90 | 1.79 | 0.92 | 0.89 | 1.32 | 0.92 | 1.16 | 0.93 | 0.89 | 1.11 |
| 21 | 0.92 | 0.87 | 0.84 | 1.00 | 0.89 | | 0.94 | 0.91 | 1.39 | 0.95 | 0.82 | 1.27 |
| 22 | 0.93 | 1.13 | 1.14 | 0.98 | 0.92 | | 0.93 | 0.87 | 0.97 | 0.95 | 1.14 | 0.78 |
| 23 | 0.88 | 1.42 | 1.35 | 0.96 | 0.85 | | 0.94 | 1.19 | 0.93 | 0.99 | 1.41 | 0.79 |
| 24 | 0.83 | 0.96 | 0.91 | 0.92 | 1.16 | | 0.88 | 1.33 | 0.93 | 0.88 | 0.87 | 1.01 |
| 25 | 1.13 | 0.96 | 0.88 | 0.88 | 1.28 | | 0.87 | 0.96 | 0.92 | 1.21 | 0.82 | 2.84 |
| 26 | 1.41 | 0.94 | 0.90 | 1.22 | 1.67 | | 1.20 | 0.92 | 0.85 | 1.48 | 0.93 | 1.23 |
| 27 | 0.93 | 0.93 | 0.87 | 1.42 | 0.91 | | 1.36 | 0.94 | 1.16 | 0.98 | 2.30 | 1.36 |
| 28 | 0.90 | 0.88 | 0.86 | 0.92 | 0.92 | | 0.98 | 0.92 | 1.33 | 0.95 | 1.26 | 1.51 |
| 29 | 0.89 | | 1.12 | 0.90 | 0.87 | | 0.92 | 0.87 | 0.97 | 0.97 | 1.36 | 0.94 |
| 30 | 0.85 | | 1.51 | 0.90 | 0.86 | | 0.91 | 1.21 | 0.95 | 0.91 | 1.53 | 0.89 |
| 31 | 0.80 | | 0.92 | | 1.12 | | 0.89 | 1.35 | | 0.89 | | 0.93 |
| **MADT to AADT** | **1.13** | **1.11** | **1.10** | **1.01** | **0.92** | **0.90** | **0.93** | **0.93** | **0.96** | **0.96** | **1.05** | **1.08** |

10/18

**2014 Monthly Factors by Site**
**MADT to AADT**

| Site ID | Route | Town | Seasonal Adjustment Factor Group | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P6F096 | I89 | Swanton | 1 | 1.30 | 1.20 | 1.13 | 1.03 | 0.95 | 0.90 | 0.83 | 0.79 | 0.95 | 0.97 | 1.08 | 1.13 |
| P6N001 | I91 | Fairlee | 1 | 1.27 | 1.20 | 1.19 | 1.11 | 1.02 | 0.94 | 0.77 | 0.77 | 0.90 | 0.91 | 1.08 | 1.08 |
| P6N002 | I91 | Bradford | 1 | 1.25 | 1.16 | 1.13 | 1.06 | 0.99 | 0.91 | 0.83 | 0.82 | 0.91 | 0.92 | 1.07 | 1.12 |
| P6R001 | US4 | Fair Haven | 1 | 1.22 | 1.13 | 1.10 | 1.05 | 0.98 | 0.93 | 0.84 | 0.81 | 0.96 | 0.95 | 1.08 | 1.10 |
| P6R084 | US4 | West Rutland | 1 | 1.15 | 1.09 | 1.06 | 1.01 | 0.98 | 0.93 | 0.89 | 0.87 | 0.94 | 0.99 | 1.06 | 1.10 |
| P6W088 | I89 | Middlesex | 1 | 1.24 | 1.14 | 1.14 | 1.03 | 0.98 | 0.93 | 0.87 | 0.83 | 0.92 | 0.91 | 1.08 | 1.06 |
| P6W089 | I89 | Waterbury | 1 | 1.20 | 1.18 | 1.14 | 1.03 | 0.97 | 0.91 | 0.87 | 0.83 | 0.93 | 0.93 | 1.06 | 1.10 |
| P6X071 | I91 | Vernon | 1 | 1.11 | 0.99 | 1.06 | 1.16 | 1.12 | 0.97 | 0.87 | 0.87 | 0.99 | 0.94 | 1.05 | 0.97 |
| P6X072 | I91 | Brattleboro | 1 | 1.17 | 1.11 | 1.08 | 1.06 | 1.01 | 0.94 | 0.86 | 0.86 | 0.95 | 0.93 | 1.05 | 1.06 |
| P6X073 | I91 | Putney | 1 | 1.11 | 0.99 | 1.07 | 1.10 | 1.06 | 0.93 | 0.83 | 0.92 | 0.98 | 0.95 | 1.15 | 0.96 |
| P6X074 | I91 | Rockingham | 1 | 1.16 | 1.05 | 1.08 | 1.11 | 1.06 | 0.96 | 0.84 | 0.83 | 0.96 | 0.93 | 1.06 | 1.06 |
| P6Y001 | I89 | Bethel | 1 | 1.26 | 1.16 | 1.12 | 1.05 | 0.98 | 0.92 | 0.82 | 0.79 | 0.93 | 0.95 | 1.09 | 1.14 |
| P6Y002 | I91 | Norwich | 1 | 1.22 | 1.16 | 1.13 | 1.07 | 0.99 | 0.91 | 0.85 | 0.83 | 0.93 | 0.92 | 1.07 | 1.11 |
| P6Y085 | I89 | Hartford | 1 | 1.17 | 1.14 | 1.12 | 1.06 | 0.97 | 0.89 | 0.83 | 0.82 | 0.96 | 1.01 | 1.06 | 1.15 |
| **Group 1 Avg** | | | | **1.20** | **1.12** | **1.11** | **1.07** | **1.00** | **0.93** | **0.85** | **0.83** | **0.94** | **0.94** | **1.07** | **1.08** |
| P6A018 | US7 | Leicester | 2 | 1.17 | 1.15 | 1.10 | 0.98 | 0.91 | 0.90 | 0.89 | 0.87 | 0.96 | 0.98 | 1.05 | 1.10 |
| P6A019 | VT22A | Orwell | 2 | 1.25 | 1.21 | 1.16 | 1.04 | 0.94 | 0.88 | 0.86 | 0.83 | 0.93 | 0.97 | 1.07 | 1.12 |
| P6A041 | US7 | New Haven | 2 | 1.14 | 1.12 | 1.12 | 1.02 | 0.96 | 0.94 | 0.94 | 0.90 | 0.95 | 0.92 | 1.04 | 1.07 |
| P6A111 | VT22A | Addison | 2 | 1.26 | 1.21 | 1.18 | 1.03 | 0.91 | 0.89 | 0.83 | 0.80 | 0.93 | 0.96 | 1.04 | 1.11 |
| P6B037 | US7 | Pownal | 2 | 1.20 | 1.13 | 1.08 | 1.00 | 0.95 | 0.91 | 0.90 | 0.89 | 0.93 | 0.91 | 1.05 | 1.07 |
| P6B041 | VT9 | Bennington | 2 | 1.16 | 1.12 | 1.10 | 1.04 | 0.98 | 0.92 | 0.90 | 0.87 | 0.92 | 0.90 | 1.09 | 1.09 |
| P6B282 | US7 | Shaftsbury | 2 | 1.07 | 1.01 | 1.06 | 1.14 | 1.07 | 0.97 | 0.90 | 0.87 | 0.94 | 0.90 | 1.11 | 1.03 |
| P6B379 | VT279 | Bennington | 2 | 1.07 | 0.96 | 1.11 | 1.13 | 1.07 | 0.96 | 0.89 | 0.86 | 0.96 | 0.95 | 1.12 | 1.03 |
| P6C007 | VT15 | Hardwick | 2 | 1.17 | 1.15 | 1.14 | 1.04 | 0.93 | 0.93 | 0.87 | 0.86 | 0.88 | 0.92 | 1.06 | 1.14 |
| P6C028 | US2 | Danville | 2 | 1.22 | 1.22 | 1.25 | 1.04 | 0.96 | 0.90 | 0.84 | 0.83 | 0.89 | 0.92 | 1.11 | 1.18 |
| P6D132 | US7 | Charlotte | 2 | 1.15 | 1.15 | 1.09 | 1.01 | 0.96 | 0.91 | 0.90 | 0.87 | 0.96 | 0.95 | 1.06 | 1.09 |
| P6L047 | VT12 | Elmore | 2 | 1.13 | 1.14 | 1.18 | 1.06 | 0.92 | 0.95 | 0.99 | 0.92 | 0.81 | 0.85 | 1.03 | 1.13 |
| P6P004 | VT100 | Westfield | 2 | 1.31 | 1.14 | 1.14 | 1.03 | 0.91 | 0.90 | 0.90 | 0.89 | 0.94 | 0.96 | 1.06 | 1.08 |
| P6P215 | US5 | Derby | 2 | 1.15 | 1.08 | 1.11 | 1.02 | 0.92 | 0.90 | 0.89 | 0.93 | 0.96 | 0.97 | 1.06 | 1.05 |
| P6R017 | VT103 | Mt Holly | 2 | 1.10 | 1.04 | 1.12 | 1.21 | 1.11 | 0.94 | 0.87 | 0.83 | 0.90 | 0.92 | 1.03 | 0.98 |
| P6R100 | US7 | Brandon | 2 | 1.17 | 1.12 | 1.09 | 0.99 | 0.92 | 0.89 | 0.85 | 0.87 | 0.99 | 0.99 | 1.13 | 1.14 |
| P6X008 | US5 | Rockingham | 2 | 1.18 | 1.11 | 1.07 | 1.01 | 0.94 | 0.91 | 0.94 | 0.92 | 0.94 | 0.94 | 1.08 | 1.09 |
| P6Y031 | US5 | Norwich | 2 | 1.13 | 1.14 | 1.14 | 1.03 | 0.88 | 0.83 | 0.83 | 0.85 | 0.90 | 0.92 | 1.04 | 1.10 |
| P6Y119 | US4 | Hartford | 2 | 1.18 | 1.12 | 1.13 | 1.10 | 1.01 | 0.89 | 0.85 | 0.83 | 0.91 | 0.91 | 1.10 | 1.08 |
| **Group 2 Avg** | | | | **1.17** | **1.12** | **1.13** | **1.05** | **0.96** | **0.91** | **0.89** | **0.87** | **0.93** | **0.93** | **1.07** | **1.09** |
| P6D001 | VT127 | Burlington | 3 | 1.11 | 1.10 | 1.08 | 1.00 | 0.93 | 0.92 | 0.95 | 0.95 | 0.97 | 0.96 | 1.03 | 1.06 |
| P6D040 | US7 | Colchester | 3 | 1.13 | 1.11 | 1.10 | 1.01 | 0.92 | 0.90 | 0.93 | 0.93 | 0.96 | 0.96 | 1.05 | 1.08 |
| P6D061 | US2 | Williston | 3 | 1.07 | 1.08 | 1.05 | 0.99 | 0.94 | 0.95 | 0.98 | 0.96 | 1.01 | 0.98 | 1.03 | 1.00 |
| P6D091 | I89 | South Burlington | 3 | 1.08 | 1.09 | 1.07 | 1.00 | 0.96 | 0.95 | 0.94 | 0.90 | 0.95 | 0.95 | 1.04 | 1.11 |
| P6D092 | I89 | Colchester | 3 | 1.17 | 1.14 | 1.11 | 1.02 | 0.97 | 0.92 | 0.89 | 0.86 | 0.95 | 0.95 | 1.01 | 1.12 |
| P6D129 | VT2A | Williston | 3 | 1.12 | 1.11 | 1.07 | 1.00 | 0.96 | 0.93 | 0.97 | 0.93 | 0.97 | 0.95 | 1.02 | 1.02 |
| P6D277 | US7 | Shelburne | 3 | 1.09 | 1.11 | 1.09 | 1.01 | 0.96 | 0.93 | 0.94 | 0.91 | 0.96 | 0.97 | 1.07 | 1.06 |
| P6D530 | VT289 | Essex | 3 | 1.11 | 1.11 | 1.09 | 1.02 | 0.92 | 0.90 | 0.95 | 0.93 | 0.96 | 0.97 | 1.03 | 1.04 |
| P6D531 | VT289 | Essex | 3 | 1.15 | 1.16 | 1.13 | 1.03 | 0.93 | 0.89 | 0.90 | 0.91 | 0.92 | 0.93 | 1.02 | 1.06 |
| P6F029 | US7 | Georgia | 3 | 1.12 | 1.12 | 1.12 | 1.02 | 0.91 | 0.89 | 0.89 | 0.91 | 0.92 | 0.96 | 1.08 | 1.08 |
| P6R022 | US7 | Rutland Town | 3 | 1.11 | 1.11 | 1.06 | 1.02 | 0.99 | 0.94 | 0.93 | 0.92 | 0.93 | 0.95 | 1.04 | 1.05 |
| P6W004 | VT62 | Barre City | 3 | 1.11 | 1.07 | 1.05 | 0.98 | 0.95 | 0.92 | 0.99 | 0.97 | 0.99 | 0.95 | 1.01 | 1.00 |
| P6W006 | US302 | Berlin | 3 | 1.05 | 1.03 | 1.07 | 1.03 | 0.97 | 0.98 | 1.00 | 0.97 | 0.94 | 0.93 | 1.01 | 1.00 |
| P6W014 | US 302 | Barre City | 3 | 1.08 | 1.08 | 1.05 | 0.98 | 0.94 | 0.95 | 0.98 | 0.96 | 0.97 | 0.97 | 1.05 | 1.01 |
| P6W024 | US2 | Montpelier | 3 | 1.12 | 1.10 | 1.09 | 1.02 | 0.95 | 0.92 | 0.91 | 0.91 | 0.95 | 0.94 | 1.08 | 1.10 |
| P6X011 | US5 | Brattleboro | 3 | 1.07 | 1.06 | 1.03 | 0.96 | 0.97 | 0.94 | 0.96 | 0.97 | 0.99 | 0.98 | 1.05 | 1.04 |
| P6Y033 | VT10A | Norwich | 3 | 1.07 | 1.07 | 1.08 | 1.01 | 0.94 | 0.91 | 0.96 | 0.98 | 0.96 | 0.92 | 1.04 | 1.12 |
| **Group 3 Avg** | | | | **1.10** | **1.10** | **1.08** | **1.01** | **0.95** | **0.93** | **0.95** | **0.93** | **0.96** | **0.96** | **1.04** | **1.06** |
| P6C002 | I91 | Sheffield | 4 | 1.43 | 1.28 | 1.22 | 1.19 | 1.03 | 0.88 | 0.81 | 0.67 | 0.86 | 0.92 | 1.18 | 1.15 |
| P6C015 | I93 | Waterford | 4 | 1.46 | 1.31 | 1.26 | 1.14 | 1.04 | 0.86 | 0.80 | 0.69 | 0.83 | 0.89 | 1.20 | 1.23 |
| P6E020 | US2 | Concord | 4 | 1.30 | 1.19 | 1.22 | 1.11 | 0.97 | 0.87 | 0.79 | 0.75 | 0.83 | 0.91 | 1.09 | 1.23 |
| P6E131 | US2 | Guildhall | 4 | 1.28 | 1.23 | 1.19 | 1.09 | 0.97 | 0.87 | 0.80 | 0.76 | 0.86 | 0.93 | 1.11 | 1.20 |
| P6G025 | US2 | Grand Isle | 4 | 1.51 | 1.49 | 1.49 | 1.21 | 0.89 | 0.78 | 0.67 | 0.68 | 0.87 | 0.95 | 1.33 | 1.44 |
| P6G118 | US2 | Alburg | 4 | 1.32 | 1.25 | 1.22 | 1.08 | 0.96 | 0.85 | 0.77 | 0.76 | 0.88 | 0.93 | 1.08 | 1.20 |
| P6P082 | I91 | Derby | 4 | 1.52 | 1.41 | 1.33 | 1.15 | 1.03 | 0.95 | 0.73 | 0.64 | 0.82 | 0.91 | 1.24 | 1.26 |
| P6X027 | VT9 | Wilmington | 4 | 1.36 | 1.25 | 1.25 | 1.22 | 1.05 | 0.87 | 0.74 | 0.74 | 0.86 | 0.88 | 1.21 | 1.22 |
| **Group 4 Avg** | | | | **1.40** | **1.30** | **1.27** | **1.15** | **0.99** | **0.87** | **0.76** | **0.71** | **0.85** | **0.92** | **1.18** | **1.24** |

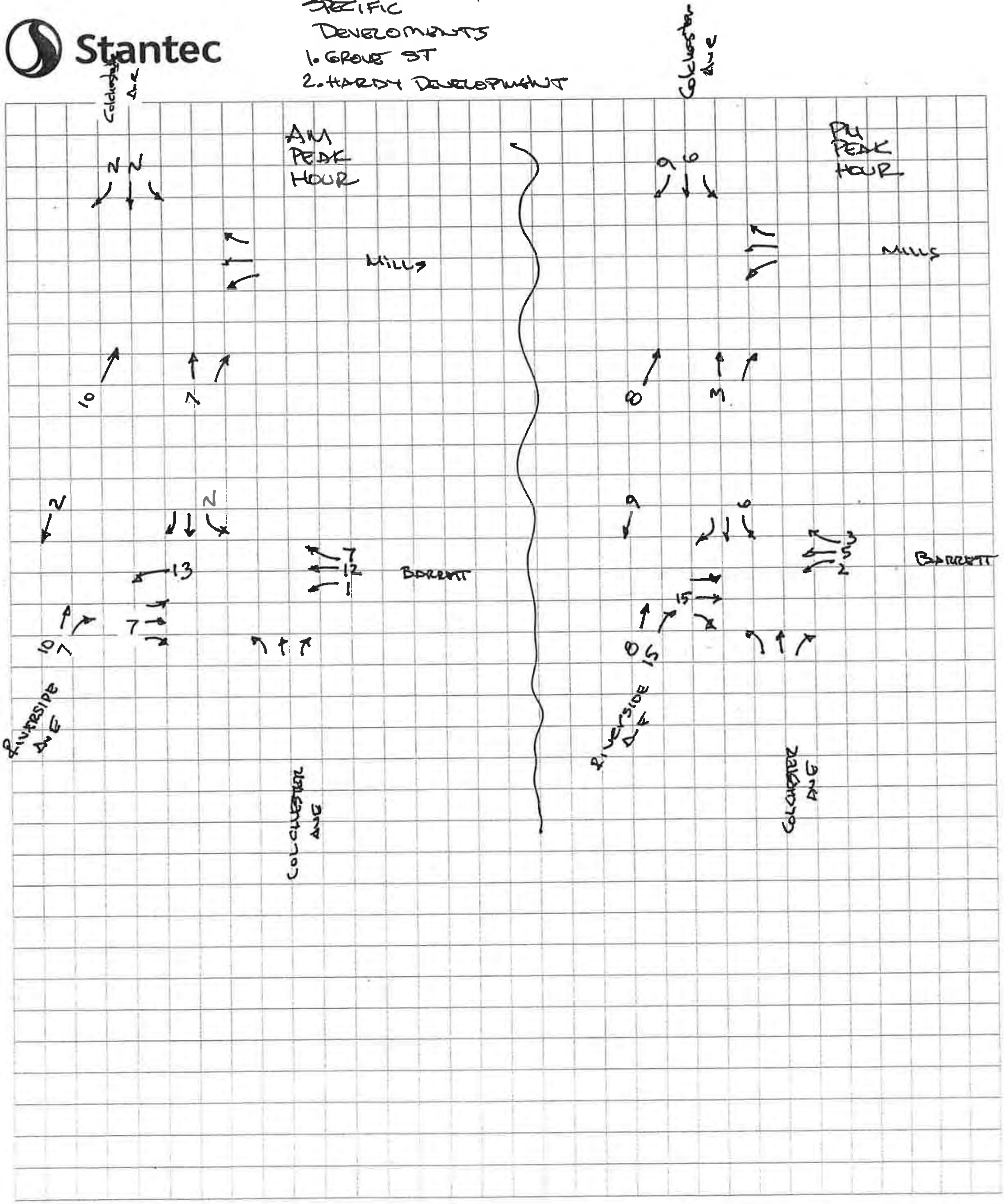
11/18

## 2014 CTC Summary

| Site ID | Route | Town | Seasonal Adjustment Factor Group | Regression Group | AADT | AAWDT | #1 High Hour | 30th High Hour | %k |
|---|---|---|---|---|---|---|---|---|---|
| P6A018 | US7 | Leicester | 2 | C | 6200 | 6700 | 724 | 676 | 10.9 |
| P6A019 | VT22A | Orwell | 2 | C | 3600 | 3600 | 585 | 438 | 12.2 |
| P6A041 | US7 | New Haven | 2 | C | 7000 | 7500 | 840 | 723 | 10.3 |
| P6A111 | VT22A | Addison | 2 | C | 4900 | 4800 | 653 | 565 | 11.5 |
| P6B026 | VT11 | Winhall | 5 | C | 4200 | 4100 | 840 | 645 | 15.4 |
| P6B037 | US7 | Pownal | 2 | C | 6500 | 6700 | 900 | 734 | 11.3 |
| P6B041 | VT9 | Bennington | 2 | B | 4500 | 4700 | 891 | 537 | 11.9 |
| P6B061 | MC0118 | Winhall | 6 | E | 3200 | 2900 | 1091 | 847 | 26.5 |
| P6B282 | US7 | Shaftsbury | 2 | C | 6500 | 6700 | 1062 | 876 | 13.5 |
| P6B379 | VT279 | Bennington | 2 | C | 6500 | 6300 | 1114 | 913 | 14.0 |
| P6C002 | I91 | Sheffield | 4 | A | 4800 | 4900 | 949 | 700 | 14.6 |
| P6C007 | VT15 | Hardwick | 2 | C | 4900 | 5200 | 664 | 560 | 11.4 |
| P6C015 | I93 | Waterford | 4 | A | 6300 | 6000 | 1045 | 911 | 14.5 |
| P6C028 | US2 | Danville | 2 | C | 6900 | 7100 | 861 | 756 | 11.0 |
| P6C043 | VT114 | Burke | 5 | E | 3100 | 3100 | 610 | 392 | 12.6 |
| P6C309 | MC0268 | Burke | 6 | E | 1100 | 1100 | 475 | 244 | 22.2 |
| P6D001 | VT127 | Burlington | 3 | B | 14100 | 15100 | 1659 | 1578 | 11.2 |
| P6D040 | US7 | Colchester | 3 | B | 15400 | 16600 | 1912 | 1780 | 11.6 |
| P6D059 | MC0223 | Bolton | 6 | E | 890 | 820 | 441 | 282 | 31.7 |
| P6D061 | US2 | Williston | 3 | B | 10800 | 11900 | 1363 | 1187 | 11.0 |
| P6D091 | I89 | South Burlington | 3 | A | 53100 | 58000 | 7455 | 5644 | 10.6 |
| P6D092 | I89 | Colchester | 3 | A | 30400 | 33000 | 3846 | 3603 | 11.9 |
| P6D129 | VT2A | Williston | 3 | B | 16800 | 17700 | 1815 | 1694 | 10.1 |
| P6D132 | US7 | Charlotte | 2 | C | 11500 | 12100 | 1320 | 1177 | 10.2 |
| P6D277 | US7 | Shelburne | 3 | B | 17600 | 18200 | 1850 | 1533 | 8.7 |
| P6D530 | VT289 | Essex | 3 | B | 16400 | 17400 | 1880 | 1757 | 10.7 |
| P6D531 | VT289 | Essex | 3 | B | 5400 | 5900 | 1032 | 712 | 13.2 |
| P6E020 | US2 | Concord | 4 | C | 2600 | 2700 | 403 | 340 | 13.1 |
| P6E131 | US2 | Guildhall | 4 | C | 3100 | 3200 | 480 | 397 | 12.8 |
| P6F029 | US7 | Georgia | 3 | C | 3800 | 4100 | 556 | 472 | 12.4 |
| P6F096 | I89 | Swanton | 1 | A | 9900 | 10500 | 1483 | 1156 | 11.7 |
| P6G025 | US2 | Grand Isle | 4 | C | 2900 | 2900 | 513 | 444 | 15.3 |
| P6G118 | US2 | Alburg | 4 | C | 4400 | 4400 | 608 | 545 | 12.4 |
| P6L047 | VT12 | Elmore | 2 | C | 890 | 980 | 169 | 133 | 14.9 |
| P6L057 | VT108 | Stowe | 6 | C | 4100 | 3700 | 1173 | 897 | 21.9 |
| P6N001 | I91 | Fairlee | 1 | A | 8500 | 8800 | 1269 | 1027 | 12.1 |
| P6N002 | I91 | Bradford | 1 | A | 7600 | 8000 | 1049 | 920 | 12.1 |
| P6P004 | VT100 | Westfield | 2 | C | 2100 | 2200 | 304 | 228 | 10.9 |
| P6P082 | I91 | Derby | 4 | A | 3000 | 3000 | 543 | 447 | 14.9 |
| P6P215 | US5 | Derby | 2 | C | 10200 | 11100 | 1305 | 1132 | 11.1 |
| P6R001 | US4 | Fair Haven | 1 | A | 6800 | 6500 | 959 | 817 | 12.0 |
| P6R005 | US4 | Killington | 5 | C | 9000 | 8900 | 1455 | 1105 | 12.3 |
| P6R017 | VT103 | Mt Holly | 2 | C | 4700 | 4900 | 648 | 534 | 11.4 |
| P6R022 | US7 | Rutland Town | 3 | B | 21500 | 23000 | 2405 | 2206 | 10.3 |
| P6R054 | MC0159 | Killington | 6 | E | 4600 | 4400 | 1329 | 902 | 19.6 |
| P6R084 | US4 | West Rutland | 1 | C | 12700 | 13400 | 1470 | 1314 | 10.3 |
| P6R100 | US7 | Brandon | 2 | C | 5700 | 5900 | 702 | 605 | 10.6 |
| P6W004 | VT62 | Barre City | 3 | B | 11100 | 12400 | 1378 | 1291 | 11.6 |
| P6W006 | US302 | Berlin | 3 | B | 13000 | 14200 | 1541 | 1414 | 10.9 |

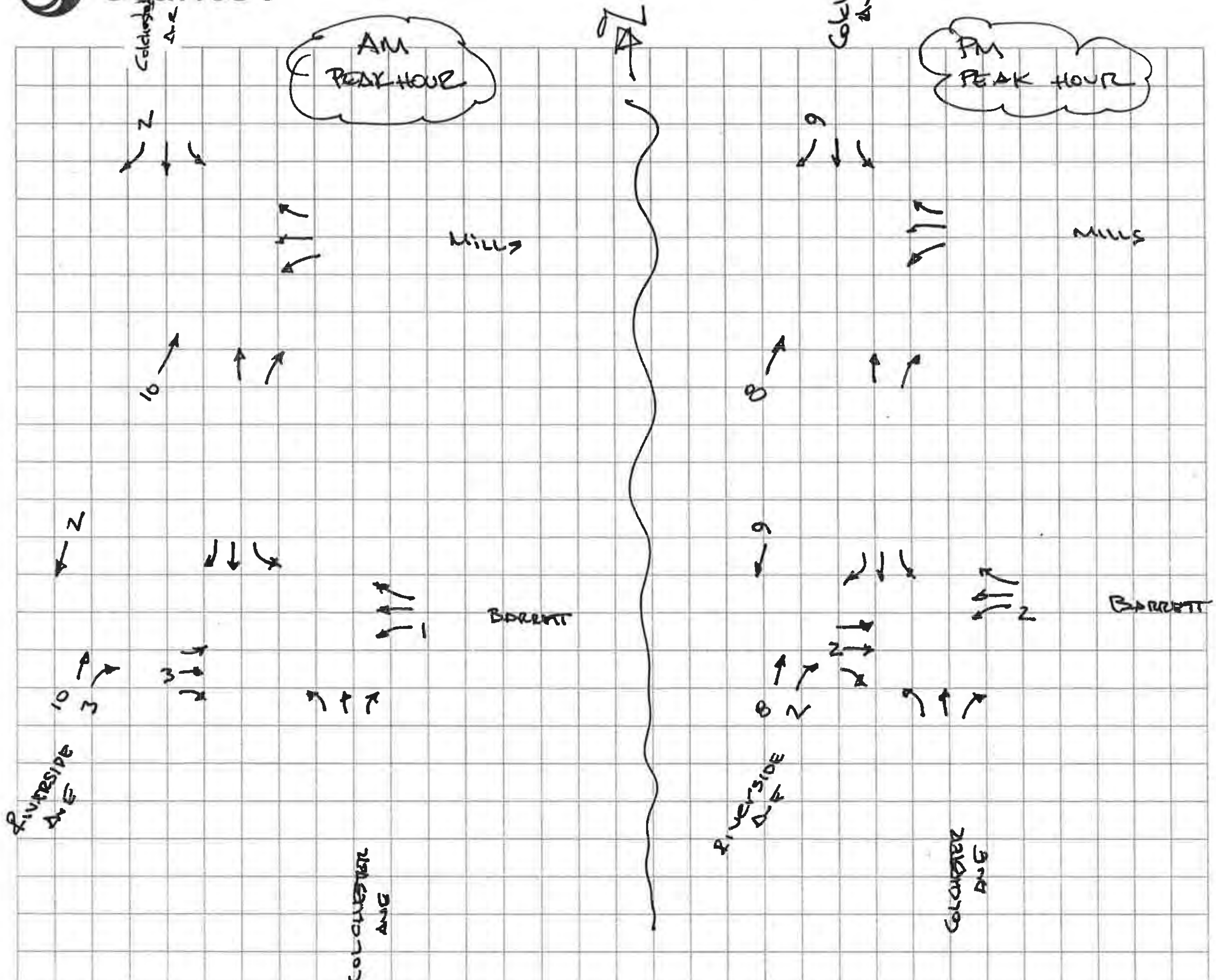
Stantec

SPECIFIC DEVELOPMENTS
1. GROVE ST
2. HARDY DEVELOPMENT



HARDY DEVELOPMENT
(SISTERS AND BROTHERS INVESTMENT)






FROM: TRAFFIC IMPACT SUMMARY (3-14-2013) PREPARED BY TRUDELL CONSULTING ENGINEERS

DEVELOPMENT OF 57 RESIDENTIAL UNITS AT A LOCATION SOUTH OF THE INTERSECTION.

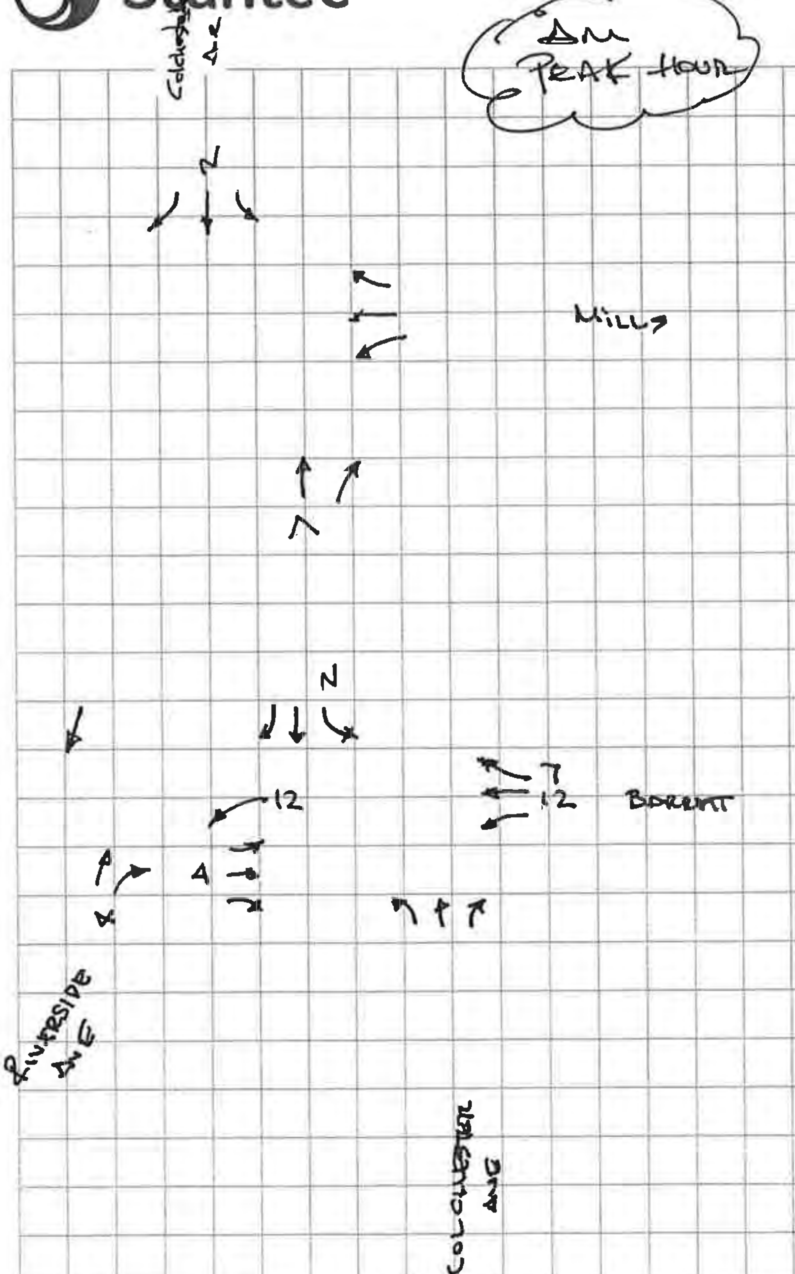
SISTERS AND BROTHERS TRIP DISTRIBUTION THROUGH RIVERSIDE / COLCHESTER / BARRETT INTERSECTION

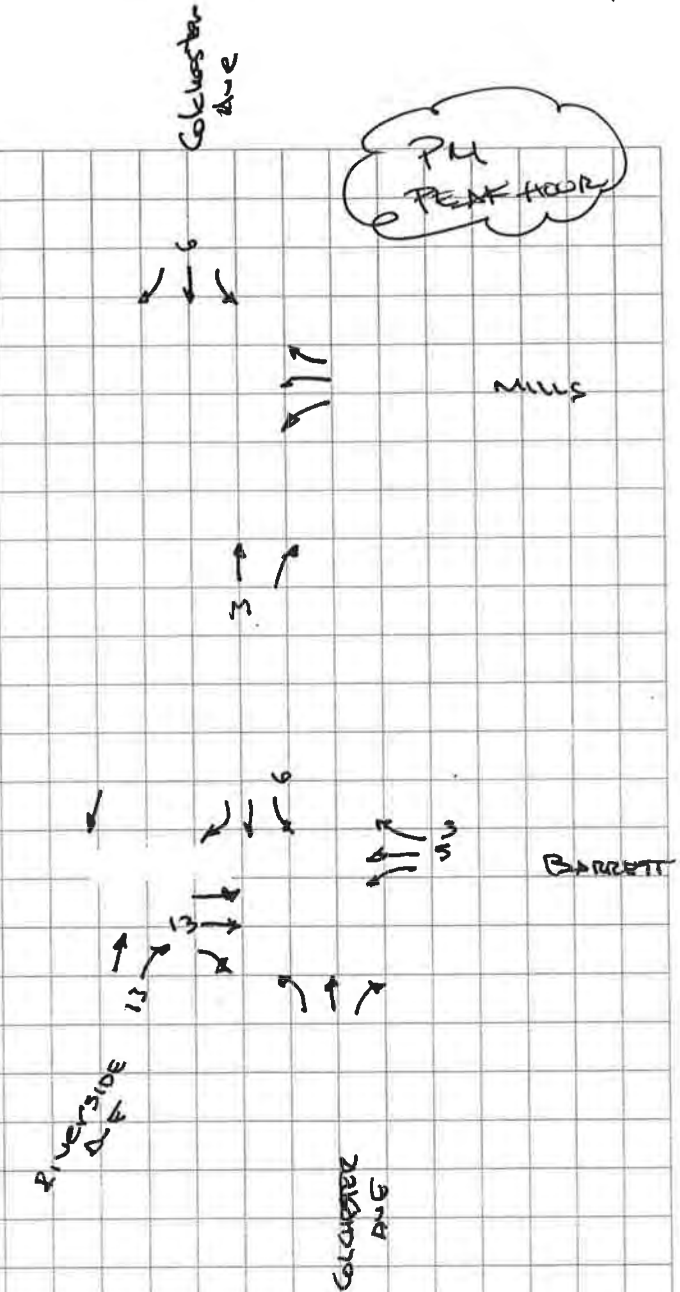
Designed by: DSD

Checked by:

GROVE STREET

Stantec



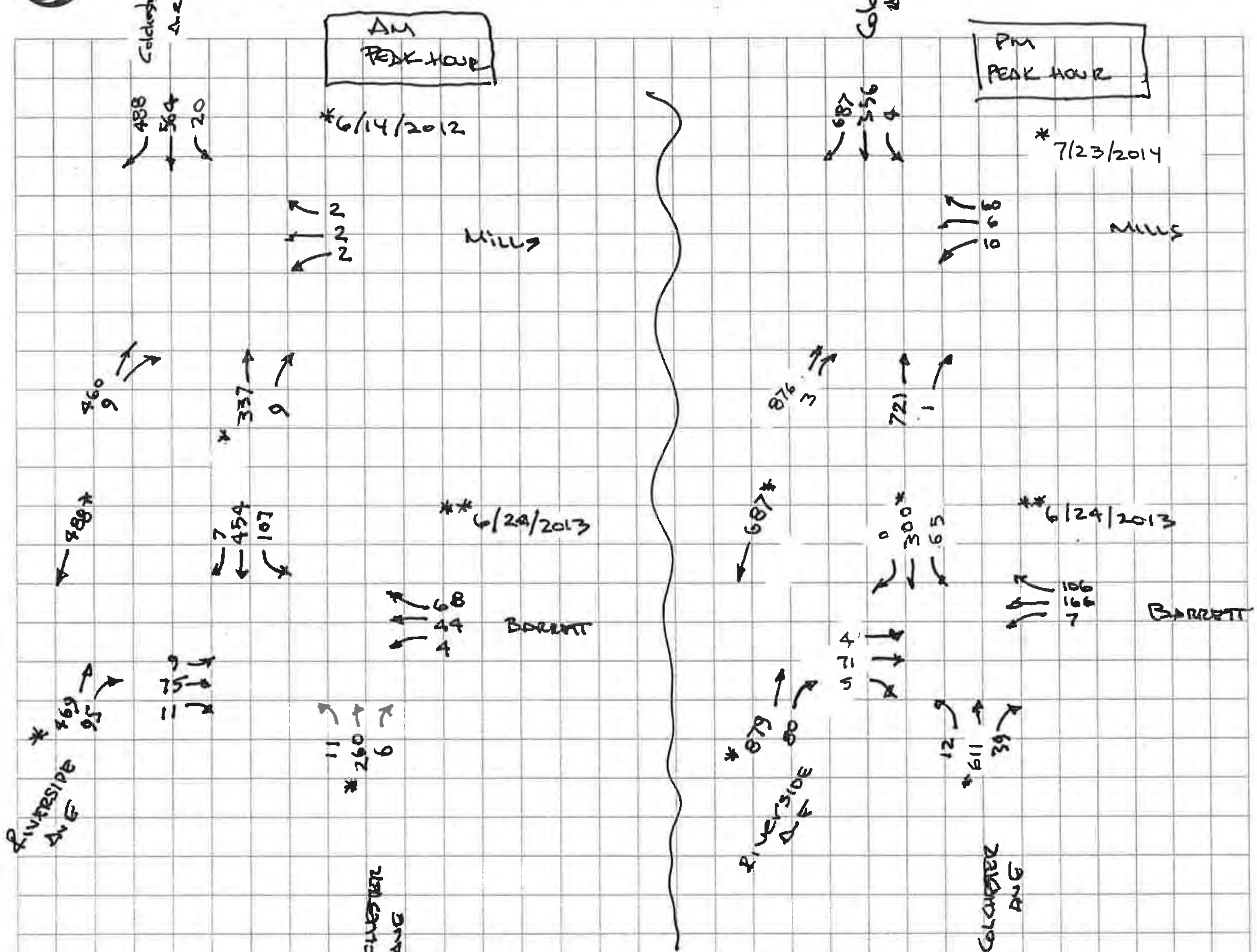

FROM: SD IRELAND / GROVE STREET HOUSING TRAFFIC IMPACT STUDY PREPARED BY RSG OCTOBER 11, 2013

DEVELOPMENT INCLUDES 232 HOUSING UNITS

GROVE STREET DEVELOPMENT TRIPS THROUGH RIVERSIDE/COLCHESTER/BARRETT INTERSECTION

Designed by: DJD Checked by:

Stantec




BASED ON VTRANS COUNTS DATED 6/14/2012, 6/24/2013 & 7/23/2014

EXISTING TRAFFIC VOLUMES (BALANCED BUT NOT FACTORED FOR DHV)

Designed by: DJD 1/26/16 Checked by:

File Name: Z:\PPID\PPAndRBureau\TrafficResearch\CountPrograms\TurningMovementCountProgram\2014\MergedCounts\7-25_3merged1
Start Date: 7/23/2014
Start Time: 6:00:00 AM
Site Code: 30403780
Comment 1: Counter: TU 1494, T2093
Comment 2: Counted by: M Lawson, J Booth
Comment 3: Weather: Rainy
Comment 4: Town: 7-25.3 Burlington

| | Colchester Ave/US 7 from Winooski | | | | Mill St from Dead End | | | | Colchester Ave from East Ave | | | | Riverside Ave from Winooski Ave | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | Peds | Right | Thru | Left | Peds | Right | Thru | Left | Peds | Right | Thru | Left | Peds | | |
| 06:00 AM | 16 | 54 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 24 | 0 | 0 | 0 | 0 | 39 | 0 | 134 | |
| 06:15 AM | 19 | 111 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 0 | 42 | 0 | 196 | |
| 06:30 AM | 21 | 120 | 4 | 1 | 0 | 0 | 0 | 0 | 1 | 36 | 0 | 0 | 0 | 1 | 72 | 0 | 256 | |
| 06:45 AM | 59 | 135 | 3 | 0 | 2 | 0 | 0 | 0 | 1 | 52 | 0 | 0 | 0 | 0 | 57 | 0 | 309 | 895 |
| 07:00 AM | 67 | 157 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 12 | 0 | 250 | 1011 |
| 07:15 AM | 53 | 174 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 23 | 0 | 0 | 1 | 1 | 30 | 0 | 283 | 1098 |
| 07:30 AM | 95 | 167 | 3 | 5 | 1 | 0 | 0 | 0 | 0 | 60 | 0 | 0 | 0 | 3 | 58 | 0 | 392 | 1234 |
| 07:45 AM | 115 | 171 | 7 | 1 | 0 | 0 | 1 | 0 | 1 | 36 | 0 | 0 | 0 | 1 | 59 | 0 | 392 | 1317 |
| 08:00 AM | 63 | 209 | 3 | 0 | 1 | 0 | 1 | 0 | 1 | 36 | 0 | 0 | 0 | 0 | 50 | 0 | 364 | 1431 |
| 08:15 AM | 53 | 188 | 3 | 0 | 0 | 0 | 0 | 0 | 5 | 70 | 0 | 0 | 0 | 0 | 89 | 0 | 408 | 1556 |
| 08:30 AM | 75 | 163 | 10 | 1 | 0 | 0 | 0 | 0 | 1 | 85 | 0 | 0 | 0 | 0 | 110 | 0 | 445 | 1609 |
| 08:45 AM | 94 | 118 | 2 | 0 | 1 | 0 | 0 | 0 | 6 | 87 | 0 | 0 | 0 | 0 | 89 | 0 | 397 | 1614 |
| 09:00 AM | 57 | 118 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 71 | 1 | 0 | 0 | 0 | 66 | 0 | 317 | 1567 |
| 09:15 AM | 52 | 131 | 5 | 0 | 0 | 0 | 0 | 0 | 2 | 57 | 1 | 0 | 0 | 1 | 71 | 0 | 320 | 1479 |
| 09:30 AM | 27 | 132 | 4 | 0 | 0 | 0 | 0 | 0 | 3 | 64 | 0 | 0 | 0 | 1 | 62 | 0 | 293 | 1327 |
| 09:45 AM | 46 | 165 | 2 | 0 | 2 | 0 | 1 | 0 | 1 | 71 | 0 | 0 | 0 | 1 | 62 | 0 | 351 | 1281 |
| 10:00 AM | 63 | 85 | 2 | 0 | 2 | 1 | 2 | 0 | 2 | 65 | 0 | 0 | 0 | 1 | 86 | 0 | 309 | 1273 |
| 10:15 AM | 50 | 129 | 4 | 0 | 2 | 0 | 1 | 0 | 2 | 65 | 0 | 0 | 0 | 0 | 69 | 0 | 322 | 1275 |
| 10:30 AM | 34 | 132 | 2 | 8 | 1 | 0 | 1 | 0 | 1 | 87 | 0 | 0 | 0 | 1 | 68 | 0 | 335 | 1317 |
| 10:45 AM | 45 | 143 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 57 | 0 | 0 | 0 | 0 | 64 | 0 | 312 | 1278 |
| 11:00 AM | 46 | 93 | 7 | 1 | 0 | 0 | 0 | 0 | 1 | 96 | 0 | 0 | 0 | 0 | 63 | 0 | 307 | 1276 |
| 11:15 AM | 75 | 154 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 82 | 0 | 0 | 0 | 1 | 70 | 0 | 387 | 1341 |
| 11:30 AM | 81 | 161 | 4 | 0 | 2 | 0 | 2 | 0 | 1 | 83 | 0 | 0 | 0 | 1 | 77 | 0 | 412 | 1418 |
| 11:45 AM | 69 | 137 | 11 | 0 | 0 | 1 | 2 | 0 | 2 | 101 | 1 | 0 | 0 | 1 | 97 | 0 | 422 | 1528 |
| 12:00 PM | 105 | 96 | 8 | 1 | 7 | 2 | 3 | 0 | 3 | 119 | 0 | 0 | 0 | 1 | 112 | 0 | 457 | 1678 |
| 12:15 PM | 126 | 86 | 10 | 0 | 3 | 6 | 3 | 0 | 8 | 92 | 0 | 0 | 0 | 3 | 89 | 0 | 426 | 1717 |
| 12:30 PM | 107 | 112 | 1 | 1 | 3 | 0 | 4 | 0 | 5 | 110 | 1 | 0 | 0 | 2 | 99 | 0 | 445 | 1750 |
| 12:45 PM | 122 | 102 | 8 | 0 | 8 | 0 | 3 | 0 | 7 | 77 | 1 | 0 | 0 | 1 | 96 | 0 | 425 | 1753 |
| 01:00 PM | 108 | 91 | 8 | 0 | 4 | 2 | 2 | 0 | 3 | 111 | 0 | 0 | 0 | 1 | 93 | 0 | 423 | 1719 |
| 01:15 PM | 121 | 81 | 7 | 1 | 5 | 1 | 1 | 0 | 4 | 146 | 1 | 0 | 0 | 4 | 109 | 0 | 481 | 1774 |
| 01:30 PM | 129 | 84 | 5 | 9 | 11 | 3 | 4 | 0 | 0 | 130 | 0 | 0 | 0 | 2 | 103 | 0 | 480 | 1809 |
| 01:45 PM | 96 | 94 | 5 | 0 | 4 | 2 | 4 | 0 | 3 | 136 | 0 | 0 | 0 | 0 | 129 | 0 | 473 | 1857 |
| 02:00 PM | 98 | 87 | 0 | 0 | 4 | 2 | 2 | 0 | 3 | 134 | 0 | 0 | 0 | 1 | 108 | 0 | 439 | 1873 |
| 02:15 PM | 104 | 84 | 0 | 0 | 4 | 2 | 0 | 0 | 0 | 135 | 0 | 0 | 0 | 0 | 85 | 0 | 414 | 1806 |
| 02:30 PM | 89 | 101 | 0 | 0 | 2 | 2 | 6 | 0 | 4 | 142 | 0 | 0 | 0 | 1 | 86 | 0 | 433 | 1759 |
| 02:45 PM | 90 | 90 | 7 | 1 | 2 | 1 | 2 | 0 | 1 | 114 | 1 | 0 | 0 | 0 | 123 | 0 | 432 | 1718 |
| 03:00 PM | 99 | 76 | 2 | 0 | 5 | 3 | 2 | 0 | 19 | 124 | 0 | 0 | 0 | 3 | 130 | 0 | 463 | 1742 |
| 03:15 PM | 132 | 67 | 4 | 0 | 6 | 0 | 0 | 0 | 3 | 154 | 0 | 0 | 0 | 0 | 132 | 0 | 498 | 1826 |
| 03:30 PM | 137 | 98 | 2 | 0 | 11 | 1 | 0 | 0 | 3 | 150 | 1 | 0 | 0 | 1 | 147 | 0 | 551 | 1944 |
| 03:45 PM | 122 | 93 | 8 | 2 | 5 | 1 | 2 | 0 | 2 | 180 | 1 | 0 | 0 | 0 | 159 | 0 | 575 | 2087 |
| 04:00 PM | 126 | 83 | 4 | 0 | 10 | 2 | 3 | 0 | 0 | 197 | 0 | 0 | 0 | 3 | 137 | 0 | 565 | 2189 |
| 04:15 PM | 103 | 95 | 1 | 0 | 5 | 1 | 2 | 0 | 3 | 188 | 0 | 0 | 0 | 5 | 185 | 0 | 588 | 2279 |
| 04:30 PM | 123 | 100 | 4 | 0 | 8 | 2 | 1 | 0 | 2 | 174 | 0 | 0 | 0 | 4 | 156 | 0 | 574 | 2302 |
| 04:45 PM | 165 | 83 | 1 | 0 | 13 | 1 | 2 | 0 | 0 | 167 | 0 | 0 | 0 | 1 | 218 | 0 | 651 | 2378 |
| 05:00 PM | 177 | 90 | 1 | 0 | 16 | 1 | 2 | 0 | 0 | 175 | 0 | 0 | 1 | 0 | 229 | 0 | 692 | 2505 |
| 05:15 PM | 176 | 95 | 2 | 0 | 16 | 2 | 2 | 0 | 1 | 190 | 0 | 0 | 0 | 2 | 223 | 0 | 709 | 2626 |
| 05:30 PM | 169 | 88 | 0 | 0 | 15 | 2 | 4 | 0 | 0 | 189 | 0 | 0 | 0 | 0 | 206 | 0 | 673 | 2725 |
| 05:45 PM | 154 | 73 | 2 | 0 | 14 | 2 | 2 | 0 | 0 | 183 | 0 | 0 | 0 | 0 | 201 | 0 | 631 | 2705 |
| AM Peak H | 285 | 678 | 18 | 1 | 2 | 0 | 1 | 0 | 13 | 278 | 0 | 0 | 0 | 0 | 338 | 0 | 1614 | |
| AM HV | 20 | 26 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 19 | 0 | 0 | 0 | 0 | 10 | 0 | | |
| | 5% | | | | 40% | | | | 7% | | | | 3% | | | | | |
| PM Peak H | 687 | 356 | 4 | 0 | 60 | 6 | 10 | 0 | 1 | 721 | 0 | 0 | 1 | 3 | 876 | 0 | 2725 | |
| PM HV | 13 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 7 | 0 | | |
| | 2% | | | | 0% | | | | 1% | | | | 1% | | | | | |

$PHF = \frac{1614}{445 \times 4} = 0.91$

$PHF = \frac{2729}{709 \times 4} = 0.96$

16/18

File Name: Z:\PPID\PPAndRBureau\TrafficResearch\CountPrograms\TurningMovementCountProgram\2013\Merged2013\FAU5004-23merg
Start Date: 6/24/2013
Start Time: 6:00:00 AM
Site Code: 30403805
Comment 1: Counter: T 2091
Comment 2: Counted by: E Fournier
Comment 3: Weather: Cloudy
Comment 4: Town: FAU 5004-23 Burlington

| | Colchester Ave from Winooski | | | | Barrett St from Grove St | | | | Colchester Ave from East Ave | | | | Barrett St from Riverside Ave | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | Peds | Right | Thru | Left | Peds | Right | Thru | Left | Peds | Right | Thru | Left | Peds | | |
| 06:00 AM | 4 | 101 | 21 | 0 | 0 | 6 | 6 | 0 | 0 | 18 | 2 | 0 | 8 | 7 | 0 | 0 | 173 | |
| 06:15 AM | 0 | 97 | 47 | 0 | 7 | 8 | 1 | 1 | 0 | 11 | 0 | 0 | 3 | 13 | 1 | 0 | 189 | |
| 06:30 AM | 0 | 112 | 30 | 0 | 8 | 6 | 3 | 3 | 1 | 29 | 3 | 0 | 1 | 30 | 0 | 0 | 226 | |
| 06:45 AM | 0 | 163 | 40 | 0 | 12 | 8 | 1 | 3 | 0 | 35 | 0 | 0 | 8 | 23 | 0 | 0 | 293 | 881 |
| 07:00 AM | 1 | 170 | 36 | 0 | 7 | 10 | 1 | 2 | 1 | 33 | 1 | 0 | 5 | 27 | 0 | 0 | 294 | 1002 |
| 07:15 AM | 0 | 73 | 20 | 0 | 4 | 9 | 2 | 0 | 2 | 30 | 0 | 0 | 3 | 13 | 0 | 0 | 156 | 969 |
| 07:30 AM | 3 | 96 | 17 | 0 | 3 | 10 | 1 | 4 | 0 | 44 | 1 | 0 | 2 | 25 | 0 | 0 | 206 | 949 |
| 07:45 AM | 1 | 35 | 8 | 0 | 8 | 8 | 0 | 5 | 2 | 18 | 0 | 0 | 1 | 10 | 2 | 0 | 98 | 754 |
| 08:00 AM | 0 | 124 | 23 | 0 | 18 | 17 | 4 | 0 | 0 | 44 | 1 | 0 | 8 | 14 | 0 | 0 | 253 | 713 |
| 08:15 AM | 1 | 75 | 13 | 0 | 12 | 11 | 1 | 2 | 5 | 41 | 1 | 0 | 2 | 25 | 0 | 0 | 189 | 746 |
| 08:30 AM | 5 | 51 | 8 | 0 | 5 | 6 | 0 | 5 | 3 | 41 | 0 | 1 | 3 | 16 | 4 | 1 | 149 | 689 |
| 08:45 AM | 1 | 42 | 6 | 0 | 1 | 0 | 0 | 4 | 3 | 20 | 1 | 0 | 2 | 5 | 5 | 0 | 90 | 681 |
| 09:00 AM | 3 | 52 | 12 | 0 | 3 | 7 | 1 | 0 | 3 | 15 | 0 | 0 | 1 | 4 | 0 | 0 | 101 | 529 |
| 09:15 AM | 0 | 54 | 20 | 0 | 11 | 24 | 0 | 2 | 1 | 31 | 1 | 0 | 2 | 9 | 0 | 1 | 156 | 496 |
| 09:30 AM | 1 | 77 | 18 | 0 | 11 | 13 | 0 | 1 | 2 | 42 | 2 | 0 | 4 | 12 | 0 | 0 | 183 | 530 |
| 09:45 AM | 3 | 102 | 17 | 0 | 11 | 9 | 0 | 1 | 1 | 51 | 4 | 0 | 6 | 14 | 2 | 0 | 221 | 661 |
| 10:00 AM | 4 | 118 | 41 | 0 | 25 | 7 | 3 | 3 | 0 | 43 | 0 | 0 | 2 | 16 | 5 | 0 | 267 | 827 |
| 10:15 AM | 0 | 102 | 22 | 0 | 14 | 9 | 1 | 0 | 4 | 66 | 3 | 0 | 3 | 19 | 0 | 0 | 243 | 914 |
| 10:30 AM | 0 | 132 | 27 | 0 | 18 | 19 | 0 | 1 | 1 | 52 | 4 | 0 | 0 | 26 | 2 | 0 | 282 | 1013 |
| 10:45 AM | 0 | 105 | 28 | 0 | 6 | 9 | 0 | 1 | 1 | 41 | 0 | 0 | 3 | 12 | 0 | 0 | 206 | 998 |
| 11:00 AM | 0 | 68 | 23 | 0 | 9 | 5 | 1 | 0 | 1 | 33 | 0 | 0 | 3 | 18 | 2 | 0 | 163 | 894 |
| 11:15 AM | 0 | 62 | 18 | 0 | 6 | 2 | 1 | 0 | 0 | 43 | 0 | 0 | 1 | 17 | 1 | 0 | 151 | 802 |
| 11:30 AM | 0 | 34 | 22 | 0 | 10 | 8 | 0 | 0 | 0 | 23 | 1 | 0 | 1 | 23 | 0 | 0 | 122 | 642 |
| 11:45 AM | 4 | 39 | 22 | 0 | 11 | 7 | 3 | 3 | 0 | 29 | 3 | 1 | 2 | 26 | 0 | 0 | 150 | 586 |
| 12:00 PM | 2 | 68 | 21 | 0 | 18 | 18 | 3 | 3 | 7 | 96 | 1 | 1 | 4 | 18 | 0 | 0 | 260 | 683 |
| 12:15 PM | 5 | 92 | 15 | 0 | 15 | 24 | 5 | 6 | 1 | 98 | 2 | 0 | 2 | 27 | 2 | 0 | 294 | 826 |
| 12:30 PM | 0 | 94 | 23 | 0 | 32 | 26 | 0 | 2 | 2 | 87 | 3 | 0 | 2 | 21 | 1 | 0 | 293 | 997 |
| 12:45 PM | 0 | 87 | 23 | 0 | 22 | 25 | 1 | 4 | 1 | 116 | 4 | 1 | 1 | 17 | 0 | 0 | 302 | 1149 |
| 01:00 PM | 2 | 76 | 22 | 0 | 21 | 19 | 0 | 3 | 2 | 82 | 2 | 0 | 6 | 29 | 0 | 0 | 264 | 1153 |
| 01:15 PM | 0 | 85 | 16 | 0 | 15 | 18 | 1 | 2 | 5 | 80 | 2 | 1 | 5 | 30 | 0 | 0 | 260 | 1119 |
| 01:30 PM | 2 | 81 | 20 | 0 | 21 | 18 | 2 | 0 | 4 | 112 | 3 | 0 | 3 | 32 | 0 | 0 | 298 | 1124 |
| 01:45 PM | 0 | 54 | 12 | 0 | 12 | 30 | 1 | 4 | 0 | 76 | 0 | 2 | 5 | 22 | 2 | 0 | 220 | 1042 |
| 02:00 PM | 0 | 71 | 16 | 0 | 14 | 26 | 2 | 0 | 0 | 95 | 3 | 0 | 5 | 25 | 0 | 0 | 257 | 1035 |
| 02:15 PM | 0 | 89 | 14 | 0 | 18 | 16 | 1 | 1 | 2 | 99 | 2 | 0 | 4 | 24 | 0 | 0 | 270 | 1045 |
| 02:30 PM | 0 | 88 | 17 | 0 | 30 | 17 | 0 | 1 | 1 | 133 | 3 | 1 | 1 | 27 | 0 | 0 | 319 | 1066 |
| 02:45 PM | 0 | 83 | 16 | 0 | 25 | 29 | 2 | 5 | 0 | 104 | 1 | 0 | 3 | 25 | 0 | 0 | 293 | 1139 |
| 03:00 PM | 0 | 82 | 14 | 0 | 28 | 28 | 0 | 3 | 5 | 129 | 2 | 0 | 10 | 13 | 0 | 0 | 314 | 1196 |
| 03:15 PM | 0 | 65 | 12 | 0 | 23 | 24 | 2 | 0 | 0 | 144 | 3 | 0 | 5 | 21 | 0 | 1 | 300 | 1226 |
| 03:30 PM | 0 | 67 | 14 | 0 | 25 | 27 | 2 | 2 | 0 | 151 | 2 | 0 | 5 | 22 | 0 | 0 | 317 | 1224 |
| 03:45 PM | 0 | 61 | 16 | 0 | 25 | 23 | 1 | 1 | 1 | 123 | 2 | 0 | 4 | 21 | 0 | 0 | 278 | 1209 |
| 04:00 PM | 1 | 55 | 17 | 0 | 25 | 17 | 1 | 0 | 4 | 105 | 4 | 0 | 3 | 21 | 0 | 0 | 253 | 1148 |
| 04:15 PM | 0 | 68 | 8 | 0 | 19 | 33 | 2 | 1 | 5 | 109 | 2 | 0 | 0 | 21 | 1 | 0 | 269 | 1117 |
| 04:30 PM | 0 | 77 | 25 | 0 | 28 | 35 | 3 | 4 | 4 | 131 | 1 | 0 | 1 | 17 | 0 | 0 | 326 | 1126 |
| 04:45 PM | 0 | 79 | 14 | 0 | 33 | 46 | 2 | 0 | 3 | 121 | 0 | 0 | 2 | 16 | 0 | 0 | 316 | 1164 |
| 05:00 PM | 0 | 77 | 20 | 0 | 23 | 43 | 2 | 8 | 12 | 137 | 4 | 0 | 0 | 20 | 0 | 1 | 347 | 1258 |
| 05:15 PM | 0 | 79 | 18 | 0 | 30 | 35 | 1 | 5 | 18 | 146 | 2 | 0 | 0 | 17 | 2 | 3 | 356 | 1345 |
| 05:30 PM | 0 | 82 | 14 | 0 | 26 | 44 | 1 | 3 | 4 | 131 | 3 | 0 | 3 | 17 | 1 | 0 | 329 | 1348 |
| 05:45 PM | 0 | 79 | 13 | 0 | 27 | 44 | 3 | 2 | 5 | 129 | 3 | 2 | 2 | 17 | 1 | 0 | 327 | 1359 |
| | | | | | | | | | | | | | | | | | | |
| AM Peak H | 7 | 454 | 107 | 0 | 68 | 44 | 4 | 5 | 6 | 212 | 11 | 0 | 11 | 75 | 9 | 0 | 1013 | |
| AM HV | 0 | 13 | 3 | 0 | 3 | 0 | 0 | 0 | 1 | 14 | 0 | 0 | 4 | 3 | 3 | 0 | | |
| | | 3% | | | | 3% | | | | 7% | | | | 11% | | | | |
| PM Peak H | 0 | 317 | 65 | 0 | 106 | 166 | 7 | 18 | 39 | 543 | 12 | 2 | 5 | 71 | 4 | 4 | 1359 | |
| PM HV | 0 | 6 | 4 | 0 | 2 | 0 | 1 | 0 | 0 | 15 | 0 | 0 | 0 | 1 | 0 | 0 | | |
| | | 3% | | | | 1% | | | | 3% | | | | 1% | | | | |

PHF = $\frac{1013}{282 \times 4}$ 0.89

PHF = $\frac{1359}{356 \times 4}$ = 0.95

17/18

File Name: Z:\PPID\PPAndRBureau\TrafficResearch\From Tech Services\Traffic\TRFCRES\TR_TM\JAMAR\PETRA\Data Files\2012\merg
Start Date: 6/14/2012
Start Time: 6:00:00 AM
Site Code: 30403780
Comment 1: Counter: TU0118, T12-1198
Comment 2: Counted by: K Bessette, C Richards
Comment 3: Weather: Sunny
Comment 4: Town: 7-25.3 Burlington

| | US 7/2 from Winooski From North | | | | Mill St from Dead End From East | | | | Colchester Ave from East Ave From South | | | | US 7/Riverside Ave from N Winooski Ave From West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Right | Thru | Left | Peds | Right | Thru | Left | Peds | Right | Thru | Left | Peds | Right | Thru | Left | Peds | | |
| 06:00 AM | 26 | 58 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 17 | 0 | 0 | 0 | 0 | 36 | 0 | 140 | |
| 06:15 AM | 31 | 70 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 17 | 0 | 0 | 0 | 0 | 42 | 0 | 162 | |
| 06:30 AM | 54 | 93 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 54 | 0 | 0 | 0 | 0 | 48 | 0 | 253 | |
| 06:45 AM | 60 | 116 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 41 | 0 | 0 | 0 | 0 | 70 | 0 | 289 | 844 |
| 07:00 AM | 82 | 100 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 42 | 0 | 0 | 0 | 0 | 48 | 0 | 278 | 982 |
| 07:15 AM | 107 | 125 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | 66 | 0 | 0 | 0 | 1 | 87 | 0 | 394 | 1214 |
| 07:30 AM | 126 | 152 | 7 | 0 | 0 | 1 | 2 | 0 | 1 | 71 | 0 | 0 | 0 | 1 | 121 | 0 | 482 | 1443 |
| 07:45 AM | 118 | 144 | 4 | 0 | 1 | 0 | 0 | 0 | 2 | 89 | 0 | 0 | 0 | 1 | 112 | 0 | 471 | 1625 |
| 08:00 AM | 126 | 132 | 5 | 0 | 0 | 1 | 0 | 0 | 2 | 81 | 0 | 0 | 0 | 4 | 110 | 0 | 461 | 1808 |
| 08:15 AM | 118 | 136 | 4 | 0 | 1 | 0 | 0 | 0 | 4 | 96 | 0 | 0 | 0 | 3 | 117 | 0 | 479 | 1893 |
| 08:30 AM | 109 | 147 | 2 | 0 | 1 | 0 | 3 | 0 | 1 | 84 | 0 | 0 | 0 | 0 | 106 | 0 | 453 | 1864 |
| 08:45 AM | 99 | 113 | 5 | 0 | 2 | 0 | 0 | 0 | 8 | 110 | 0 | 0 | 0 | 1 | 99 | 0 | 437 | 1830 |
| 09:00 AM | 107 | 99 | 3 | 0 | 3 | 0 | 3 | 1 | 2 | 94 | 0 | 0 | 0 | 5 | 77 | 0 | 394 | 1763 |
| 09:15 AM | 124 | 102 | 5 | 0 | 2 | 0 | 3 | 0 | 1 | 59 | 0 | 0 | 0 | 0 | 74 | 0 | 370 | 1654 |
| 09:30 AM | 91 | 99 | 3 | 0 | 1 | 0 | 2 | 0 | 1 | 80 | 0 | 0 | 0 | 0 | 81 | 0 | 358 | 1559 |
| 09:45 AM | 104 | 123 | 1 | 0 | 1 | 0 | 3 | 0 | 2 | 88 | 0 | 0 | 0 | 1 | 79 | 0 | 402 | 1524 |
| 10:00 AM | 116 | 106 | 2 | 0 | 3 | 1 | 0 | 0 | 0 | 81 | 0 | 0 | 0 | 0 | 77 | 0 | 386 | 1516 |
| 10:15 AM | 106 | 113 | 3 | 0 | 3 | 0 | 2 | 0 | 0 | 77 | 0 | 0 | 0 | 0 | 85 | 0 | 389 | 1535 |
| 10:30 AM | 113 | 101 | 1 | 0 | 4 | 0 | 0 | 0 | 2 | 88 | 0 | 0 | 0 | 1 | 86 | 0 | 396 | 1573 |
| 10:45 AM | 104 | 94 | 2 | 0 | 2 | 0 | 2 | 0 | 2 | 92 | 0 | 0 | 0 | 1 | 84 | 0 | 383 | 1554 |
| 11:00 AM | 89 | 97 | 4 | 0 | 2 | 2 | 2 | 0 | 2 | 91 | 0 | 0 | 0 | 2 | 82 | 0 | 373 | 1541 |
| 11:15 AM | 81 | 97 | 3 | 0 | 4 | 1 | 3 | 0 | 0 | 84 | 0 | 0 | 0 | 0 | 85 | 0 | 358 | 1510 |
| 11:30 AM | 96 | 107 | 4 | 0 | 3 | 2 | 2 | 0 | 0 | 80 | 0 | 0 | 0 | 0 | 84 | 0 | 376 | 1492 |
| 11:45 AM | 108 | 116 | 3 | 0 | 2 | 0 | 3 | 0 | 4 | 105 | 0 | 0 | 0 | 2 | 95 | 0 | 438 | 1547 |
| 12:00 PM | 98 | 114 | 3 | 7 | 3 | 1 | 5 | 0 | 3 | 122 | 0 | 0 | 0 | 2 | 114 | 0 | 472 | 1646 |
| 12:15 PM | 99 | 88 | 4 | 0 | 2 | 2 | 1 | 3 | 7 | 106 | 0 | 0 | 0 | 2 | 104 | 0 | 418 | 1706 |
| 12:30 PM | 112 | 108 | 1 | 0 | 2 | 0 | 2 | 0 | 0 | 137 | 0 | 0 | 0 | 1 | 97 | 0 | 460 | 1788 |
| 12:45 PM | 101 | 110 | 5 | 0 | 2 | 1 | 2 | 0 | 0 | 125 | 0 | 0 | 0 | 1 | 124 | 0 | 471 | 1821 |
| 01:00 PM | 136 | 100 | 2 | 0 | 3 | 0 | 1 | 0 | 3 | 123 | 0 | 0 | 0 | 1 | 95 | 0 | 464 | 1813 |
| 01:15 PM | 121 | 121 | 2 | 0 | 5 | 0 | 1 | 0 | 0 | 94 | 0 | 0 | 0 | 0 | 116 | 0 | 460 | 1855 |
| 01:30 PM | 116 | 107 | 1 | 0 | 1 | 2 | 4 | 0 | 1 | 105 | 0 | 0 | 0 | 0 | 116 | 0 | 453 | 1848 |
| 01:45 PM | 112 | 100 | 1 | 0 | 4 | 0 | 1 | 0 | 4 | 115 | 0 | 0 | 0 | 0 | 149 | 0 | 486 | 1863 |
| 02:00 PM | 101 | 104 | 1 | 3 | 0 | 1 | 2 | 0 | 2 | 125 | 0 | 0 | 0 | 1 | 113 | 0 | 453 | 1852 |
| 02:15 PM | 99 | 93 | 4 | 0 | 2 | 0 | 0 | 0 | 1 | 139 | 0 | 0 | 0 | 0 | 134 | 0 | 472 | 1864 |
| 02:30 PM | 124 | 106 | 6 | 0 | 6 | 1 | 3 | 0 | 1 | 115 | 0 | 0 | 0 | 1 | 115 | 0 | 478 | 1889 |
| 02:45 PM | 101 | 106 | 2 | 0 | 3 | 0 | 0 | 0 | 3 | 134 | 0 | 0 | 0 | 2 | 140 | 0 | 491 | 1894 |
| 03:00 PM | 121 | 99 | 0 | 0 | 3 | 0 | 2 | 0 | 0 | 152 | 0 | 0 | 0 | 0 | 130 | 0 | 507 | 1948 |
| 03:15 PM | 132 | 90 | 1 | 0 | 2 | 0 | 2 | 0 | 1 | 154 | 0 | 0 | 0 | 0 | 142 | 0 | 524 | 2000 |
| 03:30 PM | 121 | 89 | 2 | 0 | 6 | 0 | 1 | 1 | 3 | 160 | 0 | 0 | 0 | 1 | 141 | 0 | 525 | 2047 |
| 03:45 PM | 134 | 83 | 3 | 0 | 5 | 0 | 4 | 0 | 0 | 141 | 0 | 0 | 0 | 0 | 149 | 0 | 519 | 2075 |
| 04:00 PM | 128 | 96 | 4 | 0 | 7 | 0 | 0 | 1 | 0 | 171 | 0 | 0 | 0 | 0 | 175 | 0 | 582 | 2150 |
| 04:15 PM | 112 | 107 | 4 | 0 | 8 | 0 | 1 | 0 | 2 | 179 | 0 | 0 | 0 | 1 | 197 | 0 | 611 | 2237 |
| 04:30 PM | 136 | 115 | 0 | 0 | 5 | 3 | 1 | 4 | 1 | 161 | 0 | 0 | 0 | 0 | 185 | 0 | 611 | 2323 |
| 04:45 PM | 121 | 76 | 2 | 0 | 8 | 1 | 1 | 1 | 2 | 170 | 0 | 0 | 0 | 1 | 216 | 0 | 599 | 2403 |
| 05:00 PM | 126 | 80 | 2 | 0 | 7 | 1 | 3 | 0 | 2 | 177 | 0 | 0 | 0 | 1 | 203 | 0 | 602 | 2423 |
| 05:15 PM | 137 | 79 | 1 | 0 | 4 | 1 | 5 | 0 | 0 | 182 | 0 | 0 | 0 | 0 | 217 | 0 | 626 | 2438 |
| 05:30 PM | 123 | 70 | 3 | 0 | 3 | 0 | 4 | 0 | 0 | 183 | 0 | 0 | 0 | 0 | 210 | 0 | 596 | 2423 |
| 05:45 PM | 125 | 61 | 2 | 0 | 5 | 1 | 1 | 0 | 0 | 163 | 0 | 0 | 0 | 0 | 187 | 0 | 545 | 2369 |
| AM Peak Hour | 488 | 564 | 20 | 0 | 2 | 2 | 2 | 0 | 9 | 337 | 0 | 0 | 0 | 9 | 460 | 0 | 1893 | |
| Heavy Trucks | 19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | |
| | 4% | | | | 0% | | | | 5% | | | | 4% | | | | | |
| PM Peak Hour | 520 | 350 | 5 | 0 | 24 | 6 | 10 | 5 | 5 | 690 | 0 | 0 | 0 | 2 | 821 | 0 | 2438 | |
| Heavy Trucks | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | |
| | 1% | | | | 0% | | | | 1% | | | | 1% | | | | | |

PHF = $\frac{1893}{482 \times 4}$ = 0.98

PHF = $\frac{2438}{626 \times 4}$ = 0.97

18/100

# APPENDIX D

## Capacity Analysis Worksheets

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 64 | 0 | 487 | 98 | 0 | 510 |
| Future Volume (vph) | 64 | 0 | 487 | 98 | 0 | 510 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | | 5.0 | | | 5.0 |
| Lane Util. Factor | 1.00 | | 0.95 | | | 1.00 |
| Frt | 1.00 | | 0.97 | | | 1.00 |
| Flt Protected | 0.95 | | 1.00 | | | 1.00 |
| Satd. Flow (prot) | 1752 | | 3417 | | | 1810 |
| Flt Permitted | 0.95 | | 1.00 | | | 1.00 |
| Satd. Flow (perm) | 1752 | | 3417 | | | 1810 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 67 | 0 | 513 | 103 | 0 | 537 |
| RTOR Reduction (vph) | 0 | 0 | 17 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 67 | 0 | 599 | 0 | 0 | 537 |
| Heavy Vehicles (%) | 3% | 0% | 3% | 3% | 0% | 5% |
| Turn Type | Prot | | NA | | | NA |
| Protected Phases | 4 | | 3 | | | 2 3 |
| Permitted Phases | | | | | | |
| Actuated Green, G (s) | 9.5 | | 23.0 | | | 77.7 |
| Effective Green, g (s) | 9.5 | | 23.0 | | | 77.7 |
| Actuated g/C Ratio | 0.10 | | 0.24 | | | 0.80 |
| Clearance Time (s) | 5.0 | | 5.0 | | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | | | |
| Lane Grp Cap (vph) | 171 | | 808 | | | 1446 |
| v/s Ratio Prot | c0.04 | | c0.18 | | | c0.30 |
| v/s Ratio Perm | | | | | | |
| v/c Ratio | 0.39 | | 0.74 | | | 0.37 |
| Uniform Delay, d1 | 41.1 | | 34.3 | | | 2.8 |
| Progression Factor | 0.76 | | 1.00 | | | 0.92 |
| Incremental Delay, d2 | 1.3 | | 3.7 | | | 0.2 |
| Delay (s) | 32.5 | | 38.0 | | | 2.7 |
| Level of Service | C | | D | | | A |
| Approach Delay (s) | 32.5 | | 38.0 | | | 2.7 |
| Approach LOS | C | | D | | | A |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 22.2 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.49 | | |
| Actuated Cycle Length (s) | 97.2 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 41.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | WBL | NBT | SBT |
|---|---|---|---|
| Lane Group Flow (vph) | 67 | 616 | 537 |
| v/c Ratio | 0.39 | 0.75 | 0.37 |
| Control Delay | 38.0 | 40.1 | 3.4 |
| Queue Delay | 0.0 | 0.0 | 0.3 |
| Total Delay | 38.0 | 40.1 | 3.7 |
| Queue Length 50th (ft) | 26 | 183 | 71 |
| Queue Length 95th (ft) | m45 | 252 | 84 |
| Internal Link Dist (ft) | 16 | 61 | 108 |
| Turn Bay Length (ft) | | | |
| Base Capacity (vph) | 198 | 826 | 1447 |
| Starvation Cap Reductn | 0 | 0 | 413 |
| Spillback Cap Reductn | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.34 | 0.75 | 0.52 |

Intersection Summary

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

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 9 | 78 | 11 | 4 | 46 | 71 | 11 | 270 | 6 | 111 | 472 | 7 |
| Future Volume (vph) | 9 | 78 | 11 | 4 | 46 | 71 | 11 | 270 | 6 | 111 | 472 | 7 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.98 | | | 0.92 | | | 1.00 | | 1.00 | 1.00 | |
| Flt Protected | | 1.00 | | | 1.00 | | | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1677 | | | 1715 | | | 1774 | | 1752 | 1842 | |
| Flt Permitted | | 1.00 | | | 1.00 | | | 0.98 | | 0.54 | 1.00 | |
| Satd. Flow (perm) | | 1677 | | | 1715 | | | 1739 | | 1002 | 1842 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 9 | 82 | 12 | 4 | 48 | 75 | 12 | 284 | 6 | 117 | 497 | 7 |
| RTOR Reduction (vph) | 0 | 5 | 0 | 0 | 52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 98 | 0 | 0 | 75 | 0 | 0 | 302 | 0 | 117 | 504 | 0 |
| Heavy Vehicles (%) | 11% | 11% | 11% | 0% | 0% | 3% | 0% | 7% | 0% | 3% | 3% | 0% |
| Turn Type | Split | NA | | Split | NA | | custom | NA | | custom | NA | |
| Protected Phases | 3 | 3 | | 4 | 4 | | | | | | | |
| Permitted Phases | | | | | | | 6 | 6 | | 2 | 2 | |
| Actuated Green, G (s) | | 23.0 | | | 9.5 | | | 49.7 | | 49.7 | 49.7 | |
| Effective Green, g (s) | | 23.0 | | | 9.5 | | | 49.7 | | 49.7 | 49.7 | |
| Actuated g/C Ratio | | 0.24 | | | 0.10 | | | 0.51 | | 0.51 | 0.51 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 396 | | | 167 | | | 889 | | 512 | 941 | |
| v/s Ratio Prot | | c0.06 | | | c0.04 | | | | | | | |
| v/s Ratio Perm | | | | | | | | 0.17 | | 0.12 | c0.27 | |
| v/c Ratio | | 0.25 | | | 0.45 | | | 0.34 | | 0.23 | 0.54 | |
| Uniform Delay, d1 | | 30.1 | | | 41.4 | | | 14.0 | | 13.1 | 16.0 | |
| Progression Factor | | 0.12 | | | 1.00 | | | 1.00 | | 0.19 | 0.16 | |
| Incremental Delay, d2 | | 0.2 | | | 1.9 | | | 0.2 | | 0.2 | 0.4 | |
| Delay (s) | | 3.9 | | | 43.3 | | | 14.3 | | 2.7 | 2.9 | |
| Level of Service | | A | | | D | | | B | | A | A | |
| Approach Delay (s) | | 3.9 | | | 43.3 | | | 14.3 | | | 2.9 | |
| Approach LOS | | A | | | D | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 10.4 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.44 | | |
| Actuated Cycle Length (s) | 97.2 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 66.1% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | EBT | WBT | NBT | SBL | SBT |
|---|---|---|---|---|---|
| Lane Group Flow (vph) | 103 | 127 | 302 | 117 | 504 |
| v/c Ratio | 0.26 | 0.58 | 0.34 | 0.23 | 0.54 |
| Control Delay | 4.7 | 35.3 | 15.4 | 3.4 | 4.2 |
| Queue Delay | 0.0 | 0.6 | 0.2 | 1.0 | 0.7 |
| Total Delay | 4.7 | 35.9 | 15.7 | 4.3 | 4.8 |
| Queue Length 50th (ft) | 0 | 41 | 105 | 5 | 20 |
| Queue Length 95th (ft) | m0 | 100 | 169 | m7 | 26 |
| Internal Link Dist (ft) | 16 | 90 | 10 | | 120 |
| Turn Bay Length (ft) | | | | | |
| Base Capacity (vph) | 401 | 245 | 913 | 526 | 967 |
| Starvation Cap Reductn | 0 | 0 | 0 | 238 | 190 |
| Spillback Cap Reductn | 0 | 17 | 171 | 0 | 181 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.26 | 0.56 | 0.41 | 0.41 | 0.65 |

**Intersection Summary**

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

| Movement | WBL2 | WBL | WBR | NBL | NBT | NBR | SBL | SBT | SBR | NEL | NER |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | |
| Traffic Volume (vph) | 2 | 2 | 2 | 0 | 350 | 9 | 21 | 587 | 508 | 478 | 9 |
| Future Volume (vph) | 2 | 2 | 2 | 0 | 350 | 9 | 21 | 587 | 508 | 478 | 9 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | | | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 0.95 | | | 1.00 | 1.00 | 0.97 | |
| Frt | | 0.95 | | | 1.00 | | | 1.00 | 0.85 | 1.00 | |
| Flt Protected | | 0.97 | | | 1.00 | | | 1.00 | 1.00 | 0.95 | |
| Satd. Flow (prot) | | 1171 | | | 3366 | | | 1809 | 1538 | 3404 | |
| Flt Permitted | | 0.97 | | | 1.00 | | | 0.98 | 1.00 | 0.95 | |
| Satd. Flow (perm) | | 1171 | | | 3366 | | | 1776 | 1538 | 3404 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 2 | 2 | 2 | 0 | 368 | 9 | 22 | 618 | 535 | 503 | 9 |
| RTOR Reduction (vph) | 0 | 5 | 0 | 0 | 1 | 0 | 0 | 0 | 107 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 1 | 0 | 0 | 376 | 0 | 0 | 640 | 428 | 512 | 0 |
| Heavy Vehicles (%) | 50% | 50% | 50% | 1% | 7% | 1% | 0% | 5% | 5% | 3% | 0% |
| Turn Type | Prot | Prot | | | NA | | Perm | NA | pt+ov | Prot | |
| Protected Phases | 4 | 4 | | | 2 | | | 2 | 2 3 | 3 | |
| Permitted Phases | | | | | | | 2 | | | | |
| Actuated Green, G (s) | | 9.5 | | | 49.7 | | | 49.7 | 77.7 | 23.0 | |
| Effective Green, g (s) | | 9.5 | | | 49.7 | | | 49.7 | 77.7 | 23.0 | |
| Actuated g/C Ratio | | 0.10 | | | 0.51 | | | 0.51 | 0.80 | 0.24 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | | 3.0 | | 3.0 | |
| Lane Grp Cap (vph) | | 114 | | | 1721 | | | 908 | 1229 | 805 | |
| v/s Ratio Prot | | c0.00 | | | 0.11 | | | | 0.28 | c0.15 | |
| v/s Ratio Perm | | | | | | | | c0.36 | | | |
| v/c Ratio | | 0.01 | | | 0.22 | | | 0.70 | 0.35 | 0.64 | |
| Uniform Delay, d1 | | 39.6 | | | 13.1 | | | 18.1 | 2.7 | 33.3 | |
| Progression Factor | | 1.00 | | | 0.37 | | | 1.00 | 1.00 | 0.26 | |
| Incremental Delay, d2 | | 0.0 | | | 0.1 | | | 2.5 | 0.2 | 1.1 | |
| Delay (s) | | 39.6 | | | 4.9 | | | 20.7 | 2.9 | 9.8 | |
| Level of Service | | D | | | A | | | C | A | A | |
| Approach Delay (s) | | 39.6 | | | 4.9 | | | 12.6 | | 9.8 | |
| Approach LOS | | D | | | A | | | B | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 10.6 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.60 | | |
| Actuated Cycle Length (s) | 97.2 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 81.0% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | WBL | NBT | SBT | SBR | NEL |
|---|---|---|---|---|---|
| Lane Group Flow (vph) | 6 | 377 | 640 | 535 | 512 |
| v/c Ratio | 0.03 | 0.22 | 0.70 | 0.40 | 0.64 |
| Control Delay | 0.3 | 5.1 | 23.5 | 1.1 | 11.4 |
| Queue Delay | 0.0 | 0.5 | 0.0 | 0.0 | 0.6 |
| Total Delay | 0.3 | 5.6 | 23.5 | 1.2 | 12.0 |
| Queue Length 50th (ft) | 0 | 29 | 288 | 0 | 13 |
| Queue Length 95th (ft) | 0 | 41 | 436 | 18 | 56 |
| Internal Link Dist (ft) | 88 | 120 | 132 | | 108 |
| Turn Bay Length (ft) | | | | | |
| Base Capacity (vph) | 200 | 1768 | 932 | 1337 | 805 |
| Starvation Cap Reductn | 0 | 957 | 0 | 0 | 79 |
| Spillback Cap Reductn | 0 | 0 | 0 | 20 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.03 | 0.46 | 0.69 | 0.41 | 0.71 |

Intersection Summary

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 185 | 0 | 914 | 83 | 0 | 724 |
| Future Volume (vph) | 185 | 0 | 914 | 83 | 0 | 724 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | | 5.0 | | | 5.0 |
| Lane Util. Factor | 1.00 | | 0.95 | | | 1.00 |
| Frt | 1.00 | | 0.99 | | | 1.00 |
| Flt Protected | 0.95 | | 1.00 | | | 1.00 |
| Satd. Flow (prot) | 1805 | | 3530 | | | 1863 |
| Flt Permitted | 0.95 | | 1.00 | | | 1.00 |
| Satd. Flow (perm) | 1805 | | 3530 | | | 1863 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 195 | 0 | 962 | 87 | 0 | 762 |
| RTOR Reduction (vph) | 0 | 0 | 6 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 195 | 0 | 1043 | 0 | 0 | 762 |
| Heavy Vehicles (%) | 0% | 0% | 1% | 1% | 0% | 2% |
| Turn Type | Prot | | NA | | | NA |
| Protected Phases | 4 | | 3 | | | 2 3 |
| Permitted Phases | | | | | | |
| Actuated Green, G (s) | 20.0 | | 36.0 | | | 90.0 |
| Effective Green, g (s) | 20.0 | | 36.0 | | | 90.0 |
| Actuated g/C Ratio | 0.17 | | 0.30 | | | 0.75 |
| Clearance Time (s) | 5.0 | | 5.0 | | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | | | |
| Lane Grp Cap (vph) | 300 | | 1059 | | | 1397 |
| v/s Ratio Prot | c0.11 | | c0.30 | | | c0.41 |
| v/s Ratio Perm | | | | | | |
| v/c Ratio | 0.65 | | 0.99 | | | 0.55 |
| Uniform Delay, d1 | 46.7 | | 41.7 | | | 6.3 |
| Progression Factor | 0.34 | | 1.00 | | | 0.95 |
| Incremental Delay, d2 | 1.5 | | 23.9 | | | 0.4 |
| Delay (s) | 17.6 | | 65.6 | | | 6.4 |
| Level of Service | B | | E | | | A |
| Approach Delay (s) | 17.6 | | 65.6 | | | 6.4 |
| Approach LOS | B | | E | | | A |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 38.5 | HCM 2000 Level of Service | D |
| HCM 2000 Volume to Capacity ratio | 0.73 | | |
| Actuated Cycle Length (s) | 120.0 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 56.7% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | WBL | NBT | SBT |
|---|---|---|---|
| Lane Group Flow (vph) | 195 | 1049 | 762 |
| v/c Ratio | 0.65 | 0.99 | 0.55 |
| Control Delay | 19.6 | 66.1 | 7.6 |
| Queue Delay | 0.0 | 2.0 | 0.3 |
| Total Delay | 19.6 | 68.1 | 7.8 |
| Queue Length 50th (ft) | 33 | 422 | 215 |
| Queue Length 95th (ft) | m39 | #572 | 297 |
| Internal Link Dist (ft) | 16 | 61 | 108 |
| Turn Bay Length (ft) | | | |
| Base Capacity (vph) | 300 | 1064 | 1397 |
| Starvation Cap Reductn | 0 | 0 | 174 |
| Spillback Cap Reductn | 0 | 10 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.65 | 1.00 | 0.62 |

Intersection Summary

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

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

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ✥ | | | ✥ | | | ✥ | | ↰ | ↑ | |
| Traffic Volume (vph) | 4 | 74 | 5 | 7 | 173 | 110 | 12 | 635 | 41 | 68 | 315 | 0 |
| Future Volume (vph) | 4 | 74 | 5 | 7 | 173 | 110 | 12 | 635 | 41 | 68 | 315 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.99 | | | 0.95 | | | 0.99 | | 1.00 | 1.00 | |
| Flt Protected | | 1.00 | | | 1.00 | | | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1862 | | | 1783 | | | 1832 | | 1752 | 1845 | |
| Flt Permitted | | 1.00 | | | 1.00 | | | 0.99 | | 0.22 | 1.00 | |
| Satd. Flow (perm) | | 1862 | | | 1783 | | | 1819 | | 407 | 1845 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 4 | 78 | 5 | 7 | 182 | 116 | 13 | 668 | 43 | 72 | 332 | 0 |
| RTOR Reduction (vph) | 0 | 2 | 0 | 0 | 18 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 85 | 0 | 0 | 287 | 0 | 0 | 722 | 0 | 72 | 332 | 0 |
| Heavy Vehicles (%) | 1% | 1% | 1% | 1% | 1% | 1% | 0% | 3% | 0% | 3% | 3% | 0% |
| Turn Type | Split | NA | | Split | NA | | custom | NA | | custom | NA | |
| Protected Phases | 3 | 3 | | 4 | 4 | | | | | | | |
| Permitted Phases | | | | | | | 6 | 6 | | 2 | 2 | |
| Actuated Green, G (s) | | 36.0 | | | 20.0 | | | 49.0 | | 49.0 | 49.0 | |
| Effective Green, g (s) | | 36.0 | | | 20.0 | | | 49.0 | | 49.0 | 49.0 | |
| Actuated g/C Ratio | | 0.30 | | | 0.17 | | | 0.41 | | 0.41 | 0.41 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 558 | | | 297 | | | 742 | | 166 | 753 | |
| v/s Ratio Prot | | c0.05 | | | c0.16 | | | | | | | |
| v/s Ratio Perm | | | | | | | | c0.40 | | 0.18 | 0.18 | |
| v/c Ratio | | 0.15 | | | 0.97 | | | 0.97 | | 0.43 | 0.44 | |
| Uniform Delay, d1 | | 30.8 | | | 49.7 | | | 34.9 | | 25.5 | 25.6 | |
| Progression Factor | | 0.14 | | | 1.00 | | | 1.00 | | 0.16 | 0.15 | |
| Incremental Delay, d2 | | 0.0 | | | 42.4 | | | 26.4 | | 1.6 | 0.4 | |
| Delay (s) | | 4.4 | | | 92.1 | | | 61.2 | | 5.6 | 4.1 | |
| Level of Service | | A | | | F | | | E | | A | A | |
| Approach Delay (s) | | 4.4 | | | 92.1 | | | 61.2 | | | 4.4 | |
| Approach LOS | | A | | | F | | | E | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 49.1 | HCM 2000 Level of Service | D |
| HCM 2000 Volume to Capacity ratio | 0.69 | | |
| Actuated Cycle Length (s) | 120.0 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 72.2% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| | → | ← | ↑ | ↘ | ↓ |
|---|---|---|---|---|---|
| Lane Group | EBT | WBT | NBT | SBL | SBT |
| Lane Group Flow (vph) | 87 | 305 | 724 | 72 | 332 |
| v/c Ratio | 0.16 | 0.97 | 0.97 | 0.44 | 0.44 |
| Control Delay | 4.5 | 89.8 | 62.4 | 11.5 | 5.5 |
| Queue Delay | 0.0 | 10.6 | 45.6 | 0.2 | 0.3 |
| Total Delay | 4.5 | 100.5 | 108.0 | 11.8 | 5.8 |
| Queue Length 50th (ft) | 0 | 222 | 540 | 4 | 18 |
| Queue Length 95th (ft) | m0 | #404 | #803 | 8 | 26 |
| Internal Link Dist (ft) | 16 | 90 | 10 | | 120 |
| Turn Bay Length (ft) | | | | | |
| Base Capacity (vph) | 560 | 315 | 744 | 165 | 753 |
| Starvation Cap Reductn | 0 | 0 | 0 | 5 | 105 |
| Spillback Cap Reductn | 0 | 14 | 401 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.16 | 1.01 | 2.11 | 0.45 | 0.51 |

Intersection Summary

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

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

| Movement | WBL2 | WBL | WBR | NBL | NBT | NBR | SBL | SBT | SBR | NEL | NER |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | |
| Traffic Volume (vph) | 10 | 6 | 62 | 0 | 750 | 1 | 4 | 370 | 714 | 911 | 3 |
| Future Volume (vph) | 10 | 6 | 62 | 0 | 750 | 1 | 4 | 370 | 714 | 911 | 3 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | | | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 0.95 | | | 1.00 | 1.00 | 0.97 | |
| Frt | | 0.89 | | | 1.00 | | | 1.00 | 0.85 | 1.00 | |
| Flt Protected | | 0.99 | | | 1.00 | | | 1.00 | 1.00 | 0.95 | |
| Satd. Flow (prot) | | 1679 | | | 3574 | | | 1880 | 1599 | 3475 | |
| Flt Permitted | | 0.99 | | | 1.00 | | | 0.99 | 1.00 | 0.95 | |
| Satd. Flow (perm) | | 1679 | | | 3574 | | | 1868 | 1599 | 3475 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 11 | 6 | 65 | 0 | 789 | 1 | 4 | 389 | 752 | 959 | 3 |
| RTOR Reduction (vph) | 0 | 53 | 0 | 0 | 0 | 0 | 0 | 0 | 188 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 29 | 0 | 0 | 790 | 0 | 0 | 393 | 564 | 962 | 0 |
| Heavy Vehicles (%) | 0% | 0% | 0% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% |
| Turn Type | Prot | Prot | | | NA | | Perm | NA | pt+ov | Prot | |
| Protected Phases | 4 | 4 | | | 2 | | | 2 | 2 3 | 3 | |
| Permitted Phases | | | | | | | 2 | | | | |
| Actuated Green, G (s) | | 20.0 | | | 49.0 | | | 49.0 | 90.0 | 36.0 | |
| Effective Green, g (s) | | 20.0 | | | 49.0 | | | 49.0 | 90.0 | 36.0 | |
| Actuated g/C Ratio | | 0.17 | | | 0.41 | | | 0.41 | 0.75 | 0.30 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | | 3.0 | | 3.0 | |
| Lane Grp Cap (vph) | | 279 | | | 1459 | | | 762 | 1199 | 1042 | |
| v/s Ratio Prot | | c0.02 | | | c0.22 | | | | 0.35 | c0.28 | |
| v/s Ratio Perm | | | | | | | | 0.21 | | | |
| v/c Ratio | | 0.10 | | | 0.54 | | | 0.52 | 0.47 | 0.92 | |
| Uniform Delay, d1 | | 42.4 | | | 27.0 | | | 26.6 | 5.8 | 40.7 | |
| Progression Factor | | 1.00 | | | 0.28 | | | 1.00 | 1.00 | 0.22 | |
| Incremental Delay, d2 | | 0.2 | | | 0.1 | | | 0.6 | 0.3 | 4.1 | |
| Delay (s) | | 42.6 | | | 7.6 | | | 27.2 | 6.1 | 13.1 | |
| Level of Service | | D | | | A | | | C | A | B | |
| Approach Delay (s) | | 42.6 | | | 7.6 | | | 13.3 | | 13.1 | |
| Approach LOS | | D | | | A | | | B | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 12.6 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.59 | | |
| Actuated Cycle Length (s) | 120.0 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 67.9% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | WBL | NBT | SBT | SBR | NEL |
|---|---|---|---|---|---|
| Lane Group Flow (vph) | 82 | 790 | 393 | 752 | 962 |
| v/c Ratio | 0.25 | 0.54 | 0.52 | 0.54 | 0.92 |
| Control Delay | 17.0 | 8.0 | 29.6 | 1.9 | 15.1 |
| Queue Delay | 0.0 | 10.8 | 0.0 | 0.2 | 5.0 |
| Total Delay | 17.0 | 18.8 | 29.6 | 2.1 | 20.1 |
| Queue Length 50th (ft) | 12 | 76 | 225 | 0 | 54 |
| Queue Length 95th (ft) | 58 | m86 | 321 | 27 | m61 |
| Internal Link Dist (ft) | 88 | 120 | 132 | | 108 |
| Turn Bay Length (ft) | | | | | |
| Base Capacity (vph) | 333 | 1459 | 762 | 1387 | 1043 |
| Starvation Cap Reductn | 0 | 643 | 0 | 0 | 53 |
| Spillback Cap Reductn | 0 | 0 | 0 | 138 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.25 | 0.97 | 0.52 | 0.60 | 0.97 |

Intersection Summary

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

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 80 | 0 | 522 | 111 | 0 | 537 |
| Future Volume (vph) | 80 | 0 | 522 | 111 | 0 | 537 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | | 5.0 | | | 5.0 |
| Lane Util. Factor | 1.00 | | 0.95 | | | 1.00 |
| Frt | 1.00 | | 0.97 | | | 1.00 |
| Flt Protected | 0.95 | | 1.00 | | | 1.00 |
| Satd. Flow (prot) | 1752 | | 3412 | | | 1810 |
| Flt Permitted | 0.95 | | 1.00 | | | 1.00 |
| Satd. Flow (perm) | 1752 | | 3412 | | | 1810 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 84 | 0 | 549 | 117 | 0 | 565 |
| RTOR Reduction (vph) | 0 | 0 | 20 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 84 | 0 | 646 | 0 | 0 | 565 |
| Heavy Vehicles (%) | 3% | 0% | 3% | 3% | 0% | 5% |
| Turn Type | Prot | | NA | | | NA |
| Protected Phases | 4 | | 3 | | | 2 3 |
| Permitted Phases | | | | | | |
| Actuated Green, G (s) | 10.7 | | 17.0 | | | 62.1 |
| Effective Green, g (s) | 10.7 | | 17.0 | | | 62.1 |
| Actuated g/C Ratio | 0.13 | | 0.21 | | | 0.75 |
| Clearance Time (s) | 5.0 | | 5.0 | | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | | | |
| Lane Grp Cap (vph) | 226 | | 700 | | | 1357 |
| v/s Ratio Prot | c0.05 | | c0.19 | | | c0.31 |
| v/s Ratio Perm | | | | | | |
| v/c Ratio | 0.37 | | 0.92 | | | 0.42 |
| Uniform Delay, d1 | 33.0 | | 32.3 | | | 3.8 |
| Progression Factor | 0.64 | | 1.00 | | | 0.90 |
| Incremental Delay, d2 | 1.0 | | 17.8 | | | 0.2 |
| Delay (s) | 21.9 | | 50.0 | | | 3.6 |
| Level of Service | C | | D | | | A |
| Approach Delay (s) | 21.9 | | 50.0 | | | 3.6 |
| Approach LOS | C | | D | | | A |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 28.3 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.60 | | |
| Actuated Cycle Length (s) | 82.8 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 43.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | WBL | NBT | SBT |
|---|---|---|---|
| Lane Group Flow (vph) | 84 | 666 | 565 |
| v/c Ratio | 0.37 | 0.92 | 0.42 |
| Control Delay | 25.2 | 52.1 | 4.8 |
| Queue Delay | 0.0 | 2.0 | 0.3 |
| Total Delay | 25.2 | 54.1 | 5.1 |
| Queue Length 50th (ft) | 25 | 170 | 79 |
| Queue Length 95th (ft) | m41 | #305 | 119 |
| Internal Link Dist (ft) | 16 | 61 | 108 |
| Turn Bay Length (ft) | | | |
| Base Capacity (vph) | 381 | 722 | 1357 |
| Starvation Cap Reductn | 0 | 0 | 295 |
| Spillback Cap Reductn | 0 | 16 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.22 | 0.94 | 0.53 |

Intersection Summary

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

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

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ✥ | | | ✥ | | | ✥ | | ↰ | ↑ | |
| Traffic Volume (vph) | 10 | 89 | 12 | 5 | 60 | 81 | 12 | 284 | 7 | 119 | 496 | 8 |
| Future Volume (vph) | 10 | 89 | 12 | 5 | 60 | 81 | 12 | 284 | 7 | 119 | 496 | 8 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.99 | | | 0.93 | | | 1.00 | | 1.00 | 1.00 | |
| Flt Protected | | 1.00 | | | 1.00 | | | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1678 | | | 1726 | | | 1774 | | 1752 | 1841 | |
| Flt Permitted | | 1.00 | | | 1.00 | | | 0.97 | | 0.40 | 1.00 | |
| Satd. Flow (perm) | | 1678 | | | 1726 | | | 1730 | | 731 | 1841 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 11 | 94 | 13 | 5 | 63 | 85 | 13 | 299 | 7 | 125 | 522 | 8 |
| RTOR Reduction (vph) | 0 | 5 | 0 | 0 | 54 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 113 | 0 | 0 | 99 | 0 | 0 | 318 | 0 | 125 | 529 | 0 |
| Heavy Vehicles (%) | 11% | 11% | 11% | 0% | 0% | 3% | 0% | 7% | 0% | 3% | 3% | 0% |
| Turn Type | Split | NA | | Split | NA | | custom | NA | | pm+pt | NA | |
| Protected Phases | 3 | 3 | | 4 | 4 | | | | | 5 | 2 | |
| Permitted Phases | | | | | | | 6 | 6 | | 2 | 2 | |
| Actuated Green, G (s) | | 17.0 | | | 10.7 | | | 29.1 | | 40.1 | 40.1 | |
| Effective Green, g (s) | | 17.0 | | | 10.7 | | | 29.1 | | 40.1 | 40.1 | |
| Actuated g/C Ratio | | 0.21 | | | 0.13 | | | 0.35 | | 0.48 | 0.48 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 344 | | | 223 | | | 608 | | 428 | 891 | |
| v/s Ratio Prot | | c0.07 | | | c0.06 | | | | | 0.02 | c0.29 | |
| v/s Ratio Perm | | | | | | | | 0.18 | | 0.12 | | |
| v/c Ratio | | 0.33 | | | 0.44 | | | 0.52 | | 0.29 | 0.59 | |
| Uniform Delay, d1 | | 28.0 | | | 33.3 | | | 21.3 | | 13.2 | 15.5 | |
| Progression Factor | | 0.27 | | | 1.00 | | | 1.00 | | 0.31 | 0.23 | |
| Incremental Delay, d2 | | 0.2 | | | 1.4 | | | 0.8 | | 0.2 | 0.6 | |
| Delay (s) | | 7.7 | | | 34.7 | | | 22.2 | | 4.3 | 4.1 | |
| Level of Service | | A | | | C | | | C | | A | A | |
| Approach Delay (s) | | 7.7 | | | 34.7 | | | 22.2 | | | 4.2 | |
| Approach LOS | | A | | | C | | | C | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 12.9 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.54 | | |
| Actuated Cycle Length (s) | 82.8 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 67.4% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | EBT | WBT | NBT | SBL | SBT |
|---|---|---|---|---|---|
| Lane Group Flow (vph) | 118 | 153 | 319 | 125 | 530 |
| v/c Ratio | 0.34 | 0.55 | 0.53 | 0.29 | 0.59 |
| Control Delay | 8.5 | 28.2 | 25.8 | 5.0 | 5.5 |
| Queue Delay | 0.0 | 0.0 | 0.6 | 0.9 | 1.1 |
| Total Delay | 8.5 | 28.3 | 26.4 | 6.0 | 6.6 |
| Queue Length 50th (ft) | 0 | 44 | 127 | 5 | 21 |
| Queue Length 95th (ft) | m12 | 101 | 228 | m14 | m57 |
| Internal Link Dist (ft) | 16 | 90 | 10 | | 120 |
| Turn Bay Length (ft) | | | | | |
| Base Capacity (vph) | 349 | 424 | 607 | 427 | 891 |
| Starvation Cap Reductn | 0 | 0 | 0 | 140 | 168 |
| Spillback Cap Reductn | 0 | 11 | 85 | 0 | 90 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.34 | 0.37 | 0.61 | 0.44 | 0.73 |

| Intersection Summary |
|---|
| m Volume for 95th percentile queue is metered by upstream signal. |

| Movement | WBL2 | WBL | WBR | NBL | NBT | NBR | SBL | SBT | SBR | NEL | NER |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | |
| Traffic Volume (vph) | 2 | 2 | 2 | 0 | 375 | 10 | 22 | 618 | 535 | 512 | 10 |
| Future Volume (vph) | 2 | 2 | 2 | 0 | 375 | 10 | 22 | 618 | 535 | 512 | 10 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | | | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 0.95 | | | 1.00 | 1.00 | 0.97 | |
| Frt | | 0.95 | | | 1.00 | | | 1.00 | 0.85 | 1.00 | |
| Flt Protected | | 0.97 | | | 1.00 | | | 1.00 | 1.00 | 0.95 | |
| Satd. Flow (prot) | | 1171 | | | 3365 | | | 1809 | 1538 | 3403 | |
| Flt Permitted | | 0.97 | | | 1.00 | | | 0.98 | 1.00 | 0.95 | |
| Satd. Flow (perm) | | 1171 | | | 3365 | | | 1774 | 1538 | 3403 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 2 | 2 | 2 | 0 | 395 | 11 | 23 | 651 | 563 | 539 | 11 |
| RTOR Reduction (vph) | 0 | 5 | 0 | 0 | 2 | 0 | 0 | 0 | 141 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 1 | 0 | 0 | 404 | 0 | 0 | 674 | 422 | 550 | 0 |
| Heavy Vehicles (%) | 50% | 50% | 50% | 1% | 7% | 1% | 0% | 5% | 5% | 3% | 0% |
| Turn Type | Prot | Prot | | | NA | | Perm | NA | pt+ov | Prot | |
| Protected Phases | 4 | 4 | | | 2 | | | 2 | 2 3 | 3 | |
| Permitted Phases | | | | | | | 2 | | | | |
| Actuated Green, G (s) | | 10.7 | | | 40.1 | | | 40.1 | 62.1 | 17.0 | |
| Effective Green, g (s) | | 10.7 | | | 40.1 | | | 40.1 | 62.1 | 17.0 | |
| Actuated g/C Ratio | | 0.13 | | | 0.48 | | | 0.48 | 0.75 | 0.21 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | | 3.0 | | 3.0 | |
| Lane Grp Cap (vph) | | 151 | | | 1629 | | | 859 | 1153 | 698 | |
| v/s Ratio Prot | | c0.00 | | | 0.12 | | | | 0.27 | c0.16 | |
| v/s Ratio Perm | | | | | | | | c0.38 | | | |
| v/c Ratio | | 0.01 | | | 0.25 | | | 0.78 | 0.37 | 0.79 | |
| Uniform Delay, d1 | | 31.4 | | | 12.5 | | | 17.8 | 3.6 | 31.2 | |
| Progression Factor | | 1.00 | | | 0.40 | | | 1.00 | 1.00 | 0.48 | |
| Incremental Delay, d2 | | 0.0 | | | 0.1 | | | 4.7 | 0.2 | 2.3 | |
| Delay (s) | | 31.4 | | | 5.1 | | | 22.5 | 3.8 | 17.3 | |
| Level of Service | | C | | | A | | | C | A | B | |
| Approach Delay (s) | | 31.4 | | | 5.1 | | | 14.0 | | 17.3 | |
| Approach LOS | | C | | | A | | | B | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 13.2 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.71 | | |
| Actuated Cycle Length (s) | 82.8 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 84.4% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | WBL | NBT | SBT | SBR | NEL |
|---|---|---|---|---|---|
| Lane Group Flow (vph) | 6 | 406 | 674 | 563 | 550 |
| v/c Ratio | 0.02 | 0.25 | 0.79 | 0.44 | 0.79 |
| Control Delay | 0.2 | 5.5 | 26.8 | 1.5 | 20.0 |
| Queue Delay | 0.0 | 0.5 | 0.0 | 0.0 | 1.9 |
| Total Delay | 0.2 | 6.0 | 26.8 | 1.5 | 22.0 |
| Queue Length 50th (ft) | 0 | 29 | 271 | 0 | 40 |
| Queue Length 95th (ft) | 0 | 47 | #525 | 27 | m60 |
| Internal Link Dist (ft) | 88 | 120 | 132 | | 108 |
| Turn Bay Length (ft) | | | | | |
| Base Capacity (vph) | 368 | 1630 | 858 | 1294 | 699 |
| Starvation Cap Reductn | 0 | 794 | 0 | 0 | 57 |
| Spillback Cap Reductn | 0 | 0 | 0 | 59 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.02 | 0.49 | 0.79 | 0.46 | 0.86 |

**Intersection Summary**

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

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

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 80 | 0 | 522 | 111 | 0 | 537 |
| Future Volume (vph) | 80 | 0 | 522 | 111 | 0 | 537 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | | 5.0 | | | 5.0 |
| Lane Util. Factor | 1.00 | | 0.95 | | | 1.00 |
| Frt | 1.00 | | 0.97 | | | 1.00 |
| Flt Protected | 0.95 | | 1.00 | | | 1.00 |
| Satd. Flow (prot) | 1752 | | 3412 | | | 1810 |
| Flt Permitted | 0.95 | | 1.00 | | | 1.00 |
| Satd. Flow (perm) | 1752 | | 3412 | | | 1810 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 84 | 0 | 549 | 117 | 0 | 565 |
| RTOR Reduction (vph) | 0 | 0 | 18 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 84 | 0 | 648 | 0 | 0 | 565 |
| Heavy Vehicles (%) | 3% | 0% | 3% | 3% | 0% | 5% |
| Turn Type | Prot | | NA | | | NA |
| Protected Phases | 4 | | 3 | | | 2 3 |
| Permitted Phases | | | | | | |
| Actuated Green, G (s) | 10.0 | | 23.0 | | | 79.0 |
| Effective Green, g (s) | 10.0 | | 23.0 | | | 79.0 |
| Actuated g/C Ratio | 0.10 | | 0.23 | | | 0.80 |
| Clearance Time (s) | 5.0 | | 5.0 | | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | | | |
| Lane Grp Cap (vph) | 176 | | 792 | | | 1444 |
| v/s Ratio Prot | c0.05 | | c0.19 | | | c0.31 |
| v/s Ratio Perm | | | | | | |
| v/c Ratio | 0.48 | | 0.82 | | | 0.39 |
| Uniform Delay, d1 | 42.0 | | 36.0 | | | 2.9 |
| Progression Factor | 0.73 | | 1.00 | | | 0.93 |
| Incremental Delay, d2 | 1.7 | | 6.6 | | | 0.2 |
| Delay (s) | 32.1 | | 42.6 | | | 2.9 |
| Level of Service | C | | D | | | A |
| Approach Delay (s) | 32.1 | | 42.6 | | | 2.9 |
| Approach LOS | C | | D | | | A |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 24.9 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.53 | | |
| Actuated Cycle Length (s) | 99.0 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 43.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | WBL | NBT | SBT |
|---|---|---|---|
| Lane Group Flow (vph) | 84 | 666 | 565 |
| v/c Ratio | 0.47 | 0.82 | 0.39 |
| Control Delay | 38.0 | 44.8 | 3.6 |
| Queue Delay | 0.0 | 0.0 | 0.3 |
| Total Delay | 38.0 | 44.8 | 3.9 |
| Queue Length 50th (ft) | 28 | 206 | 86 |
| Queue Length 95th (ft) | m50 | #294 | 90 |
| Internal Link Dist (ft) | 16 | 61 | 108 |
| Turn Bay Length (ft) | | | |
| Base Capacity (vph) | 194 | 810 | 1443 |
| Starvation Cap Reductn | 0 | 0 | 362 |
| Spillback Cap Reductn | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.43 | 0.82 | 0.52 |

Intersection Summary

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

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

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ✣ | | | ✣ | | | ✣ | | ↰ | ↑ | |
| Traffic Volume (vph) | 10 | 89 | 12 | 5 | 60 | 81 | 12 | 284 | 7 | 119 | 496 | 8 |
| Future Volume (vph) | 10 | 89 | 12 | 5 | 60 | 81 | 12 | 284 | 7 | 119 | 496 | 8 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.99 | | | 0.93 | | | 1.00 | | 1.00 | 1.00 | |
| Flt Protected | | 1.00 | | | 1.00 | | | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1678 | | | 1726 | | | 1774 | | 1752 | 1841 | |
| Flt Permitted | | 1.00 | | | 1.00 | | | 0.98 | | 0.53 | 1.00 | |
| Satd. Flow (perm) | | 1678 | | | 1726 | | | 1734 | | 979 | 1841 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 11 | 94 | 13 | 5 | 63 | 85 | 13 | 299 | 7 | 125 | 522 | 8 |
| RTOR Reduction (vph) | 0 | 5 | 0 | 0 | 46 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 113 | 0 | 0 | 107 | 0 | 0 | 318 | 0 | 125 | 530 | 0 |
| Heavy Vehicles (%) | 11% | 11% | 11% | 0% | 0% | 3% | 0% | 7% | 0% | 3% | 3% | 0% |
| Turn Type | Split | NA | | Split | NA | | custom | NA | | custom | NA | |
| Protected Phases | 3 | 3 | | 4 | 4 | | | | | | | |
| Permitted Phases | | | | | | | 6 | 6 | | 2 | 2 | |
| Actuated Green, G (s) | | 23.0 | | | 10.0 | | | 51.0 | | 51.0 | 51.0 | |
| Effective Green, g (s) | | 23.0 | | | 10.0 | | | 51.0 | | 51.0 | 51.0 | |
| Actuated g/C Ratio | | 0.23 | | | 0.10 | | | 0.52 | | 0.52 | 0.52 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 389 | | | 174 | | | 893 | | 504 | 948 | |
| v/s Ratio Prot | | c0.07 | | | c0.06 | | | | | | | |
| v/s Ratio Perm | | | | | | | | 0.18 | | 0.13 | c0.29 | |
| v/c Ratio | | 0.29 | | | 0.62 | | | 0.36 | | 0.25 | 0.56 | |
| Uniform Delay, d1 | | 31.3 | | | 42.7 | | | 14.3 | | 13.3 | 16.3 | |
| Progression Factor | | 0.14 | | | 1.00 | | | 1.00 | | 0.21 | 0.17 | |
| Incremental Delay, d2 | | 0.2 | | | 6.3 | | | 0.2 | | 0.2 | 0.5 | |
| Delay (s) | | 4.6 | | | 49.0 | | | 14.5 | | 3.0 | 3.3 | |
| Level of Service | | A | | | D | | | B | | A | A | |
| Approach Delay (s) | | 4.6 | | | 49.0 | | | 14.5 | | | 3.2 | |
| Approach LOS | | A | | | D | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 11.9 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.49 | | |
| Actuated Cycle Length (s) | 99.0 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 67.4% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | EBT | WBT | NBT | SBL | SBT |
|---|---|---|---|---|---|
| Lane Group Flow (vph) | 118 | 153 | 319 | 125 | 530 |
| v/c Ratio | 0.30 | 0.70 | 0.36 | 0.25 | 0.56 |
| Control Delay | 5.4 | 45.7 | 15.8 | 3.7 | 4.5 |
| Queue Delay | 0.0 | 1.7 | 0.4 | 1.2 | 1.7 |
| Total Delay | 5.4 | 47.3 | 16.2 | 4.9 | 6.2 |
| Queue Length 50th (ft) | 0 | 63 | 116 | 5 | 21 |
| Queue Length 95th (ft) | m0 | #143 | 179 | m9 | 37 |
| Internal Link Dist (ft) | 16 | 90 | 10 | | 120 |
| Turn Bay Length (ft) | | | | | |
| Base Capacity (vph) | 394 | 237 | 894 | 504 | 948 |
| Starvation Cap Reductn | 0 | 0 | 0 | 224 | 190 |
| Spillback Cap Reductn | 0 | 20 | 240 | 0 | 254 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.30 | 0.71 | 0.49 | 0.45 | 0.76 |

Intersection Summary

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

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

| Movement | WBL2 | WBL | WBR | NBL | NBT | NBR | SBL | SBT | SBR | NEL | NER |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | |
| Traffic Volume (vph) | 2 | 2 | 2 | 0 | 375 | 10 | 22 | 618 | 535 | 512 | 10 |
| Future Volume (vph) | 2 | 2 | 2 | 0 | 375 | 10 | 22 | 618 | 535 | 512 | 10 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | | | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 0.95 | | | 1.00 | 1.00 | 0.97 | |
| Frt | | 0.95 | | | 1.00 | | | 1.00 | 0.85 | 1.00 | |
| Flt Protected | | 0.97 | | | 1.00 | | | 1.00 | 1.00 | 0.95 | |
| Satd. Flow (prot) | | 1171 | | | 3365 | | | 1809 | 1538 | 3403 | |
| Flt Permitted | | 0.97 | | | 1.00 | | | 0.98 | 1.00 | 0.95 | |
| Satd. Flow (perm) | | 1171 | | | 3365 | | | 1774 | 1538 | 3403 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 2 | 2 | 2 | 0 | 395 | 11 | 23 | 651 | 563 | 539 | 11 |
| RTOR Reduction (vph) | 0 | 5 | 0 | 0 | 2 | 0 | 0 | 0 | 114 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 1 | 0 | 0 | 404 | 0 | 0 | 674 | 449 | 550 | 0 |
| Heavy Vehicles (%) | 50% | 50% | 50% | 1% | 7% | 1% | 0% | 5% | 5% | 3% | 0% |
| Turn Type | Prot | Prot | | | NA | | Perm | NA | pt+ov | Prot | |
| Protected Phases | 4 | 4 | | | 2 | | | 2 | 2 3 | 3 | |
| Permitted Phases | | | | | | | 2 | | | | |
| Actuated Green, G (s) | | 10.0 | | | 51.0 | | | 51.0 | 79.0 | 23.0 | |
| Effective Green, g (s) | | 10.0 | | | 51.0 | | | 51.0 | 79.0 | 23.0 | |
| Actuated g/C Ratio | | 0.10 | | | 0.52 | | | 0.52 | 0.80 | 0.23 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | | 3.0 | | 3.0 | |
| Lane Grp Cap (vph) | | 118 | | | 1733 | | | 913 | 1227 | 790 | |
| v/s Ratio Prot | | c0.00 | | | 0.12 | | | | 0.29 | c0.16 | |
| v/s Ratio Perm | | | | | | | | c0.38 | | | |
| v/c Ratio | | 0.01 | | | 0.23 | | | 0.74 | 0.37 | 0.70 | |
| Uniform Delay, d1 | | 40.0 | | | 13.2 | | | 18.8 | 2.9 | 34.8 | |
| Progression Factor | | 1.00 | | | 0.37 | | | 1.00 | 1.00 | 0.29 | |
| Incremental Delay, d2 | | 0.0 | | | 0.1 | | | 3.2 | 0.2 | 1.5 | |
| Delay (s) | | 40.0 | | | 5.0 | | | 21.9 | 3.0 | 11.5 | |
| Level of Service | | D | | | A | | | C | A | B | |
| Approach Delay (s) | | 40.0 | | | 5.0 | | | 13.3 | | 11.5 | |
| Approach LOS | | D | | | A | | | B | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 11.4 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.64 | | |
| Actuated Cycle Length (s) | 99.0 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 84.4% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | WBL | NBT | SBT | SBR | NEL |
|---|---|---|---|---|---|
| Lane Group Flow (vph) | 6 | 406 | 674 | 563 | 550 |
| v/c Ratio | 0.03 | 0.23 | 0.74 | 0.42 | 0.70 |
| Control Delay | 0.3 | 5.2 | 25.1 | 1.2 | 12.9 |
| Queue Delay | 0.0 | 0.6 | 0.0 | 0.0 | 1.0 |
| Total Delay | 0.3 | 5.8 | 25.1 | 1.2 | 14.0 |
| Queue Length 50th (ft) | 0 | 36 | 325 | 0 | 15 |
| Queue Length 95th (ft) | 0 | 44 | 473 | 18 | m57 |
| Internal Link Dist (ft) | 88 | 120 | 132 | | 108 |
| Turn Bay Length (ft) | | | | | |
| Base Capacity (vph) | 197 | 1735 | 913 | 1341 | 790 |
| Starvation Cap Reductn | 0 | 918 | 0 | 0 | 82 |
| Spillback Cap Reductn | 0 | 0 | 0 | 49 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.03 | 0.50 | 0.74 | 0.44 | 0.78 |

| Intersection Summary |
|---|
| m Volume for 95th percentile queue is metered by upstream signal. |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 199 | 0 | 968 | 102 | 0 | 870 |
| Future Volume (vph) | 199 | 0 | 968 | 102 | 0 | 870 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | | 5.0 | | | 5.0 |
| Lane Util. Factor | 1.00 | | 0.95 | | | 1.00 |
| Frt | 1.00 | | 0.99 | | | 1.00 |
| Flt Protected | 0.95 | | 1.00 | | | 1.00 |
| Satd. Flow (prot) | 1805 | | 3523 | | | 1863 |
| Flt Permitted | 0.95 | | 1.00 | | | 1.00 |
| Satd. Flow (perm) | 1805 | | 3523 | | | 1863 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 209 | 0 | 1019 | 107 | 0 | 916 |
| RTOR Reduction (vph) | 0 | 0 | 6 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 209 | 0 | 1120 | 0 | 0 | 916 |
| Heavy Vehicles (%) | 0% | 0% | 1% | 1% | 0% | 2% |
| Turn Type | Prot | | NA | | | NA |
| Protected Phases | 4 | | 3 | | | 2 3 |
| Permitted Phases | | | | | | |
| Actuated Green, G (s) | 20.0 | | 36.0 | | | 90.0 |
| Effective Green, g (s) | 20.0 | | 36.0 | | | 90.0 |
| Actuated g/C Ratio | 0.17 | | 0.30 | | | 0.75 |
| Clearance Time (s) | 5.0 | | 5.0 | | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | | | |
| Lane Grp Cap (vph) | 300 | | 1056 | | | 1397 |
| v/s Ratio Prot | c0.12 | | c0.32 | | | c0.49 |
| v/s Ratio Perm | | | | | | |
| v/c Ratio | 0.70 | | 1.06 | | | 0.66 |
| Uniform Delay, d1 | 47.1 | | 42.0 | | | 7.4 |
| Progression Factor | 0.35 | | 1.00 | | | 0.96 |
| Incremental Delay, d2 | 0.6 | | 45.2 | | | 1.0 |
| Delay (s) | 17.1 | | 87.2 | | | 8.1 |
| Level of Service | B | | F | | | A |
| Approach Delay (s) | 17.1 | | 87.2 | | | 8.1 |
| Approach LOS | B | | F | | | A |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 48.5 | HCM 2000 Level of Service | D |
| HCM 2000 Volume to Capacity ratio | 0.82 | | |
| Actuated Cycle Length (s) | 120.0 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 65.1% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | WBL | NBT | SBT |
|---|---|---|---|
| Lane Group Flow (vph) | 209 | 1126 | 916 |
| v/c Ratio | 0.70 | 1.06 | 0.66 |
| Control Delay | 18.3 | 85.1 | 9.6 |
| Queue Delay | 0.0 | 5.5 | 0.3 |
| Total Delay | 18.3 | 90.6 | 9.8 |
| Queue Length 50th (ft) | 40 | ~502 | 301 |
| Queue Length 95th (ft) | m38 | #639 | 420 |
| Internal Link Dist (ft) | 16 | 61 | 108 |
| Turn Bay Length (ft) | | | |
| Base Capacity (vph) | 300 | 1063 | 1397 |
| Starvation Cap Reductn | 0 | 0 | 99 |
| Spillback Cap Reductn | 0 | 14 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.70 | 1.07 | 0.71 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

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

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

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 4 | 93 | 5 | 10 | 186 | 119 | 13 | 667 | 43 | 77 | 328 | 0 |
| Future Volume (vph) | 4 | 93 | 5 | 10 | 186 | 119 | 13 | 667 | 43 | 77 | 328 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.99 | | | 0.95 | | | 0.99 | | 1.00 | 1.00 | |
| Flt Protected | | 1.00 | | | 1.00 | | | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1866 | | | 1783 | | | 1832 | | 1752 | 1845 | |
| Flt Permitted | | 1.00 | | | 1.00 | | | 0.99 | | 0.21 | 1.00 | |
| Satd. Flow (perm) | | 1866 | | | 1783 | | | 1818 | | 379 | 1845 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 4 | 98 | 5 | 11 | 196 | 125 | 14 | 702 | 45 | 81 | 345 | 0 |
| RTOR Reduction (vph) | 0 | 1 | 0 | 0 | 18 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 106 | 0 | 0 | 314 | 0 | 0 | 759 | 0 | 81 | 345 | 0 |
| Heavy Vehicles (%) | 1% | 1% | 1% | 1% | 1% | 1% | 0% | 3% | 0% | 3% | 3% | 0% |
| Turn Type | Split | NA | | Split | NA | | custom | NA | | custom | NA | |
| Protected Phases | 3 | 3 | | 4 | 4 | | | | | | | |
| Permitted Phases | | | | | | | 6 | 6 | | 2 | 2 | |
| Actuated Green, G (s) | | 36.0 | | | 20.0 | | | 49.0 | | 49.0 | 49.0 | |
| Effective Green, g (s) | | 36.0 | | | 20.0 | | | 49.0 | | 49.0 | 49.0 | |
| Actuated g/C Ratio | | 0.30 | | | 0.17 | | | 0.41 | | 0.41 | 0.41 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 559 | | | 297 | | | 742 | | 154 | 753 | |
| v/s Ratio Prot | | c0.06 | | | c0.18 | | | | | | | |
| v/s Ratio Perm | | | | | | | | c0.42 | | 0.21 | 0.19 | |
| v/c Ratio | | 0.19 | | | 1.06 | | | 1.02 | | 0.53 | 0.46 | |
| Uniform Delay, d1 | | 31.2 | | | 50.0 | | | 35.5 | | 26.7 | 25.8 | |
| Progression Factor | | 0.16 | | | 1.00 | | | 1.00 | | 0.17 | 0.14 | |
| Incremental Delay, d2 | | 0.0 | | | 67.8 | | | 39.1 | | 2.7 | 0.4 | |
| Delay (s) | | 5.1 | | | 117.8 | | | 74.6 | | 7.4 | 4.0 | |
| Level of Service | | A | | | F | | | E | | A | A | |
| Approach Delay (s) | | 5.1 | | | 117.8 | | | 74.6 | | | 4.6 | |
| Approach LOS | | A | | | F | | | E | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 60.5 | HCM 2000 Level of Service | E |
| HCM 2000 Volume to Capacity ratio | 0.74 | | |
| Actuated Cycle Length (s) | 120.0 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 79.8% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | EBT | WBT | NBT | SBL | SBT |
|---|---|---|---|---|---|
| Lane Group Flow (vph) | 107 | 332 | 761 | 81 | 345 |
| v/c Ratio | 0.19 | 1.05 | 1.02 | 0.53 | 0.46 |
| Control Delay | 5.1 | 110.6 | 74.4 | 15.6 | 5.4 |
| Queue Delay | 0.0 | 16.8 | 45.3 | 0.2 | 0.4 |
| Total Delay | 5.1 | 127.5 | 119.7 | 15.8 | 5.7 |
| Queue Length 50th (ft) | 0 | ~266 | ~626 | 4 | 18 |
| Queue Length 95th (ft) | m0 | #453 | #868 | 23 | 26 |
| Internal Link Dist (ft) | 16 | 90 | 10 | | 120 |
| Turn Bay Length (ft) | | | | | |
| Base Capacity (vph) | 561 | 315 | 744 | 154 | 753 |
| Starvation Cap Reductn | 0 | 0 | 0 | 2 | 116 |
| Spillback Cap Reductn | 0 | 17 | 586 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.19 | 1.11 | 4.82 | 0.53 | 0.54 |

**Intersection Summary**

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

| Movement | WBL2 | WBL | WBR | NBL | NBT | NBR | SBL | SBT | SBR | NEL | NER |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | |
| Traffic Volume (vph) | 11 | 7 | 66 | 0 | 790 | 1 | 4 | 395 | 759 | 965 | 3 |
| Future Volume (vph) | 11 | 7 | 66 | 0 | 790 | 1 | 4 | 395 | 759 | 965 | 3 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | | | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 0.95 | | | 1.00 | 1.00 | 0.97 | |
| Frt | | 0.89 | | | 1.00 | | | 1.00 | 0.85 | 1.00 | |
| Flt Protected | | 0.99 | | | 1.00 | | | 1.00 | 1.00 | 0.95 | |
| Satd. Flow (prot) | | 1681 | | | 3574 | | | 1880 | 1599 | 3475 | |
| Flt Permitted | | 0.99 | | | 1.00 | | | 0.99 | 1.00 | 0.95 | |
| Satd. Flow (perm) | | 1681 | | | 3574 | | | 1868 | 1599 | 3475 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 12 | 7 | 69 | 0 | 832 | 1 | 4 | 416 | 799 | 1016 | 3 |
| RTOR Reduction (vph) | 0 | 53 | 0 | 0 | 0 | 0 | 0 | 0 | 200 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 35 | 0 | 0 | 833 | 0 | 0 | 420 | 599 | 1019 | 0 |
| Heavy Vehicles (%) | 0% | 0% | 0% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% |
| Turn Type | Prot | Prot | | | NA | | Perm | NA | pt+ov | Prot | |
| Protected Phases | 4 | 4 | | | 2 | | | 2 | 2 3 | 3 | |
| Permitted Phases | | | | | | | 2 | | | | |
| Actuated Green, G (s) | | 20.0 | | | 49.0 | | | 49.0 | 90.0 | 36.0 | |
| Effective Green, g (s) | | 20.0 | | | 49.0 | | | 49.0 | 90.0 | 36.0 | |
| Actuated g/C Ratio | | 0.17 | | | 0.41 | | | 0.41 | 0.75 | 0.30 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | | 3.0 | | 3.0 | |
| Lane Grp Cap (vph) | | 280 | | | 1459 | | | 762 | 1199 | 1042 | |
| v/s Ratio Prot | | c0.02 | | | c0.23 | | | | 0.37 | c0.29 | |
| v/s Ratio Perm | | | | | | | | 0.22 | | | |
| v/c Ratio | | 0.12 | | | 0.57 | | | 0.55 | 0.50 | 0.98 | |
| Uniform Delay, d1 | | 42.5 | | | 27.4 | | | 27.1 | 6.0 | 41.6 | |
| Progression Factor | | 1.00 | | | 0.28 | | | 1.00 | 1.00 | 0.25 | |
| Incremental Delay, d2 | | 0.2 | | | 0.0 | | | 0.9 | 0.3 | 4.5 | |
| Delay (s) | | 42.7 | | | 7.9 | | | 28.0 | 6.3 | 14.9 | |
| Level of Service | | D | | | A | | | C | A | B | |
| Approach Delay (s) | | 42.7 | | | 7.9 | | | 13.8 | | 14.9 | |
| Approach LOS | | D | | | A | | | B | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 13.4 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.63 | | |
| Actuated Cycle Length (s) | 120.0 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 70.8% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | WBL | NBT | SBT | SBR | NEL |
|---|---|---|---|---|---|
| Lane Group Flow (vph) | 88 | 833 | 420 | 799 | 1019 |
| v/c Ratio | 0.26 | 0.57 | 0.55 | 0.57 | 0.98 |
| Control Delay | 18.2 | 8.0 | 30.5 | 2.0 | 17.5 |
| Queue Delay | 0.0 | 22.3 | 0.0 | 0.3 | 16.9 |
| Total Delay | 18.2 | 30.3 | 30.5 | 2.3 | 34.4 |
| Queue Length 50th (ft) | 16 | 90 | 245 | 0 | 64 |
| Queue Length 95th (ft) | 64 | m87 | 347 | 28 | m60 |
| Internal Link Dist (ft) | 88 | 120 | 132 | | 108 |
| Turn Bay Length (ft) | | | | | |
| Base Capacity (vph) | 333 | 1459 | 762 | 1399 | 1043 |
| Starvation Cap Reductn | 0 | 643 | 0 | 0 | 64 |
| Spillback Cap Reductn | 0 | 0 | 0 | 166 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.26 | 1.02 | 0.55 | 0.65 | 1.04 |

Intersection Summary

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

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 199 | 0 | 968 | 102 | 0 | 870 |
| Future Volume (vph) | 199 | 0 | 968 | 102 | 0 | 870 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | | 5.0 | | | 5.0 |
| Lane Util. Factor | 1.00 | | 0.95 | | | 1.00 |
| Frt | 1.00 | | 0.99 | | | 1.00 |
| Flt Protected | 0.95 | | 1.00 | | | 1.00 |
| Satd. Flow (prot) | 1805 | | 3523 | | | 1863 |
| Flt Permitted | 0.95 | | 1.00 | | | 1.00 |
| Satd. Flow (perm) | 1805 | | 3523 | | | 1863 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 209 | 0 | 1019 | 107 | 0 | 916 |
| RTOR Reduction (vph) | 0 | 0 | 7 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 209 | 0 | 1119 | 0 | 0 | 916 |
| Heavy Vehicles (%) | 0% | 0% | 1% | 1% | 0% | 2% |
| Turn Type | Prot | | NA | | | NA |
| Protected Phases | 4 | | 3 | | | 2 3 |
| Permitted Phases | | | | | | |
| Actuated Green, G (s) | 18.0 | | 32.0 | | | 93.0 |
| Effective Green, g (s) | 18.0 | | 32.0 | | | 93.0 |
| Actuated g/C Ratio | 0.15 | | 0.26 | | | 0.77 |
| Clearance Time (s) | 5.0 | | 5.0 | | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | | | |
| Lane Grp Cap (vph) | 268 | | 931 | | | 1431 |
| v/s Ratio Prot | c0.12 | | c0.32 | | | c0.49 |
| v/s Ratio Perm | | | | | | |
| v/c Ratio | 0.78 | | 1.20 | | | 0.64 |
| Uniform Delay, d1 | 49.6 | | 44.5 | | | 6.4 |
| Progression Factor | 0.40 | | 1.00 | | | 0.96 |
| Incremental Delay, d2 | 1.3 | | 101.4 | | | 0.9 |
| Delay (s) | 21.0 | | 145.9 | | | 7.0 |
| Level of Service | C | | F | | | A |
| Approach Delay (s) | 21.0 | | 145.9 | | | 7.0 |
| Approach LOS | C | | F | | | A |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 77.8 | HCM 2000 Level of Service | E |
| HCM 2000 Volume to Capacity ratio | 0.89 | | |
| Actuated Cycle Length (s) | 121.0 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 65.1% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | WBL | NBT | SBT |
|---|---|---|---|
| Lane Group Flow (vph) | 209 | 1126 | 916 |
| v/c Ratio | 0.77 | 1.19 | 0.64 |
| Control Delay | 23.2 | 135.0 | 8.5 |
| Queue Delay | 0.0 | 0.2 | 0.3 |
| Total Delay | 23.2 | 135.2 | 8.7 |
| Queue Length 50th (ft) | 42 | ~553 | 276 |
| Queue Length 95th (ft) | m37 | #690 | 385 |
| Internal Link Dist (ft) | 16 | 61 | 108 |
| Turn Bay Length (ft) | | | |
| Base Capacity (vph) | 270 | 946 | 1428 |
| Starvation Cap Reductn | 0 | 0 | 112 |
| Spillback Cap Reductn | 0 | 38 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.77 | 1.24 | 0.70 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

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

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

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ✣ | | | ✣ | | | ✣ | | ↰ | ↑ | |
| Traffic Volume (vph) | 4 | 93 | 5 | 10 | 186 | 119 | 13 | 667 | 43 | 77 | 328 | 0 |
| Future Volume (vph) | 4 | 93 | 5 | 10 | 186 | 119 | 13 | 667 | 43 | 77 | 328 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.99 | | | 0.95 | | | 0.99 | | 1.00 | 1.00 | |
| Flt Protected | | 1.00 | | | 1.00 | | | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1866 | | | 1783 | | | 1832 | | 1752 | 1845 | |
| Flt Permitted | | 1.00 | | | 1.00 | | | 0.99 | | 0.21 | 1.00 | |
| Satd. Flow (perm) | | 1866 | | | 1783 | | | 1817 | | 379 | 1845 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 4 | 98 | 5 | 11 | 196 | 125 | 14 | 702 | 45 | 81 | 345 | 0 |
| RTOR Reduction (vph) | 0 | 1 | 0 | 0 | 18 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 106 | 0 | 0 | 314 | 0 | 0 | 759 | 0 | 81 | 345 | 0 |
| Heavy Vehicles (%) | 1% | 1% | 1% | 1% | 1% | 1% | 0% | 3% | 0% | 3% | 3% | 0% |
| Turn Type | Split | NA | | Split | NA | | Perm | NA | | pm+pt | NA | |
| Protected Phases | 3 | 3 | | 4 | 4 | | | 6 | | 5 | 2 | |
| Permitted Phases | | | | | | | 6 | 6 | | 2 | 2 | |
| Actuated Green, G (s) | | 32.0 | | | 18.0 | | | 47.0 | | 56.0 | 56.0 | |
| Effective Green, g (s) | | 32.0 | | | 18.0 | | | 47.0 | | 56.0 | 56.0 | |
| Actuated g/C Ratio | | 0.26 | | | 0.15 | | | 0.39 | | 0.46 | 0.46 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 493 | | | 265 | | | 705 | | 220 | 853 | |
| v/s Ratio Prot | | c0.06 | | | c0.18 | | | | | 0.01 | c0.19 | |
| v/s Ratio Perm | | | | | | | | c0.42 | | 0.16 | | |
| v/c Ratio | | 0.21 | | | 1.19 | | | 1.08 | | 0.37 | 0.40 | |
| Uniform Delay, d1 | | 34.7 | | | 51.5 | | | 37.0 | | 40.8 | 21.5 | |
| Progression Factor | | 0.18 | | | 1.00 | | | 1.00 | | 0.18 | 0.15 | |
| Incremental Delay, d2 | | 0.0 | | | 114.9 | | | 56.5 | | 0.9 | 0.3 | |
| Delay (s) | | 6.4 | | | 166.4 | | | 93.5 | | 8.4 | 3.5 | |
| Level of Service | | A | | | F | | | F | | A | A | |
| Approach Delay (s) | | 6.4 | | | 166.4 | | | 93.5 | | | 4.4 | |
| Approach LOS | | A | | | F | | | F | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 79.3 | HCM 2000 Level of Service | E |
| HCM 2000 Volume to Capacity ratio | 0.81 | | |
| Actuated Cycle Length (s) | 121.0 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 79.8% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | EBT | WBT | NBT | SBL | SBT |
|---|---|---|---|---|---|
| Lane Group Flow (vph) | 107 | 332 | 761 | 81 | 345 |
| v/c Ratio | 0.21 | 1.16 | 1.07 | 0.35 | 0.41 |
| Control Delay | 6.4 | 147.8 | 89.1 | 8.2 | 4.6 |
| Queue Delay | 0.0 | 0.8 | 35.6 | 1.5 | 0.3 |
| Total Delay | 6.4 | 148.6 | 124.8 | 9.8 | 4.9 |
| Queue Length 50th (ft) | 0 | ~292 | ~676 | 4 | 17 |
| Queue Length 95th (ft) | m0 | #479 | #919 | 15 | 24 |
| Internal Link Dist (ft) | 16 | 90 | 10 | | 120 |
| Turn Bay Length (ft) | | | | | |
| Base Capacity (vph) | 499 | 285 | 713 | 230 | 845 |
| Starvation Cap Reductn | 0 | 0 | 0 | 59 | 142 |
| Spillback Cap Reductn | 0 | 18 | 595 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.21 | 1.24 | 6.45 | 0.47 | 0.49 |

**Intersection Summary**

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

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

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

| Movement | WBL2 | WBL | WBR | NBL | NBT | NBR | SBL | SBT | SBR | NEL | NER |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | |
| Traffic Volume (vph) | 11 | 7 | 66 | 0 | 790 | 1 | 4 | 395 | 759 | 965 | 3 |
| Future Volume (vph) | 11 | 7 | 66 | 0 | 790 | 1 | 4 | 395 | 759 | 965 | 3 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | | | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 0.95 | | | 1.00 | 1.00 | 0.97 | |
| Frt | | 0.89 | | | 1.00 | | | 1.00 | 0.85 | 1.00 | |
| Flt Protected | | 0.99 | | | 1.00 | | | 1.00 | 1.00 | 0.95 | |
| Satd. Flow (prot) | | 1681 | | | 3574 | | | 1862 | 1583 | 3475 | |
| Flt Permitted | | 0.99 | | | 1.00 | | | 0.99 | 1.00 | 0.95 | |
| Satd. Flow (perm) | | 1681 | | | 3574 | | | 1851 | 1583 | 3475 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 12 | 7 | 69 | 0 | 832 | 1 | 4 | 416 | 799 | 1016 | 3 |
| RTOR Reduction (vph) | 0 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 185 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 13 | 0 | 0 | 833 | 0 | 0 | 420 | 614 | 1019 | 0 |
| Heavy Vehicles (%) | 0% | 0% | 0% | 1% | 1% | 1% | 0% | 2% | 2% | 1% | 1% |
| Turn Type | Prot | Prot | | | NA | | Perm | NA | pt+ov | Prot | |
| Protected Phases | 4 | 4 | | | 2 | | | 2 | 2 3 | 3 | |
| Permitted Phases | | | | | | | 2 | | | | |
| Actuated Green, G (s) | | 18.0 | | | 56.0 | | | 56.0 | 93.0 | 32.0 | |
| Effective Green, g (s) | | 18.0 | | | 56.0 | | | 56.0 | 93.0 | 32.0 | |
| Actuated g/C Ratio | | 0.15 | | | 0.46 | | | 0.46 | 0.77 | 0.26 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | | 3.0 | | 3.0 | |
| Lane Grp Cap (vph) | | 250 | | | 1654 | | | 856 | 1216 | 919 | |
| v/s Ratio Prot | | c0.01 | | | 0.23 | | | | c0.39 | c0.29 | |
| v/s Ratio Perm | | | | | | | | 0.23 | | | |
| v/c Ratio | | 0.05 | | | 0.50 | | | 0.49 | 0.51 | 1.11 | |
| Uniform Delay, d1 | | 44.2 | | | 22.8 | | | 22.6 | 5.3 | 44.5 | |
| Progression Factor | | 1.00 | | | 0.10 | | | 1.00 | 1.00 | 0.31 | |
| Incremental Delay, d2 | | 0.1 | | | 0.0 | | | 0.4 | 0.3 | 50.7 | |
| Delay (s) | | 44.3 | | | 2.3 | | | 23.0 | 5.6 | 64.3 | |
| Level of Service | | D | | | A | | | C | A | E | |
| Approach Delay (s) | | 44.3 | | | 2.3 | | | 11.6 | | 64.3 | |
| Approach LOS | | D | | | A | | | B | | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 27.1 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.65 | | |
| Actuated Cycle Length (s) | 121.0 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 70.8% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | WBL | NBT | SBT | SBR | NEL |
|---|---|---|---|---|---|
| Lane Group Flow (vph) | 88 | 833 | 420 | 799 | 1019 |
| v/c Ratio | 0.26 | 0.51 | 0.50 | 0.57 | 1.10 |
| Control Delay | 6.9 | 2.5 | 25.3 | 2.0 | 63.6 |
| Queue Delay | 0.0 | 15.3 | 0.0 | 0.3 | 0.6 |
| Total Delay | 6.9 | 17.8 | 25.3 | 2.2 | 64.2 |
| Queue Length 50th (ft) | 0 | 47 | 222 | 0 | ~423 |
| Queue Length 95th (ft) | 32 | m43 | 317 | 25 | m59 |
| Internal Link Dist (ft) | 88 | 120 | 132 | | 108 |
| Turn Bay Length (ft) | | | | | |
| Base Capacity (vph) | 344 | 1638 | 847 | 1400 | 927 |
| Starvation Cap Reductn | 0 | 800 | 0 | 0 | 55 |
| Spillback Cap Reductn | 0 | 0 | 0 | 153 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.26 | 0.99 | 0.50 | 0.64 | 1.17 |

**Intersection Summary**

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

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

Riverside Avenue/Colchester Avenue Scoping Study
Burlington, VT

AM

| Source | Approach | Lane Group | Volume | V/C | Delay | V/S | Critical | LOS | Total Delay |
|---|---|---|---|---|---|---|---|---|---|
| 8 | Riverside Ave NEB | All | 599 | 0.74 | 38 | 0.18 | 0.18 | D | 22762 |
| 1 | Colchester Ave SB | TH/LT | 640 | 0.7 | 20.7 | 0.36 | 0.36 | C | 13248 |
| 1 | | RT | 428 | 0.35 | 2.9 | 0.28 | | A | 1241 |
| 6 | Colchester Ave NB | All | 302 | 0.34 | 14.3 | 0.17 | | B | 4319 |
| 6 | Barrett Street WB | All | 75 | 0.45 | 43.3 | 0.04 | 0.04 | D | 3248 |
| 1 | Mill Street WB | All | 1 | 0.01 | 39.6 | 0 | | D | 40 |
| | | | 2045 | | | | 0.58 | | 44857 |

| | |
|---|---|
| Cycle Length | 97.2 |
| Lost Time | 15 |

| | |
|---|---|
| Overall V/C = | 0.69 |
| Average Delay = | 21.9 |
| LOS= | C |

PM

| Source | Approach | Lane Group | Volume | V/C | Delay | V/S | Critical | LOS | Total Delay |
|---|---|---|---|---|---|---|---|---|---|
| 8 | Riverside Ave NEB | All | 1043 | 0.99 | 65.6 | 0.3 | 0.3 | E | 68421 |
| 1 | Colchester Ave SB | TH/LT | 393 | 0.52 | 27.2 | 0.21 | | C | 10690 |
| 1 | | RT | 564 | 0.47 | 6.1 | 0.35 | | A | 3440 |
| 6 | Colchester Ave NB | All | 722 | 0.97 | 61.2 | 0.4 | 0.4 | E | 44186 |
| 6 | Barrett Street WB | All | 287 | 0.97 | 92.1 | 0.16 | 0.16 | F | 26433 |
| 1 | Mill Street WB | All | 29 | 0.1 | 42.6 | 0.02 | | D | 1235 |
| | | | 3038 | | | | 0.86 | | 154405 |

| | |
|---|---|
| Cycle Length | 120 |
| Lost Time | 15 |

| | |
|---|---|
| Overall V/C = | 0.98 |
| Average Delay = | 50.8 |
| LOS= | D |

Riverside Avenue/Colchester Avenue Scoping Study
Burlington, VT

| Peak Hour | Approach | Lane Group | V/C | Delay | LOS |
|---|---|---|---|---|---|
| AM | Riverside Ave NEB | All | 0.74 | 38 | D |
| | Colchester Ave SB | TH/LT | 0.7 | 20.7 | C |
| | | RT | 0.35 | 2.9 | A |
| | Colchester Ave NB | All | 0.34 | 14.3 | B |
| | Barrett Street WB | All | 0.45 | 43.3 | D |
| | Mill Street WB | All | 0.01 | 39.6 | D |
| | **Overall** | | **0.69** | **21.9** | **C** |
| PM | Riverside Ave NEB | All | 0.99 | 65.6 | E |
| | Colchester Ave SB | TH/LT | 0.52 | 27.2 | C |
| | | RT | 0.47 | 6.1 | A |
| | Colchester Ave NB | All | 0.97 | 61.2 | E |
| | Barrett Street WB | All | 0.97 | 92.1 | F |
| | Mill Street WB | All | 0.1 | 42.6 | D |
| | **Overall** | | **0.98** | **50.8** | **D** |

Riverside Avenue/Colchester Avenue Scoping Study

AM

| Source | Approach | Lane Group | Volume | V/C | Delay | V/S | Critical | LOS | Total Delay |
|---|---|---|---|---|---|---|---|---|---|
| 8 | Riverside Ave NEB | All | 648 | 0.82 | 42.6 | 0.19 | 0.19 | D | 27605 |
| 1 | Colchester Ave SB | TH/LT | 674 | 0.74 | 21.9 | 0.38 | 0.38 | C | 14761 |
| 1 | | RT | 449 | 0.37 | 3 | 0.29 | | A | 1347 |
| 6 | Colchester Ave NB | All | 318 | 0.36 | 14.5 | 0.18 | | B | 4611 |
| 6 | Barrett Street WB | All | 107 | 0.62 | 49 | 0.06 | 0.06 | D | 5243 |
| 1 | Mill Street WB | All | 1 | 0.01 | 40 | 0 | | D | 40 |
| | | | 2197 | | | | 0.63 | | 53606 |

| | |
|---|---|
| Cycle Length | 99 |
| Lost Time | 15 |

| | |
|---|---|
| Overall V/C = | 0.74 |
| Average Delay = | 24.4 |
| LOS= | C |

PM

| Source | Approach | Lane Group | Volume | V/C | Delay | V/S | Critical | LOS | Total Delay |
|---|---|---|---|---|---|---|---|---|---|
| 8 | Riverside Ave NEB | All | 1120 | 1.06 | 87.2 | 0.32 | 0.32 | F | 97664 |
| 1 | Colchester Ave SB | TH/LT | 420 | 0.55 | 28 | 0.22 | | C | 11760 |
| 1 | | RT | 599 | 0.5 | 6.3 | 0.37 | | A | 3774 |
| 6 | Colchester Ave NB | All | 759 | 1.02 | 74.6 | 0.42 | 0.42 | E | 56621 |
| 6 | Barrett Street WB | All | 314 | 1.06 | 117.8 | 0.18 | 0.18 | F | 36989 |
| 1 | Mill Street WB | All | 35 | 0.12 | 42.7 | 0.02 | | D | 1495 |
| | | | 3247 | | | | 0.92 | | 208303 |

| | |
|---|---|
| Cycle Length | 120 |
| Lost Time | 15 |

| | |
|---|---|
| Overall V/C = | 1.05 |
| Average Delay = | 64.2 |
| LOS= | E |

| Peak Hour | Approach | Lane Group | V/C | Delay | LOS |
|---|---|---|---|---|---|
| AM | Riverside Ave NEB | All | 0.82 | 42.6 | D |
| | Colchester Ave SB | TH/LT | 0.74 | 21.9 | C |
| | | RT | 0.37 | 3 | A |
| | Colchester Ave NB | All | 0.36 | 14.5 | B |
| | Barrett Street WB | All | 0.62 | 49 | D |
| | Mill Street WB | All | 0.01 | 40 | D |
| | **Overall** | | **0.74** | **24.4** | **C** |
| PM | Riverside Ave NEB | All | 1.06 | 87.2 | F |
| | Colchester Ave SB | TH/LT | 0.55 | 28 | C |
| | | RT | 0.5 | 6.3 | A |
| | Colchester Ave NB | All | 1.02 | 74.6 | E |
| | Barrett Street WB | All | 1.06 | 117.8 | F |
| | Mill Street WB | All | 0.12 | 42.7 | D |
| | **Overall** | | **1.05** | **64.2** | **E** |

AM

| Source | Approach | Lane Group | Volume | V/C | Delay | V/S | Critical | LOS | Total Delay |
|---|---|---|---|---|---|---|---|---|---|
| 8 | Riverside Ave NEB | All | 646 | 0.92 | 50 | 0.19 | 0.19 | D | 32300 |
| 1 | Colchester Ave SB | TH/LT | 674 | 0.78 | 22.5 | 0.38 | 0.38 | C | 15165 |
| 1 | | RT | 422 | 0.37 | 3.8 | 0.27 | | A | 1604 |
| 6 | Colchester Ave NB | All | 318 | 0.52 | 22.2 | 0.18 | | C | 7060 |
| 6 | Barrett Street WB | All | 99 | 0.44 | 34.7 | 0.06 | 0.06 | C | 3435 |
| 1 | Mill Street WB | All | 1 | 0.01 | 31.4 | 0 | | C | 31 |
| | | | 2160 | | | | 0.63 | | 59595 |

| | |
|---|---|
| Cycle Length | 82.8 |
| Lost Time | 20 |

| | |
|---|---|
| Overall V/C = | 0.83 |
| Average Delay = | 27.6 |
| LOS= | C |

PM

| Source | Approach | Lane Group | Volume | V/C | Delay | V/S | Critical | LOS | Total Delay |
|---|---|---|---|---|---|---|---|---|---|
| 8 | Riverside Ave NEB | All | 119 | 1.2 | 145.9 | 0.32 | 0.32 | F | 17362 |
| 1 | Colchester Ave SB | TH/LT | 420 | 0.49 | 23 | 0.23 | | C | 9660 |
| 1 | | RT | 614 | 0.51 | 5.6 | 0.39 | | A | 3438 |
| 6 | Colchester Ave NB | All | 759 | 1.08 | 93.5 | 0.42 | 0.42 | F | 70967 |
| 6 | Barrett Street WB | All | 314 | 1.19 | 166.4 | 0.18 | 0.18 | F | 52250 |
| 1 | Mill Street WB | All | 13 | 0.05 | 44.3 | 0.01 | | D | 576 |
| | | | 2239 | | | | 0.92 | | 154253 |

| | |
|---|---|
| Cycle Length | 121 |
| Lost Time | 20 |

| | |
|---|---|
| Overall V/C = | 1.10 |
| Average Delay = | 68.9 |
| LOS= | E |

| Peak Hour | Approach | Lane Group | V/C | Delay | LOS |
|---|---|---|---|---|---|
| AM | Riverside Ave NEB | All | 0.92 | 50 | D |
| | Colchester Ave SB | TH/LT | 0.78 | 22.5 | C |
| | | RT | 0.37 | 3.8 | A |
| | Colchester Ave NB | All | 0.52 | 22.2 | C |
| | Barrett Street WB | All | 0.44 | 34.7 | C |
| | Mill Street WB | All | 0.01 | 31.4 | C |
| | **Overall** | | **0.83** | **27.6** | **C** |
| PM | Riverside Ave NEB | All | 1.2 | 145.9 | F |
| | Colchester Ave SB | TH/LT | 0.49 | 23 | C |
| | | RT | 0.51 | 5.6 | A |
| | Colchester Ave NB | All | 1.08 | 93.5 | F |
| | Barrett Street WB | All | 1.19 | 166.4 | F |
| | Mill Street WB | All | 0.05 | 44.3 | D |
| | **Overall** | | **1.10** | **68.9** | **E** |

Riverside Avenue/Colchester Avenue
Scoping Study

| Alternative | Movement | Peak Hour | 50th Queue | 95th Queue | Storage |
|---|---|---|---|---|---|
| #1 | SB Left | AM | 33 | 62 | 40 |
| | | PM | 41 | 78 | 40 |
| | SB Through | AM | 217 | 411 | 130 |
| | | PM | 231 | 353 | 130 |
| | SB Right | AM | 102 | 206 | 130 |
| | | PM | 509 | 875 | 130 |
| #2 | SB Left | AM | 32 | 63 | 40 |
| | | PM | 40 | 75 | 40 |
| | SB Through | AM | 172 | 275 | 130 |
| | | PM | 200 | 290 | 130 |

AM

| Source | Approach | Lane Group | Volume | V/C | Delay | V/S | Critical | LOS | Total Delay |
|---|---|---|---|---|---|---|---|---|---|
| 8 | Riverside Ave NEB | All | 646 | 0.92 | 50 | 0.19 | 0.19 | D | 32300 |
| 1 | Colchester Ave SB | TH/LT | 674 | 0.78 | 22.5 | 0.38 | 0.38 | C | 15165 |
| 1 | | RT | 422 | 0.37 | 3.8 | 0.27 | | A | 1604 |
| 6 | Colchester Ave NB | All | 317 | 0.34 | 20 | 0.12 | | B | 6340 |
| 6 | Barrett Street WB | All | 99 | 0.44 | 34.7 | 0.06 | 0.06 | C | 3435 |
| 1 | Mill Street WB | All | 1 | 0.01 | 31.4 | 0 | | C | 31 |
| | | | 2159 | | | | 0.63 | | 58875 |

| | |
|---|---|
| Cycle Length | 82.8 |
| Lost Time | 20 |

| | |
|---|---|
| Overall V/C = | 0.83 |
| Average Delay = | 27.3 |
| LOS= | C |

PM

| Source | Approach | Lane Group | Volume | V/C | Delay | V/S | Critical | LOS | Total Delay |
|---|---|---|---|---|---|---|---|---|---|
| 8 | Riverside Ave NEB | All | 119 | 1.2 | 145.9 | 0.32 | 0.32 | F | 17362 |
| 1 | Colchester Ave SB | TH/LT | 420 | 0.49 | 23 | 0.23 | | C | 9660 |
| 1 | | RT | 614 | 0.51 | 5.6 | 0.39 | | A | 3438 |
| 6 | Colchester Ave NB | All | 756 | 1.01 | 65.1 | 0.27 | 0.27 | E | 49216 |
| 6 | Barrett Street WB | All | 306 | 0.86 | 51.6 | 0.17 | 0.17 | D | 15790 |
| 1 | Mill Street WB | All | 13 | 0.05 | 44.3 | 0.01 | | D | 576 |
| | | | 2228 | | | | 0.76 | | 96042 |

| | |
|---|---|
| Cycle Length | 121 |
| Lost Time | 20 |

| | |
|---|---|
| Overall V/C = | 0.91 |
| Average Delay = | 43.1 |
| LOS= | D |

| Peak Hour | Approach | Lane Group | V/C | Delay | LOS |
|---|---|---|---|---|---|
| AM | Riverside Ave NEB | All | 0.92 | 50 | D |
| | Colchester Ave SB | TH/LT | 0.78 | 22.5 | C |
| | | RT | 0.37 | 3.8 | A |
| | Colchester Ave NB | All | 0.34 | 20 | B |
| | Barrett Street WB | All | 0.44 | 34.7 | C |
| | Mill Street WB | All | 0.01 | 31.4 | C |
| | **Overall** | | **0.83** | **27.3** | **C** |
| PM | Riverside Ave NEB | All | 1.2 | 145.9 | F |
| | Colchester Ave SB | TH/LT | 0.49 | 23 | C |
| | | RT | 0.51 | 5.6 | A |
| | Colchester Ave NB | All | 1.01 | 65.1 | E |
| | Barrett Street WB | All | 0.86 | 51.6 | D |
| | Mill Street WB | All | 0.05 | 44.3 | D |
| | **Overall** | | **0.91** | **43.1** | **D** |

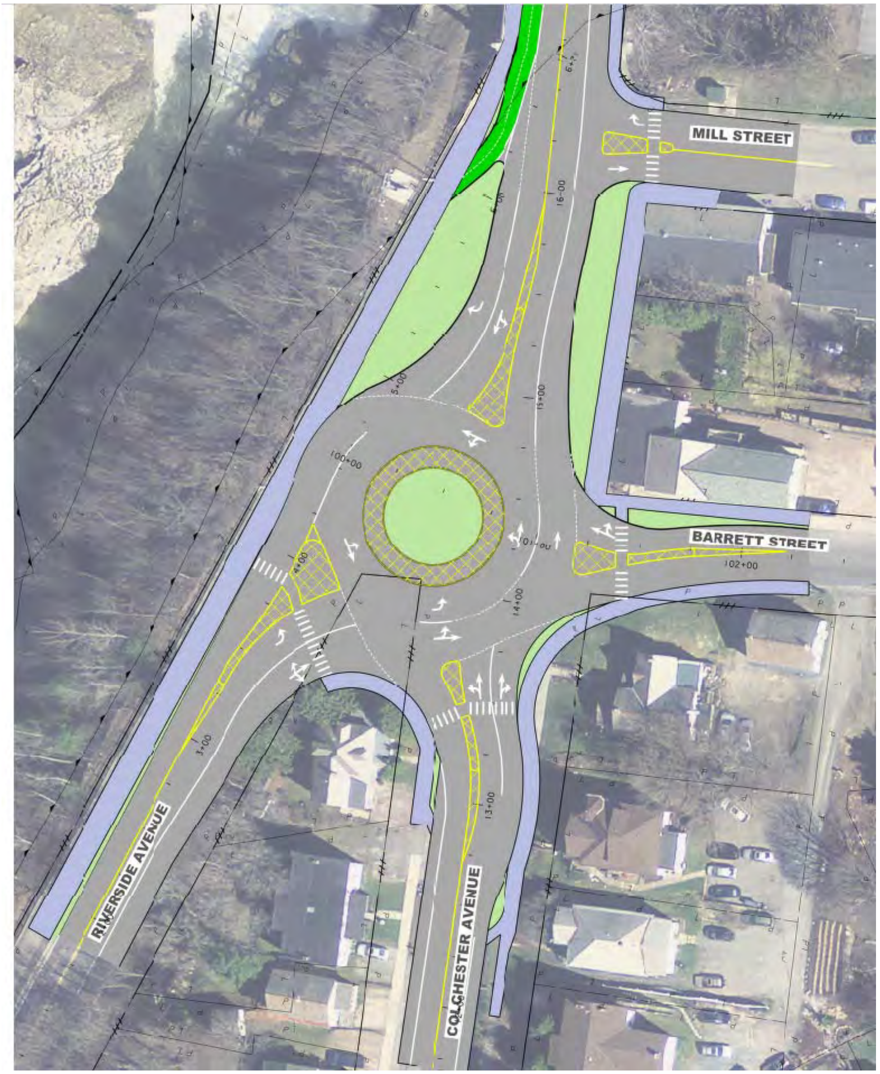
# MTJ Rodel Analysis

Colchester and River Side, Burlington VT

Long-Range Traffic (as provided in GDOT spreadsheet)

# Proposed Design

- GDOT HCM spread sheet analysis
- Will not provide how much flare length is necessary can guess based on 95%Q
- Review Comments / Issues:
  - General circle placement is where it needs to be.
  - However, refinements may be possible to balance impacts, but are out of the scope for this work effort.
  - Missing spiral for movements to SW bound Riverside. (see sketch recommendations provided below)
  - Lane assignment arrows need revising - Use 45 deg arrows (see sketch recommendations provided below)



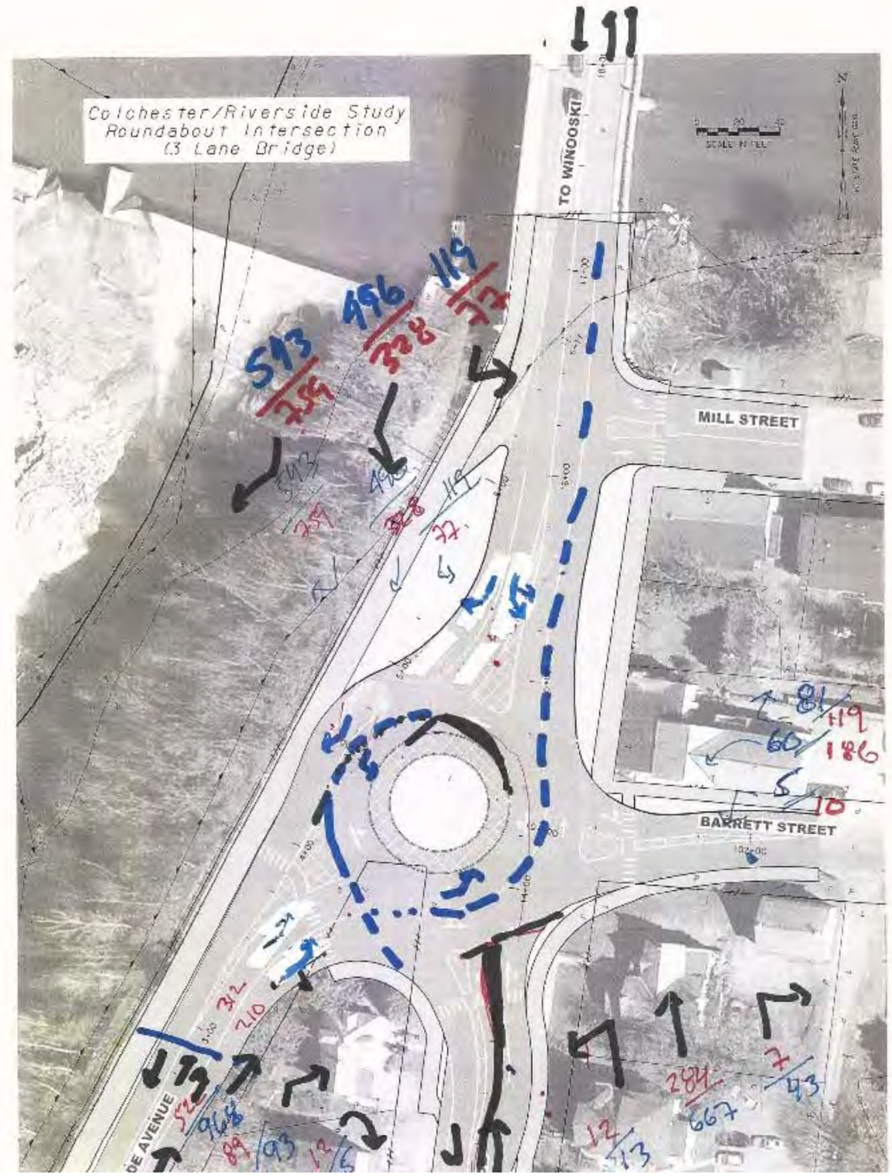
# Summary

**Operational Results – Rodel 1.88**

- South Leg (NB entry) only needs a single-lane entry (Rodel Analysis- High Definition Q theory- see attached)
- Rodel accounts for the amount of Flare length necessary both SB and from the SW leg. This together with the single lane NB entry may provide additional design space to optimize geometric.

**Horizontal Design**

- The sketch image to the right depicts generalized lane assignment modifications to account for the skewed intersection – tilt 45 deg. lane assignment arrows necessary.
- includes necessary spiral to account for lane assignment congruency.
- “Generally” the circle placement is about where it needs to be –the southerly placement accounts for skew. The ICD ~ 150’
- Within the identified foot print geometric optimization and refinements are likely possible to balance impacts and perhaps improve feasibility. However, this work effort is out of my scope of work.



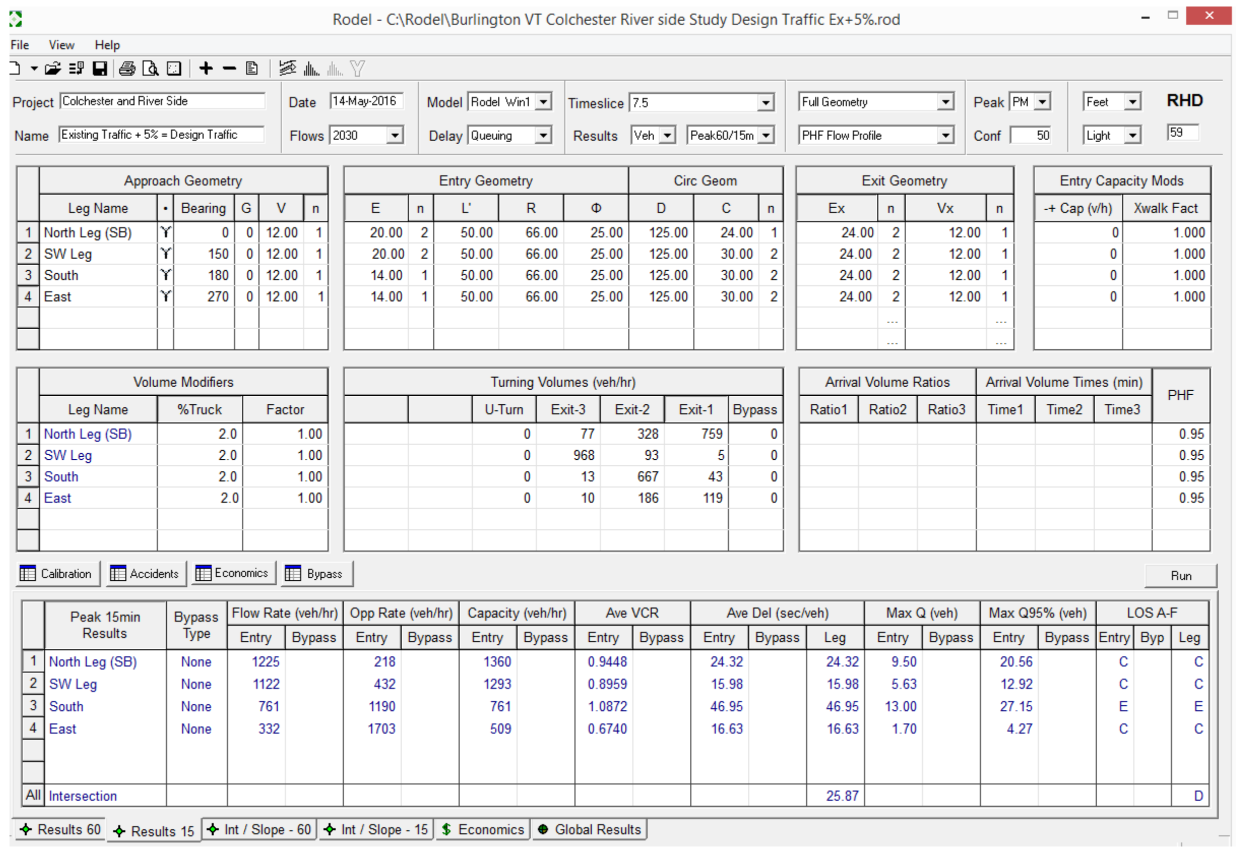

MTJ Roundabout Engineering

# PM Peak Design Year Traffic – (Existing +5%)

**<u>Rodel Results (pm peak 15 min)</u>**

SB, NE

- Short Flared Two-Lane Entry
  - E=20' (2 - 10' lanes)
  - Flare = 50'
- Single-Lane is acceptable for South Leg (NB)
  - Ave Del = 42 sec
  - Ave Q = 13 veh (rolling Q)



Rodel - C:\Rodel\Burlington VT Colchester River side Study Design Traffic Ex+5%.rod

File View Help

Project: Colchester and River Side | Date: 14-May-2016 | Model: Rodel Win1 | Timeslice: 7.5 | Full Geometry | Peak: PM | Feet | RHD

Name: Existing Traffic + 5% = Design Traffic | Flows: 2030 | Delay: Queuing | Results: Veh, Peak60/15m | PHF Flow Profile | Conf: 50 | Light | 59

| | Approach Geometry | | | | | Entry Geometry | | | | | Circ Geom | | | Exit Geometry | | | | Entry Capacity Mods | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Leg Name | • | Bearing | G | V | n | E | n | L' | R | Φ | D | C | n | Ex | n | Vx | n | -+ Cap (v/h) | Xwalk Fact |
| 1 | North Leg (SB) | Y | 0 | 0 | 12.00 | 1 | 20.00 | 2 | 50.00 | 66.00 | 25.00 | 125.00 | 24.00 | 1 | 24.00 | 2 | 12.00 | 1 | 0 | 1.000 |
| 2 | SW Leg | Y | 150 | 0 | 12.00 | 1 | 20.00 | 2 | 50.00 | 66.00 | 25.00 | 125.00 | 30.00 | 2 | 24.00 | 2 | 12.00 | 1 | 0 | 1.000 |
| 3 | South | Y | 180 | 0 | 12.00 | 1 | 14.00 | 1 | 50.00 | 66.00 | 25.00 | 125.00 | 30.00 | 2 | 24.00 | 2 | 12.00 | 1 | 0 | 1.000 |
| 4 | East | Y | 270 | 0 | 12.00 | 1 | 14.00 | 1 | 50.00 | 66.00 | 25.00 | 125.00 | 30.00 | 2 | 24.00 | 2 | 12.00 | 1 | 0 | 1.000 |

| | Volume Modifiers | | | Turning Volumes (veh/hr) | | | | | | | Arrival Volume Ratios | | | Arrival Volume Times (min) | | | PHF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Leg Name | %Truck | Factor | | | U-Turn | Exit-3 | Exit-2 | Exit-1 | Bypass | Ratio1 | Ratio2 | Ratio3 | Time1 | Time2 | Time3 | |
| 1 | North Leg (SB) | 2.0 | 1.00 | | | 0 | 77 | 328 | 759 | 0 | | | | | | | 0.95 |
| 2 | SW Leg | 2.0 | 1.00 | | | 0 | 968 | 93 | 5 | 0 | | | | | | | 0.95 |
| 3 | South | 2.0 | 1.00 | | | 0 | 13 | 667 | 43 | 0 | | | | | | | 0.95 |
| 4 | East | 2.0 | 1.00 | | | 0 | 10 | 186 | 119 | 0 | | | | | | | 0.95 |

Calibration | Accidents | Economics | Bypass | Run

| | Peak 15min Results | Bypass Type | Flow Rate (veh/hr) | | Opp Rate (veh/hr) | | Capacity (veh/hr) | | Ave VCR | | Ave Del (sec/veh) | | | Max Q (veh) | | Max Q95% (veh) | | LOS A-F | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Entry | Bypass | Entry | Bypass | Entry | Bypass | Entry | Bypass | Entry | Bypass | Leg | Entry | Bypass | Entry | Bypass | Entry | Byp | Leg |
| 1 | North Leg (SB) | None | 1225 | | 218 | | 1360 | | 0.9448 | | 24.32 | | 24.32 | 9.50 | | 20.56 | | C | | C |
| 2 | SW Leg | None | 1122 | | 432 | | 1293 | | 0.8959 | | 15.98 | | 15.98 | 5.63 | | 12.92 | | C | | C |
| 3 | South | None | 761 | | 1190 | | 761 | | 1.0872 | | 46.95 | | 46.95 | 13.00 | | 27.15 | | E | | E |
| 4 | East | None | 332 | | 1703 | | 509 | | 0.6740 | | 16.63 | | 16.63 | 1.70 | | 4.27 | | C | | C |
| All | Intersection | | | | | | | | | | | | 25.87 | | | | | | | D |

Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | Economics | Global Results

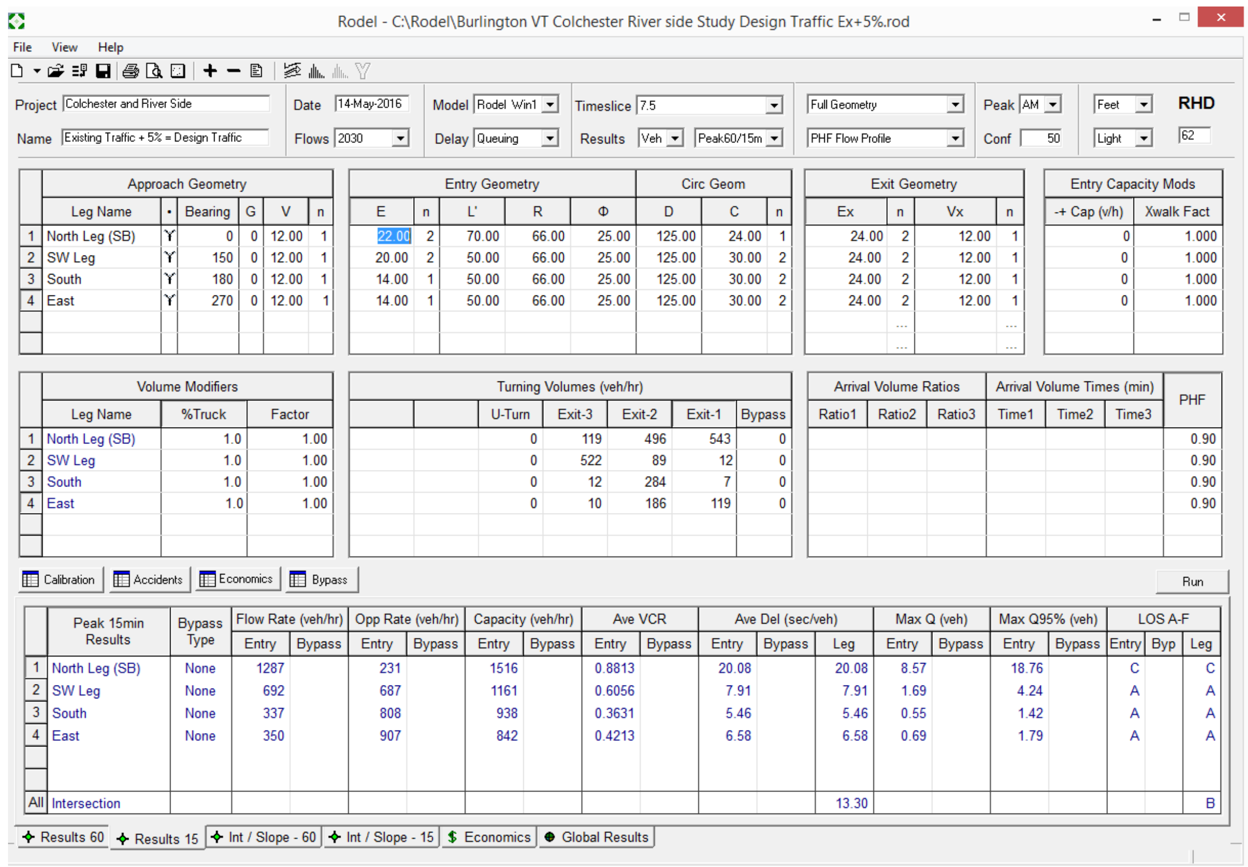
MTJ Roundabout Engineering

# AM Peak Design Year Traffic – (Existing +5%)

**Rodel Results (am peak 15 min)**

SB, Short Flared Two-Lane Entry

- E=22' (2 - 11' lanes)
- Flare = 70'



Rodel - C:\Rodel\Burlington VT Colchester River side Study Design Traffic Ex+5%.rod

File View Help

Project: Colchester and River Side | Date: 14-May-2016 | Model: Rodel Win1 | Timeslice: 7.5 | Full Geometry | Peak: AM | Feet | RHD

Name: Existing Traffic + 5% = Design Traffic | Flows: 2030 | Delay: Queuing | Results: Veh, Peak60/15m | PHF Flow Profile | Conf: 50 | Light | 62

| | Approach Geometry | | | | | | Entry Geometry | | | | | Circ Geom | | | Exit Geometry | | | | Entry Capacity Mods | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Leg Name | • | Bearing | G | V | n | E | n | L' | R | Φ | D | C | n | Ex | n | Vx | n | -+ Cap (v/h) | Xwalk Fact |
| 1 | North Leg (SB) | Y | 0 | 0 | 12.00 | 1 | 22.00 | 2 | 70.00 | 66.00 | 25.00 | 125.00 | 24.00 | 1 | 24.00 | 2 | 12.00 | 1 | 0 | 1.000 |
| 2 | SW Leg | Y | 150 | 0 | 12.00 | 1 | 20.00 | 2 | 50.00 | 66.00 | 25.00 | 125.00 | 30.00 | 2 | 24.00 | 2 | 12.00 | 1 | 0 | 1.000 |
| 3 | South | Y | 180 | 0 | 12.00 | 1 | 14.00 | 1 | 50.00 | 66.00 | 25.00 | 125.00 | 30.00 | 2 | 24.00 | 2 | 12.00 | 1 | 0 | 1.000 |
| 4 | East | Y | 270 | 0 | 12.00 | 1 | 14.00 | 1 | 50.00 | 66.00 | 25.00 | 125.00 | 30.00 | 2 | 24.00 | 2 | 12.00 | 1 | 0 | 1.000 |

| | Volume Modifiers | | | Turning Volumes (veh/hr) | | | | | Arrival Volume Ratios | | | Arrival Volume Times (min) | | | PHF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Leg Name | %Truck | Factor | U-Turn | Exit-3 | Exit-2 | Exit-1 | Bypass | Ratio1 | Ratio2 | Ratio3 | Time1 | Time2 | Time3 | |
| 1 | North Leg (SB) | 1.0 | 1.00 | 0 | 119 | 496 | 543 | 0 | | | | | | | 0.90 |
| 2 | SW Leg | 1.0 | 1.00 | 0 | 522 | 89 | 12 | 0 | | | | | | | 0.90 |
| 3 | South | 1.0 | 1.00 | 0 | 12 | 284 | 7 | 0 | | | | | | | 0.90 |
| 4 | East | 1.0 | 1.00 | 0 | 10 | 186 | 119 | 0 | | | | | | | 0.90 |

Calibration | Accidents | Economics | Bypass | Run

| | Peak 15min Results | Bypass Type | Flow Rate (veh/hr) | | Opp Rate (veh/hr) | | Capacity (veh/hr) | | Ave VCR | | Ave Del (sec/veh) | | | Max Q (veh) | | Max Q95% (veh) | | LOS A-F | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Entry | Bypass | Entry | Bypass | Entry | Bypass | Entry | Bypass | Entry | Bypass | Leg | Entry | Bypass | Entry | Bypass | Entry | Byp | Leg |
| 1 | North Leg (SB) | None | 1287 | | 231 | | 1516 | | 0.8813 | | 20.08 | | 20.08 | 8.57 | | 18.76 | | C | | C |
| 2 | SW Leg | None | 692 | | 687 | | 1161 | | 0.6056 | | 7.91 | | 7.91 | 1.69 | | 4.24 | | A | | A |
| 3 | South | None | 337 | | 808 | | 938 | | 0.3631 | | 5.46 | | 5.46 | 0.55 | | 1.42 | | A | | A |
| 4 | East | None | 350 | | 907 | | 842 | | 0.4213 | | 6.58 | | 6.58 | 0.69 | | 1.79 | | A | | A |
| All | Intersection | | | | | | | | | | | | 13.30 | | | | | | | B |

Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | Economics | Global Results

MTJ Roundabout Engineering

# Sensitivity Testing

Single Lane on Existing Traffic

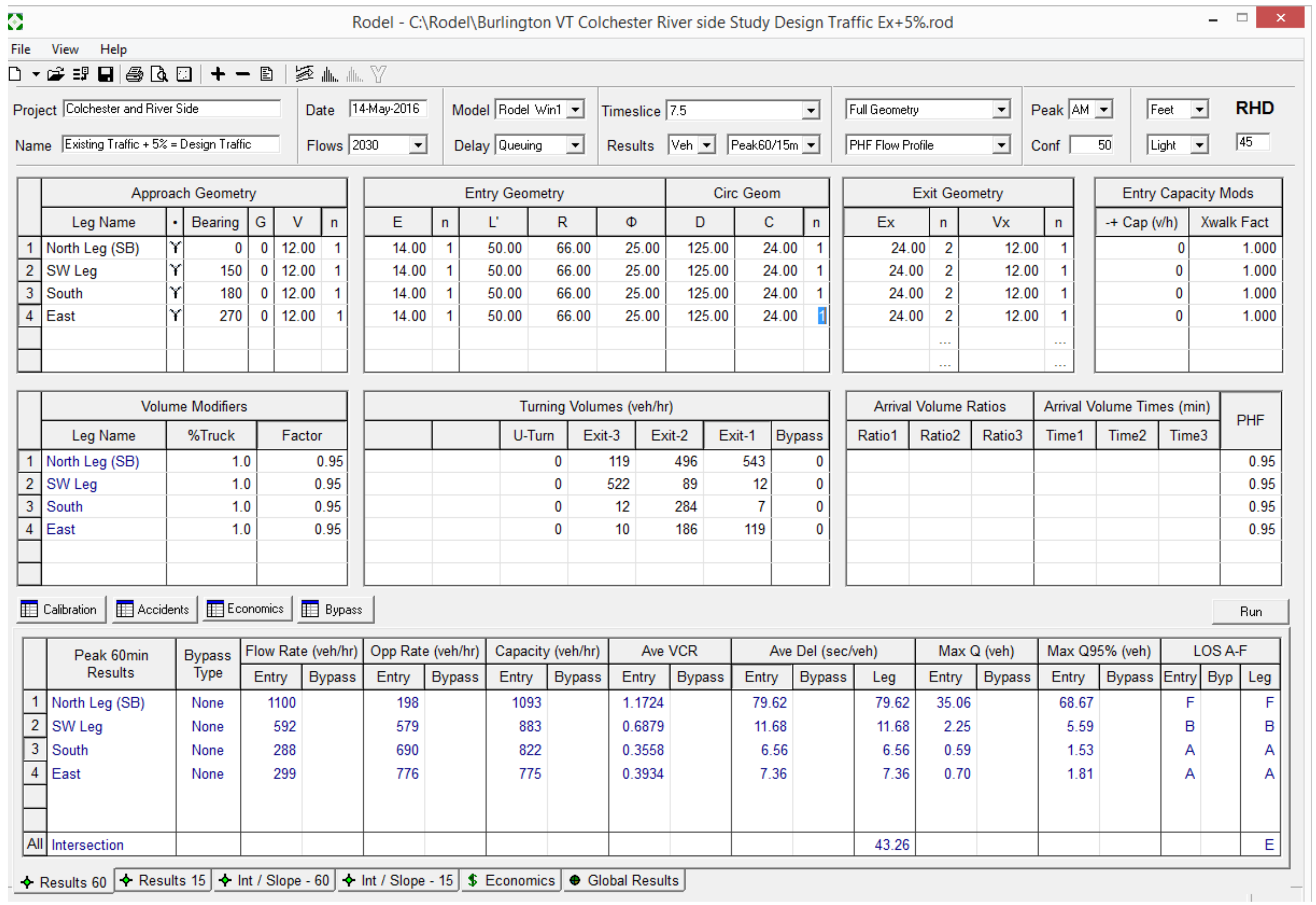
Single-Lane on Design Year Traffic

# AM Peak Existing Traffic – (Existing = entered -5% flow factor)

## Single Lane on Existing Traffic

Single Lane Entries SB and NE entries?

No for SB morning



Rodel - C:\Rodel\Burlington VT Colchester River side Study Design Traffic Ex+5%.rod

File View Help

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project | Colchester and River Side | Date | 14-May-2016 | Model | Rodel Win1 | Timeslice | 7.5 |
| Name | Existing Traffic + 5% = Design Traffic | Flows | 2030 | Delay | Queuing | Results | Veh / Peak60/15m |

Full Geometry · PHF Flow Profile · Peak AM · Conf 50 · Feet · Light · RHD · 45

| | Approach Geometry | | | | | | Entry Geometry | | | | | Circ Geom | | | Exit Geometry | | | | Entry Capacity Mods | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Leg Name | • | Bearing | G | V | n | E | n | L' | R | Φ | D | C | n | Ex | n | Vx | n | -+ Cap (v/h) | Xwalk Fact |
| 1 | North Leg (SB) | Y | 0 | 0 | 12.00 | 1 | 14.00 | 1 | 50.00 | 66.00 | 25.00 | 125.00 | 24.00 | 1 | 24.00 | 2 | 12.00 | 1 | 0 | 1.000 |
| 2 | SW Leg | Y | 150 | 0 | 12.00 | 1 | 14.00 | 1 | 50.00 | 66.00 | 25.00 | 125.00 | 24.00 | 1 | 24.00 | 2 | 12.00 | 1 | 0 | 1.000 |
| 3 | South | Y | 180 | 0 | 12.00 | 1 | 14.00 | 1 | 50.00 | 66.00 | 25.00 | 125.00 | 24.00 | 1 | 24.00 | 2 | 12.00 | 1 | 0 | 1.000 |
| 4 | East | Y | 270 | 0 | 12.00 | 1 | 14.00 | 1 | 50.00 | 66.00 | 25.00 | 125.00 | 24.00 | 1 | 24.00 | 2 | 12.00 | 1 | 0 | 1.000 |

| | Volume Modifiers | | | Turning Volumes (veh/hr) | | | | | | | Arrival Volume Ratios | | | Arrival Volume Times (min) | | | PHF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Leg Name | %Truck | Factor | | | U-Turn | Exit-3 | Exit-2 | Exit-1 | Bypass | Ratio1 | Ratio2 | Ratio3 | Time1 | Time2 | Time3 | |
| 1 | North Leg (SB) | 1.0 | 0.95 | | | 0 | 119 | 496 | 543 | 0 | | | | | | | 0.95 |
| 2 | SW Leg | 1.0 | 0.95 | | | 0 | 522 | 89 | 12 | 0 | | | | | | | 0.95 |
| 3 | South | 1.0 | 0.95 | | | 0 | 12 | 284 | 7 | 0 | | | | | | | 0.95 |
| 4 | East | 1.0 | 0.95 | | | 0 | 10 | 186 | 119 | 0 | | | | | | | 0.95 |

Calibration · Accidents · Economics · Bypass · Run

| | Peak 60min Results | Bypass Type | Flow Rate (veh/hr) | | Opp Rate (veh/hr) | | Capacity (veh/hr) | | Ave VCR | | Ave Del (sec/veh) | | | Max Q (veh) | | Max Q95% (veh) | | LOS A-F | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Entry | Bypass | Entry | Bypass | Entry | Bypass | Entry | Bypass | Entry | Bypass | Leg | Entry | Bypass | Entry | Bypass | Entry | Byp | Leg |
| 1 | North Leg (SB) | None | 1100 | | 198 | | 1093 | | 1.1724 | | 79.62 | | 79.62 | 35.06 | | 68.67 | | F | | F |
| 2 | SW Leg | None | 592 | | 579 | | 883 | | 0.6879 | | 11.68 | | 11.68 | 2.25 | | 5.59 | | B | | B |
| 3 | South | None | 288 | | 690 | | 822 | | 0.3558 | | 6.56 | | 6.56 | 0.59 | | 1.53 | | A | | A |
| 4 | East | None | 299 | | 776 | | 775 | | 0.3934 | | 7.36 | | 7.36 | 0.70 | | 1.81 | | A | | A |
| All | Intersection | | | | | | | | | | | | 43.26 | | | | | | | E |

Results 60 · Results 15 · Int / Slope - 60 · Int / Slope - 15 · Economics · Global Results

MTJ Roundabout Engineering

# PM Peak Existing Traffic – (Existing = entered -5%)

Poor Delay for NB entry as single circulating lane (this is resolved with two lane entry NE bound and then two lanes circulating)

Rodel - C:\Rodel\Burlington VT Colchester River side Study Design Traffic Ex+5%.rod

Project: Colchester and River Side | Date: 14-May-2016 | Model: Rodel Win1 | Timeslice: 7.5 | Full Geometry | Peak: PM | Feet | RHD

Name: Existing Traffic + 5% = Design Traffic | Flows: 2030 | Delay: Queuing | Results: Veh, Peak60/15m | PHF Flow Profile | Conf: 50 | Light | 46

| | Approach Geometry | | | | | | Entry Geometry | | | | Circ Geom | | | Exit Geometry | | | | Entry Capacity Mods | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Leg Name | • | Bearing | G | V | n | E | n | L' | R | Φ | D | C | n | Ex | n | Vx | n | -+ Cap (v/h) | Xwalk Fact |
| 1 | North Leg (SB) | Y | 0 | 0 | 12.00 | 1 | 14.00 | 1 | 50.00 | 66.00 | 25.00 | 125.00 | 24.00 | 1 | 24.00 | 2 | 12.00 | 1 | 0 | 1.000 |
| 2 | SW Leg | Y | 150 | 0 | 12.00 | 1 | 14.00 | 1 | 50.00 | 66.00 | 25.00 | 125.00 | 24.00 | 1 | 24.00 | 2 | 12.00 | 1 | 0 | 1.000 |
| 3 | South | Y | 180 | 0 | 12.00 | 1 | 14.00 | 1 | 50.00 | 66.00 | 25.00 | 125.00 | 24.00 | 1 | 24.00 | 2 | 12.00 | 1 | 0 | 1.000 |
| 4 | East | Y | 270 | 0 | 12.00 | 1 | 14.00 | 1 | 50.00 | 66.00 | 25.00 | 125.00 | 24.00 | 1 | 24.00 | 2 | 12.00 | 1 | 0 | 1.000 |

| | Volume Modifiers | | | Turning Volumes (veh/hr) | | | | | | | Arrival Volume Ratios | | | Arrival Volume Times (min) | | | PHF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Leg Name | %Truck | Factor | | | U-Turn | Exit-3 | Exit-2 | Exit-1 | Bypass | Ratio1 | Ratio2 | Ratio3 | Time1 | Time2 | Time3 | |
| 1 | North Leg (SB) | 1.0 | 0.95 | | | 0 | 77 | 328 | 759 | 0 | | | | | | | 0.95 |
| 2 | SW Leg | 1.0 | 0.95 | | | 0 | 968 | 93 | 5 | 0 | | | | | | | 0.95 |
| 3 | South | 1.0 | 0.95 | | | 0 | 13 | 667 | 43 | 0 | | | | | | | 0.95 |
| 4 | East | 1.0 | 0.95 | | | 0 | 10 | 186 | 119 | 0 | | | | | | | 0.95 |

Calibration | Accidents | Economics | Bypass | Run

| | Peak 60min Results | Bypass Type | Flow Rate (veh/hr) | | Opp Rate (veh/hr) | | Capacity (veh/hr) | | Ave VCR | | Ave Del (sec/veh) | | | Max Q (veh) | | Max Q95% (veh) | | LOS A-F | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Entry | Bypass | Entry | Bypass | Entry | Bypass | Entry | Bypass | Entry | Bypass | Leg | Entry | Bypass | Entry | Bypass | Entry | Byp | Leg |
| 1 | North Leg (SB) | None | 1106 | | 196 | | 1094 | | 1.1853 | | 83.35 | | 83.35 | 37.37 | | 73.11 | | F | | F |
| 2 | SW Leg | None | 1013 | | 384 | | 991 | | 1.2260 | | 96.91 | | 96.91 | 41.54 | | 81.16 | | F | | F |
| 3 | South | None | 687 | | 1045 | | 627 | | 1.5393 | | 200.67 | | 200.67 | 68.45 | | 133.49 | | F | | F |
| 4 | East | None | 299 | | 1475 | | 390 | | 0.8262 | | 34.95 | | 34.95 | 3.54 | | 8.49 | | D | | D |
| All | Intersection | | | | | | | | | | | | 109.06 | | | | | | | F |

Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | Economics | Global Results

MTJ Roundabout Engineering

# RODEL v 1.88 Summary

**Roundabout Analysis Software Accurate for North American Capacity Predictions**
**Rodel v. 1.88**

**Rodel is a high definition, robust and accurate roundabout analysis program that utilizes the U.K. Empirical Capacity Model and included the HCM capacity model. Rodel v1.88 extends the application of the U.K. capacity equations to U.S./North American design practices and principles to include lane-based analysis and explicit and robust analysis of right turn lanes, flared entries, and closely spaced roundabouts.**

**It has been reported that the U.K.-derived capacity predictions may over-predict capacity on U.S. roundabouts since U.K. drivers are more accustomed to roundabouts. However, review of U.S. field-measured capacity data collected by FHWA in 2012 as compared to the U.K. data upon which Rodel is predicated demonstrates that there is, in fact, a very strong correlation of U.S. capacity to Rodel's capacity predictions.**

**Key Similarities and Differences between HCM and Rodel**
**Both HCM and Rodel utilize 'Time Dependent Queuing Theory' (developed by U.S. researcher P.M. Morse in the 1960's), and because delay is derived from queuing theory equations, nothing in this respect is different from HCM to Rodel.**

**However, there is an important analysis methodology that differentiates Rodel v.1.88 from other analysis programs and that is:**

**Rodel incorporates 'High Definition' queuing theory equations (vs. low definition). 'High definition' queuing theory equations provided is that at high v/c ratios Rodel provides accurate and stable predictions for Q and Delay. This is in sharp contrast to HCS and other programs that use 'low definition' queuing theory equations, as the low definition equations become unstable at v/c ratios above 0.90. This can then result in additional laneage to maintain acceptable LOS that is often not necessary.**

MTJ Roundabout Engineering

| Lane Group | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 2 | 2 | 375 | 10 | 22 | 1153 |
| Future Volume (vph) | 2 | 2 | 375 | 10 | 22 | 1153 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 | 1.00 |
| Frt | | 0.850 | 0.996 | | | |
| Flt Protected | 0.950 | | | | | 0.999 |
| Satd. Flow (prot) | 1203 | 1077 | 3365 | 0 | 0 | 1809 |
| Flt Permitted | 0.950 | | | | | 0.999 |
| Satd. Flow (perm) | 1203 | 1077 | 3365 | 0 | 0 | 1809 |
| Link Speed (mph) | 25 | | 25 | | | 25 |
| Link Distance (ft) | 168 | | 200 | | | 212 |
| Travel Time (s) | 4.6 | | 5.5 | | | 5.8 |
| Peak Hour Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Heavy Vehicles (%) | 50% | 50% | 7% | 1% | 0% | 5% |
| Adj. Flow (vph) | 2 | 2 | 395 | 11 | 23 | 1214 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 2 | 2 | 406 | 0 | 0 | 1237 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Right | Left | Left |
| Median Width(ft) | 12 | | 12 | | | 12 |
| Link Offset(ft) | 0 | | 0 | | | 0 |
| Crosswalk Width(ft) | 16 | | 16 | | | 16 |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | | 9 | 15 | |
| Sign Control | Stop | | Free | | | Free |

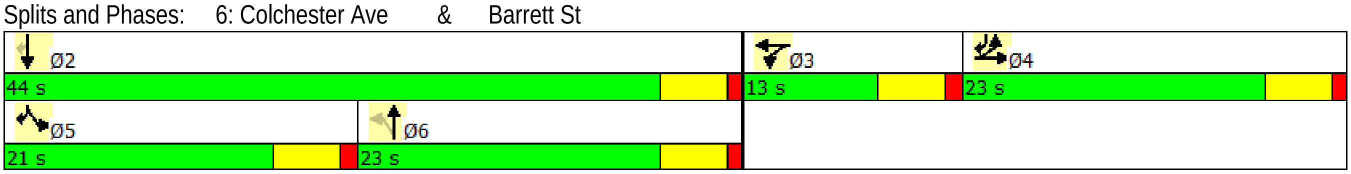
| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 85.9% | ICU Level of Service E |
| Analysis Period (min) 15 | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 532 | 89 | 12 | 5 | 60 | 81 | 12 | 284 | 7 | 119 | 496 | 543 |
| Future Volume (vph) | 532 | 89 | 12 | 5 | 60 | 81 | 12 | 284 | 7 | 119 | 496 | 543 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1600 | 1600 | 1600 | 1900 | 1300 | 1300 |
| Storage Length (ft) | 0 | | 0 | 0 | | 0 | 200 | | 0 | 50 | | 0 |
| Storage Lanes | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | | 1 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.994 | | | 0.925 | | | 0.997 | | | | 0.850 |
| Flt Protected | 0.950 | 0.967 | | | 0.998 | | | 0.998 | | 0.950 | | |
| Satd. Flow (prot) | 1681 | 1701 | 0 | 0 | 1711 | 0 | 0 | 2836 | 0 | 1752 | 1262 | 1083 |
| Flt Permitted | 0.950 | 0.967 | | | 0.998 | | | 0.926 | | 0.950 | | |
| Satd. Flow (perm) | 1681 | 1701 | 0 | 0 | 1711 | 0 | 0 | 2632 | 0 | 1752 | 1262 | 1083 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | No |
| Satd. Flow (RTOR) | | 2 | | | 62 | | | 3 | | | | |
| Link Speed (mph) | | 30 | | | 25 | | | 25 | | | 25 | |
| Link Distance (ft) | | 228 | | | 170 | | | 250 | | | 200 | |
| Travel Time (s) | | 5.2 | | | 4.6 | | | 6.8 | | | 5.5 | |
| Peak Hour Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Heavy Vehicles (%) | 2% | 2% | 2% | 0% | 2% | 3% | 2% | 7% | 0% | 3% | 3% | 2% |
| Adj. Flow (vph) | 560 | 94 | 13 | 5 | 63 | 85 | 13 | 299 | 7 | 125 | 522 | 572 |
| Shared Lane Traffic (%) | 41% | | | | | | | | | | | |
| Lane Group Flow (vph) | 330 | 337 | 0 | 0 | 153 | 0 | 0 | 319 | 0 | 125 | 522 | 572 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.24 | 1.24 | 1.24 | 1.00 | 1.60 | 1.60 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | Split | NA | | Split | NA | | Perm | NA | | Prot | NA | custom |
| Protected Phases | 4 | 4 | | 3 | 3 | | | 6 | | 5 | 2 | 4 5 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Permitted Phases | | | | | | | 6 | | | | | 2 |
| Detector Phase | 4 | 4 | | 3 | 3 | | 6 | 6 | | 5 | 2 | 4 5 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 15.0 | 15.0 | | 8.0 | 8.0 | | 15.0 | 15.0 | | 5.0 | 15.0 | |
| Minimum Split (s) | 21.0 | 21.0 | | 13.0 | 13.0 | | 20.0 | 20.0 | | 19.0 | 21.0 | |
| Total Split (s) | 23.0 | 23.0 | | 13.0 | 13.0 | | 23.0 | 23.0 | | 21.0 | 44.0 | |
| Total Split (%) | 28.8% | 28.8% | | 16.3% | 16.3% | | 28.8% | 28.8% | | 26.3% | 55.0% | |
| Maximum Green (s) | 18.0 | 18.0 | | 8.0 | 8.0 | | 18.0 | 18.0 | | 16.0 | 39.0 | |
| Yellow Time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| All-Red Time (s) | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | |
| Lost Time Adjust (s) | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | 0.0 | 0.0 | |
| Total Lost Time (s) | 5.0 | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Lead/Lag | Lag | Lag | | Lead | Lead | | Lag | Lag | | Lead | | |
| Lead-Lag Optimize? | Yes | Yes | | Yes | Yes | | Yes | Yes | | Yes | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Recall Mode | None | None | | None | None | | Min | Min | | None | Min | |
| Walk Time (s) | 5.0 | 5.0 | | | | | 5.0 | 5.0 | | | 5.0 | |
| Flash Dont Walk (s) | 9.0 | 9.0 | | | | | 5.0 | 5.0 | | | 9.0 | |
| Pedestrian Calls (#/hr) | 10 | 10 | | | | | 10 | 10 | | | 10 | |
| Act Effct Green (s) | 17.8 | 17.8 | | | 8.0 | | | 19.0 | | 11.0 | 35.1 | 57.9 |
| Actuated g/C Ratio | 0.23 | 0.23 | | | 0.11 | | | 0.25 | | 0.14 | 0.46 | 0.76 |
| v/c Ratio | 0.84 | 0.84 | | | 0.65 | | | 0.48 | | 0.49 | 0.90 | 0.69 |
| Control Delay | 49.9 | 50.0 | | | 35.8 | | | 27.6 | | 36.8 | 39.4 | 9.9 |
| Queue Delay | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Delay | 49.9 | 50.0 | | | 35.8 | | | 27.6 | | 36.8 | 39.4 | 9.9 |
| LOS | D | D | | | D | | | C | | D | D | A |
| Approach Delay | | 50.0 | | | 35.8 | | | 27.6 | | | 25.3 | |
| Approach LOS | | D | | | D | | | C | | | C | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 80 | |
| Actuated Cycle Length: 76 | |
| Natural Cycle: 80 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.90 | |
| Intersection Signal Delay: 33.3 | Intersection LOS: C |
| Intersection Capacity Utilization 93.2% | ICU Level of Service F |
| Analysis Period (min) 15 | |

Splits and Phases: 6: Colchester Ave & Barrett St



| Lane Group | EBL | EBT | WBT | NBT | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 330 | 337 | 153 | 319 | 125 | 522 | 572 |
| v/c Ratio | 0.76 | 0.77 | 0.63 | 0.56 | 0.50 | 0.66 | 0.48 |
| Control Delay | 39.3 | 39.2 | 34.0 | 30.6 | 36.8 | 21.7 | 4.9 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 39.3 | 39.2 | 34.0 | 30.6 | 36.8 | 21.7 | 4.9 |
| Queue Length 50th (ft) | 142 | 145 | 40 | 68 | 53 | 187 | 75 |
| Queue Length 95th (ft) | #296 | #304 | #125 | 114 | 107 | 288 | 119 |
| Internal Link Dist (ft) | | 148 | 90 | 170 | | 120 | |
| Turn Bay Length (ft) | | | | | 50 | | |
| Base Capacity (vph) | 460 | 467 | 242 | 649 | 335 | 934 | 1193 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.72 | 0.72 | 0.63 | 0.49 | 0.37 | 0.56 | 0.48 |

Intersection Summary

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

Rev
4 lane BRIDGE

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 532 | 89 | 12 | 5 | 60 | 81 | 12 | 284 | 7 | 119 | 496 | 543 |
| Future Volume (vph) | 532 | 89 | 12 | 5 | 60 | 81 | 12 | 284 | 7 | 119 | 496 | 543 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1600 | 1600 | 1600 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 0.95 | 0.95 | | | 1.00 | | | 0.95 | | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.99 | | | 0.93 | | | 1.00 | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 0.97 | | | 1.00 | | | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1681 | 1701 | | | 1712 | | | 2835 | | 1752 | 1845 | 1583 |
| Flt Permitted | 0.95 | 0.97 | | | 1.00 | | | 0.92 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1681 | 1701 | | | 1712 | | | 2625 | | 1752 | 1845 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 560 | 94 | 13 | 5 | 63 | 85 | 13 | 299 | 7 | 125 | 522 | 572 |
| RTOR Reduction (vph) | 0 | 1 | 0 | 0 | 55 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 330 | 336 | 0 | 0 | 98 | 0 | 0 | 317 | 0 | 125 | 522 | 572 |
| Heavy Vehicles (%) | 2% | 2% | 2% | 0% | 2% | 3% | 2% | 7% | 0% | 3% | 3% | 2% |
| Turn Type | Split | NA | | Split | NA | | Perm | NA | | Prot | NA | custom |
| Protected Phases | 4 | 4 | | 3 | 3 | | | 6 | | 5 | 2 | 4 5 |
| Permitted Phases | | | | | | | 6 | | | | | 2 |
| Actuated Green, G (s) | 19.0 | 19.0 | | | 8.0 | | | 15.9 | | 10.5 | 31.4 | 55.4 |
| Effective Green, g (s) | 19.0 | 19.0 | | | 8.0 | | | 15.9 | | 10.5 | 31.4 | 55.4 |
| Actuated g/C Ratio | 0.26 | 0.26 | | | 0.11 | | | 0.22 | | 0.14 | 0.43 | 0.75 |
| Clearance Time (s) | 5.0 | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 435 | 440 | | | 186 | | | 568 | | 250 | 789 | 1194 |
| v/s Ratio Prot | 0.20 | c0.20 | | | c0.06 | | | | | 0.07 | c0.28 | 0.22 |
| v/s Ratio Perm | | | | | | | | 0.12 | | | | 0.14 |
| v/c Ratio | 0.76 | 0.76 | | | 0.53 | | | 0.56 | | 0.50 | 0.66 | 0.48 |
| Uniform Delay, d1 | 25.1 | 25.1 | | | 30.9 | | | 25.6 | | 29.0 | 16.8 | 3.5 |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 7.4 | 7.6 | | | 2.7 | | | 1.2 | | 1.6 | 2.1 | 0.3 |
| Delay (s) | 32.5 | 32.8 | | | 33.6 | | | 26.8 | | 30.6 | 18.9 | 3.8 |
| Level of Service | C | C | | | C | | | C | | C | B | A |
| Approach Delay (s) | | 32.6 | | | 33.6 | | | 26.8 | | | 13.0 | |
| Approach LOS | | C | | | C | | | C | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 21.7 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.74 | | |
| Actuated Cycle Length (s) | 73.4 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 81.1% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

V/C Ratio with 15 sec lost time is 0.69

| Lane Group | WBL2 | WBL | WBR | NBL | NBT | NBR | SBL | SBT | SBR | NEL | NER |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | |
| Traffic Volume (vph) | 2 | 0 | 2 | 0 | 375 | 10 | 22 | 618 | 535 | 0 | 0 |
| Future Volume (vph) | 2 | 0 | 2 | 0 | 375 | 10 | 22 | 618 | 535 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.850 | | 0.996 | | | 0.936 | | | |
| Flt Protected | 0.950 | | | | | | | 0.999 | | | |
| Satd. Flow (prot) | 1203 | 0 | 1077 | 0 | 3365 | 0 | 0 | 1717 | 0 | 0 | 0 |
| Flt Permitted | 0.950 | | | | | | | 0.999 | | | |
| Satd. Flow (perm) | 1203 | 0 | 1077 | 0 | 3365 | 0 | 0 | 1717 | 0 | 0 | 0 |
| Link Speed (mph) | | 25 | | | 25 | | | 25 | | 30 | |
| Link Distance (ft) | | 168 | | | 200 | | | 212 | | 265 | |
| Travel Time (s) | | 4.6 | | | 5.5 | | | 5.8 | | 6.0 | |
| Peak Hour Factor | 1.00 | 0.92 | 1.00 | 0.92 | 1.00 | 1.00 | 1.00 | 1.00 | 0.92 | 0.92 | 0.92 |
| Heavy Vehicles (%) | 50% | 2% | 50% | 2% | 7% | 1% | 0% | 5% | 2% | 2% | 2% |
| Adj. Flow (vph) | 2 | 0 | 2 | 0 | 375 | 10 | 22 | 618 | 582 | 0 | 0 |
| Shared Lane Traffic (%) | 10% | | | | | | | | | | |
| Lane Group Flow (vph) | 2 | 0 | 2 | 0 | 385 | 0 | 0 | 1222 | 0 | 0 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 15 | 9 | 15 | | 9 | 15 | | 9 | 15 | 9 |
| Sign Control | | Stop | | | Free | | | Free | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 90.5% | ICU Level of Service E |
| Analysis Period (min) 15 | |

| Lane Group | NBT | NBR | SBL | SBT | SWL | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 633 | 0 | 535 | 72 | 0 |
| Future Volume (vph) | 0 | 633 | 0 | 535 | 72 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 0.88 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.850 | | | | |
| Flt Protected | | | | | 0.950 | |
| Satd. Flow (prot) | 0 | 2787 | 0 | 1863 | 1770 | 0 |
| Flt Permitted | | | | | 0.950 | |
| Satd. Flow (perm) | 0 | 2787 | 0 | 1863 | 1770 | 0 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 159 | | | 265 | 120 | |
| Travel Time (s) | 3.6 | | | 6.0 | 2.7 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 688 | 0 | 582 | 78 | 0 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 688 | 0 | 582 | 78 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 0 | | | 0 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Free | | | Yield | Free | |

| Intersection Summary | | |
|---|---|---|
| Area Type: | Other | |
| Control Type: Unsignalized | | |
| Intersection Capacity Utilization 38.8% | | ICU Level of Service A |
| Analysis Period (min) 15 | | |

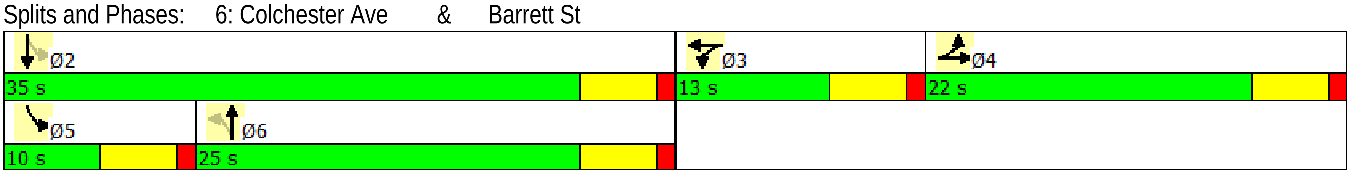
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 532 | 89 | 12 | 5 | 60 | 81 | 12 | 284 | 7 | 119 | 496 | 0 |
| Future Volume (vph) | 532 | 89 | 12 | 5 | 60 | 81 | 12 | 284 | 7 | 119 | 496 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1600 | 1600 | 1600 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | 0 | 0 | | 0 | 200 | | 0 | 50 | | 0 |
| Storage Lanes | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | | 0 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.994 | | | 0.925 | | | 0.997 | | | | |
| Flt Protected | 0.950 | 0.967 | | | 0.998 | | | 0.998 | | 0.950 | | |
| Satd. Flow (prot) | 1681 | 1701 | 0 | 0 | 1711 | 0 | 0 | 2836 | 0 | 1752 | 1845 | 0 |
| Flt Permitted | 0.950 | 0.967 | | | 0.998 | | | 0.928 | | 0.449 | | |
| Satd. Flow (perm) | 1681 | 1701 | 0 | 0 | 1711 | 0 | 0 | 2637 | 0 | 828 | 1845 | 0 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 3 | | | 73 | | | 3 | | | | *300 |
| Link Speed (mph) | | 30 | | | 25 | | | 25 | | | 25 | |
| Link Distance (ft) | | 120 | | | 170 | | | 250 | | | 200 | |
| Travel Time (s) | | 2.7 | | | 4.6 | | | 6.8 | | | 5.5 | |
| Peak Hour Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Heavy Vehicles (%) | 2% | 2% | 2% | 0% | 2% | 3% | 2% | 7% | 0% | 3% | 3% | 2% |
| Adj. Flow (vph) | 560 | 94 | 13 | 5 | 63 | 85 | 13 | 299 | 7 | 125 | 522 | 0 |
| Shared Lane Traffic (%) | 41% | | | | | | | | | | | |
| Lane Group Flow (vph) | 330 | 337 | 0 | 0 | 153 | 0 | 0 | 319 | 0 | 125 | 522 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.24 | 1.24 | 1.24 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | Split | NA | | Split | NA | | Perm | NA | | pm+pt | NA | |
| Protected Phases | 4 | 4 | | 3 | 3 | | | 6 | | 5 | 2 | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Permitted Phases | | | | | | | 6 | | | 2 | | |
| Detector Phase | 4 | 4 | | 3 | 3 | | 6 | 6 | | 5 | 2 | |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 15.0 | 15.0 | | 8.0 | 8.0 | | 20.0 | 20.0 | | 5.0 | 20.0 | |
| Minimum Split (s) | 21.0 | 21.0 | | 13.0 | 13.0 | | 25.0 | 25.0 | | 10.0 | 25.0 | |
| Total Split (s) | 22.0 | 22.0 | | 13.0 | 13.0 | | 25.0 | 25.0 | | 10.0 | 35.0 | |
| Total Split (%) | 31.4% | 31.4% | | 18.6% | 18.6% | | 35.7% | 35.7% | | 14.3% | 50.0% | |
| Maximum Green (s) | 17.0 | 17.0 | | 8.0 | 8.0 | | 20.0 | 20.0 | | 5.0 | 30.0 | |
| Yellow Time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| All-Red Time (s) | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | |
| Lost Time Adjust (s) | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | 0.0 | 0.0 | |
| Total Lost Time (s) | 5.0 | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Lead/Lag | Lag | Lag | | Lead | Lead | | Lag | Lag | | Lead | | |
| Lead-Lag Optimize? | Yes | Yes | | Yes | Yes | | Yes | Yes | | Yes | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Recall Mode | None | None | | None | None | | Min | Min | | None | Min | |
| Walk Time (s) | 5.0 | 5.0 | | | | | 5.0 | 5.0 | | | 5.0 | |
| Flash Dont Walk (s) | 9.0 | 9.0 | | | | | 5.0 | 5.0 | | | 9.0 | |
| Pedestrian Calls (#/hr) | 10 | 10 | | | | | 10 | 10 | | | 10 | |
| Act Effct Green (s) | 17.0 | 17.0 | | | 8.3 | | | 20.6 | | 28.1 | 28.1 | |
| Actuated g/C Ratio | 0.26 | 0.26 | | | 0.13 | | | 0.32 | | 0.43 | 0.43 | |
| v/c Ratio | 0.75 | 0.76 | | | 0.54 | | | 0.38 | | 0.29 | 0.66 | |
| Control Delay | 37.7 | 37.4 | | | 25.3 | | | 21.0 | | 14.4 | 20.3 | |
| Queue Delay | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | 0.0 | 0.0 | |
| Total Delay | 37.7 | 37.4 | | | 25.3 | | | 21.0 | | 14.4 | 20.3 | |
| LOS | D | D | | | C | | | C | | B | C | |
| Approach Delay | | 37.6 | | | 25.3 | | | 21.0 | | | 19.1 | |
| Approach LOS | | D | | | C | | | C | | | B | |

Intersection Summary

Area Type: Other
Cycle Length: 70
Actuated Cycle Length: 65
Natural Cycle: 70
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.76
Intersection Signal Delay: 26.9 Intersection LOS: C
Intersection Capacity Utilization 85.3% ICU Level of Service E
Analysis Period (min) 15
* User Entered Value

Splits and Phases: 6: Colchester Ave & Barrett St



| Lane Group | EBL | EBT | WBT | NBT | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 330 | 337 | 153 | 319 | 125 | 522 |
| v/c Ratio | 0.75 | 0.76 | 0.54 | 0.38 | 0.29 | 0.66 |
| Control Delay | 37.7 | 37.4 | 25.3 | 21.0 | 14.4 | 20.3 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 37.7 | 37.4 | 25.3 | 21.0 | 14.4 | 20.3 |
| Queue Length 50th (ft) | 141 | 143 | 33 | 57 | 32 | 172 |
| Queue Length 95th (ft) | #275 | #282 | #96 | 93 | 63 | 275 |
| Internal Link Dist (ft) | | 40 | 90 | 170 | | 120 |
| Turn Bay Length (ft) | | | | | 50 | |
| Base Capacity (vph) | 453 | 461 | 281 | 839 | 430 | 878 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.73 | 0.73 | 0.54 | 0.38 | 0.29 | 0.59 |

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 | | | | | | | | | | | | |
| Traffic Volume (vph) | 532 | 89 | 12 | 5 | 60 | 81 | 12 | 284 | 7 | 119 | 496 | 0 |
| Future Volume (vph) | 532 | 89 | 12 | 5 | 60 | 81 | 12 | 284 | 7 | 119 | 496 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1600 | 1600 | 1600 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | 0.95 | 0.95 | | | 1.00 | | | 0.95 | | 1.00 | 1.00 | |
| Frt | 1.00 | 0.99 | | | 0.93 | | | 1.00 | | 1.00 | 1.00 | |
| Flt Protected | 0.95 | 0.97 | | | 1.00 | | | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | 1681 | 1701 | | | 1712 | | | 2835 | | 1752 | 1845 | |
| Flt Permitted | 0.95 | 0.97 | | | 1.00 | | | 0.93 | | 0.45 | 1.00 | |
| Satd. Flow (perm) | 1681 | 1701 | | | 1712 | | | 2637 | | 829 | 1845 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 560 | 94 | 13 | 5 | 63 | 85 | 13 | 299 | 7 | 125 | 522 | 0 |
| RTOR Reduction (vph) | 0 | 2 | 0 | 0 | 67 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 330 | 335 | 0 | 0 | 86 | 0 | 0 | 317 | 0 | 125 | 522 | 0 |
| Heavy Vehicles (%) | 2% | 2% | 2% | 0% | 2% | 3% | 2% | 7% | 0% | 3% | 3% | 2% |
| Turn Type | Split | NA | | Split | NA | | Perm | NA | | pm+pt | NA | |
| Protected Phases | 4 | 4 | | 3 | 3 | | | 6 | | 5 | 2 | |
| Permitted Phases | | | | | | | 6 | | | 2 | | |
| Actuated Green, G (s) | 17.0 | 17.0 | | | 5.9 | | | 20.6 | | 29.3 | 29.3 | |
| Effective Green, g (s) | 17.0 | 17.0 | | | 5.9 | | | 20.6 | | 29.3 | 29.3 | |
| Actuated g/C Ratio | 0.25 | 0.25 | | | 0.09 | | | 0.31 | | 0.44 | 0.44 | |
| Clearance Time (s) | 5.0 | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 425 | 430 | | | 150 | | | 808 | | 412 | 804 | |
| v/s Ratio Prot | 0.20 | c0.20 | | | c0.05 | | | | | 0.02 | c0.28 | |
| v/s Ratio Perm | | | | | | | | 0.12 | | 0.12 | | |
| v/c Ratio | 0.78 | 0.78 | | | 0.58 | | | 0.39 | | 0.30 | 0.65 | |
| Uniform Delay, d1 | 23.3 | 23.3 | | | 29.4 | | | 18.4 | | 11.7 | 14.9 | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 8.6 | 8.6 | | | 5.3 | | | 0.3 | | 0.4 | 1.8 | |
| Delay (s) | 32.0 | 32.0 | | | 34.7 | | | 18.7 | | 12.1 | 16.7 | |
| Level of Service | C | C | | | C | | | B | | B | B | |
| Approach Delay (s) | | 32.0 | | | 34.7 | | | 18.7 | | | 15.8 | |
| Approach LOS | | C | | | C | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 24.0 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.75 | | |
| Actuated Cycle Length (s) | 67.2 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 85.3% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 2 | 2 | 375 | 10 | 22 | 618 |
| Future Volume (vph) | 2 | 2 | 375 | 10 | 22 | 618 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 | 1.00 |
| Frt | | 0.850 | 0.996 | | | |
| Flt Protected | 0.950 | | | | | 0.998 |
| Satd. Flow (prot) | 1203 | 1077 | 3365 | 0 | 0 | 1809 |
| Flt Permitted | 0.950 | | | | | 0.998 |
| Satd. Flow (perm) | 1203 | 1077 | 3365 | 0 | 0 | 1809 |
| Link Speed (mph) | 25 | | 25 | | | 25 |
| Link Distance (ft) | 168 | | 200 | | | 212 |
| Travel Time (s) | 4.6 | | 5.5 | | | 5.8 |
| Peak Hour Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Heavy Vehicles (%) | 50% | 50% | 7% | 1% | 0% | 5% |
| Adj. Flow (vph) | 2 | 2 | 395 | 11 | 23 | 651 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 2 | 2 | 406 | 0 | 0 | 674 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Right | Left | Left |
| Median Width(ft) | 12 | | 12 | | | 12 |
| Link Offset(ft) | 0 | | 0 | | | 0 |
| Crosswalk Width(ft) | 16 | | 16 | | | 16 |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | | 9 | 15 | |
| Sign Control | Stop | | Free | | | Free |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 57.8% | ICU Level of Service B |
| Analysis Period (min) 15 | |

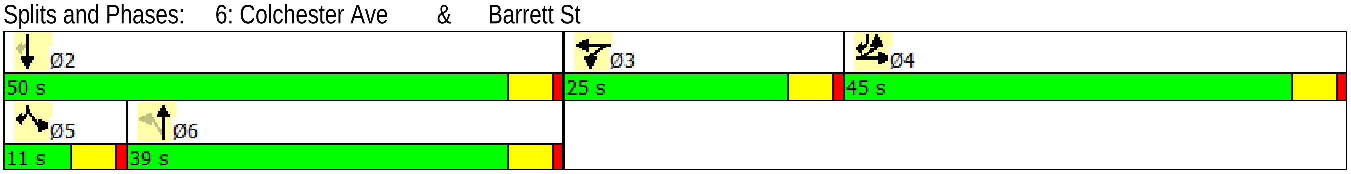
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 972 | 93 | 5 | 10 | 186 | 119 | 13 | 667 | 43 | 77 | 328 | 759 |
| Future Volume (vph) | 972 | 93 | 5 | 10 | 186 | 119 | 13 | 667 | 43 | 77 | 328 | 759 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1600 | 1600 | 1600 | 1900 | 1300 | 1300 |
| Storage Length (ft) | 0 | | 0 | 0 | | 0 | 130 | | 0 | 50 | | 0 |
| Storage Lanes | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | | 1 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.999 | | | 0.949 | | | 0.991 | | | | 0.850 |
| Flt Protected | 0.950 | 0.961 | | | 0.998 | | | 0.999 | | 0.950 | | |
| Satd. Flow (prot) | 1681 | 1699 | 0 | 0 | 1759 | 0 | 0 | 2826 | 0 | 1752 | 1262 | 1083 |
| Flt Permitted | 0.950 | 0.961 | | | 0.998 | | | 0.945 | | 0.950 | | |
| Satd. Flow (perm) | 1681 | 1699 | 0 | 0 | 1759 | 0 | 0 | 2673 | 0 | 1752 | 1262 | 1083 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | No |
| Satd. Flow (RTOR) | | | | | 22 | | | 5 | | | | |
| Link Speed (mph) | | 30 | | | 25 | | | 25 | | | 25 | |
| Link Distance (ft) | | 228 | | | 170 | | | 250 | | | 200 | |
| Travel Time (s) | | 5.2 | | | 4.6 | | | 6.8 | | | 5.5 | |
| Peak Hour Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Heavy Vehicles (%) | 2% | 2% | 2% | 0% | 2% | 3% | 2% | 7% | 0% | 3% | 3% | 2% |
| Adj. Flow (vph) | 1023 | 98 | 5 | 11 | 196 | 125 | 14 | 702 | 45 | 81 | 345 | 799 |
| Shared Lane Traffic (%) | 45% | | | | | | | | | | | |
| Lane Group Flow (vph) | 563 | 563 | 0 | 0 | 332 | 0 | 0 | 761 | 0 | 81 | 345 | 799 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.24 | 1.24 | 1.24 | 1.00 | 1.60 | 1.60 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | Split | NA | | Split | NA | | Perm | NA | | Prot | NA | custom |
| Protected Phases | 4 | 4 | | 3 | 3 | | | 6 | | 5 | 2 | 4 5 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Permitted Phases | | | | | | | 6 | | | | | 2 |
| Detector Phase | 4 | 4 | | 3 | 3 | | 6 | 6 | | 5 | 2 | 4 5 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 15.0 | 15.0 | | 8.0 | 8.0 | | 15.0 | 15.0 | | 5.0 | 15.0 | |
| Minimum Split (s) | 21.0 | 21.0 | | 13.0 | 13.0 | | 20.0 | 20.0 | | 10.0 | 21.0 | |
| Total Split (s) | 45.0 | 45.0 | | 25.0 | 25.0 | | 39.0 | 39.0 | | 11.0 | 50.0 | |
| Total Split (%) | 37.5% | 37.5% | | 20.8% | 20.8% | | 32.5% | 32.5% | | 9.2% | 41.7% | |
| Maximum Green (s) | 40.0 | 40.0 | | 20.0 | 20.0 | | 34.0 | 34.0 | | 6.0 | 45.0 | |
| Yellow Time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| All-Red Time (s) | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | |
| Lost Time Adjust (s) | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | 0.0 | 0.0 | |
| Total Lost Time (s) | 5.0 | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Lead/Lag | Lag | Lag | | Lead | Lead | | Lag | Lag | | Lead | | |
| Lead-Lag Optimize? | Yes | Yes | | Yes | Yes | | Yes | Yes | | Yes | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Recall Mode | None | None | | None | None | | Min | Min | | None | Min | |
| Walk Time (s) | 5.0 | 5.0 | | | | | 5.0 | 5.0 | | | 5.0 | |
| Flash Dont Walk (s) | 9.0 | 9.0 | | | | | 5.0 | 5.0 | | | 9.0 | |
| Pedestrian Calls (#/hr) | 10 | 10 | | | | | 10 | 10 | | | 10 | |
| Act Effct Green (s) | 40.0 | 40.0 | | | 20.0 | | | 34.0 | | 6.0 | 45.0 | 90.0 |
| Actuated g/C Ratio | 0.33 | 0.33 | | | 0.17 | | | 0.28 | | 0.05 | 0.38 | 0.75 |
| v/c Ratio | 1.01 | 0.99 | | | 1.07 | | | 1.00 | | 0.93 | 0.73 | 0.98 |
| Control Delay | 79.7 | 77.0 | | | 114.6 | | | 75.9 | | 136.1 | 42.9 | 43.9 |
| Queue Delay | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Delay | 79.7 | 77.0 | | | 114.6 | | | 75.9 | | 136.1 | 42.9 | 43.9 |
| LOS | E | E | | | F | | | E | | F | D | D |
| Approach Delay | | 78.4 | | | 114.6 | | | 75.9 | | | 49.7 | |
| Approach LOS | | E | | | F | | | E | | | D | |

Intersection Summary

Area Type: Other
Cycle Length: 120
Actuated Cycle Length: 120
Natural Cycle: 120
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.07
Intersection Signal Delay: 71.1 Intersection LOS: E
Intersection Capacity Utilization 122.8% ICU Level of Service H
Analysis Period (min) 15

Splits and Phases: 6: Colchester Ave & Barrett St



| Lane Group | EBL | EBT | WBT | NBT | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 563 | 563 | 332 | 761 | 81 | 345 | 799 |
| v/c Ratio | 1.01 | 0.99 | 1.07 | 1.00 | 0.93 | 0.50 | 0.67 |
| Control Delay | 79.7 | 77.0 | 114.6 | 75.9 | 136.1 | 31.9 | 11.1 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 79.7 | 77.0 | 114.6 | 75.9 | 136.1 | 31.9 | 11.1 |
| Queue Length 50th (ft) | ~462 | 455 | ~269 | ~308 | 64 | 203 | 269 |
| Queue Length 95th (ft) | #710 | #705 | #456 | #448 | #165 | 294 | 396 |
| Internal Link Dist (ft) | | 148 | 90 | 170 | | 120 | |
| Turn Bay Length (ft) | | | | | 50 | | |
| Base Capacity (vph) | 560 | 566 | 311 | 760 | 87 | 691 | 1187 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 1.01 | 0.99 | 1.07 | 1.00 | 0.93 | 0.50 | 0.67 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

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

PER Revision
4 Lane Bridge



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 972 | 93 | 5 | 10 | 186 | 119 | 13 | 667 | 43 | 77 | 328 | 759 |
| Future Volume (vph) | 972 | 93 | 5 | 10 | 186 | 119 | 13 | 667 | 43 | 77 | 328 | 759 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1600 | 1600 | 1600 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 0.95 | 0.95 | | | 1.00 | | | 0.95 | | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | | | 0.95 | | | 0.99 | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 0.96 | | | 1.00 | | | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1681 | 1698 | | | 1760 | | | 2827 | | 1752 | 1845 | 1583 |
| Flt Permitted | 0.95 | 0.96 | | | 1.00 | | | 0.94 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1681 | 1698 | | | 1760 | | | 2673 | | 1752 | 1845 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 1023 | 98 | 5 | 11 | 196 | 125 | 14 | 702 | 45 | 81 | 345 | 799 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 18 | 0 | 0 | 4 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 563 | 563 | 0 | 0 | 314 | 0 | 0 | 757 | 0 | 81 | 345 | 799 |
| Heavy Vehicles (%) | 2% | 2% | 2% | 0% | 2% | 3% | 2% | 7% | 0% | 3% | 3% | 2% |
| Turn Type | Split | NA | | Split | NA | | Perm | NA | | Prot | NA | custom |
| Protected Phases | 4 | 4 | | 3 | 3 | | | 6 | | 5 | 2 | 4 5 |
| Permitted Phases | | | | | | | 6 | | | | | 2 |
| Actuated Green, G (s) | 40.0 | 40.0 | | | 20.0 | | | 34.0 | | 6.0 | 45.0 | 90.0 |
| Effective Green, g (s) | 40.0 | 40.0 | | | 20.0 | | | 34.0 | | 6.0 | 45.0 | 90.0 |
| Actuated g/C Ratio | 0.33 | 0.33 | | | 0.17 | | | 0.28 | | 0.05 | 0.38 | 0.75 |
| Clearance Time (s) | 5.0 | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 560 | 566 | | | 293 | | | 757 | | 87 | 691 | 1187 |
| v/s Ratio Prot | c0.33 | 0.33 | | | c0.18 | | | | | 0.05 | 0.19 | c0.29 |
| v/s Ratio Perm | | | | | | | | c0.28 | | | | 0.22 |
| v/c Ratio | 1.01 | 0.99 | | | 1.07 | | | 1.00 | | 0.93 | 0.50 | 0.67 |
| Uniform Delay, d1 | 40.0 | 39.9 | | | 50.0 | | | 43.0 | | 56.8 | 28.8 | 7.6 |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 39.4 | 36.3 | | | 72.5 | | | 32.8 | | 73.6 | 0.6 | 1.5 |
| Delay (s) | 79.4 | 76.1 | | | 122.5 | | | 75.8 | | 130.4 | 29.4 | 9.1 |
| Level of Service | E | E | | | F | | | E | | F | C | A |
| Approach Delay (s) | | 77.8 | | | 122.5 | | | 75.8 | | | 22.8 | |
| Approach LOS | | E | | | F | | | E | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 62.1 | HCM 2000 Level of Service | E |
| HCM 2000 Volume to Capacity ratio | 1.03 | | |
| Actuated Cycle Length (s) | 120.0 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 105.0% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

V/C Ratio with 15 sec lost time is 0.98

| Lane Group | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 2 | 2 | 375 | 10 | 22 | 1142 |
| Future Volume (vph) | 2 | 2 | 375 | 10 | 22 | 1142 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 | 1.00 |
| Frt | | 0.850 | 0.996 | | | |
| Flt Protected | 0.950 | | | | | 0.999 |
| Satd. Flow (prot) | 1203 | 1077 | 3365 | 0 | 0 | 1809 |
| Flt Permitted | 0.950 | | | | | 0.999 |
| Satd. Flow (perm) | 1203 | 1077 | 3365 | 0 | 0 | 1809 |
| Link Speed (mph) | 25 | | 25 | | | 25 |
| Link Distance (ft) | 168 | | 200 | | | 212 |
| Travel Time (s) | 4.6 | | 5.5 | | | 5.8 |
| Peak Hour Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Heavy Vehicles (%) | 50% | 50% | 7% | 1% | 0% | 5% |
| Adj. Flow (vph) | 2 | 2 | 375 | 10 | 22 | 1142 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 2 | 2 | 385 | 0 | 0 | 1164 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Right | Left | Left |
| Median Width(ft) | 12 | | 12 | | | 12 |
| Link Offset(ft) | 0 | | 0 | | | 0 |
| Crosswalk Width(ft) | 16 | | 16 | | | 16 |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | | 9 | 15 | |
| Sign Control | Stop | | Free | | | Free |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 85.3% | ICU Level of Service E |
| Analysis Period (min) 15 | |

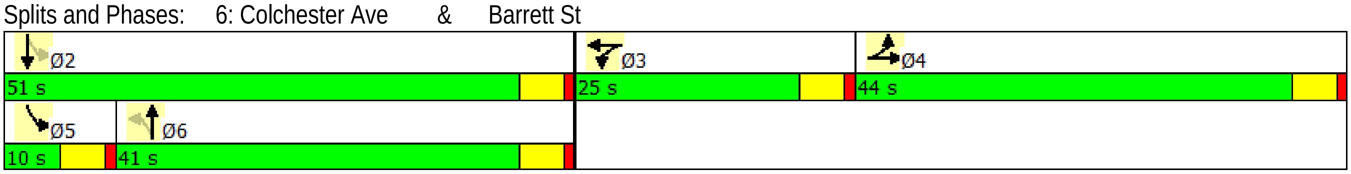
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | ↰ | ✣ | | | ✣ | | | ↰↑↱ | | ↰ | ↱ | |
| Traffic Volume (vph) | 972 | 93 | 5 | 10 | 186 | 119 | 13 | 667 | 43 | 77 | 328 | 0 |
| Future Volume (vph) | 972 | 93 | 5 | 10 | 186 | 119 | 13 | 667 | 43 | 77 | 328 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1600 | 1600 | 1600 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | 0 | 0 | | 0 | 130 | | 0 | 50 | | 0 |
| Storage Lanes | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | | 0 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.999 | | | 0.949 | | | 0.991 | | | | |
| Flt Protected | 0.950 | 0.961 | | | 0.998 | | | 0.999 | | 0.950 | | |
| Satd. Flow (prot) | 1681 | 1699 | 0 | 0 | 1759 | 0 | 0 | 2826 | 0 | 1752 | 1845 | 0 |
| Flt Permitted | 0.950 | 0.961 | | | 0.998 | | | 0.945 | | 0.147 | | |
| Satd. Flow (perm) | 1681 | 1699 | 0 | 0 | 1759 | 0 | 0 | 2673 | 0 | 271 | 1845 | 0 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | | | 22 | | | 5 | | | | |
| Link Speed (mph) | | 30 | | | 25 | | | 25 | | | 25 | |
| Link Distance (ft) | | 228 | | | 170 | | | 250 | | | 200 | |
| Travel Time (s) | | 5.2 | | | 4.6 | | | 6.8 | | | 5.5 | |
| Peak Hour Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Heavy Vehicles (%) | 2% | 2% | 2% | 0% | 2% | 3% | 2% | 7% | 0% | 3% | 3% | 2% |
| Adj. Flow (vph) | 1023 | 98 | 5 | 11 | 196 | 125 | 14 | 702 | 45 | 81 | 345 | 0 |
| Shared Lane Traffic (%) | 45% | | | | | | | | | | | |
| Lane Group Flow (vph) | 563 | 563 | 0 | 0 | 332 | 0 | 0 | 761 | 0 | 81 | 345 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.24 | 1.24 | 1.24 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | Split | NA | | Split | NA | | Perm | NA | | pm+pt | NA | |
| Protected Phases | 4 | 4 | | 3 | 3 | | | 6 | | 5 | 2 | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Permitted Phases | | | | | | | 6 | | | 2 | | |
| Detector Phase | 4 | 4 | | 3 | 3 | | 6 | 6 | | 5 | 2 | |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 15.0 | 15.0 | | 8.0 | 8.0 | | 15.0 | 15.0 | | 5.0 | 15.0 | |
| Minimum Split (s) | 21.0 | 21.0 | | 13.0 | 13.0 | | 20.0 | 20.0 | | 10.0 | 21.0 | |
| Total Split (s) | 44.0 | 44.0 | | 25.0 | 25.0 | | 41.0 | 41.0 | | 10.0 | 51.0 | |
| Total Split (%) | 36.7% | 36.7% | | 20.8% | 20.8% | | 34.2% | 34.2% | | 8.3% | 42.5% | |
| Maximum Green (s) | 39.0 | 39.0 | | 20.0 | 20.0 | | 36.0 | 36.0 | | 5.0 | 46.0 | |
| Yellow Time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| All-Red Time (s) | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | |
| Lost Time Adjust (s) | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | 0.0 | 0.0 | |
| Total Lost Time (s) | 5.0 | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Lead/Lag | Lag | Lag | | Lead | Lead | | Lag | Lag | | Lead | | |
| Lead-Lag Optimize? | Yes | Yes | | Yes | Yes | | Yes | Yes | | Yes | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Recall Mode | None | None | | None | None | | Min | Min | | None | Min | |
| Walk Time (s) | 5.0 | 5.0 | | | | | 5.0 | 5.0 | | | 5.0 | |
| Flash Dont Walk (s) | 9.0 | 9.0 | | | | | 7.0 | 7.0 | | | 9.0 | |
| Pedestrian Calls (#/hr) | 10 | 10 | | | | | 10 | 10 | | | 10 | |
| Act Effct Green (s) | 39.1 | 39.1 | | | 20.1 | | | 35.0 | | 42.8 | 42.8 | |
| Actuated g/C Ratio | 0.33 | 0.33 | | | 0.17 | | | 0.30 | | 0.37 | 0.37 | |
| v/c Ratio | 1.00 | 0.99 | | | 1.04 | | | 0.95 | | 0.50 | 0.51 | |
| Control Delay | 78.8 | 75.9 | | | 105.9 | | | 62.1 | | 35.5 | 31.8 | |
| Queue Delay | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | 0.0 | 0.0 | |
| Total Delay | 78.8 | 75.9 | | | 105.9 | | | 62.1 | | 35.5 | 31.8 | |
| LOS | E | E | | | F | | | E | | D | C | |
| Approach Delay | | 77.3 | | | 105.9 | | | 62.1 | | | 32.5 | |
| Approach LOS | | E | | | F | | | E | | | C | |

Intersection Summary

Area Type: Other
Cycle Length: 120
Actuated Cycle Length: 117
Natural Cycle: 120
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.04
Intersection Signal Delay: 69.3 Intersection LOS: E
Intersection Capacity Utilization 105.0% ICU Level of Service G
Analysis Period (min) 15

Splits and Phases: 6: Colchester Ave & Barrett St



| Lane Group | EBL | EBT | WBT | NBT | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 563 | 563 | 332 | 761 | 81 | 345 |
| v/c Ratio | 1.00 | 0.99 | 1.04 | 0.95 | 0.50 | 0.51 |
| Control Delay | 78.8 | 75.9 | 105.9 | 62.1 | 35.5 | 31.8 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 78.8 | 75.9 | 105.9 | 62.1 | 35.5 | 31.8 |
| Queue Length 50th (ft) | ~491 | ~486 | ~269 | 301 | 40 | 200 |
| Queue Length 95th (ft) | #722 | #717 | #456 | #429 | 75 | 290 |
| Internal Link Dist (ft) | | 148 | 90 | 170 | | 120 |
| Turn Bay Length (ft) | | | | | 50 | |
| Base Capacity (vph) | 562 | 568 | 319 | 828 | 162 | 727 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 1.00 | 0.99 | 1.04 | 0.92 | 0.50 | 0.47 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 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 | | | | | | | | | | | | |
| Traffic Volume (vph) | 972 | 93 | 5 | 10 | 186 | 119 | 13 | 667 | 43 | 77 | 328 | 0 |
| Future Volume (vph) | 972 | 93 | 5 | 10 | 186 | 119 | 13 | 667 | 43 | 77 | 328 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1600 | 1600 | 1600 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | 0.95 | 0.95 | | | 1.00 | | | 0.95 | | 1.00 | 1.00 | |
| Frt | 1.00 | 1.00 | | | 0.95 | | | 0.99 | | 1.00 | 1.00 | |
| Flt Protected | 0.95 | 0.96 | | | 1.00 | | | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | 1681 | 1698 | | | 1760 | | | 2827 | | 1752 | 1845 | |
| Flt Permitted | 0.95 | 0.96 | | | 1.00 | | | 0.94 | | 0.15 | 1.00 | |
| Satd. Flow (perm) | 1681 | 1698 | | | 1760 | | | 2674 | | 272 | 1845 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 1023 | 98 | 5 | 11 | 196 | 125 | 14 | 702 | 45 | 81 | 345 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 18 | 0 | 0 | 4 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 563 | 563 | 0 | 0 | 314 | 0 | 0 | 757 | 0 | 81 | 345 | 0 |
| Heavy Vehicles (%) | 2% | 2% | 2% | 0% | 2% | 3% | 2% | 7% | 0% | 3% | 3% | 2% |
| Turn Type | Split | NA | | Split | NA | | Perm | NA | | pm+pt | NA | |
| Protected Phases | 4 | 4 | | 3 | 3 | | | 6 | | 5 | 2 | |
| Permitted Phases | | | | | | | 6 | | | 2 | | |
| Actuated Green, G (s) | 39.1 | 39.1 | | | 20.1 | | | 35.0 | | 43.9 | 43.9 | |
| Effective Green, g (s) | 39.1 | 39.1 | | | 20.1 | | | 35.0 | | 43.9 | 43.9 | |
| Actuated g/C Ratio | 0.33 | 0.33 | | | 0.17 | | | 0.30 | | 0.37 | 0.37 | |
| Clearance Time (s) | 5.0 | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 556 | 562 | | | 299 | | | 792 | | 149 | 685 | |
| v/s Ratio Prot | c0.33 | 0.33 | | | c0.18 | | | | | 0.02 | c0.19 | |
| v/s Ratio Perm | | | | | | | | c0.28 | | 0.18 | | |
| v/c Ratio | 1.01 | 1.00 | | | 1.05 | | | 0.96 | | 0.54 | 0.50 | |
| Uniform Delay, d1 | 39.5 | 39.5 | | | 49.0 | | | 40.8 | | 27.2 | 28.7 | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 41.3 | 38.4 | | | 65.6 | | | 21.8 | | 4.0 | 0.6 | |
| Delay (s) | 80.8 | 77.9 | | | 114.6 | | | 62.6 | | 31.2 | 29.3 | |
| Level of Service | F | E | | | F | | | E | | C | C | |
| Approach Delay (s) | | 79.4 | | | 114.6 | | | 62.6 | | | 29.6 | |
| Approach LOS | | E | | | F | | | E | | | C | |

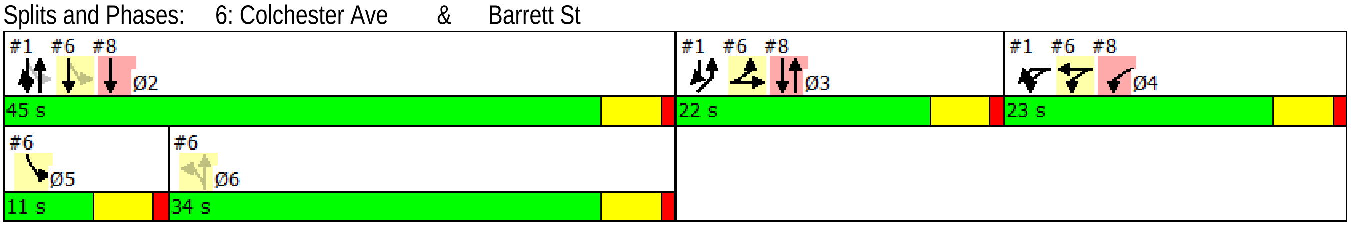
| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 70.9 | HCM 2000 Level of Service | E |
| HCM 2000 Volume to Capacity ratio | 0.99 | | |
| Actuated Cycle Length (s) | 118.1 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 105.0% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 10 | 89 | 12 | 5 | 60 | 81 | 12 | 284 | 7 | 119 | 496 | 8 |
| Future Volume (vph) | 10 | 89 | 12 | 5 | 60 | 81 | 12 | 284 | 7 | 119 | 496 | 8 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1600 | 1600 | 1600 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.985 | | | 0.925 | | | 0.997 | | | 0.998 | |
| Flt Protected | | 0.995 | | | 0.998 | | | 0.998 | | 0.950 | | |
| Satd. Flow (prot) | 0 | 1678 | 0 | 0 | 1725 | 0 | 0 | 2839 | 0 | 1752 | 1842 | 0 |
| Flt Permitted | | 0.995 | | | 0.998 | | | 0.929 | | 0.468 | | |
| Satd. Flow (perm) | 0 | 1678 | 0 | 0 | 1725 | 0 | 0 | 2642 | 0 | 863 | 1842 | 0 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 6 | | | 62 | | | 3 | | | 1 | |
| Link Speed (mph) | | 25 | | | 25 | | | 25 | | | 25 | |
| Link Distance (ft) | | 96 | | | 170 | | | 90 | | | 200 | |
| Travel Time (s) | | 2.6 | | | 4.6 | | | 2.5 | | | 5.5 | |
| Peak Hour Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Heavy Vehicles (%) | 11% | 11% | 11% | 0% | 0% | 3% | 0% | 7% | 0% | 3% | 3% | 0% |
| Adj. Flow (vph) | 11 | 94 | 13 | 5 | 63 | 85 | 13 | 299 | 7 | 125 | 522 | 8 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 118 | 0 | 0 | 153 | 0 | 0 | 319 | 0 | 125 | 530 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.24 | 1.24 | 1.24 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | Split | NA | | Split | NA | | custom | NA | | pm+pt | NA | |
| Protected Phases | 3 | 3 | | 4 | 4 | | | | | 5 | 2 | |
| Permitted Phases | | | | | | | 6 | 6 | | 2 | 2 | |
| Detector Phase | 3 | 3 | | 4 | 4 | | 6 | 6 | | 5 | 2 | |
| Switch Phase | | | | | | | | | | | | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Initial (s) | 14.0 | 14.0 | | 8.0 | 8.0 | | 20.0 | 20.0 | | 5.0 | 20.0 | |
| Minimum Split (s) | 19.0 | 19.0 | | 23.0 | 23.0 | | 25.0 | 25.0 | | 10.0 | 25.0 | |
| Total Split (s) | 22.0 | 22.0 | | 23.0 | 23.0 | | 34.0 | 34.0 | | 11.0 | 45.0 | |
| Total Split (%) | 24.4% | 24.4% | | 25.6% | 25.6% | | 37.8% | 37.8% | | 12.2% | 50.0% | |
| Maximum Green (s) | 17.0 | 17.0 | | 18.0 | 18.0 | | 29.0 | 29.0 | | 6.0 | 40.0 | |
| Yellow Time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| All-Red Time (s) | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | | 0.0 | | 0.0 | 0.0 | |
| Total Lost Time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Lead/Lag | Lead | Lead | | Lag | Lag | | Lag | Lag | | Lead | | |
| Lead-Lag Optimize? | Yes | Yes | | Yes | Yes | | Yes | Yes | | Yes | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Recall Mode | None | None | | None | None | | Min | Min | | None | Min | |
| Walk Time (s) | | | | 5.0 | 5.0 | | 5.0 | 5.0 | | | | |
| Flash Dont Walk (s) | | | | 9.0 | 9.0 | | 9.0 | 9.0 | | | | |
| Pedestrian Calls (#/hr) | | | | 10 | 10 | | 10 | 10 | | | | |
| Act Effct Green (s) | | 17.0 | | | 10.7 | | | 29.1 | | 40.1 | 40.1 | |
| Actuated g/C Ratio | | 0.21 | | | 0.13 | | | 0.35 | | 0.48 | 0.48 | |
| v/c Ratio | | 0.34 | | | 0.55 | | | 0.34 | | 0.26 | 0.59 | |
| Control Delay | | 8.5 | | | 28.2 | | | 21.5 | | 4.8 | 5.5 | |
| Queue Delay | | 0.0 | | | 0.1 | | | 0.1 | | 1.0 | 1.1 | |
| Total Delay | | 8.5 | | | 28.3 | | | 21.6 | | 5.8 | 6.6 | |
| LOS | | A | | | C | | | C | | A | A | |
| Approach Delay | | 8.5 | | | 28.3 | | | 21.6 | | | 6.5 | |
| Approach LOS | | A | | | C | | | C | | | A | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 90 | |
| Actuated Cycle Length: 82.8 | |
| Natural Cycle: 90 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.92 | |
| Intersection Signal Delay: 13.2 | Intersection LOS: B |
| Intersection Capacity Utilization 67.4% | ICU Level of Service C |
| Analysis Period (min) 15 | |

Splits and Phases: 6: Colchester Ave & Barrett St



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 10 | 89 | 12 | 5 | 60 | 81 | 12 | 284 | 7 | 119 | 496 | 8 |
| Future Volume (vph) | 10 | 89 | 12 | 5 | 60 | 81 | 12 | 284 | 7 | 119 | 496 | 8 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1600 | 1600 | 1600 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | | 0.95 | | 1.00 | 1.00 | |
| Frt | | 0.99 | | | 0.93 | | | 1.00 | | 1.00 | 1.00 | |
| Flt Protected | | 1.00 | | | 1.00 | | | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1678 | | | 1726 | | | 2838 | | 1752 | 1841 | |
| Flt Permitted | | 1.00 | | | 1.00 | | | 0.93 | | 0.47 | 1.00 | |
| Satd. Flow (perm) | | 1678 | | | 1726 | | | 2642 | | 863 | 1841 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 11 | 94 | 13 | 5 | 63 | 85 | 13 | 299 | 7 | 125 | 522 | 8 |
| RTOR Reduction (vph) | 0 | 5 | 0 | 0 | 54 | 0 | 0 | 2 | 0 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 113 | 0 | 0 | 99 | 0 | 0 | 317 | 0 | 125 | 529 | 0 |
| Heavy Vehicles (%) | 11% | 11% | 11% | 0% | 0% | 3% | 0% | 7% | 0% | 3% | 3% | 0% |
| Turn Type | Split | NA | | Split | NA | | custom | NA | | pm+pt | NA | |
| Protected Phases | 3 | 3 | | 4 | 4 | | | | | 5 | 2 | |
| Permitted Phases | | | | | | | 6 | 6 | | 2 | 2 | |
| Actuated Green, G (s) | | 17.0 | | | 10.7 | | | 29.1 | | 40.1 | 40.1 | |
| Effective Green, g (s) | | 17.0 | | | 10.7 | | | 29.1 | | 40.1 | 40.1 | |
| Actuated g/C Ratio | | 0.21 | | | 0.13 | | | 0.35 | | 0.48 | 0.48 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 344 | | | 223 | | | 928 | | 482 | 891 | |
| v/s Ratio Prot | | c0.07 | | | c0.06 | | | | | 0.02 | c0.29 | |
| v/s Ratio Perm | | | | | | | | 0.12 | | 0.11 | | |
| v/c Ratio | | 0.33 | | | 0.44 | | | 0.34 | | 0.26 | 0.59 | |
| Uniform Delay, d1 | | 28.0 | | | 33.3 | | | 19.8 | | 12.1 | 15.5 | |
| Progression Factor | | 0.27 | | | 1.00 | | | 1.00 | | 0.31 | 0.23 | |
| Incremental Delay, d2 | | 0.2 | | | 1.4 | | | 0.2 | | 0.2 | 0.6 | |
| Delay (s) | | 7.7 | | | 34.7 | | | 20.0 | | 3.9 | 4.1 | |
| Level of Service | | A | | | C | | | C | | A | A | |
| Approach Delay (s) | | 7.7 | | | 34.7 | | | 20.0 | | | 4.1 | |
| Approach LOS | | A | | | C | | | C | | | A | |

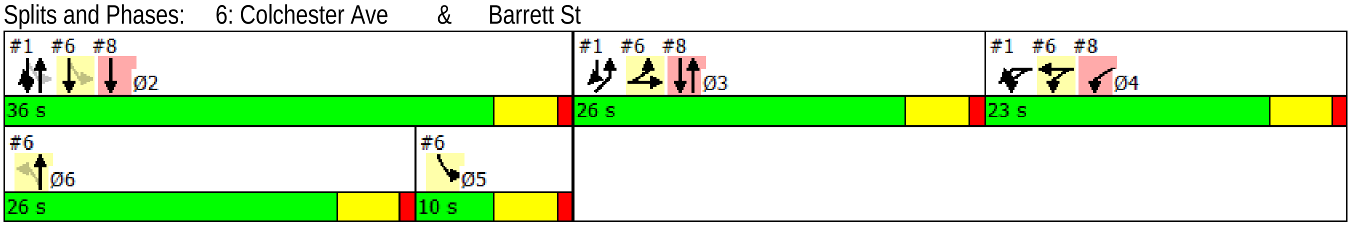
| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 12.3 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.54 | | |
| Actuated Cycle Length (s) | 82.8 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 67.4% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 4 | 93 | 5 | 10 | 186 | 119 | 13 | 667 | 43 | 77 | 328 | 0 |
| Future Volume (vph) | 4 | 93 | 5 | 10 | 186 | 119 | 13 | 667 | 43 | 77 | 328 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1600 | 1600 | 1600 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.994 | | | 0.949 | | | 0.991 | | | | |
| Flt Protected | | 0.998 | | | 0.998 | | | 0.999 | | 0.950 | | |
| Satd. Flow (prot) | 0 | 1866 | 0 | 0 | 1782 | 0 | 0 | 2929 | 0 | 1752 | 1845 | 0 |
| Flt Permitted | | 0.998 | | | 0.998 | | | 0.945 | | 0.198 | | |
| Satd. Flow (perm) | 0 | 1866 | 0 | 0 | 1782 | 0 | 0 | 2770 | 0 | 365 | 1845 | 0 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 3 | | | 32 | | | 7 | | | | |
| Link Speed (mph) | | 25 | | | 25 | | | 25 | | | 25 | |
| Link Distance (ft) | | 96 | | | 170 | | | 90 | | | 200 | |
| Travel Time (s) | | 2.6 | | | 4.6 | | | 2.5 | | | 5.5 | |
| Peak Hour Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Heavy Vehicles (%) | 1% | 1% | 1% | 1% | 1% | 1% | 0% | 3% | 0% | 3% | 3% | 0% |
| Adj. Flow (vph) | 4 | 98 | 5 | 11 | 196 | 125 | 14 | 702 | 45 | 81 | 345 | 0 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 107 | 0 | 0 | 332 | 0 | 0 | 761 | 0 | 81 | 345 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.24 | 1.24 | 1.24 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | Split | NA | | Split | NA | | Perm | NA | | pm+pt | NA | |
| Protected Phases | 3 | 3 | | 4 | 4 | | | 6 | | 5 | 2 | |
| Permitted Phases | | | | | | | 6 | 6 | | 2 | 2 | |
| Detector Phase | 3 | 3 | | 4 | 4 | | 6 | 6 | | 5 | 2 | |
| Switch Phase | | | | | | | | | | | | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Initial (s) | 14.0 | 14.0 | | 8.0 | 8.0 | | 20.0 | 20.0 | | 5.0 | 20.0 | |
| Minimum Split (s) | 23.0 | 23.0 | | 23.0 | 23.0 | | 25.0 | 25.0 | | 10.0 | 25.0 | |
| Total Split (s) | 26.0 | 26.0 | | 23.0 | 23.0 | | 26.0 | 26.0 | | 10.0 | 36.0 | |
| Total Split (%) | 30.6% | 30.6% | | 27.1% | 27.1% | | 30.6% | 30.6% | | 11.8% | 42.4% | |
| Maximum Green (s) | 21.0 | 21.0 | | 18.0 | 18.0 | | 21.0 | 21.0 | | 5.0 | 31.0 | |
| Yellow Time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| All-Red Time (s) | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | | 0.0 | | 0.0 | 0.0 | |
| Total Lost Time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Lead/Lag | Lead | Lead | | Lag | Lag | | Lead | Lead | | Lag | | |
| Lead-Lag Optimize? | Yes | Yes | | Yes | Yes | | Yes | Yes | | Yes | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Recall Mode | None | None | | None | None | | Min | Min | | None | Min | |
| Walk Time (s) | | | | 5.0 | 5.0 | | 5.0 | 5.0 | | | | |
| Flash Dont Walk (s) | | | | 9.0 | 9.0 | | 9.0 | 9.0 | | | | |
| Pedestrian Calls (#/hr) | | | | 10 | 10 | | 10 | 10 | | | | |
| Act Effct Green (s) | | 21.0 | | | 17.0 | | | 23.1 | | 31.0 | 31.0 | |
| Actuated g/C Ratio | | 0.25 | | | 0.20 | | | 0.28 | | 0.37 | 0.37 | |
| v/c Ratio | | 0.23 | | | 0.86 | | | 0.99 | | 0.37 | 0.51 | |
| Control Delay | | 7.4 | | | 52.0 | | | 64.7 | | 8.8 | 5.9 | |
| Queue Delay | | 0.0 | | | 0.7 | | | 36.4 | | 0.0 | 0.5 | |
| Total Delay | | 7.4 | | | 52.7 | | | 101.2 | | 8.8 | 6.4 | |
| LOS | | A | | | D | | | F | | A | A | |
| Approach Delay | | 7.4 | | | 52.7 | | | 101.2 | | | 6.9 | |
| Approach LOS | | A | | | D | | | F | | | A | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 85 | |
| Actuated Cycle Length: 84 | |
| Natural Cycle: 105 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 1.27 | |
| Intersection Signal Delay: 60.4 | Intersection LOS: E |
| Intersection Capacity Utilization 74.8% | ICU Level of Service D |
| Analysis Period (min) 15 | |

Splits and Phases: 6: Colchester Ave & Barrett St



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 4 | 93 | 5 | 10 | 186 | 119 | 13 | 667 | 43 | 77 | 328 | 0 |
| Future Volume (vph) | 4 | 93 | 5 | 10 | 186 | 119 | 13 | 667 | 43 | 77 | 328 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1600 | 1600 | 1600 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | | 0.95 | | 1.00 | 1.00 | |
| Frt | | 0.99 | | | 0.95 | | | 0.99 | | 1.00 | 1.00 | |
| Flt Protected | | 1.00 | | | 1.00 | | | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1866 | | | 1783 | | | 2929 | | 1752 | 1845 | |
| Flt Permitted | | 1.00 | | | 1.00 | | | 0.95 | | 0.20 | 1.00 | |
| Satd. Flow (perm) | | 1866 | | | 1783 | | | 2771 | | 366 | 1845 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 4 | 98 | 5 | 11 | 196 | 125 | 14 | 702 | 45 | 81 | 345 | 0 |
| RTOR Reduction (vph) | 0 | 2 | 0 | 0 | 26 | 0 | 0 | 5 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 105 | 0 | 0 | 306 | 0 | 0 | 756 | 0 | 81 | 345 | 0 |
| Heavy Vehicles (%) | 1% | 1% | 1% | 1% | 1% | 1% | 0% | 3% | 0% | 3% | 3% | 0% |
| Turn Type | Split | NA | | Split | NA | | Perm | NA | | pm+pt | NA | |
| Protected Phases | 3 | 3 | | 4 | 4 | | | 6 | | 5 | 2 | |
| Permitted Phases | | | | | | | 6 | 6 | | 2 | 2 | |
| Actuated Green, G (s) | | 21.0 | | | 17.0 | | | 23.1 | | 32.1 | 32.1 | |
| Effective Green, g (s) | | 21.0 | | | 17.0 | | | 23.1 | | 32.1 | 32.1 | |
| Actuated g/C Ratio | | 0.25 | | | 0.20 | | | 0.27 | | 0.38 | 0.38 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | | | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 460 | | | 356 | | | 752 | | 203 | 695 | |
| v/s Ratio Prot | | c0.06 | | | c0.17 | | | | | 0.02 | c0.19 | |
| v/s Ratio Perm | | | | | | | | c0.27 | | 0.13 | | |
| v/c Ratio | | 0.23 | | | 0.86 | | | 1.01 | | 0.40 | 0.50 | |
| Uniform Delay, d1 | | 25.6 | | | 32.9 | | | 31.0 | | 28.9 | 20.3 | |
| Progression Factor | | 0.29 | | | 1.00 | | | 1.00 | | 0.20 | 0.17 | |
| Incremental Delay, d2 | | 0.0 | | | 18.7 | | | 34.1 | | 1.0 | 0.4 | |
| Delay (s) | | 7.4 | | | 51.6 | | | 65.1 | | 6.7 | 4.0 | |
| Level of Service | | A | | | D | | | E | | A | A | |
| Approach Delay (s) | | 7.4 | | | 51.6 | | | 65.1 | | | 4.5 | |
| Approach LOS | | A | | | D | | | E | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 42.7 | HCM 2000 Level of Service | D |
| HCM 2000 Volume to Capacity ratio | 0.70 | | |
| Actuated Cycle Length (s) | 85.1 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 74.8% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

# APPENDIX E

## Crash Data

Date: 10/15/2015 Source: SQL Server VCSG

Vermont Agency of Transportation

General Yearly Summaries - Crash Listing: State Highways and All Federal Aid Highway Systems

From 01/01/10 To 12/31/14 General Yearly Summaries Information

| * | Reporting Agency/ Number | Town | Mile Marker | Date MM/DD/YY | Time | Weather | Contributing Circumstances | Direction Of Collision | Number Of Injuries | Number Of Fatalities | Number Of Untimely Deaths | Direction | Road Group |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Route: COLCHESTER AVE., BURLINGTON | | | | | | | | | | | | | |
| | VT0040100/2011BU22989 | Burlington | 0.94 | 9/30/2011 | 13:01 | Clear | Followed too closely | Rear End | 0 | 0 | 0 | E | FAU |
| | VT0040100/2013BU028008 | Burlington | 0.94 | 10/16/2013 | 7:44 | Cloudy | Unknown | Rear End | 0 | 0 | 0 | | FAU |
| | VT0040100/2014BU000507 | Burlington | 0.95 | 1/7/2014 | 14:36 | Cloudy | Followed too closely, No improper driving | Rear End | 0 | 0 | 0 | | FAU |
| | VT0040100/2012BU010705 | Burlington | 0.96 | 5/7/2012 | 13:22 | Clear | Visibility obstructed, No improper driving | Other - Explain in Narrative | 0 | 0 | 0 | | FAU |
| | VT0040100/2013BU06723 | Burlington | 0.99 | 3/26/2013 | 18:02 | Clear | Inattention, No improper driving | Rear End | 0 | 0 | 0 | E | FAU |
| | VT0040100/2014BU033157 | Burlington | 0.99 | 11/24/2014 | 17:29 | Cloudy | No improper driving, Followed too closely | Rear End | 0 | 0 | 0 | | FAU |
| | VT0040100/10-19218 | Burlington | 1 | 8/9/2010 | 15:14 | Clear | No improper driving, Disregarded traffic signs, signals, markings | Left Turn and Thru, Angle Broadside -->v-- | 0 | 0 | 0 | | FAU |
| | VT0040100/2011BU2270 | Burlington | 1 | 2/2/2011 | 19:28 | Snow | Driving too fast for conditions, No improper driving | Rear End | 0 | 0 | 0 | | FAU |
| | VT0040100/2011-2435 | Burlington | 1 | 2/4/2011 | 19:15 | Cloudy | Followed too closely, No improper driving | Rear End | 0 | 0 | 0 | N | FAU |
| | VT0040100/2011BU9859 | Burlington | 1 | 5/12/2011 | 11:24 | Clear | Unknown | Same Direction Sideswipe | 0 | 0 | 0 | W | FAU |
| | VT0040100/2011BU11440 | Burlington | 1 | 5/30/2011 | 10:20 | Clear | Followed too closely, Unknown, No improper driving | Rear End | 0 | 0 | 0 | | FAU |
| | VT0040100/2011BU24733 | Burlington | 1 | 10/19/2011 | 15:19 | Cloudy | Failed to yield right of way | Left Turn and Thru, Angle Broadside -->v-- | 2 | 0 | 0 | E | FAU |
| | VT0040100/2012BU002919 | Burlington | 1 | 2/3/2012 | 9:14 | Clear | Operating vehicle in erratic, reckless, careless, negligent, or aggressive manner, No improper driving | Same Direction Sideswipe | 0 | 0 | 0 | E | FAU |
| | VT0040100/2012BU003187 | Burlington | 1 | 2/6/2012 | 13:33 | Cloudy | Inattention, Distracted, No improper driving | Rear End | 0 | 0 | 0 | W | FAU |
| | VT0040100/2012BU003183 | Burlington | 1 | 2/6/2012 | 13:03 | Clear | Inattention, Other improper action | Single Vehicle Crash | 0 | 1 | 0 | | FAU |
| | VT0040100/2012BU12413 | Burlington | 1 | 5/25/2012 | 6:57 | Clear | Failed to yield right of way | Opp Direction Sideswipe | 1 | 0 | 0 | | FAU |
| | VT0040100/2012BU013704 | Burlington | 1 | 6/7/2012 | 12:24 | Clear | Failure to keep in proper lane, Disregarded traffic signs, signals, markings, No improper driving | Same Direction Sideswipe | 0 | 0 | 0 | W | FAU |
| | VT0040100/2012BU023698 | Burlington | 1 | 9/14/2012 | 21:30 | Clear | No improper driving, Failed to yield right of way | Left Turn and Thru, Angle Broadside -->v-- | 0 | 0 | 0 | S | FAU |
| | VT0040100/2013BU000942 | Burlington | 1 | 1/13/2013 | 16:42 | Cloudy | No improper driving | Other - Explain in Narrative | 0 | 0 | 0 | E | FAU |
| | VT0040100/2013BU002530 | Burlington | 1 | 2/1/2013 | 18:20 | Unknown | Disregarded traffic signs, signals, markings, Unknown | No Turns, Thru moves only, Broadside ^< | 0 | 0 | 0 | | FAU |
| | VT0040100/2013BU019831 | Burlington | 1 | 8/2/2013 | 11:28 | | | | 0 | 0 | 0 | | FAU |
| | VT0040100/2013BU021386 | Burlington | 1 | 8/16/2013 | 11:43 | Clear | No improper driving | | 1 | 0 | 0 | | FAU |
| | VT0040100/2013BU029191 | Burlington | 1 | 10/28/2013 | 15:38 | Clear | Followed too closely, Swerving or avoiding due to wind, slippery surface, vehicle, object, non-motoris | Rear End | 0 | 0 | 0 | E | FAU |
| | VT0040400/13WS006354 | Burlington | 1 | 11/6/2013 | 18:47 | Cloudy | Followed too closely | Rear End | 0 | 0 | 0 | S | FAU |
| | VT0040100/2014BU008654 | Burlington | 1 | 4/10/2014 | 13:16 | Clear | Unknown | No Turns, Thru moves only, Broadside ^< | 0 | 0 | 0 | | FAU |
| | VT0040100/2014BU027644 | Burlington | 1 | 9/30/2014 | 6:48 | Clear | Inattention, No improper driving | Rear End | 0 | 0 | 0 | S | FAU |
| | VT0040100/10BU19532 | Burlington | 1.01 | 8/12/2010 | 17:40 | Clear | Unknown | Rear End | 0 | 0 | 0 | E | FAU |
| | VT0040100/2013BU028641 | Burlington | 1.02 | 10/22/2013 | 12:49 | Cloudy | Visibility obstructed | Same Direction Sideswipe | 0 | 0 | 0 | E | FAU |
| | VT0040100/2011BU20278 | Burlington | 1.03 | 9/2/2011 | 11:24 | Clear | Failure to keep in proper lane, No improper driving | Same Direction Sideswipe | 0 | 0 | 0 | | FAU |
| | VT0040100/2011BU27629 | Burlington | 1.03 | 11/24/2011 | 22:40 | Sleet, Hail (Freezing Rain or Drizzle) | Driving too fast for conditions | Rear End | 0 | 0 | 0 | N | FAU |
| | VT0040100/2012BU029213 | Burlington | 1.03 | 11/14/2012 | 14:46 | Clear | Inattention, No improper driving | Rear End | 0 | 0 | 0 | W | FAU |
| | VT0040100/2012BU030153 | Burlington | 1.03 | 11/26/2012 | 13:17 | Clear | Inattention, No improper driving | Rear End | 0 | 0 | 0 | W | FAU |
| | VT0040100/2012BU03173 | Burlington | 1.03 | 12/16/2012 | 11:24 | Snow | No improper driving | Rear End | 0 | 0 | 0 | W | FAU |
| | VT0040100/2012BU031733 | Burlington | 1.03 | 12/16/2012 | 11:37 | | Driving too fast for conditions, No improper driving | Rear End | 0 | 0 | 0 | W | FAU |
| | VT0040400/13WS001691 | Burlington | 1.03 | 3/29/2013 | 12:24 | Clear | Visibility obstructed, No improper driving | Same Direction Sideswipe | 0 | 0 | 0 | N | FAU |
| | VT0040100/2013BU032162 | Burlington | 1.03 | 12/3/2013 | 18:21 | | | | 0 | 0 | 0 | N | FAU |
| | VT0040100/2013BU033037 | Burlington | 1.03 | 12/14/2013 | 23:59 | Snow | | Head On | 0 | 0 | 0 | | FAU |
| | VT0040100/2013BU033370 | Burlington | 1.03 | 12/19/2013 | 17:50 | Cloudy | Failed to yield right of way, Unknown | Same Direction Sideswipe | 0 | 0 | 0 | E | FAU |
| | VT0040100/2014BU002004 | Burlington | 1.03 | 1/23/2014 | 6:19 | Clear | Inattention, No improper driving | Rear End | 0 | 0 | 0 | W | FAU |
| | VT0040100/2014BU012857 | Burlington | 1.03 | 5/21/2014 | 16:23 | Clear | Driving too fast for conditions, Followed too closely, No improper driving | Rear End | 0 | 0 | 0 | | FAU |
| | VT0040100/10-17539 | Burlington | 1.039 | 7/22/2010 | 12:55 | Cloudy | Other improper action, Disregarded traffic signs, signals, markings | Head On | 0 | 0 | 0 | | FAU |
| | VT0040100/2010-17895 | Burlington | 1.039 | 7/26/2010 | 8:49 | Clear | Failed to yield right of way, No improper driving | Same Direction Sideswipe | 0 | 0 | 0 | N | FAU |
| Totals: | | 4 | 1 | 0 | | | | | | | | | |

Total Crash Count = 42 Fatal Crash Count = 1 Injury Crash Count = 3 PDO Crash Count = 38

Note: FAU-5014(Colchester Ave.) MM 0.92-1.04.
Barrett St. intersect Colchester Ave. at mile point 1.00.
Riverside Ave intersects Colchester Ave. at mile point 1.04.
LRoberts - Vtrans
Untimely Deaths are the result of death prior to a crash event. These deaths are not counted inthe Fatal/Fatality type counts. They are considered an Incapacitating Injury and are counted in Injury Type crashes.

Date: 10/15/2015 Source: SQL Server VCSG

Vermont Agency of Transportation

General Yearly Summaries - Crash Listing: State Highways and All Federal Aid Highway Systems

From 01/01/10 To 12/31/14 General Yearly Summaries Information

Route: US-7

| * | Reporting Agency/ Number | Town | Mile Marker | Date MM/DD/YY | Time | Weather | Contributing Circumstances | Direction Of Collision | Number Of Injuries | Number Of Fatalities | Number Of Untimely Deaths | Direction | Road Group |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VT0040100/2010-0025 | Burlington | 4.01 | 1/1/2010 | 1:17 | Snow | Under the influence of medication/drugs/alcohol | Single Vehicle Crash | 0 | 0 | 0 | N | SH |
| | VT0040100/2012BU025650 | Burlington | 4.01 | 10/5/2012 | 10:45 | Clear | Driving too fast for conditions, Failure to keep in proper lane | Single Vehicle Crash | 0 | 0 | 0 | | SH |
| | VT0040100/2010-24029 | Burlington | 4.04 | 9/28/2010 | 6:52 | Rain | Failure to keep in proper lane, Fatigued, asleep | Single Vehicle Crash | 0 | 0 | 0 | E | SH |
| | VT0040100/2014BU022024 | Burlington | 4.05 | 8/12/2014 | 17:37 | Cloudy | Followed too closely, No improper driving | Rear End | 0 | 0 | 0 | W | SH |
| | VT0040100/2011BU26854 | Burlington | 4.1 | 11/14/2011 | 13:15 | Unknown | Disregarded traffic signs, signals, markings, Other improper action, No improper driving | No Turns, Thru moves only, Broadside ^< | 0 | 0 | 0 | | SH |
| | VT0040100/2012BU004052 | Burlington | 4.1 | 2/17/2012 | 14:29 | Clear | No improper driving | Rear End | 1 | 0 | 0 | E | SH |
| | VT0040100/2013BU002795 | Burlington | 4.1 | 2/5/2013 | 13:16 | Clear | Failure to keep in proper lane, Operating defective equipment, No improper driving | Left Turn and Thru, Same Direction Sideswipe/Angle Crash vv-- | 1 | 0 | 0 | | SH |
| | VT0040100/2013BU010787 | Burlington | 4.1 | 5/8/2013 | 17:40 | Rain | Failure to keep in proper lane, Operating vehicle in erratic, reckless, careless, negligent, or aggressive | Same Direction Sideswipe | 0 | 0 | 0 | | SH |
| | VT0040100/2013BU022266 | Burlington | 4.1 | 8/24/2013 | 17:13 | Clear | Disregarded traffic signs, signals, markings, No improper driving | Right Turn and Thru, Same Direction Sideswipe/Angle Crash ^^-- | 0 | 0 | 0 | N | SH |
| | VT0040100/2013BU033719 | Burlington | 4.1 | 12/24/2013 | 8:16 | Cloudy | Operating vehicle in erratic, reckless, careless, negligent, or aggressive manner, No improper driving | Rear End | 0 | 0 | 0 | E | SH |
| | VT0040100/2014BU004299 | Burlington | 4.12 | 2/18/2014 | 16:05 | Cloudy | No improper driving, Driving too fast for conditions, Failure to keep in proper lane | Opp Direction Sideswipe | 0 | 0 | 0 | | SH |
| | VT0040100/2013BU031435 | Burlington | 4.13 | 11/24/2013 | 9:47 | Cloudy | Driving too fast for conditions | Rear End | 0 | 0 | 0 | S | SH |
| | VT0040100/2014BU006164 | Burlington | 4.13 | 3/13/2014 | 17:11 | Clear | Followed too closely, Driving too fast for conditions, No improper driving | Rear End | 0 | 0 | 0 | E | SH |
| | VT0040100/2014BU006816 | Burlington | 4.13 | 3/21/2014 | 0:19 | Clear | Under the influence of medication/drugs/alcohol | Single Vehicle Crash | 0 | 0 | 0 | | SH |
| | VT0040100/2014BU007959 | Burlington | 4.13 | 4/2/2014 | 18:19 | Clear | No improper driving, Followed too closely | Rear End | 0 | 0 | 0 | W | SH |
| | VT0040100/2014BU009842 | Burlington | 4.13 | 4/21/2014 | 17:59 | Clear | Operating defective equipment, No improper driving | Rear End | 0 | 0 | 0 | | SH |
| | VT0040100/2014BU013716 | Burlington | 4.13 | 5/30/2014 | 5:33 | Clear | Inattention, No improper driving | Rear End | 0 | 0 | 0 | | SH |
| | VT0040100/2014BU015358 | Burlington | 4.13 | 6/13/2014 | 19:43 | Clear | | Rear End | 0 | 0 | 0 | W | SH |
| | VT0040100/2014BU015617 | Burlington | 4.13 | 6/16/2014 | 14:17 | Clear | Inattention, No improper driving | Same Direction Sideswipe | 0 | 0 | 0 | S | SH |
| | VT0040100/2014BU022792 | Burlington | 4.13 | 8/19/2014 | 15:51 | | | No Turns, Thru moves only, Broadside ^< | 0 | 0 | 0 | | SH |
| | VT0040100/2014BU024874 | Burlington | 4.13 | 9/6/2014 | 12:10 | Cloudy | Unknown, No improper driving | Rear End | 0 | 0 | 0 | | SH |
| | VT0040100/2010-24030 | Burlington | 4.14 | 9/28/2010 | 7:42 | Rain | Inattention, No improper driving | Rear End | 0 | 0 | 0 | N | SH |
| | VT0040100/10-27773 | Burlington | 4.14 | 11/12/2010 | 23:24 | Clear | Disregarded traffic signs, signals, markings, Operating vehicle in erratic, reckless, careless, negligent, c | Rear End | 0 | 0 | 0 | | SH |
| | VT0040100/10BU29317 | Burlington | 4.14 | 12/3/2010 | 15:29 | Unknown | No improper driving, Failure to keep in proper lane | Same Direction Sideswipe | 0 | 0 | 0 | W | SH |
| | VT0040100/10BU29630 | Burlington | 4.14 | 12/8/2010 | 10:34 | Cloudy | Visibility obstructed, Inattention | Other - Explain in Narrative | 0 | 0 | 0 | | SH |
| | VT0040100/10-30363 | Burlington | 4.14 | 12/19/2010 | 11:32 | Clear | Followed too closely, No improper driving | Rear End | 0 | 0 | 0 | N | SH |
| | VT0040100/2011-5018 | Burlington | 4.14 | 3/12/2011 | 13:40 | Cloudy | No improper driving, Visibility obstructed | Rear End | 0 | 0 | 0 | | SH |
| | VT0040100/2011BU6986 | Burlington | 4.14 | 4/7/2011 | 18:25 | Clear | Operating defective equipment, No improper driving | Rear End | 1 | 0 | 0 | | SH |
| | VT0040100/2012BU000705 | Burlington | 4.14 | 1/8/2012 | 17:57 | Clear | No improper driving, Inattention | Rear End | 0 | 0 | 0 | N | SH |
| | VT0040100/2012BU017940 | Burlington | 4.14 | 7/20/2012 | 21:00 | Unknown | Unknown | Same Direction Sideswipe | 0 | 0 | 0 | N | SH |
| | VT0040100/2012BU027455 | Burlington | 4.14 | 10/24/2012 | 17:01 | Cloudy | Inattention, No improper driving | Rear End | 0 | 0 | 0 | E | SH |
| | VT0040100/2013BU002882 | Burlington | 4.14 | 2/6/2013 | 17:40 | Clear | Inattention, Technology Related Distraction, No improper driving, Unknown | Rear End | 1 | 0 | 0 | | SH |
| | VT0040100/2013BU003010 | Burlington | 4.14 | 2/8/2013 | 9:27 | Snow | No improper driving, Disregarded traffic signs, signals, markings | No Turns, Thru moves only, Broadside ^< | 0 | 0 | 0 | E | SH |
| | VT0040100/2013BU024167 | Burlington | 4.14 | 9/11/2013 | 9:50 | Clear | No improper driving | Single Vehicle Crash | 1 | 0 | 0 | | SH |
| | VT0040100/2013BU026197 | Burlington | 4.14 | 9/29/2013 | 0:11 | | | | 0 | 0 | 0 | | SH |
| | VT0040100/2013BU029354 | Burlington | 4.14 | 10/30/2013 | 18:46 | | | | 0 | 0 | 0 | E | SH |
| | VT0040100/2013BU029855 | Burlington | 4.14 | 11/4/2013 | 12:04 | Clear | No improper driving, Inattention | No Turns, Thru moves only, Broadside ^< | 0 | 0 | 0 | N | SH |
| | VT0040100/2013BU032829 | Burlington | 4.14 | 12/12/2013 | 8:50 | Clear | Inattention, Distracted, No improper driving | Rear End | 0 | 0 | 0 | | SH |
| | VT0040100/2014BU018418 | Burlington | 4.14 | 7/12/2014 | 19:41 | Clear | Inattention, No improper driving | Rear End | 0 | 0 | 0 | S | SH |
| | VT0040100/2011BU20763 | Burlington | 4.15 | 9/7/2011 | 16:56 | Rain | Driving too fast for conditions, Followed too closely, No improper driving | Rear End | 1 | 0 | 0 | | SH |
| | VT0040100/2013BU013952 | Burlington | 4.15 | 6/7/2013 | 13:49 | Rain | Unknown | Other - Explain in Narrative | 0 | 0 | 0 | | SH |
| | VT0040100/10-8221 | Burlington | 4.17 | 4/10/2010 | 2:39 | Clear | Under the influence of medication/drugs/alcohol, Operating vehicle in erratic, reckless, careless, negli | Same Direction Sideswipe | 0 | 0 | 0 | | SH |
| | VT0040100/10BU30764 | Burlington | 4.18 | 12/24/2010 | 20:27 | Clear | No improper driving, Unknown | Other - Explain in Narrative | 0 | 0 | 0 | E | SH |
| | VT0040100/2012BU00009567 | Burlington | 4.18 | 4/23/2012 | 8:20 | Rain | Inattention, No improper driving | Rear End | 1 | 0 | 0 | W | SH |
| | VT0040100/10-3854 | Burlington | 4.19 | 2/19/2010 | 18:32 | Cloudy | Other improper action, No improper driving | Rear End | 1 | 0 | 0 | W | SH |
| | VT0040100/10-21255 | Burlington | 4.19 | 8/30/2010 | 8:20 | Clear | Other improper action, No improper driving | Same Direction Sideswipe | 0 | 0 | 0 | | SH |
| | VT0040100/10-23103 | Burlington | 4.19 | 9/18/2010 | 9:55 | Clear | Operating vehicle in erratic, reckless, careless, negligent, or aggressive manner, Exceeded authorized | Single Vehicle Crash | 0 | 0 | 0 | | SH |
| | VT0040100/10-27485 | Burlington | 4.19 | 11/8/2010 | 18:37 | Rain | Inattention, No improper driving | Rear End | 0 | 0 | 0 | N | SH |
| | VT0040100/2011-1651 | Burlington | 4.19 | 1/24/2011 | 8:05 | Clear | Followed too closely, No improper driving | Rear End | 1 | 0 | 0 | W | SH |
| | VT0040100/2011-BU-01652 | Burlington | 4.19 | 1/24/2011 | 8:20 | Clear | No improper driving | Rear End | 0 | 0 | 0 | | SH |
| | VT0040100/2011-1653 | Burlington | 4.19 | 1/24/2011 | 8:38 | Clear | Driving too fast for conditions | Single Vehicle Crash | 0 | 0 | 0 | W | SH |
| | VT0040100/2011BU18109 | Burlington | 4.19 | 8/9/2011 | 16:35 | Cloudy | Unknown, No improper driving | Rear-to-rear | 0 | 0 | 0 | | SH |
| | VT0040100/2012BU006601 | Burlington | 4.19 | 3/19/2012 | 14:36 | Clear | Followed too closely, No improper driving | Rear End | 0 | 0 | 0 | N | SH |
| | VT0040100/2013BU002796 | Burlington | 4.19 | 2/5/2013 | 13:37 | Clear | Inattention, No improper driving | Rear End | 1 | 0 | 0 | | SH |
| | VT0040100/2013BU06372 | Burlington | 4.19 | 3/22/2013 | 10:05 | Clear | Inattention, No improper driving | Rear End | 0 | 0 | 0 | W | SH |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VT0040100/2013BU012526 | Burlington | 4.19 | 5/24/2013 | 21:59 | Rain | Followed too closely, No improper driving | Rear End | 0 | 0 | 0 | | SH |
| | VT0040100/2013BU020117 | Burlington | 4.19 | 8/5/2013 | 1:50 | Not Reported | No improper driving | Right Turn, Same Direction, Rear End ^--^-- | 0 | 0 | 0 | W | SH |
| | VT0040100/2013BU028009 | Burlington | 4.19 | 10/16/2013 | 8:05 | Cloudy | Unknown, No improper driving | Rear End | 0 | 0 | 0 | E | SH |
| Totals: | | 10 | 0 | 0 | | | | | | | | | |

Total Crash Count = 58 Fatal Crash Count = 0 Injury Crash Count = 10 PDO Crash Count = 48

Note: US-7(Riverside Ave.) MM 4.00-4.19.
Barrett St. intersects US-7 at mile point 4.10.
Colchester Ave./Mill St. intersects US-7 at mile point 4.14.
Burlington/Winooski City town line is at mile point 4.19.
LRoberts - Vtrans
Untimely Deaths are the result of death prior to a crash event. These deaths are not counted inthe Fatal/Fatality type counts. They are considered an Incapacitating Injury and are counted in Injury Type crashes.
THIS DOCUMENT IS EXEMPT FROM DISCOVERY OR ADMISSION UNDER 23 U.S.C. 409.

# APPENDIX F

## Collision Diagrams

# COLLISION DIAGRAM

Key Number = 2

| | | |
|---|---|---|
| MUNICIPALITY: *Burlington* | COUNTY: | FILE: *burlmill* |
| INTERSECTION: *BARRETT ST., BURLINGTON* | | CASE # : |
| PERIOD: 3 YEARS 0 MONTHS | FROM 1/1/2012 TO 12/31/2014 | BY: DATE: 1/8/2016 |


| SYMBOLS | | MANNER OF COLLISION | |
|---|---|---|---|
| MOVING VEHICLE | P PEDESTRIAN | REAR END | HEAD ON |
| TURNING VEHICLE | B BICYCLIST | LEFT TURN | RIGHT TURN |
| BACKING VEHICLE | A ANIMAL | LEFT TURN | RIGHT TURN |
| PARKED VEHICLE | FIXED OBJECT | OVERTAKE | RIGHT ANGLE |
| 999 RECORD NUMBER | Fatal | OUT OF CONTROL | SIDE SWIPE |

HSA Software 3.0

# COLLISION DIAGRAM

Key Number = *1*

MUNICIPALITY: *Burlington* COUNTY: 

INTERSECTION: *BARRETT ST., BURLINGTON*

PERIOD: *3* YEARS *0* MONTHS FROM *1/1/2012* TO *12/31/2014*

FILE: *burlmill*

CASE # :

BY: DATE: *1/8/2016*


| SYMBOLS | | MANNER OF COLLISION | |
|---|---|---|---|
| MOVING VEHICLE | P PEDESTRIAN | REAR END | HEAD ON |
| TURNING VEHICLE | B BICYCLIST | LEFT TURN | RIGHT TURN |
| BACKING VEHICLE | A ANIMAL | LEFT TURN | RIGHT TURN |
| PARKED VEHICLE | FIXED OBJECT | OVERTAKE | RIGHT ANGLE |
| 999 RECORD NUMBER | Fatal | OUT OF CONTROL | SIDE SWIPE |

# COLLISION DIAGRAM

Key Number = 3

| | |
|---|---|
| MUNICIPALITY: *Burlington* COUNTY: | FILE: *burlmill* |
| INTERSECTION: *BARRETT ST., BURLINGTON* | CASE # : |
| PERIOD: *3* YEARS *0* MONTHS FROM *1/1/2012* TO *12/31/2014* | BY: DATE: *1/8/2016* |


| SYMBOLS | | | |
|---|---|---|---|
| | MOVING VEHICLE | P | PEDESTRIAN |
| | TURNING VEHICLE | B | BICYCLIST |
| | BACKING VEHICLE | A | ANIMAL |
| | PARKED VEHICLE | | FIXED OBJECT |
| 999 | RECORD NUMBER | | Fatal |

| MANNER OF COLLISION | |
|---|---|
| REAR END | HEAD ON |
| LEFT TURN | RIGHT TURN |
| LEFT TURN | RIGHT TURN |
| OVERTAKE | RIGHT ANGLE |
| OUT OF CONTROL | SIDE SWIPE |

HSA Software 3.0

| Crash # | Road | Marker | Date | Time | Weather | Injuries | Fatalities | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | BARRETT ST. | 0.14 | 6/8/2012 | 13:33 | Cloudy | 1 | 0 | Other - Explain in Narrative | Male in wheelchair struck by a vehicle. Vehicle was north trying to turn left onto Barrett. Wheelchair was in the crosswalk. Said that he had the green light and did not see the wheelchair. |
| 2 | COLCHESTER AVE. | 0.99 | 3/26/2013 | 18:02 | Clear | 0 | 0 | Rear End | OP 1 was behind op 2 facing east on Colchester. The light turned green, both vehicle proceeded east. V2 came to a stop as vehicle in front of it was attempting to turn left |
| 3 | COLCHESTER AVE. | 0.99 | 11/24/2014 | 17:29 | Cloudy | 0 | 0 | Rear End | V3 was rolling to a stop or stopped when v2 collided. V2 was stopped in traffic on the Winooski Bridge. Op 1 was eastbound on Colchester Ave. Observed traffic stopped. Could not stop in time. |
| 4 | COLCHESTER AVE. | 1.00 | 2/3/2012 | 9:14 | Clear | 0 | 0 | Same Direction Sideswipe | V2 was east. Came to a stop when the vehicle in front stopped at Barrett. V2 came around the truck. Clipped the end. |
| 5 | COLCHESTER AVE. | 1.00 | 2/6/2012 | 13:03 | Clear | 0 | 1 | Single Vehicle Crash | V1 had green light. Turned left onto Barrett St. Did not see the ped and hit the ped. |
| 6 | COLCHESTER AVE. | 1.00 | 2/6/2012 | 13:33 | Cloudy | 0 | 0 | Rear End | Vehicles were wb on Colchester Ave. Vh 1 looked at a crash, then rear ended V2. |
| 7 | COLCHESTER AVE. | 1.00 | 5/25/2012 | 6:57 | Clear | 1 | 0 | Opp Direction Sideswipe | Op 1 was making a left onto Barrett. Bike was northbound. |
| 8 | COLCHESTER AVE. | 1.00 | 6/7/2012 | 12:24 | Clear | 0 | 0 | Same Direction Sideswipe | Op 1 went into the left turn lane by mistake. Not wanting to turn left, continued straight and sideswiped veh 2. |
| 9 | COLCHESTER AVE. | 1.00 | 9/14/2012 | 21:30 | Clear | 0 | 0 | Left Turn and Thru, Angle Broadside -->v-- | Was at red light. Light turned green, turned left onto Barrett Street in front of vehicle. Veh 2 was facing north. |
| 10 | COLCHESTER AVE. | 1.00 | 1/13/2013 | 16:42 | Cloudy | 0 | 0 | Other - Explain in Narrative | Was parked westbound on the northside of Colchester Ave. Brake failed and the vehicle was traveling backward. |
| 11 | COLCHESTER AVE. | 1.00 | 2/1/2013 | 18:20 | Unknown | 0 | 0 | No Turns, Thru moves only, Broadside ^< | Veh 1 was west on Barrett and Veh2 was from the bridge towards Burlington. V2 said had green light. Right Angle crash. |
| 12 | COLCHESTER AVE. | 1.00 | 8/2/2013 | 11:28 | | 0 | 0 | | Op 1 was traveling west on Colchester Av. Said was in the southern most lane. Wanted to be in the northern lane and attempted to move to northern lane. Op 2 was traveling west on Colchester Ave. |

| Crash # | Road | Marker | Date | Time | Weather | Injuries | Fatalities | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| 13 | COLCHESTER AVE. | 1.00 | 8/16/2013 | 11:43 | Clear | 1 | 0 | | Bike was traveling down the hill. Brakes were not working. Dragged his foot to slow down. Go it by a car that pulled in front of him. Vehicle was up the hill and right towards River Side. Bike was straddling the yellow line. Veh was waiting for westbound traffic to pass before going north. Did not expect a bike to pass on the left. |
| 14 | COLCHESTER AVE. | 1.00 | 10/28/2013 | 15:38 | Clear | 0 | 0 | Rear End | Veh 1 was east on River Side approaching Barrett intersection. Vehicle 2 was eastbound on River Side. A vehicle stopped in front, got rear ended by veh 1. |
| 15 | COLCHESTER AVE. | 1.00 | 11/6/2013 | 18:47 | Cloudy | 0 | 0 | Rear End | Collision occurred in left turn only lane of Colchester Ave at Barrett St. south bound, approx. 2 cars back from traffic light. Rear-End. Traveling south. |
| 16 | COLCHESTER AVE. | 1.00 | 4/10/2014 | 13:16 | Clear | 0 | 0 | No Turns, Thru moves only, Broadside ^< | V1 was stopped eastbound on Barrett St behind veh 2. Light turned green and vehicle 2 started crossing Colchester ave and hit Veh 2. |
| 17 | COLCHESTER AVE. | 1.00 | 9/30/2014 | 6:48 | Clear | 0 | 0 | Rear End | Both Vehicles were traveling south out of Winooski. Veh 1 was looking for her friend that she was supposed to pick up and slowed down and hit veh 2. Veh 2 had slammed on the brake for a ped in the road. |
| 18 | COLCHESTER AVE. | 1.02 | 10/22/2013 | 12:49 | Cloudy | 0 | 0 | Same Direction Sideswipe | Veh 1 was east on River Side when saw a somebody begging for money on the side of the road. Veh 1 was in northern eastbound lane. Went into the southern lane. Did not realized that veh 2 was in her blind spot. |
| 19 | COLCHESTER AVE. | 1.03 | 11/14/2012 | 14:46 | Clear | 0 | 0 | Rear End | Ve 1 was in left lane of westbound traffic to Burlington. Op 1 saw a friend and diverted his attention to the ped. Hit ve 2 in front. Stop and go traffic. Winooski Bridge. Rear-end. |
| 20 | COLCHESTER AVE. | 1.03 | 11/26/2012 | 13:17 | Clear | 0 | 0 | Rear End | OP 1 was travelling west on Winooski Bridge from Winooski. Swerved to the left to avoid traffic stopped in front of him. |
| 21 | COLCHESTER AVE. | 1.03 | 12/16/2012 | 11:24 | Snow | 0 | 0 | Rear End | Op 1 was west on Winooski Bridge at Mill St intersection. She was approaching a red light and was unable to stop due to the icy conditions. Hit Veh 2. |
| 22 | COLCHESTER AVE. | 1.03 | 12/16/2012 | 11:37 | | 0 | 0 | Rear End | Veh 3 was travelling west in the right lane of the Winooski bridge. Traffic in front of him slowed down. He got rear ended. |

| Crash # | Road | Marker | Date | Time | Weather | Injuries | Fatalities | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| 23 | COLCHESTER AVE. | 1.03 | 3/29/2013 | 12:24 | Clear | 0 | 0 | Same Direction Sideswipe | OP 1 was driving north in the left hand northbound traffic lane on the bridge. A slow moving vehicle was in front of her and she put on her right directional and looked in her mirrors. She did not see anything in the right hand northbound traffic lane so she made the indicated lane change. When she did this the passenger side of her vehicle made contact with the operator side of a vehicle that had been traveling north in the right hand northbound traffic lane. Op 2 had been traveling north in the right hand northbound traffic lane. As he was crossing the bridge, he too noticed a slow moving vehicle in the left hand northbound traffic lane. He said the Ford Focus moved into his lane and made contact with the driver side of his vehicle. |
| 24 | COLCHESTER AVE. | 1.03 | 12/3/2013 | 18:21 | | 0 | 0 | | Veh 1 switch from inside to outside and hit ve 2. Veh 2 was in northbound outside lane on Colchester Ave. On Bridge or near bridge, about 100 ft north of river side. |
| 25 | COLCHESTER AVE. | 1.03 | 12/14/2013 | 23:59 | Snow | 0 | 0 | Head On | No narrative. Head on. One vehicle was north. |
| 26 | COLCHESTER AVE. | 1.03 | 12/19/2013 | 17:50 | Cloudy | 0 | 0 | Same Direction Sideswipe | Op 1 was traveling eastbound on Colchester Ave. She had passed the Barrett intersection. She began going into the right lane where it splits towards the bridge. Op 2 was westbound approaching the bridge. Op 2 said that he was through the light (Barrett and said to the right to go onto the bridge. Said that Veh 1 was to the left and then as they entered the bridge veh 1 moved to the right. |
| 27 | COLCHESTER AVE. | 1.03 | 1/23/2014 | 6:19 | Clear | 0 | 0 | Rear End | 1 was driving west into Burlington and attempted to stop her vehicle at the red light. Skid into the back of ve 2 which was waiting stopped for the light to turn. |
| 28 | COLCHESTER AVE. | 1.03 | 5/21/2014 | 16:23 | Clear | 0 | 0 | Rear End | I had been traveling east in the outside lane on Riverside and was approaching the intersection with Barrett. The light for eastbound traffic on Riverside turned yellow and she tried to get through before it got red. After she passed through the intersection, she realized that traffic in front had stopped for the red light at the intersection with Colchester. |

| Crash # | Road | Marker | Date | Time | Weather | Injuries | Fatalities | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| 29 | US-7 | 4.10 | 2/17/2012 | 14:29 | Clear | 1 | 0 | Rear End | 40 ft west of Barrett St. Traveling East. Op 1 was stopped behind veh 2. Light at Barrett St turned green and she observed the vehicles at the intersection start to move forward. Vehicle behind honked at her and she started to move to realize that traffic in front was not moving. |
| 30 | US-7 | 4.10 | 2/5/2013 | 13:16 | Clear | 1 | 0 | Left Turn and Thru, Same Direction Sideswipe/Angle Crash vv-- | Witness advised he was westbound on the bridge at the west end of the bridge when he observed v1 go around cars on the left, in the oncoming lane of travel. Said that V1 drove west onto Riverside Ave, the wrong way in the eastbound lane. Said that V2 was traveling north on Barrett St and turning left/west onto Riverside Ave at the intersection with a green light. |
| 31 | US-7 | 4.10 | 5/8/2013 | 17:40 | Rain | 0 | 0 | Same Direction Sideswipe | Advised she had been traveling into Burlington from Winooski on Riverside Ave. Said that she activated her turn signal and stopped intending on making a left hand turn onto Barrett St from Riverside. She said that she had to stop as there are 2 lanes of oncoming traffic on Riverside Ave. Said that an oncoming vehicle stopped and the operator motioned for her to proceed. She proceeded at which time a motorcycle came from behind her and attempted to pass her on the left. Said that the moto collided with her. |
| 32 | US-7 | 4.10 | 8/24/2013 | 17:13 | Clear | 0 | 0 | Right Turn and Thru, Same Direction Sideswipe/Angle Crash ^^-- | Op 1 was facing north at the red light at Barret St and Colchester Ave. Light turned green and she proceeded to go forward straight across onto Riverside Ave when a vehicle traveling east on Colchester Ave struck the front passenger side. Veh 2 was originally in the lane to continue east on Colchester ave, but due to back up traffic, he attempted to turn onto Riverside Ave. Due to traffic, he was under the light and could not tell that it was red. |
| 33 | US-7 | 4.10 | 12/24/2013 | 8:16 | Cloudy | 0 | 0 | Rear End | No narrative. The report says that the vehicles were East. Rear-end crash. |

| Crash # | Road | Marker | Date | Time | Weather | Injuries | Fatalities | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| 34 | US-7 | 4.12 | 2/18/2014 | 16:05 | Cloudy | 0 | 0 | Opp Direction Sideswipe | Not in the study area. Had been driving towards Winooski on Riverside Ave and was near E&E Tire when a sub heading in the opposite direction crossed over the center line and sideswiped her vehicle. |
| 35 | US-7 | 4.13 | 11/24/2013 | 9:47 | Cloudy | 0 | 0 | Rear End | On the bridge. Road was covered with ice. Op 1 had been in the northern most westbound lane coming from Winooski into Burlington. Said that his vehicle slid on ice. Veh 2 struck his passenger side panels. Op 2 said saw op 1 fishtail and turn but could not brake in time. |
| 36 | US-7 | 4.13 | 3/13/2014 | 17:11 | Clear | 0 | 0 | Rear End | Op 1 was traveling east on Riverside through the green light at the intersection with Barret St behind VE 2. Said traveled to the next intersection just before the bridge. The light turned from green to yellow to red. Ve 2 stopped suddenly. |
| 37 | US-7 | 4.13 | 3/21/2014 | 0:19 | Clear | 0 | 0 | Single Vehicle Crash | Not in the study area. Vehicle near the tree line north of M&H auto, 110 Riverside on the eastside of Riverside facing eastbound. Along the sidewalk was a light pole on the ground. It appeared that veh 1 had struck the light pole and continued north on Riverside, through the M&H entrance. |
| 38 | US-7 | 4.13 | 4/2/2014 | 18:19 | Clear | 0 | 0 | Rear End | Op 1 was east on Riverside stopped at the red light of Barrett St. Op 1 advised the light turned green and that veh 2 which was in front of him began to pull forward. Op 1 advised that as both vehicles pulled forward, a ped crossed the street causing ve 2 to stop. |
| 39 | US-7 | 4.13 | 4/21/2014 | 17:59 | Clear | 0 | 0 | Rear End | Op 2 while she was stopped at the red light on Riverside ave at Colchester Ave that a vehicle hit her rear bumper and then turned across the southbound lanes and came to a rest on the curb. Op 1 was north on Riverside approaching the red light at Colchester Ave. Attempted to step on the brake but it the gas pedal instead. |
| 40 | US-7 | 4.13 | 5/30/2014 | 5:33 | Clear | 0 | 0 | Rear End | Op 1 said was traveling westbound and the light at Colchester and Riverside turned red. Failed to stop and bumped the car in front of her. |

| Crash # | Road | Marker | Date | Time | Weather | Injuries | Fatalities | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| 41 | US-7 | 4.13 | 6/13/2014 | 19:43 | Clear | 0 | 0 | Rear End | Op 1 was driving east on the bridge into Burlington. Said that rear-ended veh 2 that was at a complete rest at the light Colchester and Riverside. |
| 42 | US-7 | 4.13 | 6/16/2014 | 14:17 | Clear | 0 | 0 | Same Direction Sideswipe | Op 1 was south in the left lane on the bridge when she swerved into the right lane. Op 2 was in the right lane south on the bridge when she got hit by a vehicle that came in her lane. |
| 43 | US-7 | 4.13 | 8/19/2014 | 15:51 | | 0 | 0 | No Turns, Thru moves only, Broadside ^< | Ve 2 was traveling east on Riverside and was stopped at the intersection with Colchester Ave when veh 1 collided with the rear of veh 2. |
| 44 | US-7 | | 9/6/2014 | 12:10 | Cloudy | 0 | 0 | Rear End | Not in the study area. Op 2 had been west on Riverside Ave and was stopped at the entrance to 152 Riverside Ave. He was waiting for eastbound traffic to clear so that he could turn into the driveway at 142. Was hit from behind while waiting. |
| 45 | US-7 | 4.14 | 1/8/2012 | 17:57 | Clear | 0 | 0 | Rear End | Op 1 was approaching the intersection of Riverside and Colchester Ave (returning to Burlington). Saw a vehicle that was driving very fast in the opposing direction. Was focused on the speeding vehicle and did not see that the vehicle in front had stopped for the red light. |
| 46 | US-7 | 4.14 | 7/20/2012 | 21:00 | Unknown | 0 | 0 | Same Direction Sideswipe | Op 2 had been traveling in the left northeastbound lane on River Side Ave and was stopped at a red light at the intersection with Barrett. After she started moving forward through the intersection on the green light, a vehicle in the right hand lane sideswiped her vehicle. Op 1 said was driving northeast on Riverside Ace in the right hand lane and had been stopped for a red light. Did not know if her or Op 2 had moved out of their lanes. |
| 47 | US-7 | 4.14 | 10/24/2012 | 17:01 | Cloudy | 0 | 0 | Rear End | Limited narrative. Rear-end. East. Colchester and Riverside. Vehicles on Riverside. |

| Crash # | Road | Marker | Date | Time | Weather | Injuries | Fatalities | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| 48 | US-7 | 4.14 | 2/6/2013 | 17:40 | Clear | 1 | 0 | Rear End | OP 1 was not from then area. He was traveling west across the bridge when he realized he was going the wrong way. He stated that he turned around on one other side streets and that he crossed the bridge. On his way back east over the bridge, he looked down at his gps and hit the car in from of him. Op 2 sated that she was traveling east on the bridge when she was struck by a vehicle behind her. 25 ft east of Mill St. |
| 49 | US-7 | 4.14 | 2/8/2013 | 9:27 | Snow | 0 | 0 | No Turns, Thru moves only, Broadside ^< | Op 1 was traveling west on the bridge heading into Burlington. She advised she was in the left hand lane and saw a green arrow at her traffic light which allows right lane traffic to turn right onto Riverside. Admitted she mistook the green arrow to be a green light for her lane so she traveled through the intersection to go straight on Colchester. Then realized she had a red light. Op 2 was stopped at the red light on Riverside waiting to merge onto Colchester Ave to go over the bridge. Light turned green and he proceeded. |
| 50 | US-7 | 4.14 | 9/11/2013 | 9:50 | Clear | 1 | 0 | Single Vehicle Crash | Op 1 was west onto Riverside from Winooski when a boy on a bike darted in front of her. The family was on the sidewalk when they saw that eastbound traffic had a red light. It was at this time that the bike entered the road in front of OP 1. It should be noted that when eastbound traffic has a red light, westbound traffic has a green light, meaning that op 1 had a green light |
| 51 | US-7 | 4.14 | 9/29/2013 | 0:11 |  | 0 | 0 |  | A vehicle read-end his car as he was stopped at the red light heading onto Riverside Ave from the Winooski Bridge. |
| 52 | US-7 | 4.14 | 10/30/2013 | 18:46 |  | 0 | 0 |  | OP 1 rear ended v2 on Riverside near Colchester Ave. Was traveling eastbound on Riverside and began to have a coughing fit. Op 2 was stopped at a red light in the outer lane of eastbound traffic on Riverside. |

| Crash # | Road | Marker | Date | Time | Weather | Injuries | Fatalities | Type | Description |
|---|---|---|---|---|---|---|---|---|---|
| 53 | US-7 | 4.14 | 11/4/2013 | 12:04 | Clear | 0 | 0 | No Turns, Thru moves only, Broadside ^< | OP 1 had been following the truck traveling north on Riverside Avenue and had gone through the green light at Barrett. She was following the truck through the next intersection. She stated the truck was traveling slow through the intersection and she saw the light turn red while she was in the middle of the intersection. OP 2 was on Mill St, facing west and was stopped at the red light. Stated the light turned green and the semi went by, he pulled into the intersection. |
| 54 | US-7 | 4.14 | 12/12/2013 | 8:50 | Clear | 0 | 0 | Rear End | OP 1 was traveling west on the Bridge. Traffic was stopped at the signal at the intersection of Colchester and Riverside. Said became distracted and did not see the vehicle in front stopped. OP 2 was west on the bridge. Was stationary at a full stop behind five other vehicles. |
| 55 | US-7 | 4.14 | 7/12/2014 | 19:41 | Clear | 0 | 0 | Rear End | V2 in right lane, stopped for red light facing south on Bridge (Colchester Ave) preparing to turn onto Riverside Ave. V1 was stopped directly behind V2. Op 1 advised the light turned green and he took his foot off the brakes and began to creep forward. Turned his head to look at the mill when he stuck 2. Did not realized that op 2 had not started to move. |

# APPENDIX G

## High Crash Location List

Vermont Agency of Transportation

# Statewide Intersections - Route Log Order /2 - Statewide

Years: 2010 - 2014

| H.C.L No. | /3. Route | System | Town | Mileage | ADT | Years | Crashes | Fatalities | Injuries | PDO Crashes | Critical Rate | Actual Rate | Ratio Actual/Critical | Severity Index ($/Accident/1.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22 | COLCHESTER AVE., BURLINGTON, BARRETT ST., BURLINGTON | Minor Arterial (u)/Urban Collector (u) | Burlington | 0.990 - 1.010 | 7595 | 5 | 24 | 1 | 5 | 19 | 1.043 | 1.731 | 1.659 | $82,233 |
| 55 | STRONGS AVE., RUTLAND CITY, WASHINGTON ST., RUTLAND CITY | Principal Arterial (u)/Urban Collector (u) | Rutland City | 0.600 - 0.620 | 10610 | 5 | 25 | 0 | 11 | 17 | 0.979 | 1.291 | 1.318 | $40,768 |
| 16 | BATTERY ST., BURLINGTON, MAIN ST., BURLINGTON | Principal Arterial (u) | Burlington | 0.220 - 0.240 | 15300 | 5 | 52 | 0 | 11 | 42 | 1.041 | 1.862 | 1.788 | $23,879 |
| 4 | VT. 127 BELTLINE, BURLINGTON, <5009> | Freeway/Expressway (u) | Burlington | 1.340 - 1.500 | 5205 | 5 | 7 | 0 | 6 | 4 | 0.316 | 0.736 | 2.328 | $72,714 |
| 1 | VT. 127 BELTLINE, BURLINGTON, <5042> | Freeway/Expressway (u) | Burlington | 3.360 - 3.470 | 6573 | 5 | 10 | 0 | 11 | 5 | 0.298 | 0.833 | 2.797 | $91,240 |
| 28 | COLCHESTER AVE., BURLINGTON, EAST AVE., BURLINGTON | Minor Arterial (u) | Burlington | 0.430 - 0.450 | 17120 | 5 | 41 | 0 | 8 | 33 | 0.808 | 1.312 | 1.624 | $22,559 |
| 15 | MAIN ST., BURLINGTON, ST. PAUL ST., BURLINGTON | Principal Arterial (u)/Urban Collector (u) | Burlington | 0.250 - 0.270 | 10565 | 5 | 34 | 1 | 9 | 25 | 0.98 | 1.763 | 1.799 | $68,900 |
| 96 | NORTH AVE., BURLINGTON, PLATTSBURG AVE., BURLINGTON | Minor Arterial (u) | Burlington | 3.090 - 3.100 | 8700 | 5 | 16 | 0 | 3 | 13 | 0.923 | 1.007 | 1.091 | $22,025 |
| 7 | NORTH ST., BURLINGTON, N CHAMPLAIN ST., BURLINGTON | Principal Arterial (u)/Urban Collector (u) | Burlington | 0.220 - 0.240 | 6400 | 5 | 26 | 0 | 5 | 21 | 1.089 | 2.226 | 2.044 | $22,362 |
| 90 | N UNION ST., BURLINGTON, S UNION ST., BURLINGTON, <T0000> | Principal Arterial (u) | Burlington | 0.000 - 0.010 | 5435 | 5 | 14 | 0 | 3 | 11 | 1.278 | 1.411 | 1.104 | $23,900 |
| 27 | PARK ST., BURLINGTON, NORTH ST., BURLINGTON | Principal Arterial (u)/Urban Collector (u) | Burlington | 0.280 - 0.300 | 6135 | 5 | 20 | 0 | 4 | 16 | 1.099 | 1.786 | 1.625 | $22,900 |
| 100 | PARK ST., BURLINGTON, MANHATTAN DRIVE, BURLINGTON, VT. 127 BELTLINE, BURLINGTON | Freeway/Expressway (u)/Principal Arterial (u) | Burlington | 0.480 - 0.490 | 14235 | 5 | 39 | 0 | 7 | 33 | 1.385 | 1.501 | 1.084 | $21,692 |
| 41 | PEARL ST., BURLINGTON, <T0000>, S PROSPECT ST., BURLINGTON, COLCHESTER AVE., BURLINGTON | Minor Arterial (u)/Urban Collector (u) | Burlington | 0.930 - 0.940 | 20100 | 5 | 44 | 0 | 14 | 34 | 0.866 | 1.199 | 1.385 | $31,982 |
| 130 | W. ALLEN ST., WINOOSKI CITY, MALLETTS BAY AVE., WINOOSKI CITY, <T0000>, W. CENTER ST., WINOO | Minor Arterial (u)/Urban Collector (u) | Winooski City | 0.000 - 0.010 | 2925 | 5 | 7 | 0 | 0 | 7 | 1.303 | 1.311 | 1.006 | $8,900 |
| 32 | PATCHEN ROAD, SOUTH BURLINGTON, WHITE ST., SOUTH BURLINGTON | Urban Collector (u) | South Burlington | 0.080 - 0.100 | 12515 | 5 | 29 | 0 | 6 | 25 | 0.822 | 1.269 | 1.544 | $23,997 |
| 13 | SUSIE WILSON RD., ESSEX, KELLOGG ROAD, ESSEX | Urban Collector (u) | Essex | 0.480 - 0.500 | 19720 | 5 | 51 | 0 | 2 | 49 | 0.754 | 1.417 | 1.877 | $11,645 |
| 81 | VT. 127 TH, COLCHESTER, PORTER POINT RD., COLCHESTER | Minor Arterial (u)/Urban Collector (u) | Colchester | 0.860 - 0.940 | 12650 | 5 | 25 | 0 | 6 | 20 | 0.941 | 1.082 | 1.151 | $26,056 |
| 44 | VT. 127 TH, COLCHESTER, W. LAKESHORE DR., COLCHESTER | Minor Arterial (u) | Colchester | 2.170 - 2.230 | 9850 | 5 | 22 | 0 | 13 | 15 | 0.899 | 1.223 | 1.36 | $52,691 |
| 105 | VT. 127 TH, COLCHESTER, E. LAKESHORE DR., COLCHESTER | Minor Arterial (u)/Urban Collector (u) | Colchester | 3.170 - 3.250 | 13080 | 5 | 24 | 0 | 3 | 21 | 0.935 | 1.005 | 1.075 | $17,650 |

# APPENDIX H

## Natural Resources Study

Stantec

# Memo

| | | | |
|---|---|---|---|
| To: | Greg Edwards<br>South Burlington, VT | From: | Polly Harris<br>South Burlington, VT |
| File: | CCRPC Colchester/Riverside Scoping Project<br>195311163 | Date: | January 13, 2016 |

**Reference: CCRPC Colchester/Riverside Scoping Project**
**Natural Resources Review**

Stantec Consulting (Stantec) conducted a preliminary review of the natural resources present within the Chittenden County Regional Planning Commission (CCRPC) Colchester/Riverside Project area in Burlington, Vermont. Specifically, as part of this investigation, Stantec identified and characterized wetlands, streams, rare, threatened or endangered (RTE) species, wildlife habitat, agricultural land, 4(f) and 6(f) public lands, and hazardous waste sites. Following is a summary of the findings.

**General Site Description**

The CCRPC Colchester/Riverside Project area is located along Colchester Avenue, Riverside Avenue, Barrett Street, and Mill Street in Burlington, Vermont, just south of the Winooski River bridge crossing. The study area includes the intersections of these roads, and areas within the existing road rights-of-way (ROWs), as shown on the attached location figure. Development within the Project Area includes the roads as well as adjacent residential and commercial buildings. This Project Area has mixed vegetation, and includes areas of lawn and ornamental plantings near buildings, with an undeveloped embankment west of Riverside Avenue (see attached photos and Project Location figure). The Winooski River flows from east to west to the north and west of the Project area.

Natural resources were reviewed within the Project Area shown on the attached figure.

**Natural Resource Review Summary – Review of Existing Materials**

Stantec used the Vermont Agency of Natural Resources (ANR) Natural Resources Atlas mapping program[1] to evaluate known natural resources within the Project Area.

Wetlands and Streams. According to the ANR program, there are no Vermont Significant Wetland Inventory (VSWI) wetlands within the Project Area. As described above, the Winooski River flows from east to west to the north and west of the Project Area. The Winooski River has a floodway and Special Flood Hazard Area associated with it, located outside of the Project Area (see attached ANR SFHA Map). The Winooski River, in this vicinity, is considered impaired and stressed.

RTE Review. Several rare plant species and a rare habitat type are mapped along the Winooski River to the west of the Project Area. The plant species and habitat type are located near the river and not within the existing road right-of-way (ROW) or the Project Area (see attached RTE Map). In addition, several rare aquatic species are identified within the Winooski River, outside of the Project Area.

[1] http://anrmaps.vermont.gov/websites/anra/

**Reference: Natural Resources Review**

Agricultural and Hydric Soils. According to the *Natural Resource Conservation Service (NRCS) Web Soil Survey*[2] *for Chittenden County, Vermont*, the soils within the Project Area include Adams and Windsor loamy sands, 5-12% slopes and fill soils. The Adams/Windsor soils are considered Farmland of Statewide Importance (see attached Soil Map). However, no portions of the Project Area are currently in active agriculture, and any proposed improvements likely would be constructed within a narrow strip alongside the existing pavement within the road ROWs. The Farmland Policy Protection Act does not apply to projects within existing road ROWs. If any work is proposed outside of existing ROW, authorization from the NRCS via form CPA-106, the Farmland Conversion Impact Rating form for Corridor Type Projects, may be required.

None of the soil types within the Project Area is considered hydric.

Public Lands. The Project Area does not include public recreation lands (a Section 4(f) resource) or public lands developed with Land and Water Conservation Funds (a Section 6(f) resource). However, adjacent to the Project Area is a conserved parcel owned by the Winooski Valley Park District. According to signage at the park, the area was donated by Green Mountain Power.

Hazardous Waste Sites. The ANR Database was reviewed for information on Hazardous Waste Sites in the project vicinity. No active Hazardous Waste Sites or Hazardous Waste Generators are located within the Project Area. Two Hazardous sites are located nearby, as shown on the Hazardous Waste Sites Figure.

- Green Mountain Power Chase Mill site (Site #972325): In 1997, contaminated soils and transformers were removed from the site, with no residual contamination identified. In 1999, the Vermont DEC Waste Management Division Site Management Section made a determination of Site Management Activities Completed (SMAC) with no further work required.

- Vermont Gas Systems, Inc. Property on Riverside Avenue (Site #20053456). In 2005, an above ground storage tank had a spill. Contaminated soils were removed, and in 2006 the Vermont DEC Waste Management Division Site Management Section determined that the site is eligible for SMAC designation with no further work required.

R.M.H. Associates in Print is identified as a Hazardous Waste Generator in the Chase Mill on Mill Street, outside of the Project Area.

**Natural Resource Review Summary – Site Investigation**

Stantec conducted a site visit on January 13, 2016 to evaluate natural resources present within the Project Area. Natural resources are limited due to the extent of development within the Project Area.

[2] Natural Resource Conservation Service Web Soil Survey: http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx. Refer to map for Chittenden County, Vermont. Accessed on January 13, 2016.

Wetlands/Streams. Based on the site investigation, no wetlands under state or federal jurisdiction were identified within the Project Area. Wetland boundaries, if present, would be based on the technical criteria described in the 2012 Regional Supplement to the Corps of Engineers *Wetland Delineation Manual: Northcentral and Northeast Region (Version 2.0)*.

The Winooski River flows from east to west outside of the Project Area.

RTE Species. Stantec identified no RTE species during the January 13, 2016 site visit. Although the site visit was conducted during the winter, based on the Project Area location, the habitat types present, and the degree of disturbance, it is possible but unlikely that any RTE plant or animal species occur within the narrow undeveloped portions of the Project Area.

Wildlife Habitat. The Project Area provides habitat for various wildlife species common to Vermont's urban areas such as black-capped chickadee (*Poecile atricapillus*), American crow (*Corvus brachyrhynchos*), blue jay (*Cyanocitta cristata*), eastern grey squirrel (*Sciurus carolinensis* ), as well as other species that may travel through the area. The proximity to busy roads and limited habitat restricts the Project Area's wildlife habitat.

**Summary**

In summary, no wetlands, streams, RTE species, 4(f) and 6(f) public lands, or hazardous waste sites were identified within the Project Area. As noted above and shown on the attached maps, the Winooski River is located outside of the Project Area but nearby, and RTE species are associated with the river and the adjacent habitat. In addition, the Project Area includes Farmland of Statewide Importance. Any impacts to these soils outside of existing ROW may require coordination with the NRCS via form CPA-106, the Farmland Conversion Impact Rating form for Corridor Type Projects.

**STANTEC CONSULTING SERVICES INC.**

Polly Harris
Environmental Project Manager
Phone: (802) 497-6407
Fax: (802) 864-0165
Polly.Harris@stantec.com

Attachments: Photos, ANR Mapping

**Reference: Natural Resources Review**

**CCRPC Colchester/Riverside Project Area Photographs**

**Photo 1**. View to south of Colchester Ave and Riverside Ave with homes, lawns, and occasional plantings visible. 1/11/16

**Photo 2**. View to west of Barrett Street with lawn and street trees visible. 1/13/16

**Reference: Natural Resources Review**

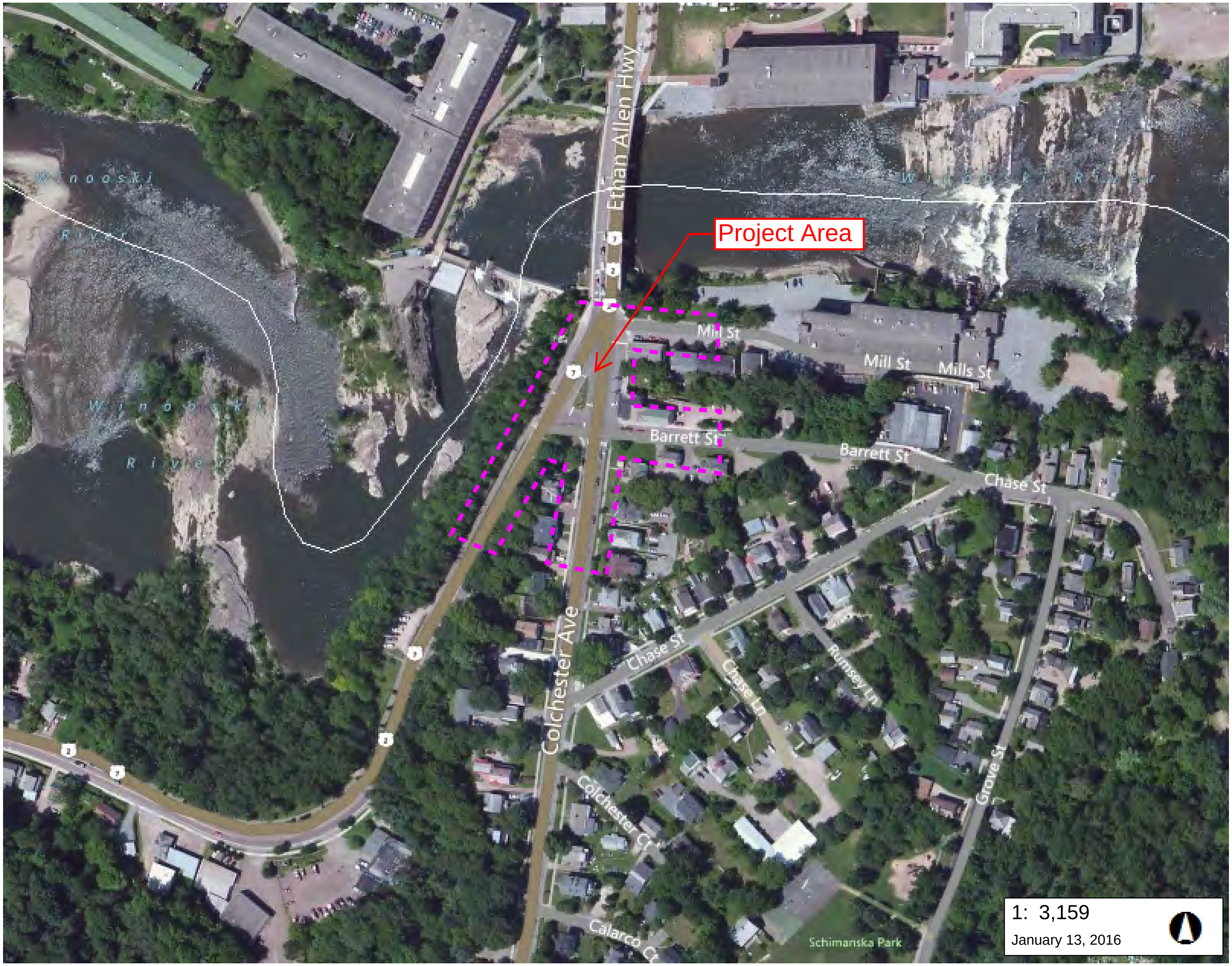
**Photo 3**. View to south along Riverside Ave. Land slopes down sharply toward the Winooski River to right. 1/11/16

**Photo 4**. View to SW of Winooski River near the Project Area. 1/13/16

# Colchester Riverside Project Area

Vermont Agency of Natural Resources

vermont.gov





## LEGEND

Town Boundary

1: 3,159

January 13, 2016

160.0 0 80.00 160.0 Meters

WGS_1984_Web_Mercator_Auxiliary_Sphere

1" = 263 Ft. 1cm = 32 Meters



THIS MAP IS NOT TO BE USED FOR NAVIGATION

DISCLAIMER: This map is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. ANR and the State of Vermont make no representations of any kind, including but not limited to, the warranties of merchantability, or fitness for a particular use, nor are any such warranties to be implied with respect to the data on this map.

## NOTES

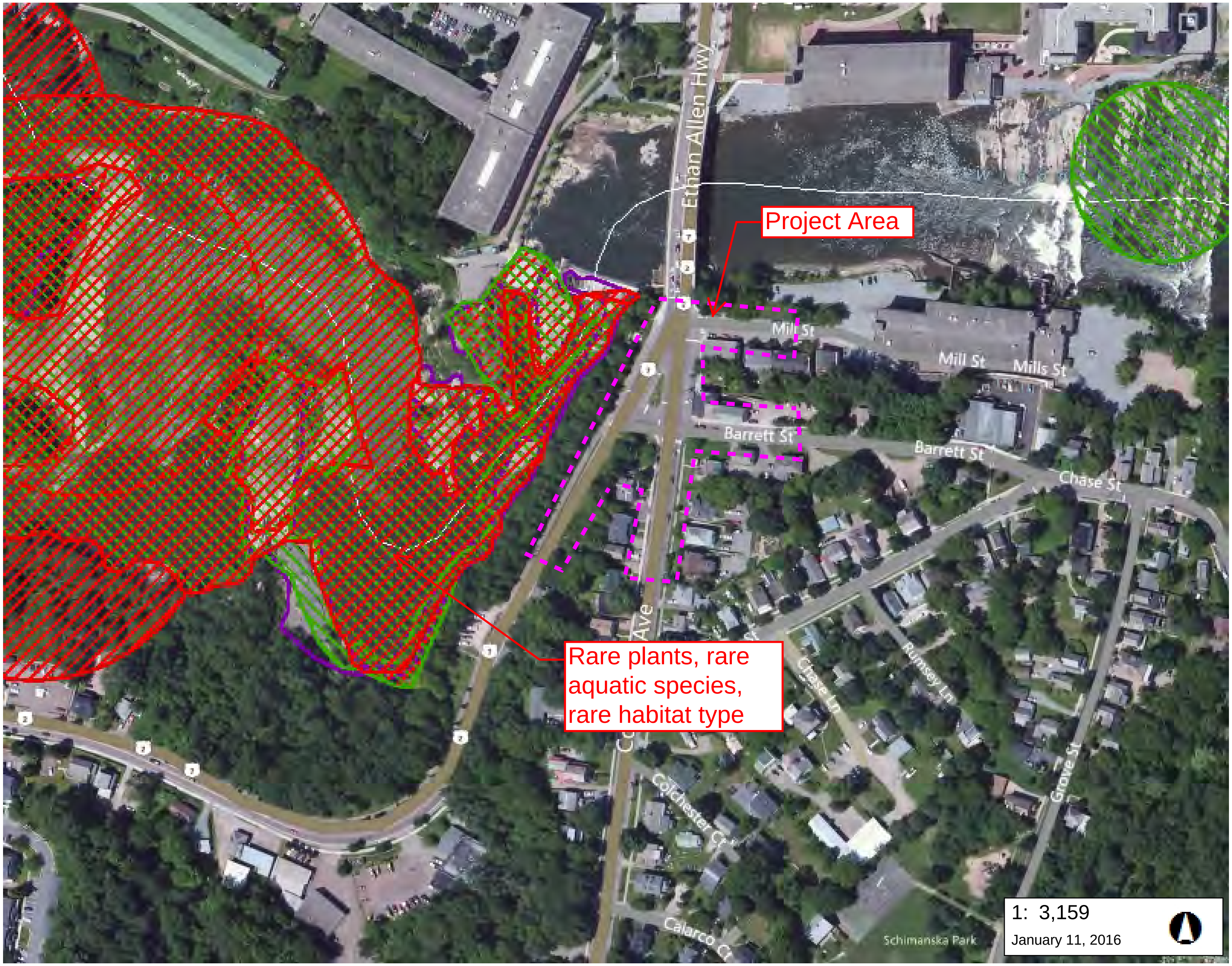
Map created using ANR's Natural Resources Atlas

# Colchester-Riverside RTE

Vermont Agency of Natural Resources

VERMONT

vermont.gov





## LEGEND

Rare Threatened Endangered

- Threatened or Endangered
- Rare

Significant Natural Community

Town Boundary

1: 3,159

January 11, 2016

160.0 0 80.00 160.0 Meters

WGS_1984_Web_Mercator_Auxiliary_Sphere

1" = 263 Ft. 1cm = 32 Meters



THIS MAP IS NOT TO BE USED FOR NAVIGATION

DISCLAIMER: This map is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. ANR and the State of Vermont make no representations of any kind, including but not limited to, the warranties of merchantability, or fitness for a particular use, nor are any such warranties to be implied with respect to the data on this map.

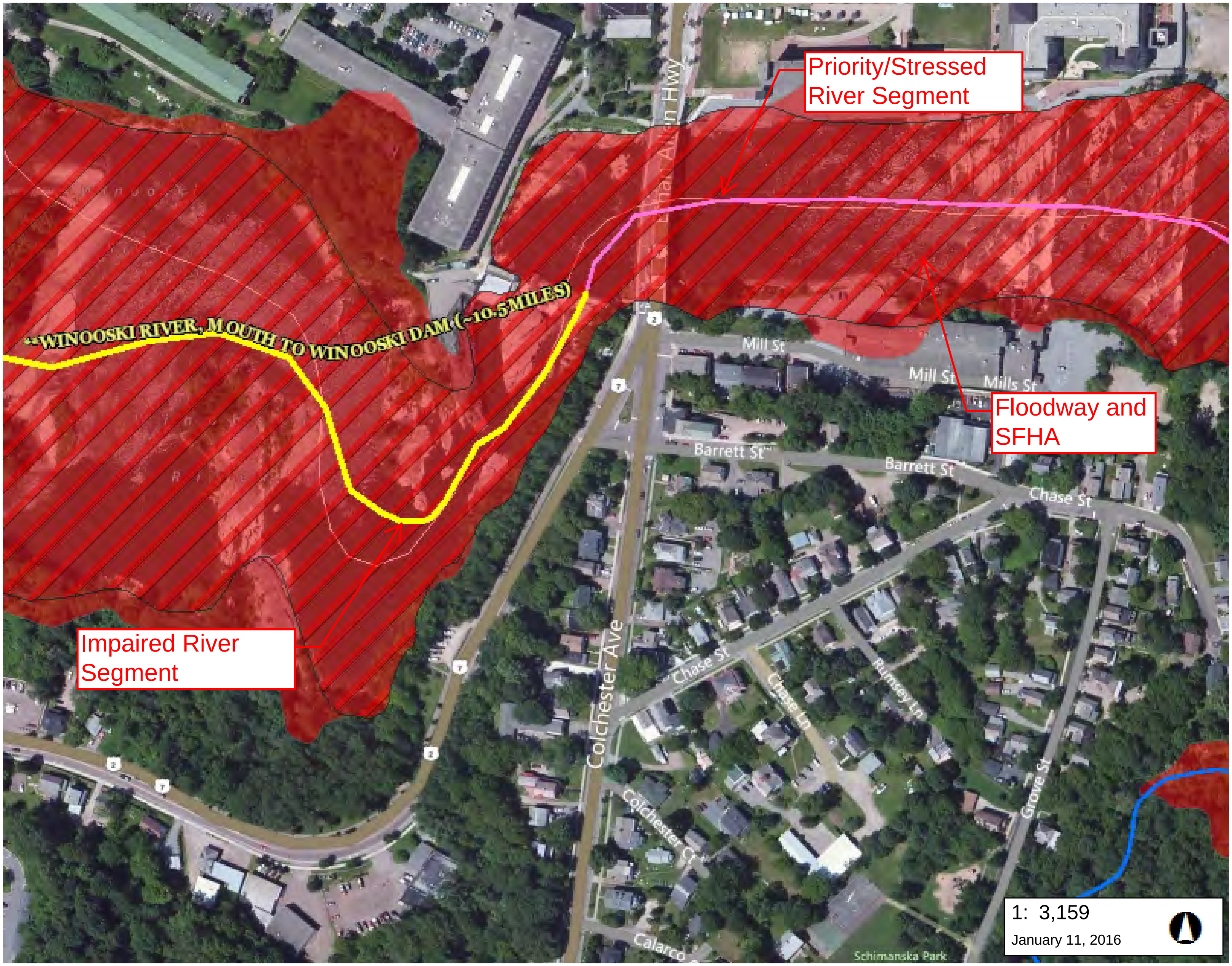
## NOTES

Map created using ANR's Natural Resources Atlas

# Colchester-Riverside River/Flood Info

Vermont Agency of Natural Resources

vermont.gov





## LEGEND

- 303(d) List of Impaired Stream
- VT List of Priority Streams and
  - Part B (impaired TMDL not required
  - Part D (impaired with approved TM
  - Part E (altered exotic species)
  - Part F (altered flow regulation)
- Wetlands - VSWI
  - Class 1 Wetland
  - Class 2 Wetland
- Wetlands Advisory Layer
- DFIRM Floodways
- Special Flood Hazard Areas (A Counties)
  - AE (1-percent annual chance flood
  - A (1-percent annual chance floodpl
  - AO (1-percent annual chance zone feet)
  - 0.2-percent annual chance flood ha
- Town Boundary

160.0 0 80.00 160.0 Meters

WGS_1984_Web_Mercator_Auxiliary_Sphere 1" = 263 Ft. 1cm = 32 Meters



THIS MAP IS NOT TO BE USED FOR NAVIGATION



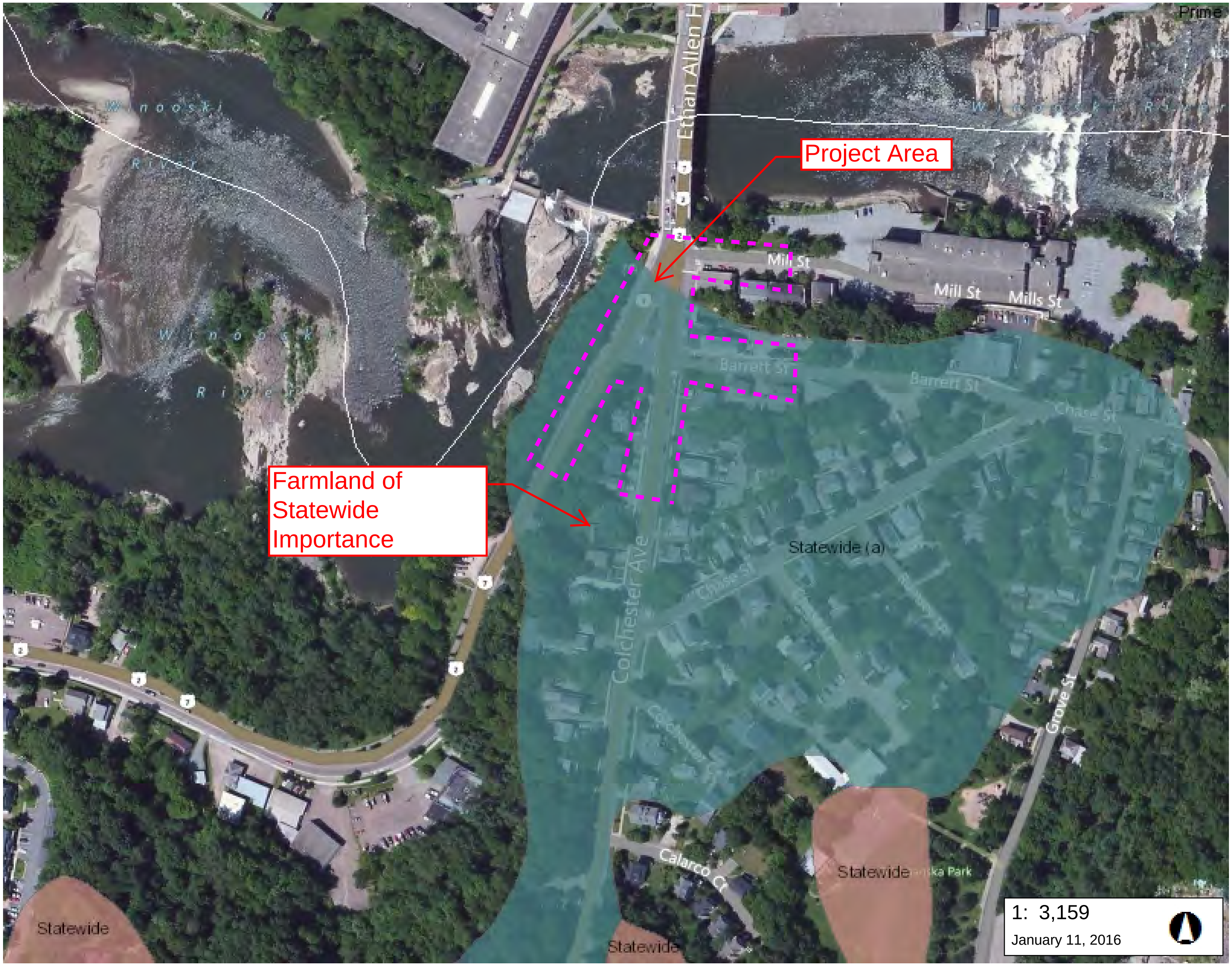
## NOTES

Map created using ANR's Natural Resources Atlas

# Colchester-Riverside Ag Soil Info

Vermont Agency of Natural Resources

vermont.gov





## LEGEND

Wetlands - VSWI
- Class 1 Wetland
- Class 2 Wetland

Wetlands Advisory Layer

Soils - Prime Agricultural
- Local
- Local (b)
- Not rated
- Prime
- Prime (b)
- Prime (f)
- Statewide
- Statewide (a)
- Statewide (b)
- Statewide (c)

Town Boundary

1: 3,159

January 11, 2016

160.0 0 80.00 160.0 Meters

WGS_1984_Web_Mercator_Auxiliary_Sphere

1" = 263 Ft. 1cm = 32 Meters



THIS MAP IS NOT TO BE USED FOR NAVIGATION



## NOTES

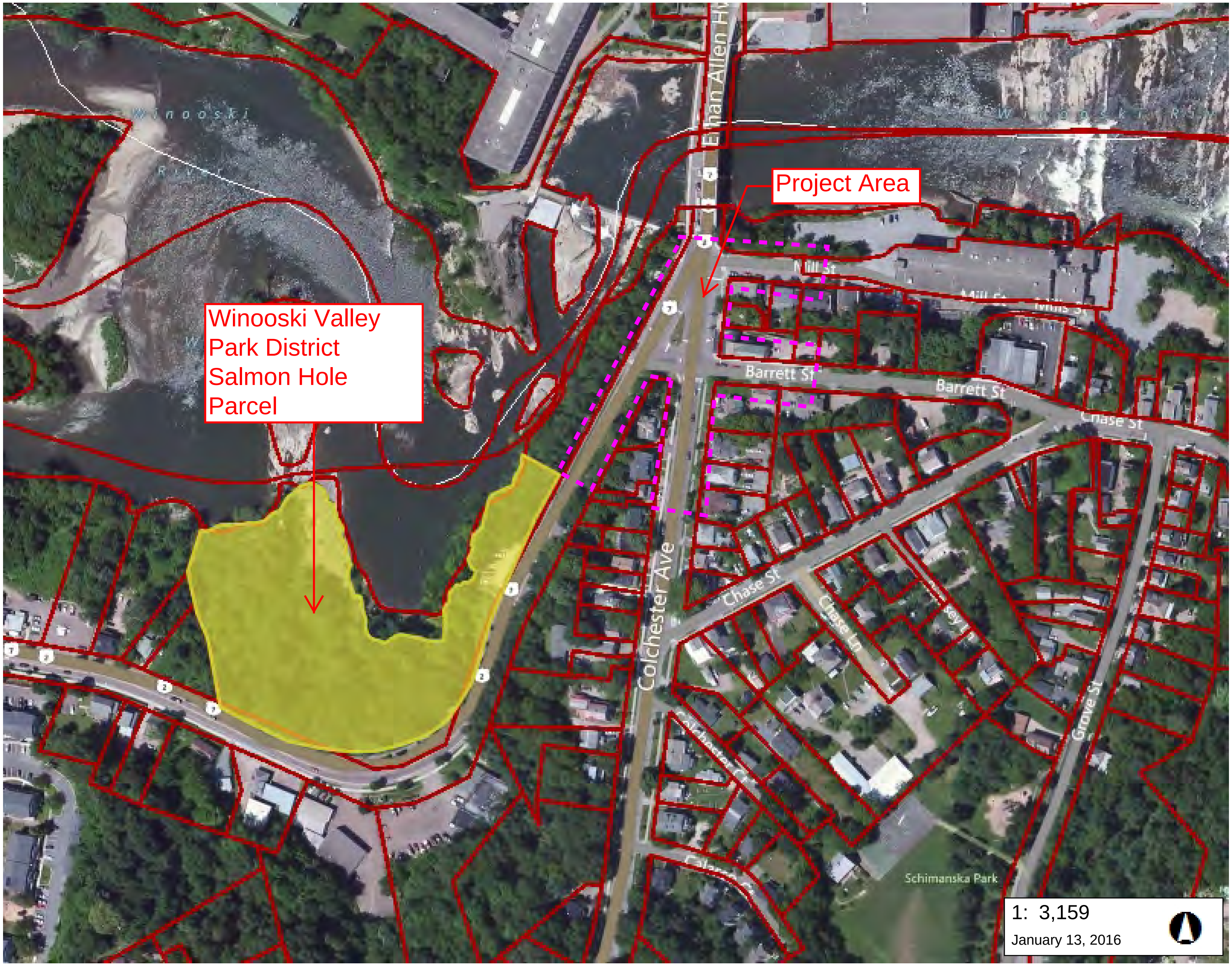
Map created using ANR's Natural Resources Atlas

VERMONT

# Colchester Riverside Conserved Lands

Vermont Agency of Natural Resources

vermont.gov





## LEGEND

**Sites**

- Boat Launch
- Campgound
- Cartop Boat Launch
- Day Use Area
- Interpretive Site
- Lookout Tower
- Nature Center
- Park Office
- Parking (summer)
- Parking (winter)
- Parking (year-round)
- Recreation Site
- Rock Climbing
- Shooting Range
- Swimming Area
- Trail Shelter
- Trailhead
- Vista

Use Value Appraisal Parcels

State Natural Areas

**Fragile Areas Registry**

- Physical Feature
- Biological Feature
- Physical and Biological Features

Ski Area Leases

Managed Lands

## NOTES

Map created using ANR's Natural Resources Atlas

160.0 0 80.00 160.0 Meters

WGS_1984_Web_Mercator_Auxiliary_Sphere 1" = 263 Ft. 1cm = 32 Meters



THIS MAP IS NOT TO BE USED FOR NAVIGATION

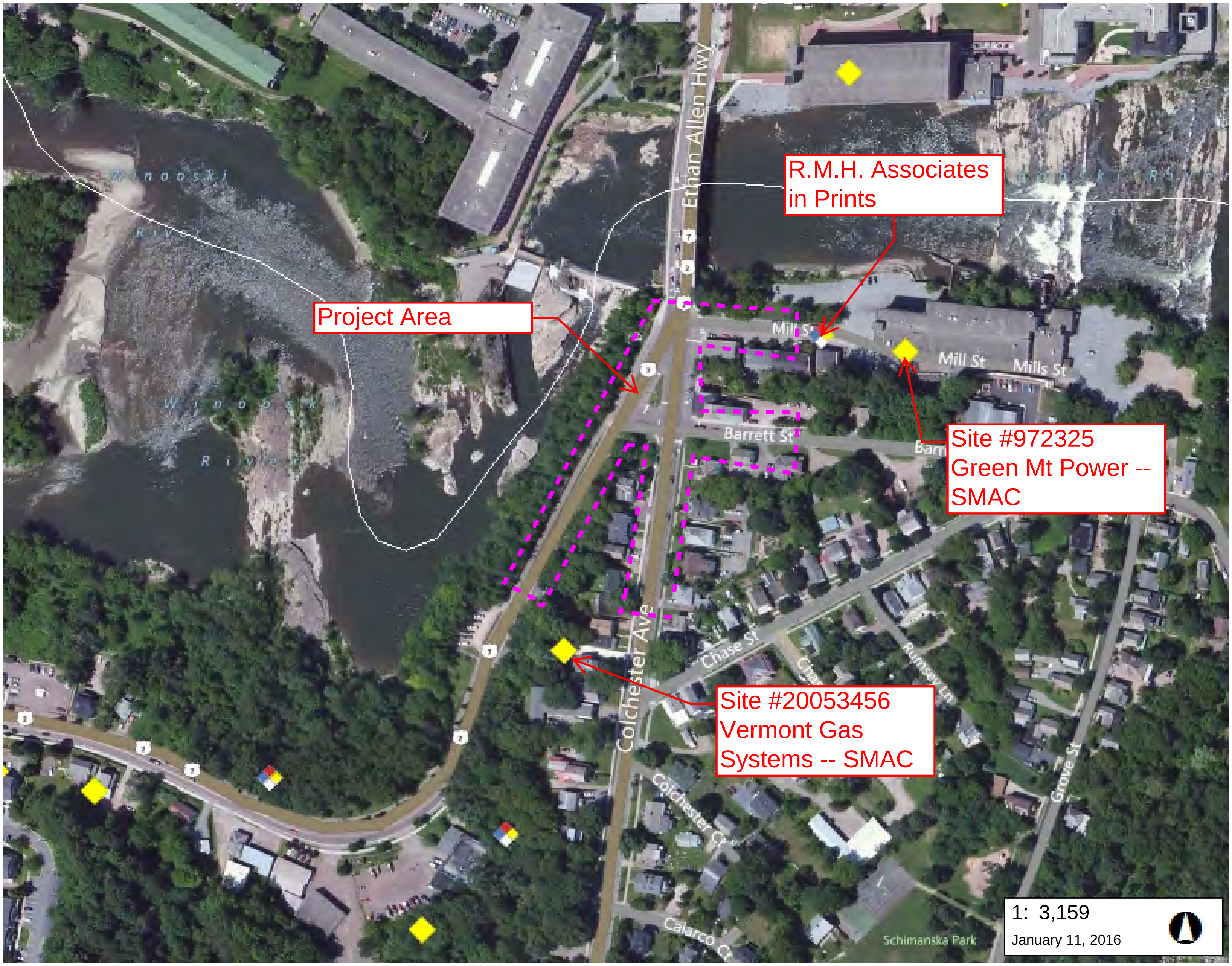
DISCLAIMER: This map is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. ANR and the State of Vermont make no representations of any kind, including but not limited to, the warranties of merchantability, or fitness for a particular use, nor are any such warranties to be implied with respect to the data on this map.

VERMONT

# Colchester-Riverside Hazardous Waste Sites

Vermont Agency of Natural Resources

vermont.gov





LEGEND

- Hazardous Site
- Hazardous Waste Generators
- Town Boundary

NOTES

Map created using ANR's Natural Resources Atlas

160.0 0 80.00 160.0 Meters

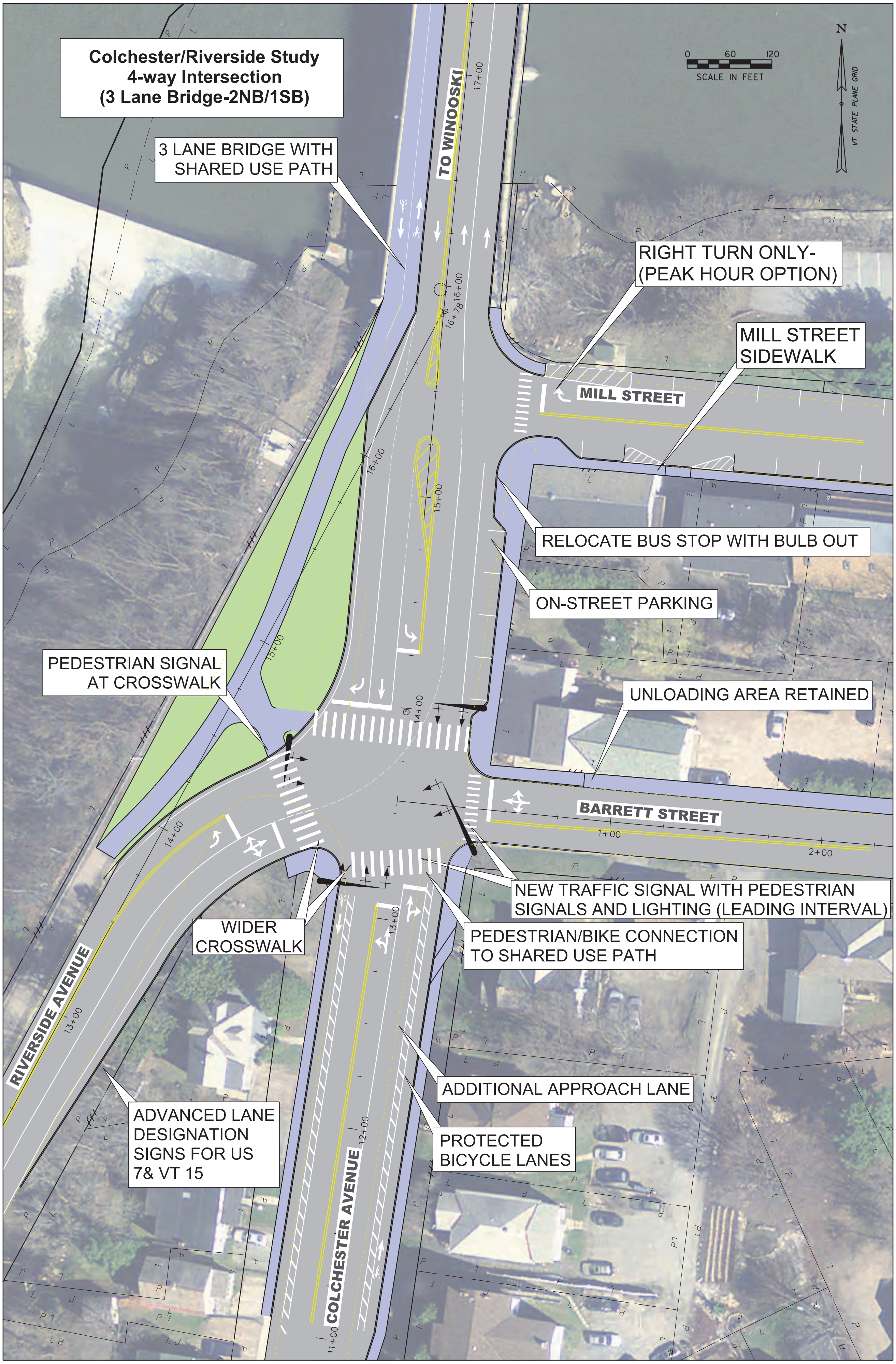
WGS_1984_Web_Mercator_Auxiliary_Sphere 1" = 263 Ft. 1cm = 32 Meters



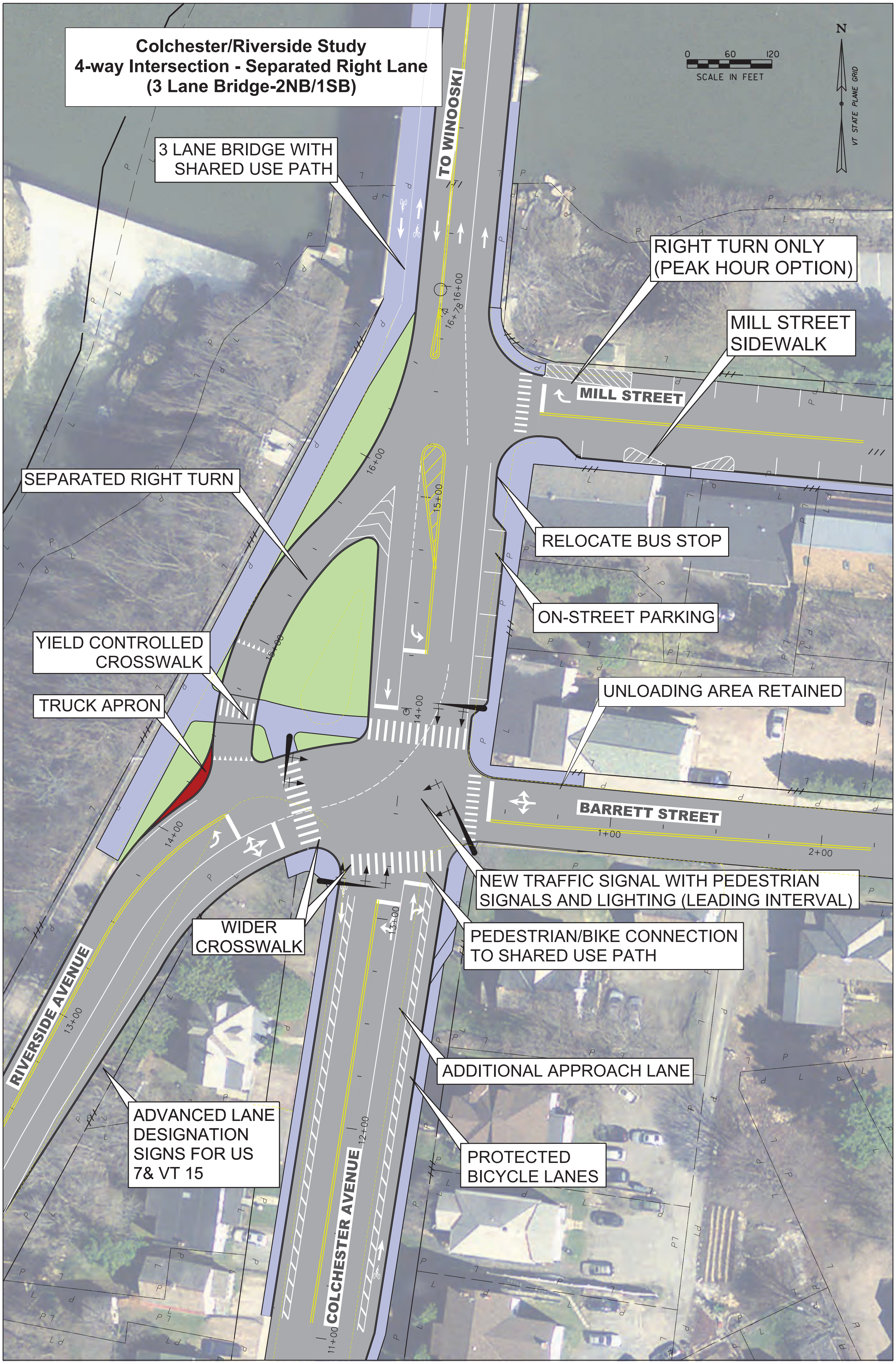
THIS MAP IS NOT TO BE USED FOR NAVIGATION

# APPENDIX I

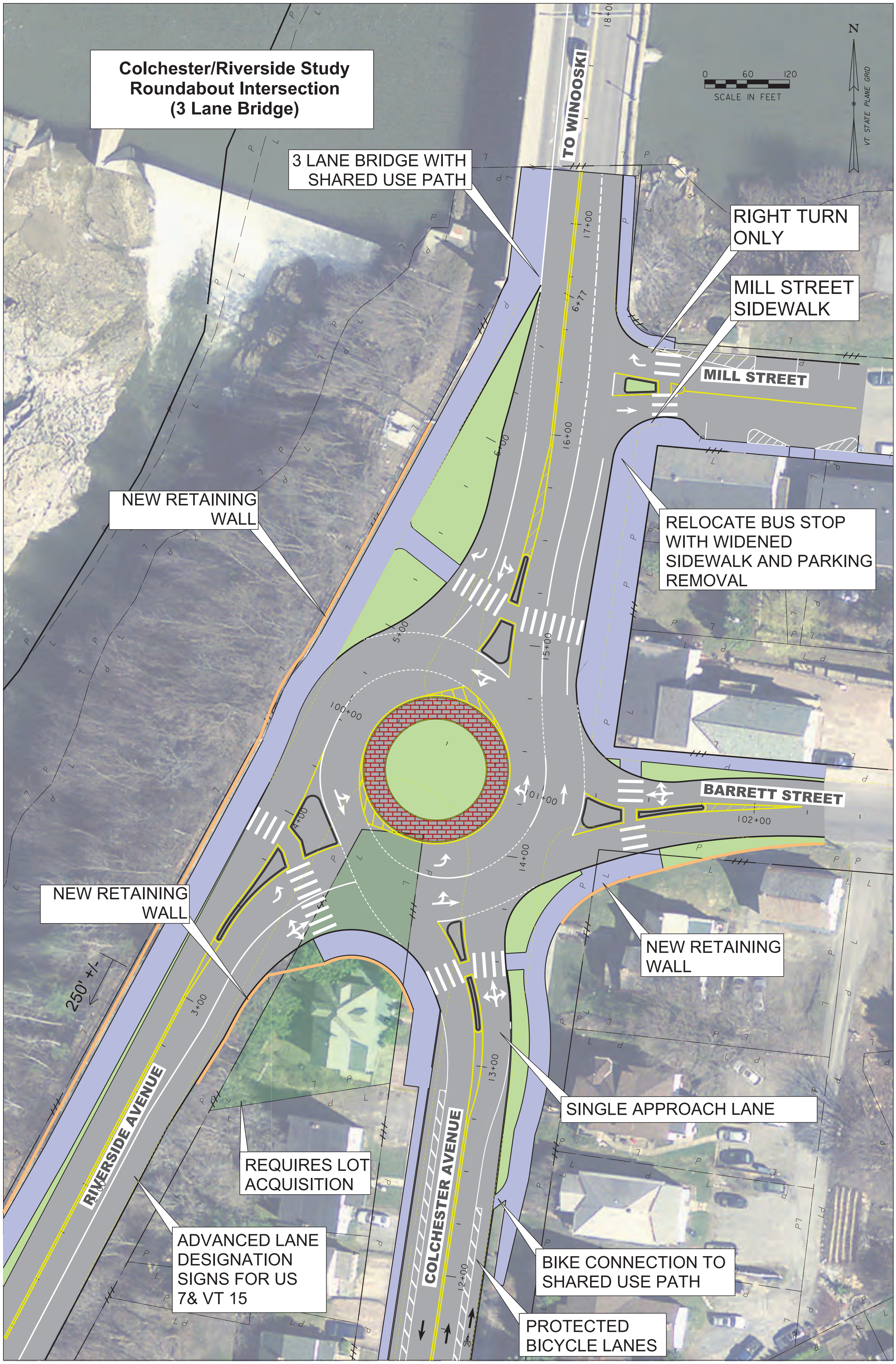
## Alternative Concepts



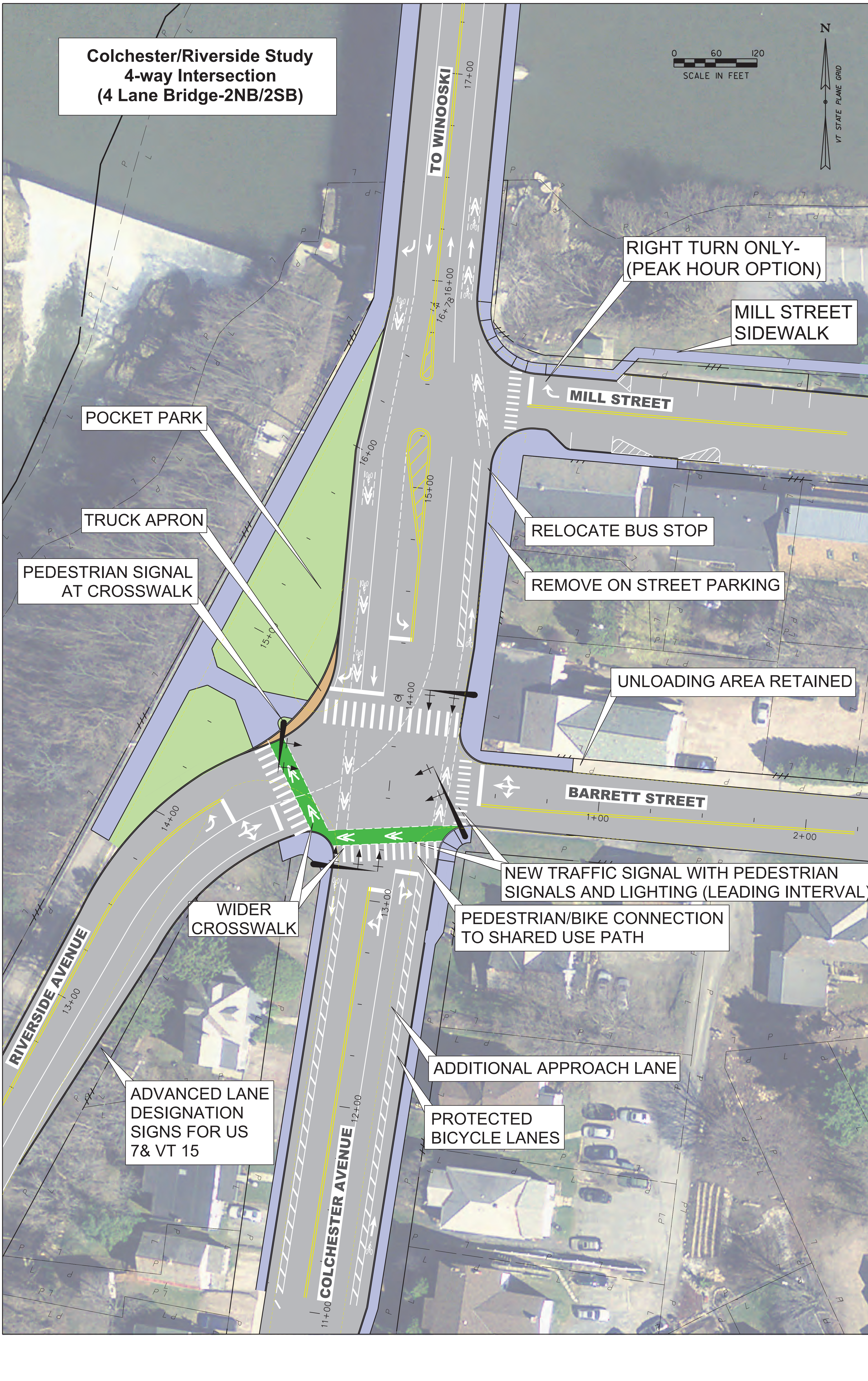
Colchester/Riverside Study
4-way Intersection
(3 Lane Bridge-2NB/1SB)
0 60 120
SCALE IN FEET
N
VT STATE PLANE GRID
TO WINOOSKI
3 LANE BRIDGE WITH SHARED USE PATH
RIGHT TURN ONLY- (PEAK HOUR OPTION)
MILL STREET SIDEWALK
MILL STREET
RELOCATE BUS STOP WITH BULB OUT
ON-STREET PARKING
PEDESTRIAN SIGNAL AT CROSSWALK
UNLOADING AREA RETAINED
BARRETT STREET
NEW TRAFFIC SIGNAL WITH PEDESTRIAN SIGNALS AND LIGHTING (LEADING INTERVAL)
WIDER CROSSWALK
PEDESTRIAN/BIKE CONNECTION TO SHARED USE PATH
RIVERSIDE AVENUE
ADDITIONAL APPROACH LANE
PROTECTED BICYCLE LANES
ADVANCED LANE DESIGNATION SIGNS FOR US 7& VT 15
COLCHESTER AVENUE



Colchester/Riverside Study
4-way Intersection - Separated Right Lane
(3 Lane Bridge-2NB/1SB)
0 60 120
SCALE IN FEET
N
VT STATE PLANE GRID
TO WINOOSKI
3 LANE BRIDGE WITH SHARED USE PATH
RIGHT TURN ONLY (PEAK HOUR OPTION)
MILL STREET SIDEWALK
MILL STREET
SEPARATED RIGHT TURN
RELOCATE BUS STOP
ON-STREET PARKING
YIELD CONTROLLED CROSSWALK
TRUCK APRON
UNLOADING AREA RETAINED
BARRETT STREET
NEW TRAFFIC SIGNAL WITH PEDESTRIAN SIGNALS AND LIGHTING (LEADING INTERVAL)
WIDER CROSSWALK
PEDESTRIAN/BIKE CONNECTION TO SHARED USE PATH
RIVERSIDE AVENUE
ADDITIONAL APPROACH LANE
ADVANCED LANE DESIGNATION SIGNS FOR US 7& VT 15
PROTECTED BICYCLE LANES
COLCHESTER AVENUE

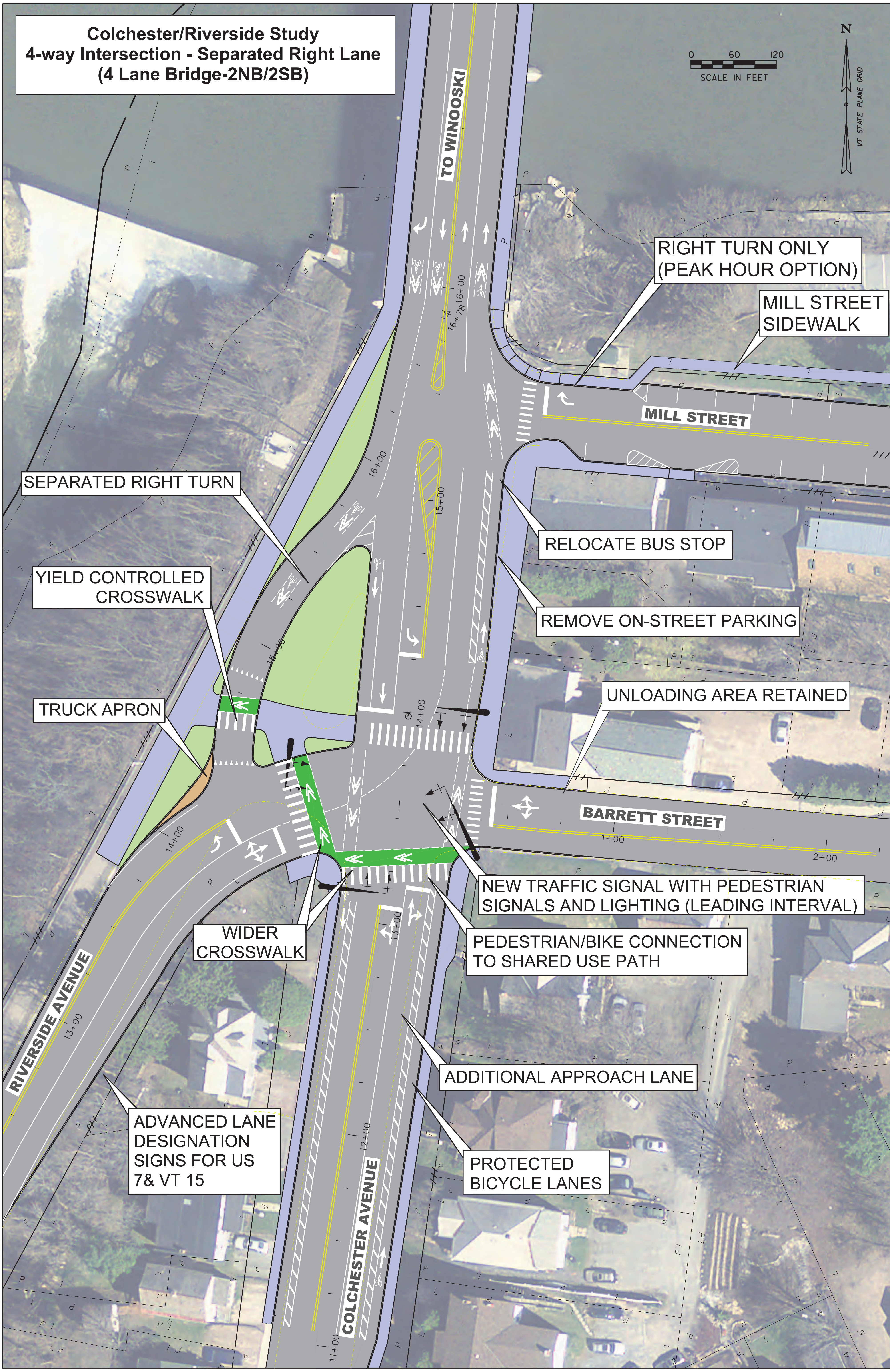


Colchester/Riverside Study
Roundabout Intersection
(3 Lane Bridge)
0 60 120
SCALE IN FEET
N
VT STATE PLANE GRID
TO WINOOSKI
3 LANE BRIDGE WITH SHARED USE PATH
RIGHT TURN ONLY
MILL STREET SIDEWALK
MILL STREET
RELOCATE BUS STOP WITH WIDENED SIDEWALK AND PARKING REMOVAL
NEW RETAINING WALL
BARRETT STREET
NEW RETAINING WALL
NEW RETAINING WALL
250' +/-
SINGLE APPROACH LANE
REQUIRES LOT ACQUISITION
RIVERSIDE AVENUE
COLCHESTER AVENUE
ADVANCED LANE DESIGNATION SIGNS FOR US 7& VT 15
BIKE CONNECTION TO SHARED USE PATH
PROTECTED BICYCLE LANES

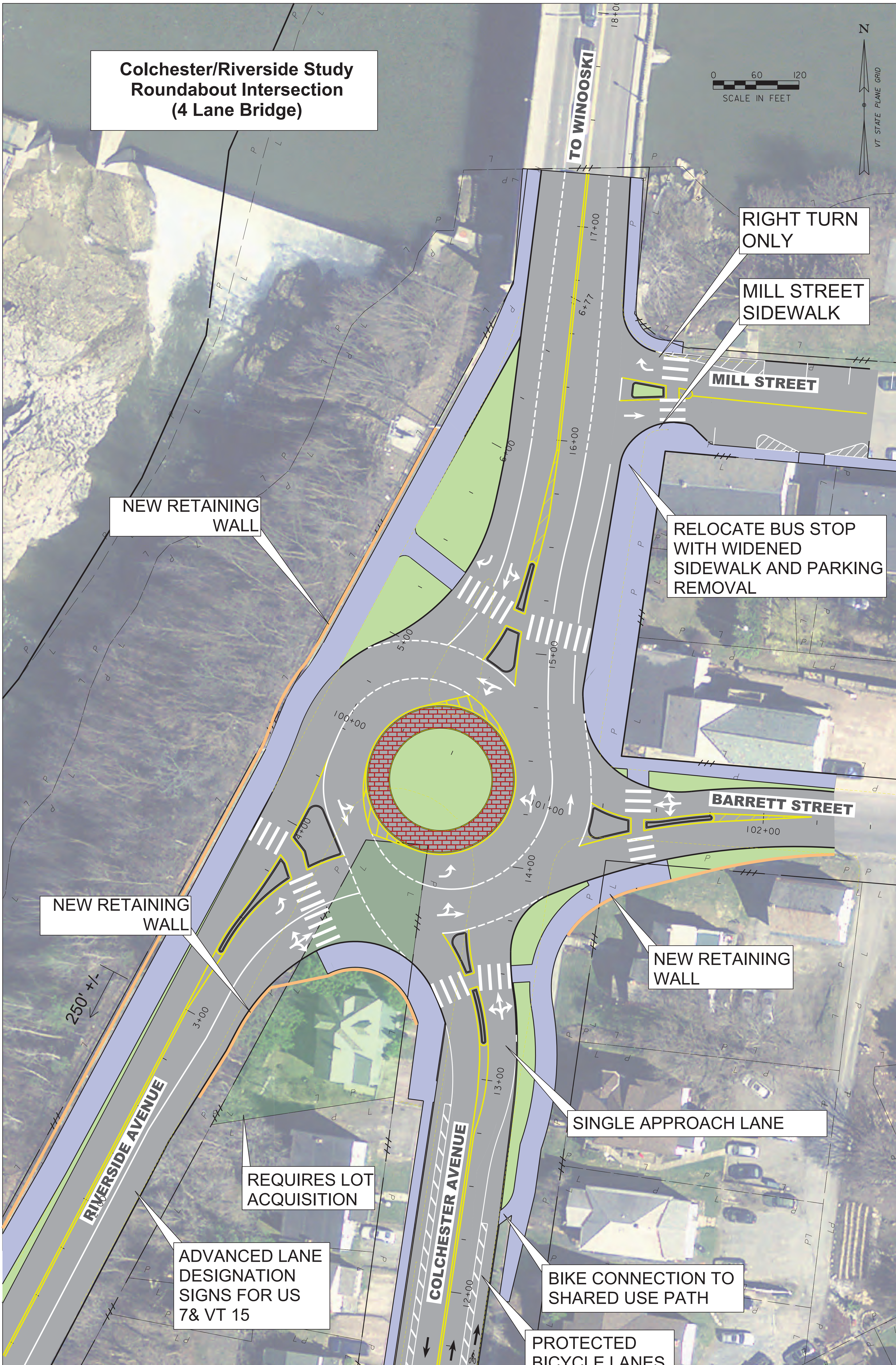


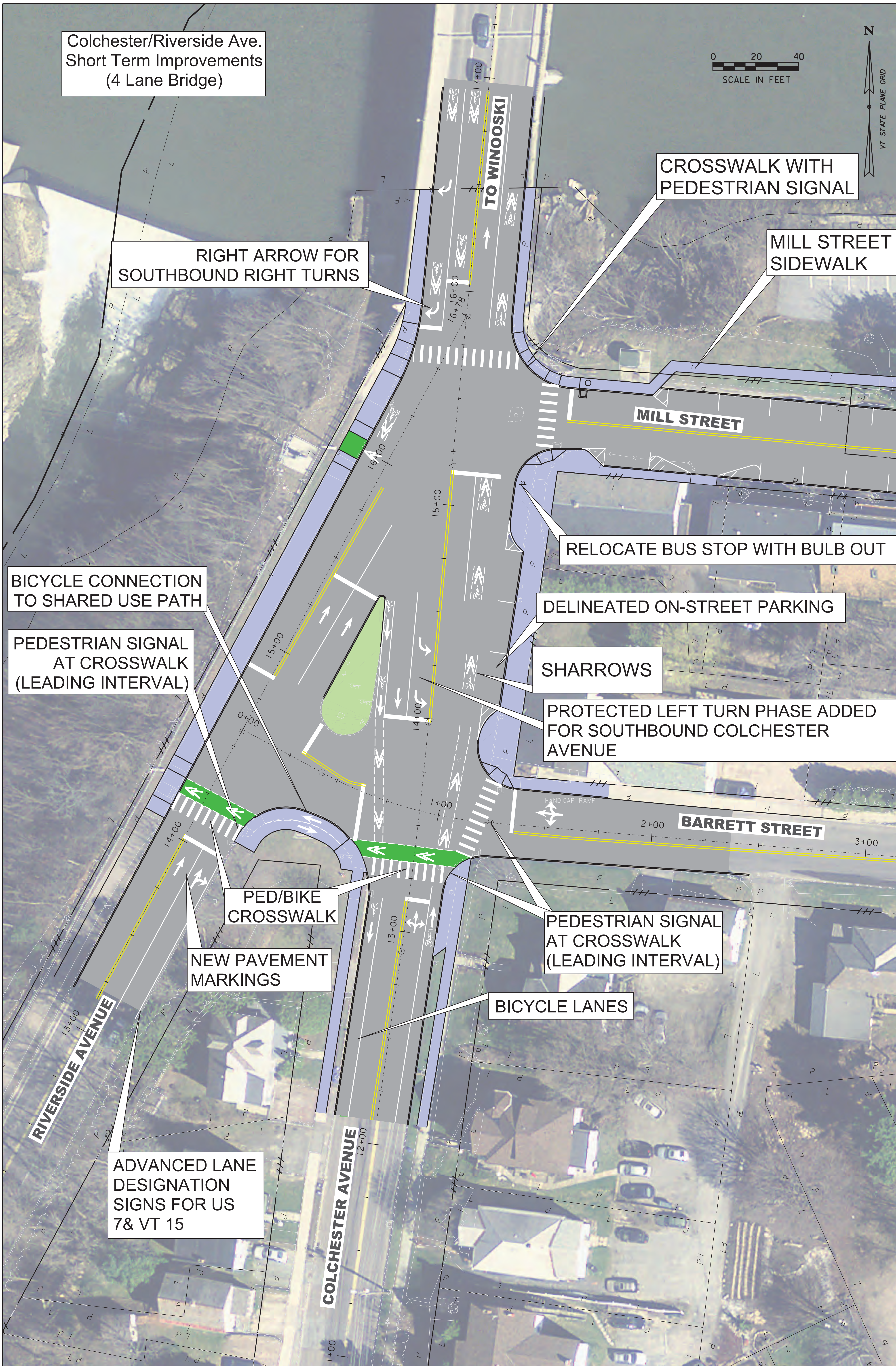
Colchester/Riverside Study
4-way Intersection
(4 Lane Bridge-2NB/2SB)
0 60 120
SCALE IN FEET
N
VT STATE PLANE GRID
TO WINOOSKI
RIGHT TURN ONLY-
(PEAK HOUR OPTION)
MILL STREET
SIDEWALK
MILL STREET
POCKET PARK
TRUCK APRON
PEDESTRIAN SIGNAL
AT CROSSWALK
RELOCATE BUS STOP
REMOVE ON STREET PARKING
UNLOADING AREA RETAINED
BARRETT STREET
NEW TRAFFIC SIGNAL WITH PEDESTRIAN
SIGNALS AND LIGHTING (LEADING INTERVAL)
PEDESTRIAN/BIKE CONNECTION
TO SHARED USE PATH
WIDER
CROSSWALK
ADDITIONAL APPROACH LANE
PROTECTED
BICYCLE LANES
ADVANCED LANE
DESIGNATION
SIGNS FOR US
7& VT 15
RIVERSIDE AVENUE
COLCHESTER AVENUE

# Colchester/Riverside Study
## 4-way Intersection - Separated Right Lane
## (4 Lane Bridge-2NB/2SB)



## Colchester/Riverside Study Roundabout Intersection (4 Lane Bridge)




Colchester/Riverside Ave.
Short Term Improvements
(4 Lane Bridge)
0 20 40
SCALE IN FEET
N
VT STATE PLANE GRID
TO WINOOSKI
CROSSWALK WITH
PEDESTRIAN SIGNAL
MILL STREET
SIDEWALK
RIGHT ARROW FOR
SOUTHBOUND RIGHT TURNS
MILL STREET
RELOCATE BUS STOP WITH BULB OUT
BICYCLE CONNECTION
TO SHARED USE PATH
DELINEATED ON-STREET PARKING
PEDESTRIAN SIGNAL
AT CROSSWALK
(LEADING INTERVAL)
SHARROWS
PROTECTED LEFT TURN PHASE ADDED
FOR SOUTHBOUND COLCHESTER
AVENUE
BARRETT STREET
PED/BIKE
CROSSWALK
PEDESTRIAN SIGNAL
AT CROSSWALK
(LEADING INTERVAL)
NEW PAVEMENT
MARKINGS
BICYCLE LANES
RIVERSIDE AVENUE
COLCHESTER AVENUE
ADVANCED LANE
DESIGNATION
SIGNS FOR US
7& VT 15

# APPENDIX J

## Crash Analysis - Potential Cost Savings

## Existing Conditions

| Location | Item | Value | Units |
|---|---|---|---|
| Barrett/Colchester | Entering Volumes (2016 PM DHV) | | |
| | NB Col Ave | 688 | |
| | SB Col Ave | 384 | |
| | EB Barrett | 83 | |
| | WB Barrett | 290 | |
| | Total | 1445 | |
| | PM DHV as % of AADT (K-Factor) | 10.4% | |
| | AADT | 13894 | |
| | Annual Entering Volume | 5071394 | |
| | Crash Study Period | 3 | Years |
| | Study Period Entering Volume | 15.2 | MEV |
| | Number of Crashes | 18 | during period |
| | Crash Rate | 1.18 | Crashes/MEV |
| | Crashes/Year | 6.00 | |
| | Cost per Crash | $ 82,233 | |
| | Annual Cost of Crashes | $ 493,400 | |
| | Project Lifespan | 20 | Years |
| | Discount Rate | 3% | Percent |
| | Present Value of Crashes | $7,340,546 | |
| Riverside/Barrett | Entering Volumes (2016 PM DHV) | | |
| | NB Riverside | 997 | |
| | SB Riverside | 724 | |
| | WB Barrett | 186 | |
| | Total | 1907 | |
| | PM DHV as % of AADT (K-Factor) | 10.4% | |
| | AADT | 18337 | |
| | Annual Entering Volume | 6692837 | |
| | Crash Study Period | 3 | Years |
| | Study Period Entering Volume | 20.1 | MEV |
| | Number of Crashes | 12 | |
| | Crash Rate | 0.60 | Crashes/MEV |
| | Crashes/Year | 4.00 | |
| | Cost per Crash | $ 29,303 | |
| | Annual Cost of Crashes | $ 117,212 | |
| | Project Lifespan | 20 | Years |
| | Discount Rate | 3% | Percent |
| | Present Value of Crashes | $1,743,819 | |
| Riverside/Mill/ Colchester | Entering Volumes (2016 PM DHV) | | |
| | NB Col Ave | 751 | |
| | SB Col Ave | 1088 | |
| | NEB Riverside | 914 | |
| | WB Mill | 78 | |
| | Total | 2831 | |
| | PM DHV as % of AADT (K-Factor) | 10.4% | |
| | AADT | 27221 | |
| | Annual Entering Volume | 9935721 | |
| | Crash Study Period | 3 | Years |
| | Study Period Entering Volume | 29.8 | MEV |
| | Number of Crashes | 25 | |
| | Crash Rate | 0.84 | Crashes/MEV |
| | Crashes/Year | 8.33 | |
| | Cost per Crash | $ 29,303 | |
| | Annual Cost of Crashes | $ 244,192 | |
| | Project Lifespan | 20 | Years |
| | Discount Rate | 3% | Percent |
| | Present Value of Crashes | $3,632,955 | |
| | Present Value - All Locations | $12,717,320 | |

## Alternative 1

| CMF's Other | CMF's Reconfig | Item | Value | Units |
|---|---|---|---|---|
| | | Entering Volumes (2016 PM DHV) | | |
| | | NB Col Ave | 688 | |
| | | SB Col Ave | 1108 | |
| | | EB Riverside | 997 | |
| | | WB Barrett | 290 | |
| | | Total | 3083 | |
| | | PM DHV as % of AADT (K-Factor) | 10.4% | |
| | | AADT | 29644 | |
| | | Annual Entering Volume | 10820144 | |
| | | Crash Study Period | 3 | Years |
| | | Study Period Entering Volume | 32.5 | MEV |
| Protected LT Phase | | Predicted Number of Crashes | 39.0 | during period |
| 0.94 | 1.08 | Crash Rate | 1.20 | Crashes/MEV |
| Eliminate one fatal | | Crashes/Year | 13.00 | |
| 0.33 | 1.02 | Cost per Crash | $ 27,680 | |
| | | Annual Cost of Crashes | $ 359,725 | |
| | | Project Lifespan | 20 | Years |
| | | Discount Rate | 3% | Percent |
| | | Present Value of Crashes | $5,351,799 | |
| | | Entering Volumes (2016 PM DHV) | | |
| | | NB Riverside | 0 | |
| | | SB Riverside | 0 | |
| | | WB Barrett | 0 | |
| | | Total | 0 | |
| | | PM DHV as % of AADT (K-Factor) | 10.4% | |
| | | AADT | 0 | |
| | | Annual Entering Volume | 0 | |
| | | Crash Study Period | 3 | Years |
| | | Study Period Entering Volume | 0.0 | MEV |
| | | Predicted Number of Crashes | 0.0 | during period |
| 1.00 | 1.00 | Crash Rate | 0.60 | Crashes/MEV |
| | | Crashes/Year | 0.00 | |
| 1.00 | 1 | Cost per Crash | $ 29,303 | |
| | | Annual Cost of Crashes | $ - | |
| | | Project Lifespan | 20 | Years |
| | | Discount Rate | 3% | Percent |
| | | Present Value of Crashes | $0 | |
| | | Entering Volumes (2016 PM DHV) | | |
| | | NB Col Ave | 751 | |
| | | SB Col Ave | 1088 | |
| | | NEB Riverside | 914 | |
| | | WB Mill | 78 | |
| | | Total | 2831 | |
| | | PM DHV as % of AADT (K-Factor) | 10.4% | |
| | | AADT | 27221 | |
| | | Annual Entering Volume | 9935721 | |
| | | Crash Study Period | 3 | Years |
| | | Study Period Entering Volume | 29.8 | MEV |
| | | Predicted Number of Crashes | 10.3 | during period |
| 1.00 | 0.41 | Crash Rate | 0.34 | Crashes/MEV |
| | | Crashes/Year | 3.42 | |
| 1.00 | 1.2 | Cost per Crash | $ 35,164 | |
| | | Annual Cost of Crashes | $ 120,142 | |
| | | Project Lifespan | 20 | Years |
| | | Discount Rate | 3% | Percent |
| | | Present Value of Crashes | $1,787,414 | |
| | | Present Value - All Locations | $7,139,213 | |

## Alternative 2

| CMF's Other | CMF's Reconfig | Item | Value | Units |
|---|---|---|---|---|
| | | Entering Volumes (2016 PM DHV) | | |
| | | NB Col Ave | 688 | |
| | | SB Col Ave | 384 | |
| | | EB Riverside | 997 | |
| | | WB Barrett | 290 | |
| | | Total | 2359 | |
| | | PM DHV as % of AADT (K-Factor) | 10.4% | |
| | | AADT | 22683 | |
| | | Annual Entering Volume | 8279183 | |
| | | Crash Study Period | 3 | Years |
| | | Study Period Entering Volume | 24.8 | MEV |
| Protected LT Phase | | Predicted Number of Crashes | 22.9 | during period |
| 0.94 | 0.83 | Crash Rate | 0.92 | Crashes/MEV |
| Eliminate one fatal | | Crashes/Year | 7.64 | |
| 0.33 | 1.01 | Cost per Crash | $ 27,408 | |
| | | Annual Cost of Crashes | $ 209,460 | |
| | | Project Lifespan | 20 | Years |
| | | Discount Rate | 3% | Percent |
| | | Present Value of Crashes | $3,116,232 | |
| | | Entering Volumes (2016 PM DHV) | | |
| | | NB Riverside | 997 | |
| | | SB Riverside | 724 | |
| | | WB Barrett | 186 | |
| | | Total | 1907 | |
| | | PM DHV as % of AADT (K-Factor) | 10.4% | |
| | | AADT | 18337 | |
| | | Annual Entering Volume | 6692837 | |
| | | Crash Study Period | 3 | Years |
| | | Study Period Entering Volume | 20.1 | MEV |
| No left turn | | Predicted Number of Crashes | 4.6 | during period |
| 0.32 | 1.20 | Crash Rate | 0.23 | Crashes/MEV |
| | | Crashes/Year | 1.54 | |
| 1.00 | 0.86 | Cost per Crash | $ 25,201 | |
| | | Annual Cost of Crashes | $ 38,708 | |
| | | Project Lifespan | 20 | Years |
| | | Discount Rate | 3% | Percent |
| | | Present Value of Crashes | $575,879 | |
| | | Entering Volumes (2016 PM DHV) | | |
| | | NB Col Ave | 751 | |
| | | SB Col Ave | 1088 | |
| | | NEB Riverside | 914 | |
| | | WB Mill | 78 | |
| | | Total | 2831 | |
| | | PM DHV as % of AADT (K-Factor) | 10.4% | |
| | | AADT | 27221 | |
| | | Annual Entering Volume | 9935721 | |
| | | Crash Study Period | 3 | Years |
| | | Study Period Entering Volume | 29.8 | MEV |
| | | Predicted Number of Crashes | 10.3 | during period |
| 1.00 | 0.41 | Crash Rate | 0.34 | Crashes/MEV |
| | | Crashes/Year | 3.42 | |
| 1.00 | 1.2 | Cost per Crash | $ 35,164 | |
| | | Annual Cost of Crashes | $ 120,142 | |
| | | Project Lifespan | 20 | Years |
| | | Discount Rate | 3% | Percent |
| | | Present Value of Crashes | $1,787,414 | |
| | | Present Value - All Locations | $5,479,524 | |

## Alternative 3

| CMF's Other | CMF's Reconfig | Item | Value | Units |
|---|---|---|---|---|
| | | Entering Volumes (2016 PM DHV) | | |
| | | NB Col Ave | 688 | |
| | | SB Col Ave | 1108 | |
| | | EB Riverside | 997 | |
| | | WB Barrett | 290 | |
| | | Total | 3083 | |
| | | PM DHV as % of AADT (K-Factor) | 10.4% | |
| | | AADT | 29644 | |
| | | Annual Entering Volume | 10820144 | |
| | | Crash Study Period | 3 | Years |
| | | Study Period Entering Volume | 32.5 | MEV |
| | | Predicted Number of Crashes | 20.0 | during period |
| 1.00 | 0.52 | Crash Rate | 0.62 | Crashes/MEV |
| Eliminate one fatal | | Crashes/Year | 6.66 | |
| 0.33 | 0.59 | Cost per Crash | $ 16,011 | |
| | | Annual Cost of Crashes | $ 106,580 | |
| | | Project Lifespan | 20 | Years |
| | | Discount Rate | 3% | Percent |
| | | Present Value of Crashes | $1,585,635 | |
| | | Entering Volumes (2016 PM DHV) | | |
| | | NB Riverside | 0 | |
| | | SB Riverside | 0 | |
| | | WB Barrett | 0 | |
| | | Total | 0 | |
| | | PM DHV as % of AADT (K-Factor) | 10.4% | |
| | | AADT | 0 | |
| | | Annual Entering Volume | 0 | |
| | | Crash Study Period | 3 | Years |
| | | Study Period Entering Volume | 0.0 | MEV |
| | | Predicted Number of Crashes | 0.0 | during period |
| 1.00 | 1.00 | Crash Rate | 0.60 | Crashes/MEV |
| | | Crashes/Year | 0.00 | |
| 1.00 | 1 | Cost per Crash | $ 29,303 | |
| | | Annual Cost of Crashes | $ - | |
| | | Project Lifespan | 20 | Years |
| | | Discount Rate | 3% | Percent |
| | | Present Value of Crashes | $0 | |
| | | Entering Volumes (2016 PM DHV) | | |
| | | NB Col Ave | 751 | |
| | | SB Col Ave | 1088 | |
| | | NEB Riverside | 914 | |
| | | WB Mill | 78 | |
| | | Total | 2831 | |
| | | PM DHV as % of AADT (K-Factor) | 10.4% | |
| | | AADT | 27221 | |
| | | Annual Entering Volume | 9935721 | |
| | | Crash Study Period | 3 | Years |
| | | Study Period Entering Volume | 29.8 | MEV |
| | | Predicted Number of Crashes | 10.3 | during period |
| 1.00 | 0.41 | Crash Rate | 0.34 | Crashes/MEV |
| | | Crashes/Year | 3.42 | |
| 1.00 | 1.2 | Cost per Crash | $ 35,164 | |
| | | Annual Cost of Crashes | $ 120,142 | |
| | | Project Lifespan | 20 | Years |
| | | Discount Rate | 3% | Percent |
| | | Present Value of Crashes | $1,787,414 | |
| | | Present Value - All Locations | $3,373,049 | |

## CMF's Converting Signal to Roundabout (from HSM)

| Setting/# of Lanes | Crash Type | CMF |
|---|---|---|
| Urban (1 or 2 lanes) | All types (all severities) | 0.99 |
| Urban (1 or 2 lanes) | All types (injury) | 0.40 |
| Suburban (2 lanes) | All types (All severities) | 0.33 |
| All Settings (1 or 2 lanes) | All types (all severities) | 0.52 |
| All Settings (1 or 2 lanes) | All types (injury) | 0.22 |

AVG. CRASH RATE* 0.561 PER MEV

*(MINOR ARTERIAL/URBAN COLLECTOR) AVERAGE STATEWIDE RATE

| Saving | #REF! |
|---|---|

| 4-WAY, SIGNALIZED CONFIGURATION | | |
|---|---|---|
| Crash Rate | 0.561 | Crashes/MEV |
| Annual Volume | #REF! | MEV |
| Crashes/Year | #REF! | |
| Cost per Crash | $ 29,303 | |
| Annual Cost of Crashes | #REF! | |
| Project Lifespan | 20 | Years |
| Discount Rate | 3% | Percent |
| Present Value of Crashes | #REF! | |

| Saving | #REF! |
|---|---|

| ROUNDABOUT CONFIGURATION | | |
|---|---|---|
| 4-Way Signal Crash Rate | 0.561 | Crashes/MEV |
| CMF | 0.52 | |
| Annual Volume | #REF! | MEV |
| Crashes/Year | #REF! | |
| Cost per Crash | $ 17,409 | (see Sheet 2) |
| Annual Cost of Crashes | #REF! | |
| Project Lifespan | 20 | Years |
| Discount Rate | 3% | Percent |
| Present Value of Crashes | #REF! | |

# APPENDIX K

## Project Cost Estimates

55 Green Mountain Drive
South Burlington, VT 05403
Tel: (802) 864-0223
Fax: (802) 864-0165

**Quantity Summary**

## Colchester Riverside

## US 7 Corridor

## Intersection Improvements

| | Initials | Date |
|---|---|---|
| Calc'd By: | tpl | 5/17/2016 |
| Checked By: | | |
| Revised By: | | |
| Checked By: | | |

| Item No. | Item Description | Unit | Unit Price | 4-WAY INTERSECTION Quantity | $ | 4-WAY INTERSECTION WITH SPUR LANE Quantity | $ | ROUNDABOUT Quantity | $ | Short Term Quantity | $ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 201.10 | Clearing And Grubbing, including Individual Trees and Stumps | LS | varies | 1 | $ 10,000 | 1 | $ 10,000 | 1 | $ 20,000 | 1 | $ 2,000 |
| 201.16 | Common Excavation | CY | $20.00 | 3100 | $ 62,000 | 3200 | $ 64,000 | 5700 | $ 114,000 | 250 | $ 5,000 |
| 203.3 | Earth Borrow | CY | $11.00 | 0 | $ - | 0 | $ - | 1000 | $ 11,000 | 0 | $ - |
| 301.35 | Subbase of Dense Graded Crushed Stone | CY | $35.00 | 3100 | $ 108,500 | 3840 | $ 134,400 | 5700 | $ 199,500 | 250 | $ 8,750 |
| 490.30 | Superpave Bituminous Concrete Pavement | TON | $125.00 | 1500 | $ 187,500 | 1600 | $ 200,000 | 2100 | $ 262,500 | 650 | $ 81,250 |
| 616.21 | Vertical Granite Curb | LF | $55.00 | 2200 | $ 121,000 | 1600 | $ 88,000 | 3300 | $ 181,500 | 1000 | $ 55,000 |
| 618.10 | Portland Cement Concrete Sidewalk, 5 Inch | SY | $75.00 | 600 | $ 45,000 | 700 | $ 52,500 | 800 | $ 60,000 | 350 | $ 26,250 |
| 618.11 | Portland Cement Concrete Sidewalk, 8 Inch | SY | $100.00 | | | | | 600 | $ 60,000 | 50 | $ 5,000 |
| 630.10 | Uniformed Traffic Officers | HRS | $60.00 | 1440 | $ 86,400 | 1440 | $ 86,400 | 2160 | $ 129,600 | 240 | $ 14,400 |
| 630.15 | Flaggers | HRS | $30.00 | 8000 | $ 240,000 | 8000 | $ 240,000 | 14400 | $ 432,000 | 1200 | $ 36,000 |
| 631.10 | Field Office, Engineers | LS | $20,000.00 | 1 | $ 20,000 | 1 | $ 20,000 | 1 | $ 20,000 | 0 | $ - |
| 641.10 | Traffic Control | LS | varies | 1 | $ 120,000 | 1 | $ 120,000 | 1 | $ 240,000 | 1 | $ 20,000 |
| 678.15 | Traffic Control Signal System, Intersection | EACH | varies | 1 | $ 250,000 | 1 | $ 250,000 | 0 | $ - | 1 | $ 100,000 |
| 900 | Excavation of contaminated soils | CY | $100.00 | 775 | $ 77,500 | 800 | $ 80,000 | 1425 | $ 142,500 | 63 | $ 30,000 |
| 901 | drainage | LF | varies | 1 | $ 84,000 | 1 | $ 104,000 | 1 | $ 109,000 | 1 | $ 10,000 |
| 902 | retaining walls | LS | varies | 1 | $ 200,000 | 1 | $ 200,000 | 1 | $ 1,200,000 | 0 | $ - |
| 903 | lighting | Units | $12,000.00 | 15 | $ 180,000 | 15 | $ 180,000 | 18 | $ 216,000 | 4 | $ 48,000 |
| 904 | Landscaping | LS | varies | 1 | $ 25,000 | 1 | $ 50,000 | 1 | $ 50,000 | 1 | $ 5,000 |

| | 4-WAY INTERSECTION | 4-WAY INTERSECTION WITH SPUR LANE | ROUNDABOUT Quantity | ROUNDABOUT | Short Term Quantity | Short Term |
|---|---|---|---|---|---|---|
| Sub Total | $ 1,816,900 | $ 1,879,300 | | $ 3,447,600 | | $ 446,650 |
| Erosion Control (2%) | $ 36,338 | $ 37,586 | | $ 68,952 | | $ 8,933 |
| Signing & Striping (2%) | $ 36,338 | $ 37,586 | | $ 68,952 | | $ 8,933 |
| Mobilization / Demobilization (10%) | $ 181,690 | $ 187,930 | | $ 344,760 | | $ 44,665 |
| Contengencies (25%) | $ 454,225 | $ 469,825 | $ - | $ 861,900 | $ - | $ 111,663 |
| Total Opinion of Probable Construction Cost* | $ 2,600,000 | $ 2,700,000 | | $ 4,800,000 | | $ 700,000 |
| Right of Way Costs | $ 50,000 | $ 50,000 | | $ 700,000 | | $ - |
| Design Engineering (15%) | $ 390,000 | $ 405,000 | | $ 720,000 | | $ 105,000 |
| Construction Engingeering (10%) | $ 260,000 | $ 270,000 | | $ 480,000 | | $ 70,000 |
| Total Project Costs | $ 3,300,000 | $ 3,430,000 | | $ 6,700,000 | | $ 880,000 |

*Estimate does not include costs associated with utilities, permitting or stormwater

<u>List of assumptions:</u>

1. Roadway structural section 6" Pavement w/30" base, and 12" base under sidewalks & paths
2. Lighting unit price includes all that's needed for installation (pole, base, arm, luminaire, wire, conduit….)
3. Assumes new drainage on both sides of road with 18" pipe and 250' spacing on catch basins
4. Short term improvements for traffic signals includes new signal heads, backplates, ped signal system and SB left onto Barrett.
5. Retaining walls LS price for roundabout alternative assumes 3 new walls
6. Retaining walls LS price for signalized alternatives assumes additional 3' high max on west side project near river.
7. 8" sidewalk assumed used for splitter islands and truck apron
8. Quantities assume that enough cut is available for fill where required for all alternatives except roundabout, which will require raising grade approximately 7'-8' at existing interseciton of Riverside and Colchester Ave.

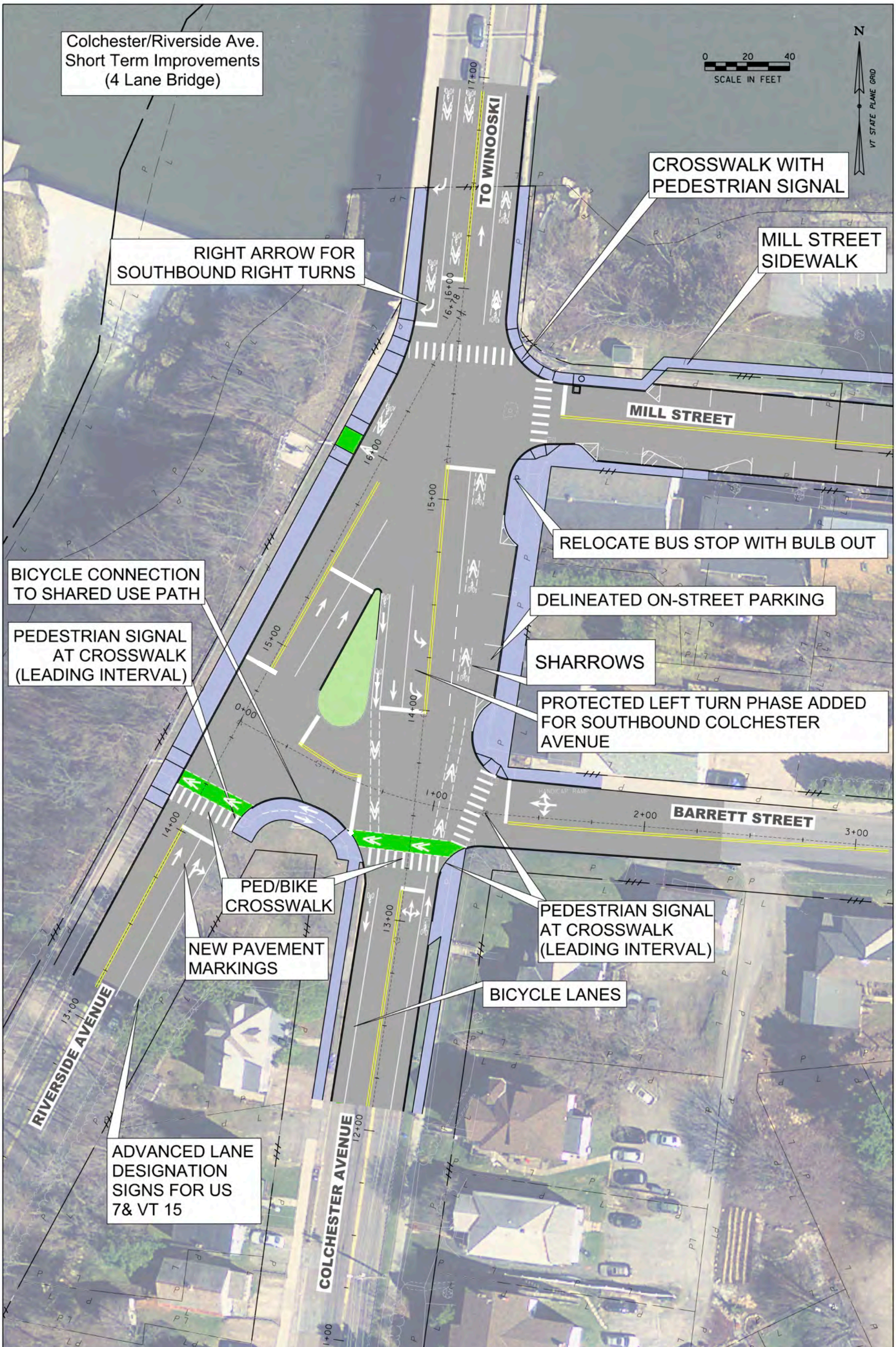
# APPENDIX L

## Correspondence-Meeting Notes

# Colchester, Barrett, & Riverside

## CURRENT DRAFT OF PROPOSED SHORT-TERM IMPROVEMENTS

*November 2016*

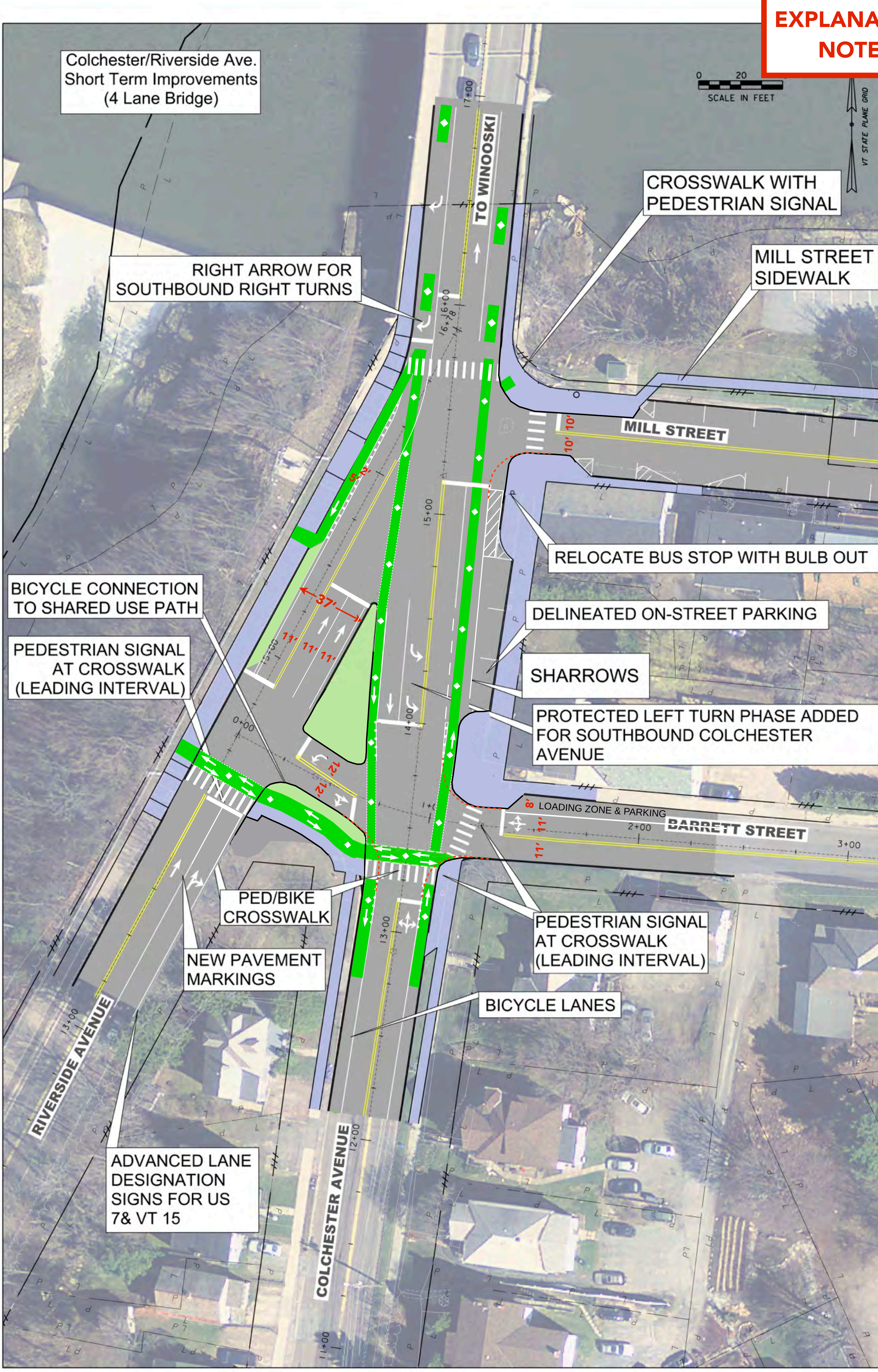


# Colchester, Barrett, & Riverside

## ADDITIONAL MODIFICATIONS TO SHORT-TERM DESIGN TO FURTHER IMPROVE PEDESTRIAN & BIKE SAFETY

*November 2016*

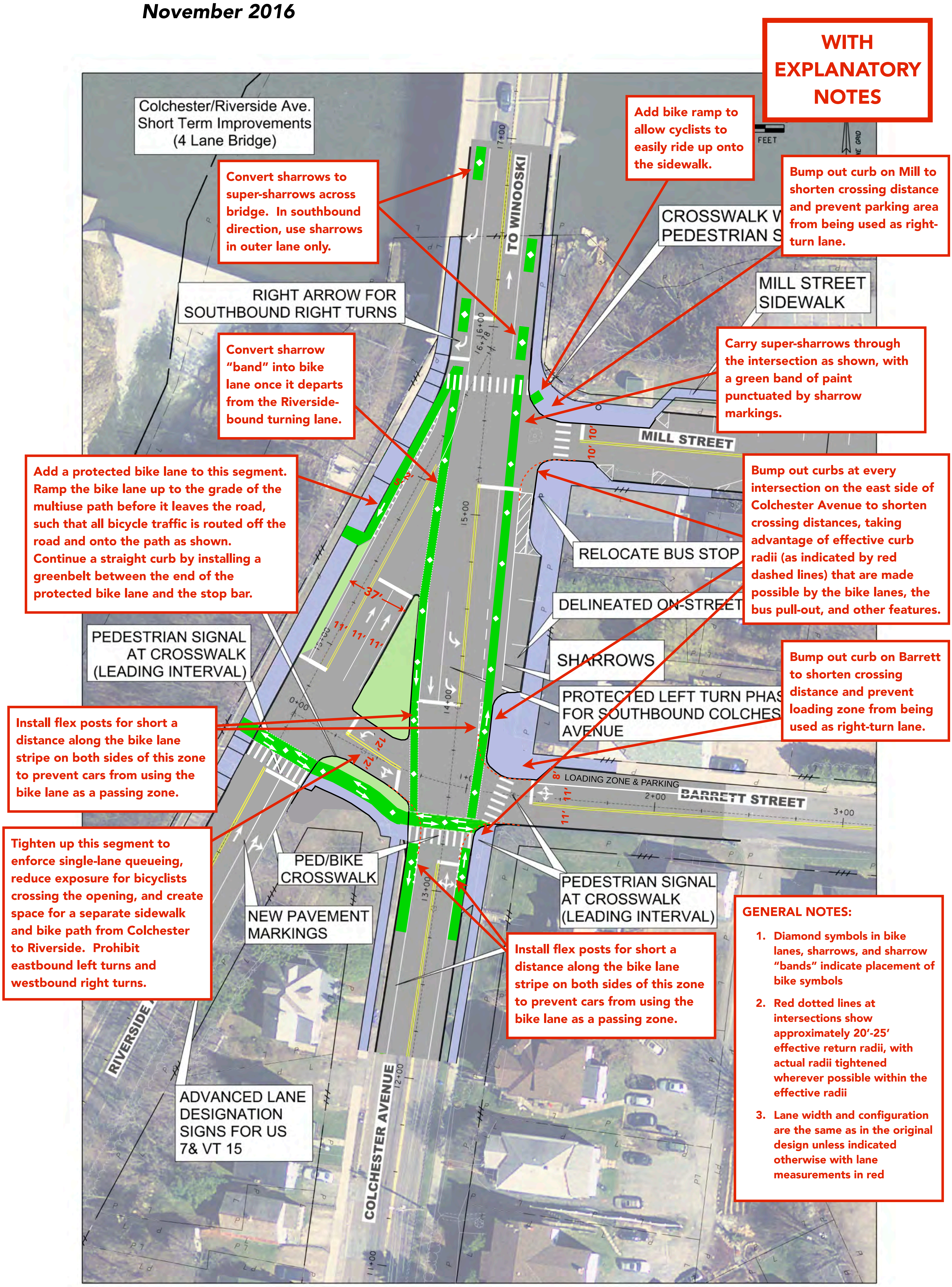
**WITHOUT EXPLANATORY NOTES**



# Colchester, Barrett, & Riverside

## ADDITIONAL MODIFICATIONS TO SHORT-TERM DESIGN TO FURTHER IMPROVE PEDESTRIAN & BIKE SAFETY

***November 2016***



Stantec

# Meeting Notes

**Project Advisory Committee (PAC) Meeting No. 1**

CCRPC Colchester/Riverside/Barret/Mill Scoping Study / 195311163

---

| | |
|---|---|
| Date/Time: | January 14, 2016 / 5:30 |
| Place: | CCRPC Offices, 110 W. Canal Street, Suite 202, Winooski, VT |
| Next Meeting: | TBD |
| Attendees: | Jason Charest (CCRPC), Peter Wernsdorfer (Winooski Public Works), Alexander Sampson (Winooski Public Works), Sharon Bushor (Ward 1 City Councilor), Jason Van Driesche (Local Motion), Amy Bell (VTrans), Sandy Thibault (CATMA, Hill Institutions), Kelly Stoddard Poor (AARP), Nicole Losch (Burlington DPW), Meagan Tuttle (Burlington P&Z), Eleni Churchill (CCRPC), Diane Meyerhoff (Third Sector Associates), Greg Edwards (Stantec), Nora Varhue (Stantec), Wayne Senville (Ward 1 NPA Representative), Linda Letourneau (Redstone - Chace Mill Property Manager) |
| Absentees: | Thad Luther (Stantec), David Armstrong (CCTA), Diane Meyerhoff (Third Sector Associates), Kelly Stoddard Poor (AARP) |
| Distribution: | Distribution List |

---

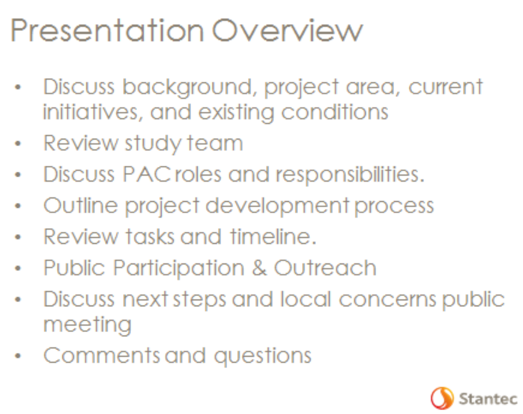
**PAC Colchester Avenue/Riverside Avenue Intersection Improvement Study Meeting:**

1) **Welcome & Introductions**


Jason Charest from the CCRPC introduces the Colchester Avenue/Riverside Avenue project and defines "scoping study". Scoping studies vary from general studies of the area to detailed planning. The Colchester/Riverside Avenue will focus on the details of the intersection and determine a preferred alternative.

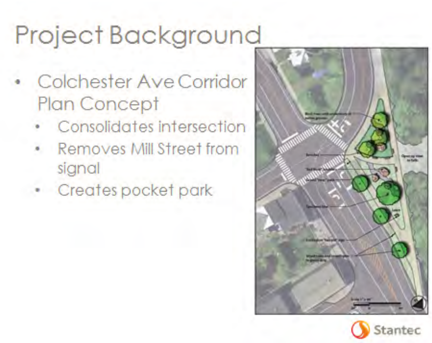
2) **Presentation Overview**

**PAC Colchester Avenue/Riverside Avenue Intersection Improvement Study Meeting:**




Greg Edwards from Stantec briefly outlines the structure of the presentation.

### 3) Project Background


Greg introduces the 2011 Colchester Corridor Plan. The purpose of the 2011 study was to improve the community by introducing complete streets. Study focused on pedestrian safety and traffic congestion. Greg briefly explains one concept for Colchester Avenue that came from the study. This concept included on-street parking, two wider lanes and a green strip in the middle. This concept is similar to the existing conditions of Colchester Avenue. The plan indicated a potential improvement to the Colchester/Riverside/Barrett/Mill intersection would be simplified to one four-way signalized intersection, eliminating the Mill Street signal and creating a pocket park. From this project it was determined that the Colchester Avenue and Riverside Avenue intersection deserved an independent scoping study.

### 4) Current Initiatives

**PAC Colchester Avenue/Riverside Avenue Intersection Improvement Study Meeting:**


Greg outlines the current initiatives in and around the project area: The Pedestrian Bridge Feasibility Study, the Walk Bike Plan BTV, the Grove Street Mitigation Project Ped Signal, and the development of the Brisson Property.

Nicole Losch of Burlington DPW updates that a revised draft of the Walk Bike Plan BTV will be available by next week or so.

Greg further explains that the Grove Street Housing Mitigation Project is planned by the City sometime this year. This project is to provide pedestrian signals at all existing crosswalks aside from Mill St and requires several conduits under the road.

Sharon Bushor from the City Council raises concern about going ahead with the pedestrian signals. She addresses that it might be an idea to hold off and utilize the money more effectively. She addresses the various safety concerns for pedestrians and specifically children going to school in the area. We should wait to see the impacts of this project before establishing new pedestrian signaling. It would be a shame to have to rip out all the new signals after spending the money and time on them.

**5) Project Area/Existing Conditions**

**PAC Colchester Avenue/Riverside Avenue Intersection Improvement Study Meeting:**


Greg brings up the existing base map of the project area with marked utilities. Greg explains that utility information and traffic information for this area was gathered by contacting the suppliers and VTrans. Stantec reached out to CCTA to gather information and an understanding of the bus routes in this area as well.

Jason Van Driesche of Local Motion brings up recent pedestrian fatality in the area. Greg goes on to say that this intersection has been identified as a high crash location.

Jason C. explains that VTrans has created a map of the crashes in the area which displays the quantity, type and location of the crashes.

Jason V. shows interest in obtaining a copy of the base map and Greg informs that a website for the project will be created and from there you can access available data.

Jason V. reports that the mouth of Barrett was the most recent death at the intersection but shares that it is crossing across Colchester Avenue that is the most challenging.

Sharon also brings up that adding pedestrian signals to this area may impact delays at the intersection.

Greg explains that traffic counts in this area have been collected but yet to be processed. Stantec's plan is to make a model and evaluate multiple alternatives to see what is most effective.

Sharon asks about project area. She goes on to explain that Colchester Avenue is one lane and is not striped but due to structure of road two lanes naturally form northbound between Barrett and Mill Streets. Jason V. adds asking how far past the Winooski bridge will be considered.

**PAC Colchester Avenue/Riverside Avenue Intersection Improvement Study Meeting:**

Greg addresses Sharon's question clarifying that one and two lanes will be considered on Colchester Avenue approach and Stantec will analyze which ones benefit the intersection. Currently the project area goes a couple hundred feet back on each leg of the intersection. Jason C. adds that two lanes will be investigated and the project area will extend further back if necessary.

Eleni Churchill of the CCRPC explains that an outline of the study area exists and will be available.

Linda Letourneau, Property manager of the Chace Mill asks for clarification on the number of lanes on Colchester Avenue between Barrett Street and Mill Street.

Jason C. confirms that it operates as two.

Greg addresses Jason V.'s question and confirms that the traffic in the Winooski traffic circulator will be considered in the scope of the project. Currently Stantec has a model of the circulator to analyze how the circulator will affect the project.

Discussion begins about traffic at the Winooski circle. Eleni informs the group that the bridge sees 30,000 cars a day. Jason C. adds that the CCRPC looked at narrowing the circulator to one lane exiting from Winooski southbound over the bridge and it was not favorable. One lane entering the circulator northbound has yet to be considered.

Discussion begins about Mill Street. Linda explains that Mill Street is a dead-end street with a parking lot. Linda closes the gates at the back entrance due to traffic trying to cut through the parking lot. The back entrance is in the Chace Mill's private ROW.

Topic changes to traffic signaling. Greg informs that a traffic graphic is to come. Sharon shares her concern about not signalizing traffic onto Mill Street. Future plans should acknowledge that people live and work down Mill Street.

Greg continues to explain base map. He notes the path along Riverside Avenue and the sidewalks provided everywhere except one side of Barrett Street and on Mill Street. He points out transit stops in the area. Discussion about the transit stop that was discontinued on Colchester Avenue's hill begins. (Correction: transit stops exist on both sides of Colchester Avenue at Barrett Street. The discontinued stop was on Riverside Avenue northbound at Barrett Street.) Another stop is provided further up the hill near Chase Street.

Greg explains that Stantec has survey requested for this area. This will

**PAC Colchester Avenue/Riverside Avenue Intersection Improvement Study Meeting:**

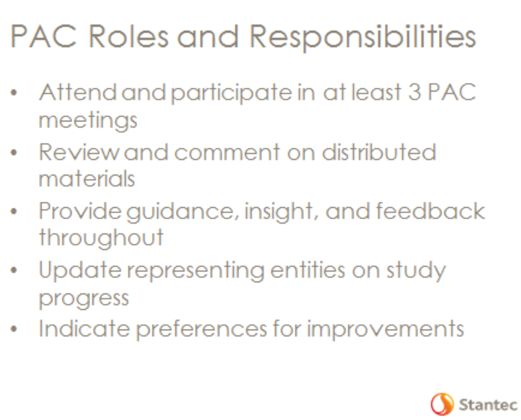
allow Stantec to determine how alternatives will impact the existing conditions.

This further solicits discussion about a previous alternative that arose during the corridor study. Eleni explains that she has those alternatives and will send them out. Nothing is off the table at this point and alternatives new and old will be considered.

**6) Project Study Team**


Greg introduces project team.

**7) PAC Roles and responsibilities**




Greg explains that there will be at least three meetings in which feedback is encouraged.

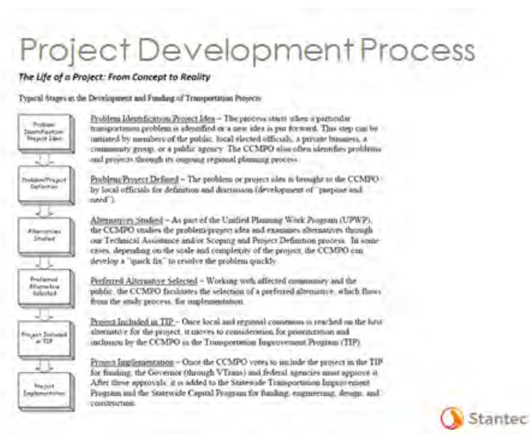
Sharon shares that she cares about people in Ward 1 and people

**PAC Colchester Avenue/Riverside Avenue Intersection Improvement Study Meeting:**

commuting through Ward 1. A project involving people and helping a larger group will produce the best results. A healthy give and take project development process is the best approach.

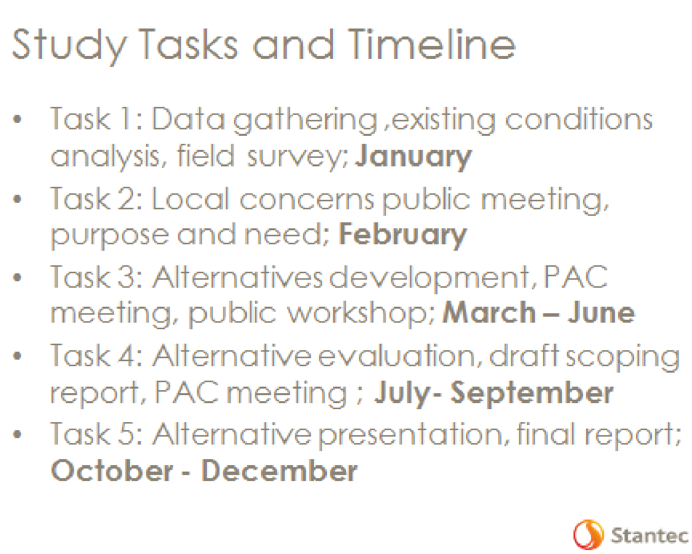
Eleni echoes that finding a solution that can be implemented as soon as possible to provide a safe intersection to those who use it is a priority.

**8)Project Development Process**




Greg generally outlines project process.

**9)Study Tasks and Timeline**




Public meeting is to come in February or March. This meeting will not have alternatives but will be more like an open discussion. Jason C. adds

**PAC Colchester Avenue/Riverside Avenue Intersection Improvement Study Meeting:**

that we will have more existing conditions information to share at that time.

Sharon acknowledges the importance of having a meeting to see people's concerns from both Winooski and Burlington. Jason C. agrees and adds that the first meeting's purpose is to do that and also to hear people's ideas for the intersection.

Sandy Thibault from CATMA adds that she has surveys from students about their experience with CATMA. Surveying users of the intersection could be a great resource. Jason V. adds that he has a pretty responsive list of people interested in the pedestrian/walking community. He presents the idea of a 3-4 question survey to receive specific feedback. Sharon adds that she performed a survey in a past project of people's needs for the street and found the information very helpful.

Discussion begins about date of public meeting. It is agreed that the meeting should avoid spring break as well as Town Meeting Day week. Greg will ask Dianne Meyerhoff about the week of February 15th to 19th. If this does not go through an alternate date would be the second week in March.

Greg explains that following the public meeting, general sketches will be brought back to the group for feedback. A public workshop will then be held in which concepts for the intersection can be introduced. These concepts will not be conclusive but just ideas. The alternative will then be finalized and a report will be drafted to be reviewed and finalized.

Jason V. addresses the importance of thinking of both short and long term solutions. He specifically brings up the example of the Prospect and Pearl Street intersection. This project was relatively inexpensive and fast. He wants the project to consider immediate fixes that may not be a permanent solution but would greatly increase the safety of the intersection.

The group agrees on this.

**10) Next Steps and public meeting**

**PAC Colchester Avenue/Riverside Avenue Intersection Improvement Study Meeting:**

Public Participation & Outreach

- 3 Public Meetings
  - Local Concerns, Alternatives Workshop, City Council Presentation
- Presentations to Ward 1 NPA, Public Works Commission, Transportation Energy & Utilities Commission (TEUC)
- Front Porch Forum
- Direct Mailings/Post Cards
- Project contact list & website
- Advisory Committee
- Contact us

Stantec

Jason C. explains that a comment section will be set up on the project's website to solicit comments and feedback. Sharon agrees that this is a good idea. This process will allow feedback from not just those who live in the district but those who commute through it and are unable to attend a public meeting.

Eleni adds that passing out postcards at intersection could be one method utilized. Sharon adds that they handed out postcards at the hospital. This gave a better picture about how commuters felt about the intersection. They also did a follow up survey to see how everyone liked the pilot project. Making a website survey is brought up again.

Linda addresses the idea of surveying those who work in the Chace Mill. Idea of having a building wide meeting about the project is brought up. Linda agrees that that could happen. She explains that people are always asking where the public transit stops are and there are a lot of bike commuters in the building. She agreed that people would like to be informed and have the chance to respond to changes in the intersection.

Jason V. brings up the idea of making a weather resistant sign with a comment box. He offers to help put the sign together.

Sandy adds that CATMA has the resources to survey and would be happy to promote the project and solicit feedback.

**11) Next Steps and Public Meeting**

**PAC Colchester Avenue/Riverside Avenue Intersection Improvement Study Meeting:**


Sharon addresses that she would like to hear more about the alternatives considered in the past. She adds the idea of providing pamphlets to educate those about the history of the intersection.

Eleni will go through her files to find the alternatives and concepts from the corridor study to share.

Sandy Thibault adds that her predecessor at CATMA was involved in the Colchester Avenue Corridor Study. CATMA facilitated this Task Force in 2006 and she has access to the files and final report to share. She will look into obtaining files.

Sharon believes previous alternatives might be doable and could be used as a pilot project to see how traffic adjusts. She adds that at the public meeting you don't want to focus too much on the history of the project. It is better to bring up the previous concerns and let the discussion develop from there.

Jason V. addresses that this intersection project has a lot of constraints making it difficult to solve every problem. He thinks it would be productive to focus the discussion around specific problems with the intersection. By focusing on the problems we can come up with solutions and talk about the pros and cons of each proposal.

Wayne Senville from Ward 1 brings up the idea of having the meeting right at the intersection. This method was used during the Walk Bike BTV project and was successful.

The idea of turning the intersection into a traffic circle is brought up. Nicole explains that a roundabout specialist, Mark Johnson, has been to this intersection and has provided feedback. Eleni adds that the roundabout is still a possibility for this intersection but it would be very difficult. At this location it would need to be a two lane roundabout and

**PAC Colchester Avenue/Riverside Avenue Intersection Improvement Study Meeting:**

space is a huge limitation. Sharon adds that two lane roundabouts are especially dangerous for pedestrians. Eleni agrees and confirms that the two lane roundabout alternative was dropped. Greg concludes that the idea will be revisited and he will reach out to Mark Johnson for input.

Amy adds that we should focus on short term solutions for the intersection. There is no guarantee when money for this project will be available. She emphasizes to look at a short term solution because it might be 10-15 years until money is available.

Greg agrees and adds that he likes the idea of breaking down the issues and hearing the public's challenges. From the public meeting he hopes to prioritize the important issues.

Linda adds that it could be helpful to get truck drivers comments.

Wayne asks if the Grove Streets impact study is available. Jason C. clarifies that we have the traffic impact study and it will be considered in the project. He adds that there is another impact study from Riverside Avenue's Handy parcel that will also be considered.

Eleni echoes that everything will be sent out.

Meeting adjourns with promise of the website to be finished soon with all the data available. The next meeting will be the public meeting with date and time to be announced.


The meeting adjourned at 6:50
The foregoing is considered to be a true and accurate record of all items discussed. If any discrepancies or inconsistencies are noted, please contact the writer immediately.

**Stantec Consulting Services Inc.**

Nora Varhue, E.I.T.
Engineering Designer, Transportation
Phone: 802-864-0223
Fax: Sender's Fax
nora.varhue@stantec.com

Attachment: Attachment

c. Cc List

**Public Meeting**

Colchester/Riverside/Barrett/ Mill Intersection Study / 195311163

---

Date/Time: March 8, 2016 / 7:00 PM
Place: UVM Medical Center Conference Room
Next Meeting: May/June
Attendees: See Attachment 1

---

**Public meeting:**

**Introductions**

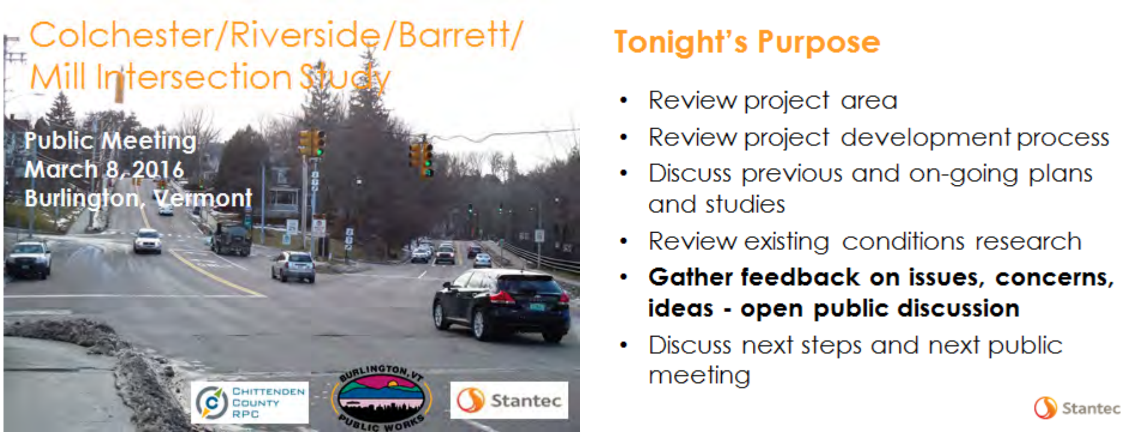
Jason Charest (CCRPC) starts the meeting by introducing the project leaders of the scoping study:

- Greg Goyette and Thad Luther, Stantec
- Eleni Churchill and Jason Charest, CCRPC.

He also introduces Diane Merenhoff from Third Sector Associates as a leader in helping organize and facilitate the meeting.

Jason encourages all to fill out an evaluation form provided near the door to help improve the project process.

**Presentation- Purpose**




Greg Goyette (Stantec) begins the presentation.

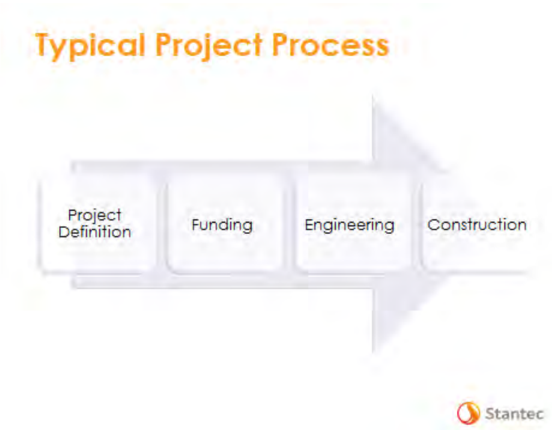
Greg discusses the purpose of the public meeting. He emphasizes that the project is in the initial phases of development. The main purpose of the meeting is to collect feedback, concerns and recommendations from the public to shape Stantec and the CCRPC's intersection recommendations.

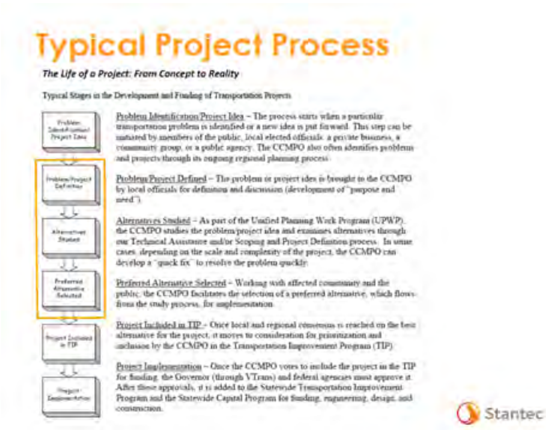
**Public meeting:**

**Project Area**


Greg shows the project area on the map. He adds that the project area has the potential to expand dependent on the communities concerns and the project's surrounding impacts.

**Project Process**




Greg briefly discusses the project process. This scoping study is currently still in the definition stage. The goal is to look at various alternatives to produce a preferred alternative from the area. Following the scoping study the community has the potential to pursue funding and follow through with the development and implementation of the preferred alternative.

Greg provides the second slide for anyone who would like clearer and more thorough explanation of the project process.

**Public meeting:**

**Study Tasks and Timeline**

## Study Tasks and Timeline

- Task 1: Data gathering ,existing conditions analysis; **January-February**
- Task 2: Local concerns public workshop; **March**
- Task 3: Alternatives development, PAC meeting, public workshop; **March – June**
- Task 4: Alternative evaluation, draft scoping report, PAC meeting ; **July- September**
- Task 5: Alternative presentation, final report; **October - December**

Stantec

Greg summarizes the study tasks and timeline of the project. The current public meeting is task two. After the public meeting the next task will be to develop alternatives for the intersection. Greg continues to explain the timing and purpose of the two meetings to follow Task 3.

**Related Projects**

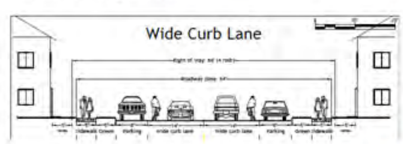
## Colchester Ave Concept Plan

- Consolidates intersection
- Removes Mill Street from signal
- Creates pocket park

"Reconstruction of the Riverside Avenue-Barrett Street-Mill Street intersection…requires additional design, engineering and public outreach."

## Colchester Avenue Corridor Plan

- Complete street corridor
- Gateway to Burlington
- Safety, Bicycle/Pedestrian Access, Transit, Streetscape, Traffic Congestion




Stantec

Greg discusses the previous projects and studies that Stantec is reviewing to help develop alternatives for the intersection. He introduces the Colchester Avenue Corridor Plan that studied Colchester Avenue between Union Street and Mill Street. From this study it was determined that this intersection required additional analysis and public outreach. The project did produce a concept plan but requires further analysis of the area's impacts.

**Public meeting:**


Greg introduces the Burlington Transportation Plan as another guide in the development of a recommendation. The Transportation Plan incorporates various modes of transportation and focuses on providing an experience for the intersection's users.


Greg briefly outlines other past and present projects that are being used and referenced throughout this scoping study. He references the interactive map on the Walk Bike Plan BTV Website where people can go and note specific complaints, recommendations and concerns on specific locations throughout Burlington. The concerns in reference to this intersection will be reviewed.

**Public meeting:**

## Project Advisory Committee

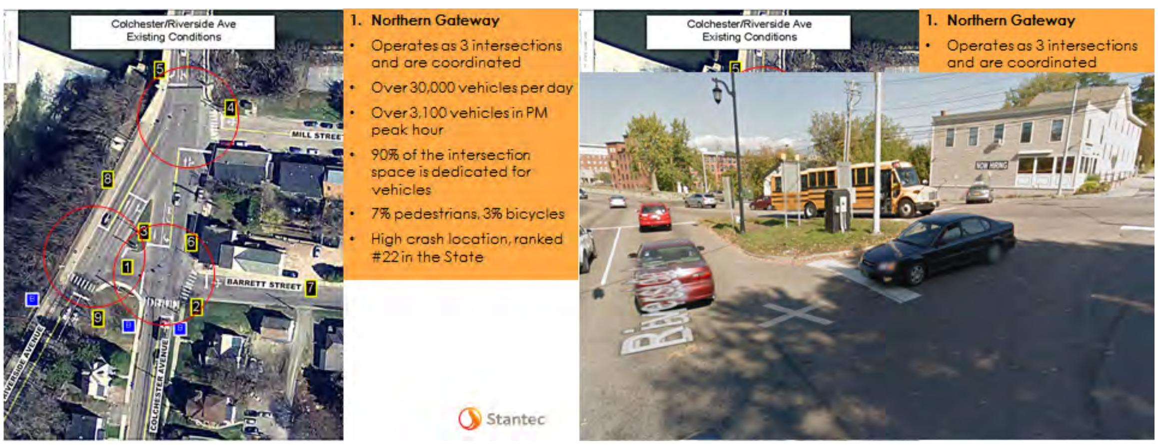
- Burlington City Staff – Nicole Losch, Meagan Tuttle
- Burlington City Council – Sharon Bushor
- Ward 1 NPA – Wayne Senville, Richard Hillyard
- CCTA – David Armstrong
- CATMA & Hill Institutions – Sandy Thibault
- AARP – Kelly Stoddard-Poor
- Winooski City Staff – Alex Sampson
- Local Motion – Jason Van Driesche
- Redstone – Linda Letourneau
- CCRPC – Eleni Churchill

## PAC Roles and Responsibilities

- Attend and participate in at least 3 PAC meetings
- Review and comment on distributed materials
- Provide guidance, insight, and feedback throughout
- Update representing entities on study progress
- Indicate preferences for improvements

Greg introduces the Project Advisory Committee (PAC) which is made up of representatives from various entities having a diverse constituency. Greg outlines the roles and responsibilities of the PAC.

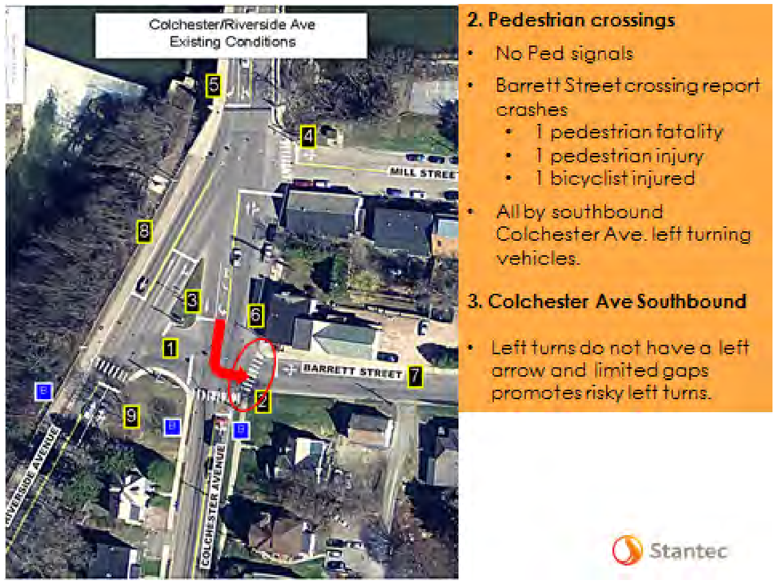
**Existing Conditions**




Greg discusses the existing conditions of the intersection.

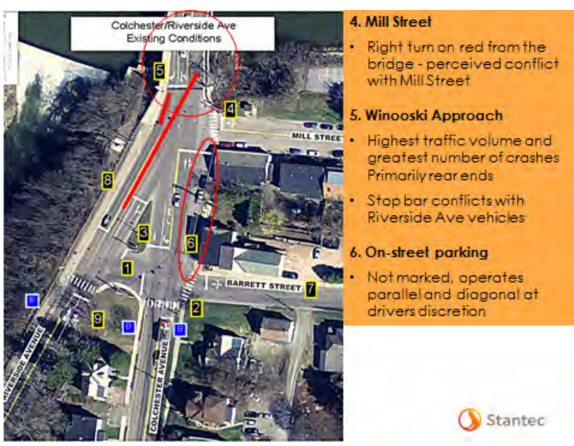
1. This intersection is a northern gateway to Burlington. This three intersection junction is in a tight area that sees very high volumes of car, pedestrian and bicycle traffic. Using 2014 VTrans data, the intersection is classified as a High Crash location. It is clarified that the percentages of pedestrians and bicycles on the slide reflect the percent space allocated for the intersection user.

**Public meeting:**




2. Greg discusses the unsafe pedestrian crossings in the area, highlighting the location and turning movement that resulted in the pedestrian fatality. The community stresses the very unsafe conditions at the #9 crossing on Riverside Avenue.

3. Colchester Avenue Southbound is discussed





4. Sharon Bushor (City Council, PAC) brings up the recent proposal to relocate Taft School's On Top Program to the Chace Mill. This school will accommodate approximately 30 students from 6th to 12th grade. It is currently moving through DRB. This project should be factored into the study and put an additional focus on safety.

   Jason follows up by sharing with the group that Stantec and the CCRPC are aware of this development and other developments in the community and anticipate a volume increase that will be incorporated into the study. Jason specifically mentions the Handy's Housing Project on Riverside Avenue and the Grove Street Housing Project as some of

**Public meeting:**

these developments.

5. Greg describes Winooski Approach

6. Greg highlights the problematic and variable parking in front of Dominos. He displays a picture of both a parallel parked car and an angled parked car. He adds that cars tend to make unpredictable moves out of the parked spot (U-turns, reversals onto Barrett Street etc.).



7. Colchester Avenue and Barrett Street experience the longest delays and queues.

8. Bicycle facilities and safety are limited throughout the intersection. Greg shares that he read a comment today on the BTV Walk Bike Plan Interactive map on Bicycle Safety. Many bicyclists use the sidewalk crossing over the Winooski Bridge.

9. Greg discusses the involvement of CCTA and the facilities provided for bus users.

**Public meeting:**

**Public Input**


Greg transitions from the presentation into the break out groups. He explains that there will be five groups each with a facilitator to keep the conversation focused on the outlined topics. He emphasizes that any ideas are good ideas at this phase of the project.

At this point a community member asks for clarification on the referenced outreach during the Colchester Corridor Study in 2011. She is concerned that those affected by the intersection are not present because they are unaware of these public meetings.

Eleni Churchill from the CCRPC introduces herself as the project manager from the 2011 study. She explains that they performed a pilot project and organized 3-4 public meetings in hopes to outreach to the community. They advertised these events through fliers, front porch forum and website surveys.

Diane Meyerhoff also adds that they used email to contact those that were interested or affected by the corridor. They posted notices in the Winooski City Hall and outreached to media outlets. Diane asks the group for feedback and suggestions and to include them on the evaluation forms.

Jason Charest follows up with asking the community members to additionally spread the word when they hear about these projects.

The groups break off into focus groups to collect ideas. They reconvene and summarize the group's discussion to everyone.

**Red Group Discussion**

Eleni Churchill introduces herself as the facilitator of the group. She emphasizes that she is here to hear everyone's concerns, issues and ideas for the intersection. She asks for peoples input about safety through the intersection.

**Public meeting:**

Discussion begins about the safety of the intersection. The group highlights various concerns:

- lack of bike lanes
- Difficulty crossing at Riverside Avenue; Need to cross over to Winooski to cross safety.
- Safety at Barrett Street crossing due to Colchester Avenue's left turn onto Barrett Street
- High traffic flow
- Complexity of the intersection - confusing to new users.
- Intersection's complexity and lack of safety is limiting people's access to businesses which is limiting business development. Current conditions yield a long wait for access to Mill Street.
- Difficulty anticipating traffic movements due to poor visibility of traffic lights at pedestrian crossings
- Unsafe pedestrian facilities for children

Eleni steers the conversation to learn about people's concerns about biking in the area. She states that we have the Riverside Avenue's Shared Use Path but other than that, bicycle facilities are limited. Discussion begins with people sharing their personal experience with traveling through the intersection.

Greg Hostetler introduces himself as a Winooski resident that bikes into Burlington. He shares that he will take the sidewalk over the bridge during the Winter, but prefers to use the right lane into Burlington during the summer with higher pedestrian traffic. He has experienced traffic getting aggressive between bridge and start of path. On Riverside he will take the road if path is congested. On his way back into Winooski he will typically stay on the sidewalk because it is dangerous crossing over to the lane from Riverside Avenue.

Tony Redington shares that he will always take sidewalk. A five foot bike area is too narrow. He will walk his bike on the sidewalk until he crosses over to Winooski.

Carol Jen Suitor points out the transition on Colchester Avenues Bridge Sidewalk to the Riverside Shared Use Path as a blind spot. (Eleni circles area on the map)

**Public meeting:**

Jennifer Koch inquiries about the pocket park idea that was presented in the Colchester Corridor Study. Eleni explains that the pocket parking was looked at as an option and will continue to be look at as an option through the alternative development stage. This option would include closing off Riverside Avenue left of the median and using the area as a pocket park. Initial analysis of this alternative predicted various engineering issues and environmental impacts. This alternative would improve pedestrian and bicycle safety but cause bridge traffic problems. Looking forward, the CCRPC is going to start a scoping project for the bridge because it will need to be replaced in the next 7-10 years resulting in improvements for the whole area and improving bicycle traffic flow. The Pocket Park will continue to be a possibility.

Discussion begins about the Mill Street area. Tony shares that last March/ April reconfiguration of Mill Street as a one-way utilizing its back entrance as an exit was discussed as a possibility to minimize traffic. Eleni adds that the back entrance is a private drive which would cause ROW issues.

The idea of converting the Chace Mill parking in front of the river into a scenic picnic area is brought up. Many are concerned due to current conditions of the area and its increase in crime. It is brought up that there have been a lot of problems with parking in that lot. People have been parking there and walking into Winooski since parking is now metered in the Winooski downtown. They have been finding a lot of abandoned cars.

Discussion transitions to congestion and traffic operations through the area. It is observed that vehicles cut through Chase Street and Mill Street when the intersection gets congested. It is added that congestion will only intensify with the anticipated developments in the surrounding area. One resident expresses that when traffic is congested and she cannot take a left onto Barrett Street, she drives up to Chase and takes a left to gain access into the back neighborhoods. A roundabout is recommended as a possible solution to difficult left turns.

Tony further addresses the idea of a roundabout. He states the project area is right on the border of being a one to two lane roundabout. Two lanes would require signalized crossings or at least the pedestrian flashing lights. The pedestrian flashing lights are a great option because most of the day pedestrians would feel comfortable crossing without them but they could be used through high traffic periods. It's been shown that two lane roundabouts with flashing pedestrian lights have a lower pedestrian injury rate then a set of signaled crossings. The Middlebury roundabout is brought up as a successful roundabout. Education on how to successfully use the roundabout is a necessity especially when first implemented.

Speed is highlighted as an issue through the intersection. Burlington lowered the speed limit to 25 but it appears people interpret it as a suggestion. Some have experienced an increase of getting passed especially by traffic coming from Winooski.

Tony shares that he is on the Walk Bike Plan Committee so he is also concerned about East Avenue safety. On the committee they have discussion the installation of a single lane roundabout at East Avenue and Colchester Avenue. Studies show that the knowledge of a roundabout at the next intersection limits the car's need to speed to catch the red light.

**Public meeting:**

This area sees a high volume of ambulance traffic due to the hospital location. The emergency department will be made aware of the project and be invited to the next public meeting.

Discussion transitions to availability of public transit in the area. It is shard that Sharon Bushor (Burlington City Council) is pushing to have public transit access Grove Street. The new development will be large enough that kid's safety should be considered in the development. Group believed that the whole area is underserved by public transit.

Discussion begins on the entrance and exit to the Grove street development. Eleni clarifies that CCTA will be doing some route planning for areas seeing more development. Things are changing and there is a need to reevaluate possible express/ loops with high volume attractions.

It is asked and clarified that the general trend of traffic over the years in this area is relatively flat.

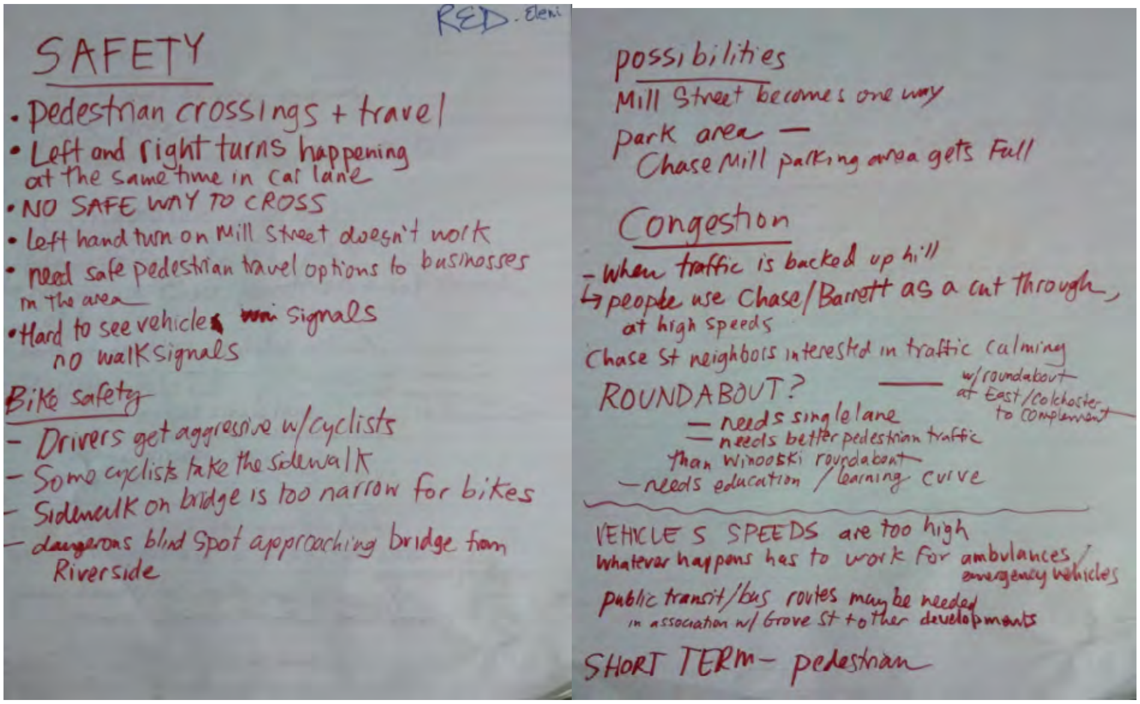
Eleni explains that they are designing the project with a 20 year design plan but cannot speak at all about when implementation of future plans will happen. Eleni says that we should also be focusing on short term solutions.

Diane calls for groups to refocus and share their ideas.

**Summary of Break out Groups**

Red Group: Selene Colburn summarizes the points discussed in the Red group.

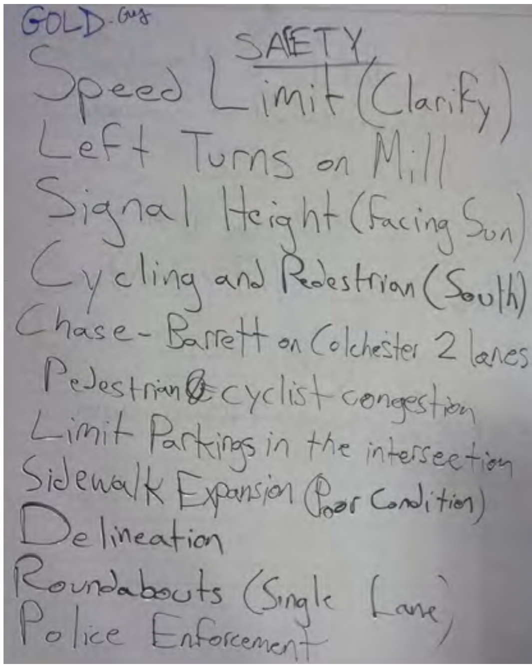
**Public meeting:**

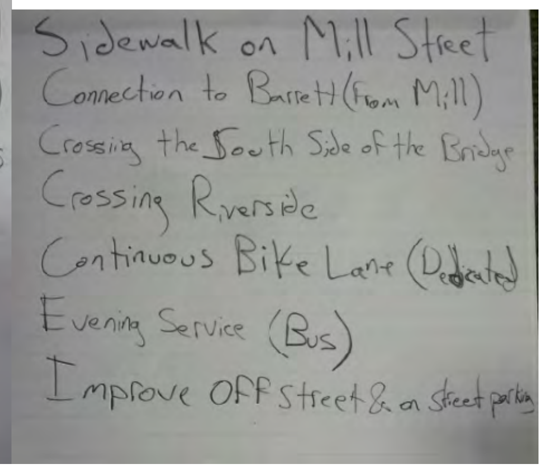




<u>Gold Group</u>: Facilitated by Greg Goyette and Summarized by Aidan Farnum Rendino.

**Public meeting:**




Aidan summarizes the group's conversation explaining that some points of concern were speeding, congestion and pedestrian safety. They highlighted Mill Street as a problematic area and noted visibility issues of the traffic signal due to the proximity to the stop bar and sunlight.

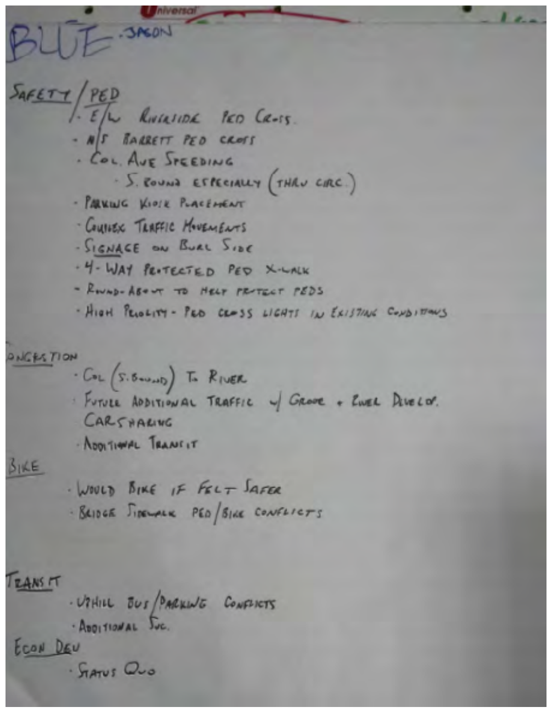
He explained that the group transitioned to a brainstorming session on different ideas for the project area. Some ideas included:

- Safety: Need to slow traffic coming down the hill on Colchester Avenue and coming from the circulator. Would be great to see roundabouts here.
- Bicycles: providing dedicated bike lanes along Colchester Avenue; providing a connection between Chase Street and Barrett Street
- Parking: Limit parking through the intersection and better mark spaces provided. Provide more off street parking. Some in the group felt that on-street parking was important between Barrett and Mill Streets along Colchester Avenue.
- Pedestrian: Expand Sidewalk; provide sidewalk on Mill Street especially with the anticipation of the Taft's School. Develop safer crossings on Burlington side of Winooski Bridge. Existing sidewalk is in poor condition.
- Transit: Provide Evening service to the area.
- Congestion: Removing the signal at Mill Street will be problematic. Gaps in the Colchester Avenue traffic stream will be reduced. There is also a left-turn trap on Colchester Avenue SB causing vehicles to move into the right lane, go down Riverside

**Public meeting:**

Avenue and then turn left at the island and then right onto Colchester Avenue/Barrett Street.

Blue Group: Facilitated and Summarized by Jason Charest. Note taking by David Armstrong (CCTA, PAC)




Jason empahsizes that safety was a main concern in their group. They discussed the existing crossings, speed through the intersection and the need for dedicated signals. They discussed the general complexity of the intersetion and the necessity for sinage to explain the lane configurations on both sides of the bridge. The idea of a roundabout was brought up.

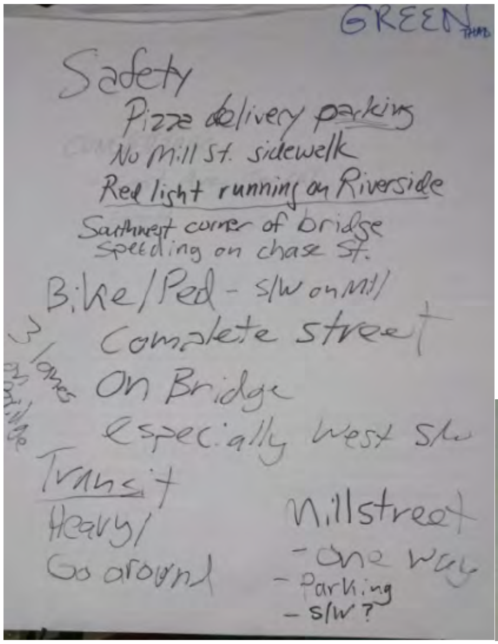
Their group talked about the congestion through the intersection. They believe it is manageable now but future developments will increase the congestion. They brought up the thought about increasing public transit through the intersection or expanding the College Street Shuttle to the Chace Mill. This improvement would require funds but could reduce traffic. The idea of increasing carshare's accessibility in this area was mentioned.

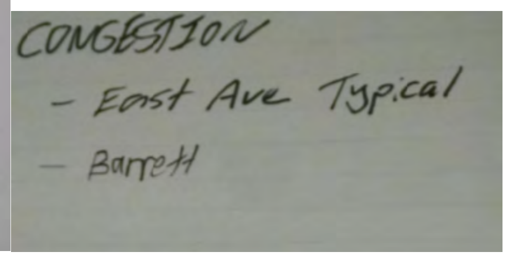
Nobody in this group bikes in this area due to safety concerns but it was observed that bicyclists typically use the sidewalk.

The problems due to transit stops was discussed. Buses do not have provided turnoffs causing back ups and will not stop on hill dependent on weather.

Green Team: This group was facilitated and summarized by Thad Luther.

**Public meeting:**




The Green team addressed the issues with dominos deliveries and parking through the intersection.

The group highlighted the Winooski developments in the area and addressed the need for a sidewalk on Mill Street. The wearing down of the curb on the southwest corner of the bridge is resulting in less and less sidewalk and provides unsafe conditions for pedestrians. The group discussed the importance of complete streets and the need to incorporate all users into the design of the intersection.

Some ideas that came up were modifying lanes on the bridge to accommodate bicyclists and pedestrians or reconfiguring Mill Street and Its back entrance to be one way to redirect traffic.

Transit stops were categorized as dangerous because cars have to pull around them when stopped. The group addressed that bus stops should have new sign explaining that they will stop weather dependent.

Congestion through the area causing backups to East Avenue was discussed.

**Closing Thoughts**

Greg asks to go around the room and give everyone the chance to list their main concerns/ or thoughts on what the focus of the intersection project should be:

- Pedestrian safety
- Slowing speeds down
- Bike lanes
- Pedestrian safety

**Public meeting:**

- Safety for pedestrian crossings- clear signaling
- Economic development opportunities- should be considered
- Safety issues- bikes and pedestrians; resolve both issues separately
- Complete street concept- multimodal friendly
- Safety for pedestrians; Make the space for multimodal transportation
- More signage for motorists. Very unclear on both sides for lane changes.
- Complete streets
- Bike and pedestrian facilities continuous through the area
- Improve access for bike pedestrian and increase buses; fewer cars
- Slowing down traffic
- Traffic speed. People run lights. Causes safety issues for cars and pedestrians
- Slow down traffic- still a neighborhood with kids
- Ped/bike safety
- Traffic calming
- Pedestrian safety; need to improve efficiency. Cannot be less efficient than it is now.
- Pedestrian safety. But addressed now while we wait for the long term project
- Remember Bruce Lapointe. One of the "dirty 17" intersections in Burlington. Believes the roundabout is the right way and needs to be concerned. We need to focus on efficiency and car and pedestrian safety.
- All types of safety and traffic flow.
- Safety and efficiency
- Overall safety and designated bike lanes. Sidewalk on Mill Street.
- Remember Mr. Lapointe who passed away when struck by a car while crossing Barrett St.
- Include Chase street in the scope of the project
- Bike/ pedestrian safety
- Importance of connectivity to Winooski

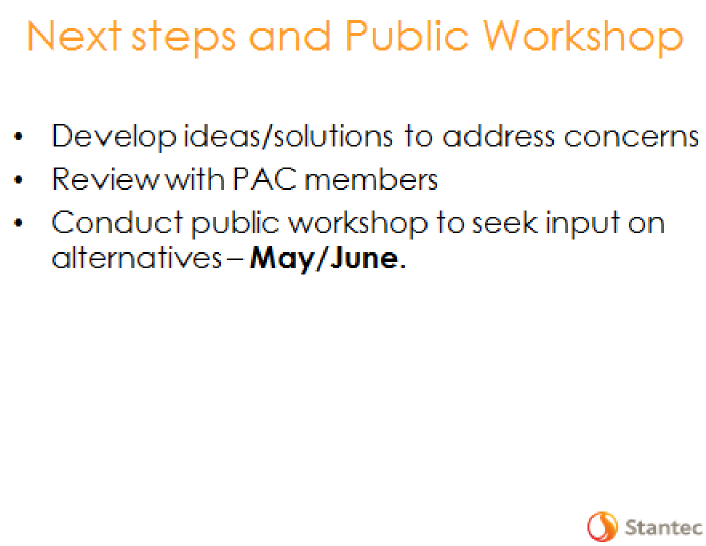
**Summary Table of Final Thoughts**

**Public meeting:**

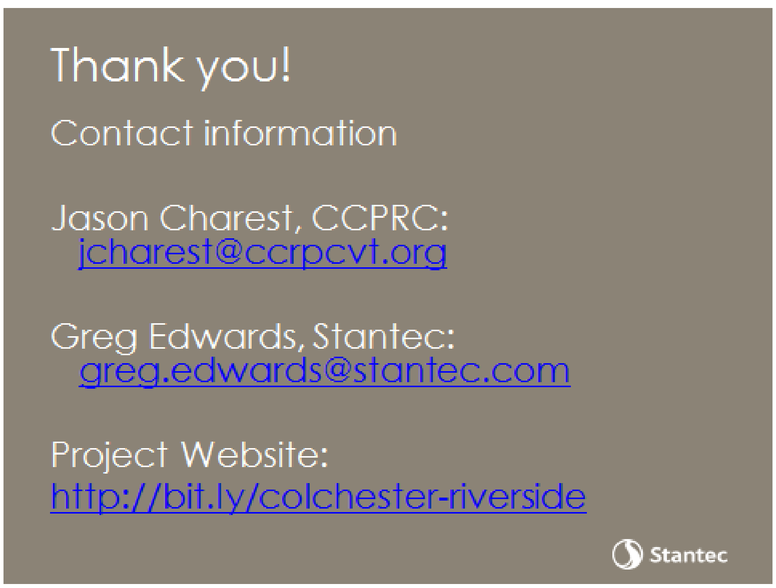
| Concern/Focus | | Freq | Additional Comments: |
|---|---|---|---|
| **Safety** | **General** | 6 | - Clear cues at pedestrian Crossings<br>- Continuous facilities for pedestrians and bikes<br>- pedestrian/bike safety issues should be solved separately<br>- Mr. Lapointe was brought up twice. Important that his fatality be remembered and that safety can be improved to stop preventable fatalities<br>- Issues need to be addressed and solved now (short term solutions) |
| | **Pedestrian** | 11 | |
| | **Bicycle** | 3 | |
| **Speed** | | 4 | - Cars are running red light |
| **Multimodal Design** | | 4 | - Complete Streets<br>- Make space for everyone<br>- Improve bike/ pedestrian/bus access; decrease cars |
| **Efficiency** | | 4 | - Improve traffic flow<br>- Roundabout could improve efficacy |
| **Economic opportunities** | | 2 | - Connectivity to Winooski |
| **Scope** | | 1 | - Include Chase Street in project Scope |
| **Signage** | | 1 | - Additional signs and markings are needed for motorists to successfully navigate the intersection |
| **Facilities** | **Bike lanes** | 2 | - Sidewalk on Mill Street<br>- Provide continuous facilities |
| | **Pedestrian** | 2 | |
| | **Bike** | 1 | |

**Next Steps**

**Public meeting:**




Greg restates that the next step for the project will include developing alternatives for the intersection. These alternatives will then be brought to the PAC within the May/June timeframe.




In closing Jason assures that more immediate/short term solutions are being looked at to improve the intersection now. The City of Burlington is working on installing pedestrian signals allowing for easier access from the shared use path over Riverside Avenue, Colchester Avenue and Barrett Street.

**Public meeting:**

A community member raises concern about presence of Winooski City Council representative and they are reassured that a greater effort to have them present at the next meeting will be made.

Feel free to contact the CCRPC through their website or through Jason directly. Their website went live today so with any issue also contact Jason.

The meeting adjourned at 9:00 PM
The foregoing is considered to be a true and accurate record of all items discussed. If any discrepancies or inconsistencies are noted, please contact the writer immediately.

**Stantec Consulting Services Inc.**

Nora Varhue, E.I.T.
Engineering Designer, Transportation
Phone: 802-864-0223
nora.varhue@stantec.com

Attachment: Attachment 1: Attendance List
Attachment 2: Evaluation Form Summary

# Meeting Notes

**Project Advisory Committee (PAC) Meeting No. 2**

CCRPC Colchester/Riverside/Barret/Mill Scoping Study / 195311163

| | |
|---|---|
| Date/Time: | April 26, 2016 / 5:30 |
| Place: | CCRPC Offices, 110 W. Canal Street, Suite 202, Winooski, VT |
| Next Meeting: | TBD |
| Attendees: | Jason Charest (CCRPC), Alexander Sampson (Winooski Public Works), Sharon Bushor (Ward 1 City Councilor), Jason Van Driesche (Local Motion), Nicole Losch (Burlington DPW), Greg Edwards (Stantec), Thad Luther(Stantec), Nora Varhue (Stantec), Wayne Senville (Ward 1 NPA Representative), Linda Letourneau (V/T Commercial - Chace Mill Property Manager), Peter Keating (CCRPC), Richard Hillyard(Ward 1 NPA Representative) |
| Absentees: | David Armstrong (CCTA), Kelly Stoddard Poor (AARP), Sandy Thibault (CATMA, Hill Institutions), Eleni Churchill (CCRPC), Meagan Tuttle (Burlington Staff) |
| Distribution: | |

**PAC Colchester Avenue/ Riverside Avenue Intersection Improvement Study Meeting:**

**Tonight's Agenda/Study Tasks and Timeline**



Following introductions Greg Edwards from Stantec outlines the meeting's agenda emphasizing two key items: gathering feedback on the issues that were highlighted at the last public workshop and discussing the set up and content of the next public workshop.

The project is currently on Task three which includes alternative development, the second PAC meeting and the second public workshop. In preparation for the next public workshop it is important to review the feedback and ideas addressed at the first public workshop.

**PAC Colchester Avenue/ Riverside Avenue Intersection Improvement Study Meeting:**

**Public Meeting Summary**

## Public Meeting Summary

| Concern/Focus | | Freq | Additional Comments: |
|---|---|---|---|
| Safety | General | 6 | - Clear cues at pedestrian Crossings<br>- Continuous facilities for pedestrians and bikes<br>- pedestrian/bike safety issues should be solved separately<br>- Mr. Lapointe was brought up twice. Important that his fatality be remembered and that safety can be improved to stop preventable fatalities<br>- Issues need to be addressed and solved now (short term solutions) |
| | Pedestrian | 11 | |
| | Bicycle | 3 | |
| Speed | | 4 | - Cars are running red light |
| Multimodal Design | | 4 | - Complete Streets<br>- Make space for everyone<br>- Improve bike/ pedestrian/bus access; decrease cars |
| Efficiency | | 4 | - Improve traffic flow<br>- Roundabout could improve efficiency |
| Economic opportunities | | 2 | - Connectivity to Winooski |
| Scope | | 1 | - Include Chase Street in project Scope |
| Signage | | 1 | - Additional signs and markings are needed for motorists to successfully navigate the intersection |
| Facilities | Bike lanes | 2 | - Sidewalk on Mill Street<br>- Provide continuous facilities |
| | Pedestrian | 2 | |
| | Bike | 1 | |

Greg presents a summary table of concerns and focuses from the public workshop. He stresses safety as a big takeaway and outlines other topics and concerns that were mentioned.

Jason Charest of the CCRPC asks the group for feedback on the summary table and asks if it accurately reflects the workshop.

Sharon Bushor of the City Council remarks that the Public Workshop's attendance was poor. She felt her break-out group was heavily focused on bicycle safety and she was disappointed that broader issues were not discussed. Topics such as vehicle traffic, mass transit and the needs of the Chace Mill and Mill Street community require further discussion. The groups' summaries touched upon other topics and issues but were not sufficient in satisfying her concerns about the intersection.

She shares her experience at a previous public meeting where participants moved from table to table with dedicated topics allowing adequate input on a range of problems. She proposes this style of meeting be considered going into the next public workshop.

Greg reassures that traffic operations will be reviewed tonight and that the focus table idea will be considered in future workshops.

Jason Van Driesche of Local Motion notes the amount of bike concerns displayed on the summary table clarifying that these bike concerns are hypothetical. Bicyclists remain too scared to utilize the intersection. He sees a lot of this attention as desire not user experience.

Hazards for bicyclists such as the chipping curb on the western sidewalk exiting the bridge, the slippery drainage structure and the lack of access to sidewalks and facilities are mentioned.

The group echoes that bike safety was a main focus at the meeting with Jason C. adding that although his group discussed traffic, safety was a focus.

Sharon redirects the discussion inquiring about plans for a new hotel in Winooski near the bridge.

Alexander Sampson from Winooski Public Works confirms a new hotel project located at the northeast corner of the bridge. Alex explains that it is an idea in progress and cannot confirm a size but would estimate that the facility to be around 80 rooms. The front entrance would be off Winooski Falls Way avoiding direct access off the Winooski circulator.

Sharon highlights that this project is relevant and should be considered into the traffic analysis.

**Draft Project Purpose and Need Statement**

[Greg passes around "Draft Project Purpose and Need Statement" for the study (See Attachments)]

Greg introduces the "Purpose and Need Statement" which will be used to measure and evaluate proposed alternatives. He reads through the handout outlining the needs of the community and summarizing key elements to be addressed in the alternatives. Greg discusses improving the safety and mobility for all users, simplifying the intersection and reducing traffic congestion.

Greg clarifies that this "Project Purpose and Needs Statement" can evolve and additional input is encouraged. This document defines a beginning point.

Jason C. asks the group to provide input now or within a couple of weeks to incorporate into a revised draft for the next public meeting.

Wayne Serville of the Burlington City Council begins discussion about the document. He believes that bike connectivity should be defined beyond a safety issue but as a greater Burlington area problem. He would additionally like reassurance in the document that the community will have access to Mill Street businesses.

Sharon asks about the On Top Burlington School program that was previously discussed as a new addition to the Chace Mill. Sharon shares her experience going to the DRB with concerns. She asks if the program has been approved.

Peter Keating believes that the program found a location elsewhere and Linda Letourneau, representing the Chace Mill, confirms. Their application has been withdrawn.

Jason C. asks Linda more about the occupancy of Chace Mill.

**PAC Colchester Avenue/ Riverside Avenue Intersection Improvement Study Meeting:**

Linda shares that the building is at about 14% vacancy. She has 7 leases lined up to begin in May and June. These businesses will bring in about 14 people. Linda explains that 80% of the Chace Mill businesses are employers while 20% are retail/ restaurants.

Linda brings up her recent experience of confronting someone who parked at Chace Mill and then started walking up Mill Street. The women explained that she was walking up to meet a focus group about the Pedestrian Bridge and Path study. The lady then continued to ask Linda about the Chase Mill's backlot.

Jason clarifies that a feasibility study for a pedestrian bridge upstream of the existing is underway. The CCRPC is managing that project and emphasizes that it is a feasibility study. Brian Davis is the project's manager and Jason offers to put Linda in contact with him.

Linda believes a pedestrian bridge in the backlot at the tree line would be a good amenity for Chace Mill users.

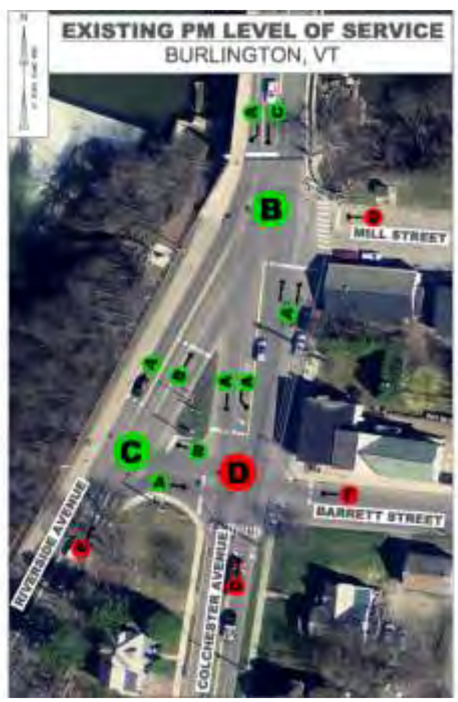
Nicole Losch of the CCRPC agrees that it would provide great connectivity across the river. She brings the groups focus back to traffic congestion.

**Existing Operations**


To summarize the existing operations of the intersection, Greg presents four graphics showing the AM Design Hour Volumes (DHV), the AM Level of Service (LOS), the PM DHV and the PM LOS. He goes through each graphic highlighting the approaches and turning movements that see the highest volumes.

**PAC Colchester Avenue/ Riverside Avenue Intersection Improvement Study Meeting:**




Greg focuses on the PM graphics due to high volumes exiting Burlington in the evening. He explains the LOS letter ranking system. The approaches and intersections are graded on an A-F scale. The lower grades reflect longer delay times for vehicles in the

**PAC Colchester Avenue/ Riverside Avenue Intersection Improvement Study Meeting:**

intersection. Greg uses Table 2 to explain how the approaches and intersections are graded.

Table 2: Intersection Level of Service Criteria

| Level of Service | Average Delay per Vehicle (Seconds) | |
|---|---|---|
| | Signalized Intersections | Unsignalized Intersections |
| A | ≤10.0 | ≤10.0 |
| B | 10.1 to 20.0 | 10.1 to 15.0 |
| C | 20.1 to 35.0 | 15.1 to 25.0 |
| D | 35.1 to 55.0 | 25.1 to 35.0 |
| E | 55.1 to 80.0 | 35.1 to 50.0 |
| F[1] | >80.0 | >50.0 |

[1]Level of Service F is also assigned if the volume-to-capacity ratio exceeds 1.0 for a specific movement or lane group. For approach-based and intersection assessments, LOS is defined solely by delay. (Source: HCM 2010 Highway Capacity Manual, Transportation Research Board, National Academy of Sciences, Washington, DC, 2010.)

The exisiting conditions report is under review and will be posted to the website.

Sharon brings up the dangerous situation when northbound buses stop on Colchester Avenue and cars pass by cutting into the southbound lane.

Jason V. emphasizes the safety issues for pedestrian's crossing when two through lanes are presented and the potential for sideswipes. He brings attention to the incident a few weeks back when two pedestrians were hit near St. Michael's College.

Peter reflects on the LOS graphics for Mill Street noticing that the AM and PM have different volumes but similar LOS values.

Greg confirms that the delay on Mill Street is due more to the length of the traffic signal cycle than the traffic volumes.

Discussion begins about Barrett Street's "F" grade. Greg shares that intersection design is about decisions and balancing approach priorities. Jason V. reflects that "F", as shown on the LOS table, has a large range and proposes that the information be further ranked to represent how badly the approach is failing.

Greg explains that further details on queues and delay can be given but explains that once an approach recieves a LOS F, any other differentiation or indication of failure is less accurate. Delay only accumulates.

Wayne asks if the delay on Barrett is signal produced or traffic produced.

Greg explains the delay is caused by competition of time from Colchester Avenue and the limitation of having a one lane approach.

Richard observes that Barrett Street delays are a combination of a short signal phase and

**PAC Colchester Avenue/ Riverside Avenue Intersection Improvement Study Meeting:**

slow dispersement of vehicles. Due to the geometry of cars exiting Barrett Street, traffic must move slowly to clear the intersection.

Sharon shares her experience of traveling behind a car trying to turn left onto Mill Street from Colchester Avenue. She shares that it is a frustrating turn and cars often wait for a red light to make an aggressive turn. This is unsafe and causes backups on Colchester Avenue over the bridge. Jason C. has observed that this turn can cause other drivers to make dangerous manuvers into the adjacent right only lane to go around a waiting vehicle.

Greg references the left turning traffic volumes for Mill Street sharing that that turn has a DHV value of 4 vehicles per hour in the PM.

Nicole brings the groups attention back to the "Needs Statement". Reading through the statements she believes that the emphasis on queues/and congestion should be clarified. She believes more emphasis should be put on striking a balance and shouldn't be a priority for every approach. She believes wording should suggest that reducing queues is not the main priority for all approaches.

Jason V. asks if there is a way to further distinguish the priority of each need.

Jason C. clarifies that the needs are not necessaritly ranked but wording should reflect the importance it holds within the project. The group agrees that the wording should be clear.

Sharon highlights her continued concern about safety through the intersection and the necessity for a shuttle service to the future Grove Street development. She shares her passion about the shuttle service and believes it will take more cars off the road and improve the safety of the area.

Jason C. asks if congestion should be adressed in the needs statement.

Jason V. believes it would be more accurate to say " improvement of traffic flow" to focus on improving the users experience.

Discussion centers on the typical traffic experienced on Colchester Avenue. Sharon and Peter share their experience observing the substantial back up extending as far back as East Avenue.

Thad Luther of Stantec adds that it takes little to cause a back up. There is no slack in the system to work with unexpected delays.

Nicole voices that a focus in the document should be incorporating the impacts of the expected growth in the area.

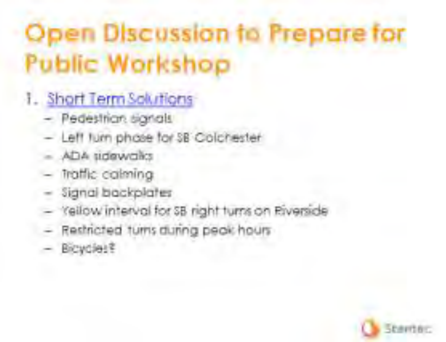
Jason V. suggests changing it to "address excessive delays" to focus more on approaches and times.

**PAC Colchester Avenue/ Riverside Avenue Intersection Improvement Study Meeting:**

Linda broadens the picture stating that congestion is a consistent issue throughout Burlington. The major arteries do not have enough capacity to hold the traffic of people exiting Burlington during the PM commute. The same issue is witnessed at other intersections leading out of downtown.

Peter recommends changing the wording from "reduce" to "manage" traffic congestion.

**Open Discussion to Prepare for Public Workshop**





Greg asks the group if the discussion should transition into potential short term or long term solution.

Sharon stresses the importance of short term solutions. She shares her experience working on the South Prospect/Pearl Street Improvement Project. It took the motivation of a resident at a public meeting to propose the preferred alternative. She believes it will take a passionate resident outside the PAC that understands the immediate needs of the community to propose an adequate short term solution.

Jason V. echoes the importance of a short term solution because of the uncertainty of available funds. Jason further asks about the northbound PM traffic volumes. He asks about the impact that one northbound lane would have across the bridge. He sees that as the only solution to enhance bike safety.

Jason V. adds that the two-to-one configuration would allow room for a two-way bike facility on the western side of the bridge that exits at Canal Street.

Greg explains that it is an option that continues to be discussed. The initial analysis of a one lane Northbound approach at the existing Colchester/Mill Street intersection indicates AM peak hour queues would extend into the Winooski circulator. Alternatively a one lane Southbound approach on Riverside would create very long PM delays on Riverside and Colchester Ave. This suggests that a reversible center lane may be necessary.

Alex shares that the Winooski Bridge's railings are being replaced along the bridge and construction would require a three-lane traffic configuration. There will effectively be a two month pilot project as a result of the construction that could be used to see the

**PAC Colchester Avenue/ Riverside Avenue Intersection Improvement Study Meeting:**

impacts of a three-lane bridge. The group agrees that this will be a great opportunity.

Greg discusses the traffic impacts of a three lane bridge with the long term four-way intersection alternative. He draws a red line on the four-way intersection alternative sketch and states that limiting the bridge to three lanes in the AM would provide approximately 150 feet of queing on the Southbound approach before becoming one lane on the bridge. The analysis indicates that the PM peak hour queue would extend further than 150 feet approximately 50% of the time during the PM peak.

Looking at the Alternative sketch Sharon is concerned about the bike lane provided between the south bound lanes. She thinks of her experience on Pine Street and communicates her confusion and dislike of the bike lane layout.

Jason V. adds that the proposed bike lane is an accepted design but would not encourage multimodal transportation. Bicyclists would still feel unsafe through the intersection.

Greg clarifies that without three-lane bridge, there are limited options for bicyclists with the existing intersection

Jason V. proposes taking bicycles out of the lane following the bridge. He states that the pedestrian bridge will be a great solution but bicyclists need more immediate resources.

Sharon asks how this configuration will serve bicyclists heading up Colchester Avenue.

Jason V. concludes that bicyclists would need to utilize the crosswalks or a two-way facility would need to extend up Colchester Avenue.

In response to a question about available data, Jason C. clarifies the DHVs do not include bicyclists but when traffic counts are conducted, bicyclist and pedestrian travel are captured. Greg adds the bicyclist facilities remain a goal throughout the alternative development.

**PAC Colchester Avenue/ Riverside Avenue Intersection Improvement Study Meeting:**

Sharon transitions the conversation to pedestrian safety and asks about flashing signals. She believes that a flashing light is the only way a cars will respect the pedestrian's right of way. She is concerned that pedestrians will not have adequate time to cross the intersection and specifically calls out cars making aggressive turns onto Mill Street and failing to yield to crossing pedestrians.

Nicole clarifies that standard pedestrian signals are used for signalized intersections.

Greg adds that once the facilities are implemented they can operate as a concurrent or exclusive pedestrian phase.

Wayne proposes adding a left turn arrow at Mill Street with an advanced turn. Sharon adds that it should be done for Mill Street and Barrett Street.

Jason V. asks Alex more about the three-lane bridge pilot project. He expresses his interest in seeing a pilot design that expands on that idea and further experiments with signalization, road narrowing, and other short term solutions.

Greg notes that is would be a great opportunity to see the 3 lane bridge's impacts on the Winooski circulator. Jason V. echoes support.

Nicole directs focus onto short term solutions. She asks about utility limitations and traffic calming techniques. She looks at the list presented on the slide and calls out curb extensions and signal backplates. Attention is brought to the need for signal backplates to fix Riverside to Barrett Street AM visibility issues.

Richard highlights the necessity for signage to orient drivers through the intersection.

Greg brings short term solution slide back up and goes through the list.


Discussion begins about adding a stop sign at Chase Street to encourage turns there but it is agreed that this change would only be moving the problem further south.

Linda expresses her concern about the long crosswalk proposed on the alternative

**PAC Colchester Avenue/ Riverside Avenue Intersection Improvement Study Meeting:**

sketch. She finds it redundant and unsafe. Greg reflects that crossings are typically provided on all approaches but exceptions are made. He adds that the pedestrian signal would work concurrently with Barrett's green light allowing for a long crossing period.

Nicole asks for further clarification on the short term options and brings attention to the alternative sketches.

Greg clarifies that the two sketches on the handout are the two long term alternatives. In response to further confusion Greg clarifies that he previously used the four–way intersection sketch to show a visual representation of the traffic impacts of narrowing the bridge to three lanes. Greg points out the redline that he drew shows the restriping discussed.

Linda asks for clarity on the yellow median lines.

Greg and Thad clarify that they are just paint and Thad further points out the sidewalk proposed on both sides of Mill Street. Wayne asks for further explanation on the difference between a short and long term solutions.

Nicole, Greg and Thad explain that they are differentiated by the amount of time and money necessary to implement. A short term solution typically remains within the curb line.

Nicole proposes that sketches of the short term alternatives be provided at the next public workshop.

Linda asks about the Mill Street's on-street parking.

Greg clarifies that this plan provides parking on one side and sidewalk on both sides.

Linda argues that on-street parking on both sides slows traffic and the proposed sidewalk would affect the newly implemented drainage riprap. She would like to see a sidewalk on the south side of Mill Street to provide access to the apartments, restaurants and businesses in Chace Mill. Greg and Thad note her preferences.

Greg asks further what short term solutions should be brought to the public workshops.

Nicole proposes the three lane bridge and asks about the feasibility of a short term T-intersection.

Thad argues that a T- intersection would be a very difficult short term solution. The alternative shown does not reflect how much grade leveling would be necessary. The existing curb line on the south end would need to be pushed back 25 feet. The elevation would be held at the northeast quadrant and the road would need to be raised around it to meet grade. This alternative would also require a six foot retaining wall. Thad adds that despite grade alterations it is a doable and good long-term solution.

**PAC Colchester Avenue/ Riverside Avenue Intersection Improvement Study Meeting:**

Wayne asks what the proposed alternative addresses.

Discussion begins explaining that the alternative simplifies the intersection, eliminates lane shifts, and provides greenspace.

Nicole suggests recapping each alternative's pros and cons at the next public meeting.

Richard asks about widening the bridge. Nicole and Jason C. clarify that is it unfeasible. The existing sidewalks are already cantilevered.

Discussion begins about signal removal at Mill Street and the limitation of left turns out of Mill Street. Greg reminds the group of the Mill Street back entrance. Linda shares that it is fine to be used by tenants. Greg suggests considering eliminating left turns on the Mill Street approach and making the rear drive a one way out road. Linda recalls it being an idea previously discussed.

Wayne further inquiries why they would need to take out the traffic light. Greg explains that Mill Street sees relatively low traffic, traffic volumes would not warrant a signal, and its addition would create additional delay and queues. Richard changes the discussion to address the bus stop on Colchester Avenue. He recalls a previous project where bus bump out were discussed but disregarded as a necessity. His experience on the road reflects that bump outs are necessary because the unsafe environment produced when buses pull over to the side of the road. He believes that bus bump outs are necessary and should remain on the table to improve safety. Greg asks if the bus stops are in the best locations or if they are better situated in front of Dominos or elsewhere.

Jason C. adds that David Armstrong from CCTA is aware of the changes being discussed and the CCRPC is currently awaiting his feedback. Jason C. hopes to see a new stop further south on Riverside Avenue.

Peter reflects that the bus system through this intersection does not see a high volume of passengers getting on and off.

Discussion shifts to the other long term option sketched on the hand out.

Richard responds to the four-way intersection predicting that it will increase Barrett Street's productivity.

Thad introduces the roundabout option explaining that traffic volumes would require a two-lane roundabout with a minimum 140 foot diameter. Thad emphasizes the grade issues presented in this alternative. The roundabout would require a cut out of the southern corner curb significantly impacting the lower lot at the bottom of Colchester Avenue.

Wayne asks about the relative safety of the roundabout option. He points out the potential difficulty for travelers moving from Barrett Street to Riverside Avenue. He explains it would be hard to find traffic gaps for travelers to cut to the inside lane to travel

**PAC Colchester Avenue/ Riverside Avenue Intersection Improvement Study Meeting:**

around to Riverside Avenue.

Roundabouts are typically considered safer but two lanes provide an additional challenge.

Nicole asks about the necessity of turning arrows leading up to the roundabout and questions the Riverside Avenue approach and the west sidewalk configurations.

Greg explains that it helps orient and prepare the driver to be in the correct lane and clarifies that the graphics provided are working sketches of an alternative.

Richard shares that more should be done to channel people out to the right lane in the configuration and questions the alternative's feasibility. He asks what would need to be done topographically speaking.

Greg explains that a retaining wall would need to be built and possibly buildings moved.

Discussion begins about moving the proposed configuration north and utilizing the Dominos building space. The group agrees that this option should be further researched.

Richard proposes the idea of having a roundabout and a signalized intersection. This option would improve pedestrian safety.

Linda mentions the challenge of bigger trucks and roundabout. The roundabout would need to provide a wide and level surface for trucks to maneuver though.

Richard argues that an infeasible alternative should not be shown at the public meeting. Discussion begins on whether it is important to present the roundabout. Many think it should be presented to show it has been discussed, and analyzed as an option but has many limitations. It would be helpful to address both the pros and cons of this option. The group summarizes the pros of a roundabout explaining that it would be aesthetically pleasing, provide better flow to the intersection and calm traffic. Jason C. concludes that the alternative will be shown and the issues will be addressed.

Peter adds that he would also like to see a cost element to the alternatives. Greg proposes the idea of developing an alternative matrix comparing the alternatives.

Wayne would like to see more explanation of the short term alternatives.

Jason C. wants to further explore the impacts of shifting the roundabout toward the Dominos building. The group decided that one roundabout alternative should be picked to be presented and analyzed at the meeting.

Richard questions Alex on his experience with the use of flashing beacons in Winooski as a short term solution. Alex shares that it really depends on traffic volumes. Flashing lights are sometimes ignored.

**PAC Colchester Avenue/ Riverside Avenue Intersection Improvement Study Meeting:**

**Next Steps and Public Workshops**


Greg transitions the conversation to the next steps and outlines what is to come. He proposes a few dates for the next public workshop. He highlights the 19th and 26th of May as dates from Diane where the UVM Conference Room is available. Everyone agrees that the 26th seems like a feasible Medical Cener's date.

The meeting adjourned at 7:45 PM
The foregoing is considered to be a true and accurate record of all items discussed. If any discrepancies or inconsistencies are noted, please contact the writer immediately.

**Stantec Consulting Services Inc.**

Nora Varhue, E.I.T.
Engineering Designer, Transportation
Phone: 802-864-0223
Fax:
nora.varhue@stantec.com

Attachment:

c.

Stantec

# Meeting Notes

**Public Meeting**

Colchester/Riverside/Barrett/ Mill Intersection Study / 195311163

---

| | |
|---|---|
| Date/Time: | May 23, 2016 / 7:00 PM |
| Place: | UVM Medical Center Conference Room |
| Next Meeting: | October-September |
| Attendees: | See Attachment 1 |

---

**Public meeting:**

**Introductions/ Agenda**


## Introductions

- CCRPC – Jason Charest
- Stantec – Greg Edwards, Rick Bryant, Nora Varhue
- GPI – Carolyn Radisch
- Third Sector – Diane Meyerhof

Stantec

## Project Advisory Committee

- Burlington City Staff – Nicole Losch, Meagan Tuttle
- Burlington City Council – Sharon Bushor
- Ward 1 NPA – Wayne Senville, Richard Hillyard
- CCTA – David Armstrong
- CATMA & Hill Institutions – Sandy Thibault
- AARP – Kelly Stoddard-Poor
- Winooski City Staff – Alex Sampson
- Local Motion – Jason Van Driesche
- Redstone – Linda Letourneau
- CCRPC – Eleni Churchill

Stantec

## Tonight's Agenda

- Review project area and status
- Review Project Purpose and Need
- Describe potential short term and long improvements
- Breakout in tables for input and discussion.
- Regroup and summarize input.

Stantec

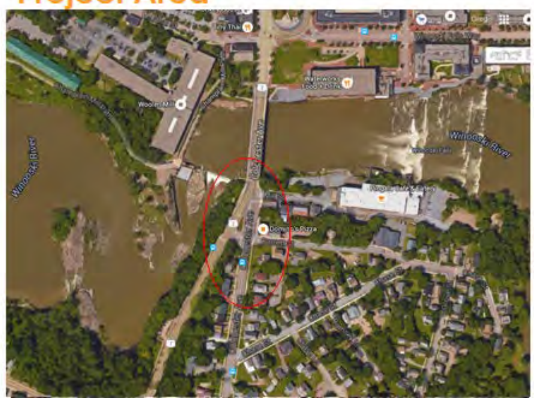
Jason Charest of the CRPC welcomes everyone to the second Mill St/Colchester Avenue/ Barrett Street Riverside Avenue Intersection Public workshop. He introduces everyone leading the Public Workshop from the CCRPC, Stantec, GPI and Third Sector Associates as well as the members of the Project Advisory Committee (PAC).

Jason briefly outlines the agenda for the night and thanks everyone for coming and participating in the project process.

**Public meeting:**

**Project Area**

Project Area



Greg Edwards of Stantec begins the presentation. Greg states the goals for the meeting asking for comments and inquiries to be held until the end. He introduces the project area as a gateway intersection between Winooski and Burlington. It is located in Burlington just south of the Winooski Bridge.

**Study Tasks and Timeline**

Study Tasks and Timeline

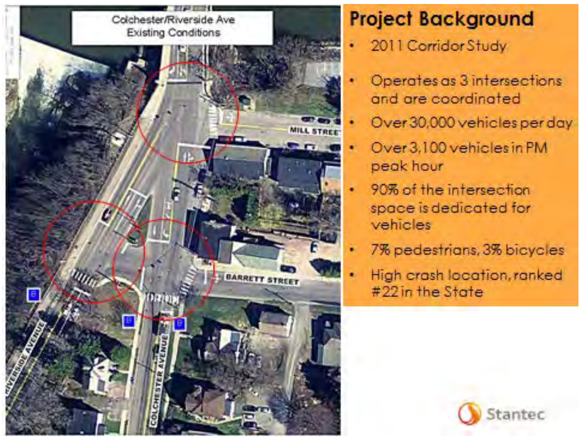
- Task 1: Data gathering ,existing conditions analysis; **January-February**
- Task 2: Local concerns public workshop; **March**
- Task 3: Alternatives development, PAC meeting, public workshop; **March – June**
- Task 4: Alternative evaluation, draft scoping report, PAC meeting ; **July- September**
- Task 5: Alternative presentation, final report; **October - December**

Stantec

Greg explains what stage the project is at by introducing the project's timeline. Tonight marks the completion of Task 3: "Alternatives development, PAC Meeting, public workshop". Following tonight's public workshop Stantec will further develop the proposed alternatives and draft a scoping report. With feedback from the PAC, a final report of the preferred alternative will be developed and presented to the community.

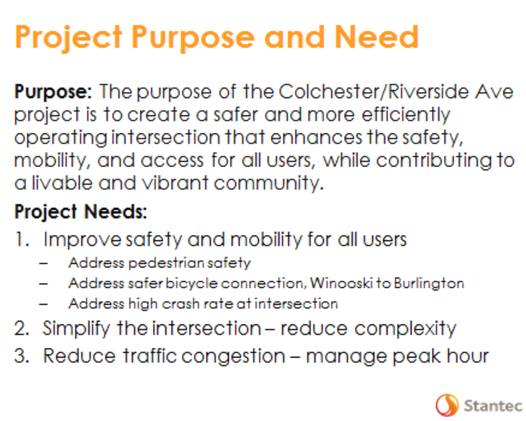
**Public meeting:**

**Project Background**




Greg discusses the previous intersection's studies. He specifically references the 2011 Corridor study. He emphasizes that Stantec used these as well as other studies and existing data to develop the proposed draft alternatives.

**Project Purpose and Need**



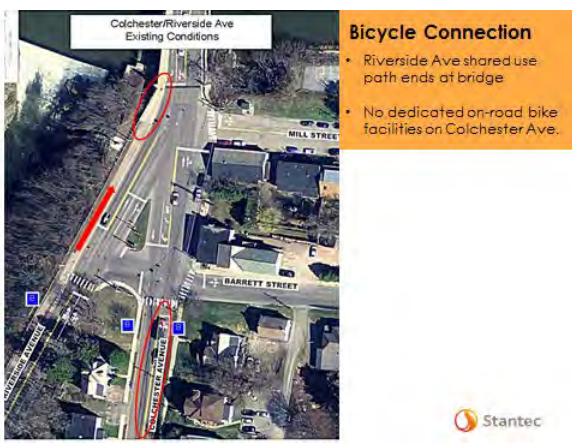

Greg outlines the draft purpose and needs statement for the intersection. He continues on further explaining and defining the community's needs for the intersection.

**Public meeting:**

**Project Needs: 1. Pedestrian Safety**


Greg first highlights the community's need for safety improvements through the intersection. Greg goes through the list on the slide to summarize features that currently limit pedestrian access and safety. He references pedestrian injuries and fatalities specifically at the Barrett Street Crosswalk. These have been caused by cars taking the unprotected left turn off of Colchester Avenue onto Barrett Street.

**Project Needs: 2. Bicycle Connection**

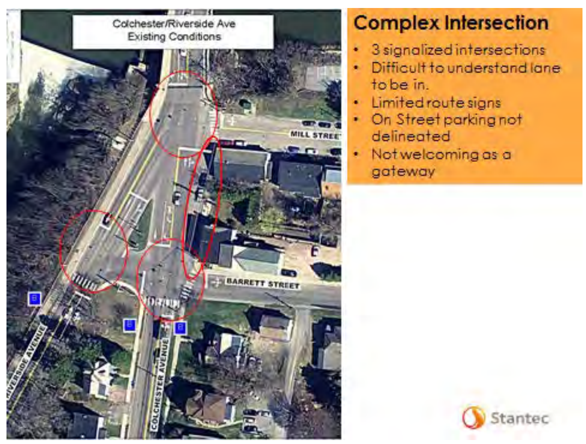




Greg transitions from pedestrian facilities to bike facilities. There is a need for bicycle connection through the intersection. The Winooski bridge currently acts as a barrier for connection into Winooski due to the abrupt end of the shared use path to a deteriorating sidewalk on the west side of the bridge. This junction is a gateway and vital connection for people traveling between Winooski and Burlington. The BTV WalkBike Plan calls for improvements to the area including a protected bike lane on Colchester Avenue.

**Public meeting:**

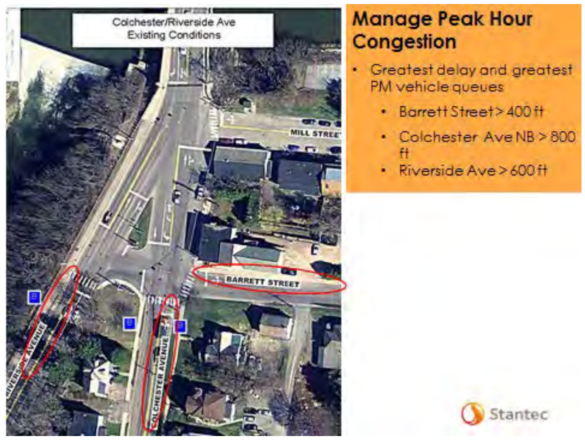
**Project Needs: 3. Manage Peak Hour Congestion**


The existing conditions of this intersection classify it as a high crash location. Greg explains the bullets on the slide summarizing that 55 crashes occurred at this intersection over a 5 year period. The majority of the accidents were rear ends, often associated with stopping traffic and signals, with no detectable pattern. Possible contributing factors include: limited visibility of the signal, unprotected left turns, and risky maneuvers caused by impatient drivers discouraged by traffic queues.

Greg addresses features of the intersection that add to its complexity. He notes the lack of a yellow phase for Northbound traffic from Riverside Avenue to Colchester Avenue as well as its tight transition for travelers in both directions. The parking in front of Dominos further complicates traffic flow. The overall complexity and confusion of drivers through the intersection hinder the area as a welcoming gateway to commuters.

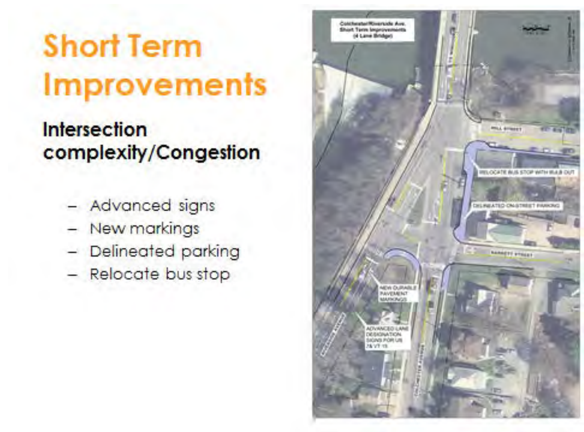
**Public meeting:**




Greg transitions to the congestion experienced through the intersection. Congestion peaks during the PM resulting in the greatest queues seen on Colchester Avenue extending back about 800 feet.

**Short Term Improvements**


**Public meeting:**




After defining the purpose and needs of the intersection, Greg begins to discuss the potential steps that can be taken to address these needs. The improvements have been broken up into both long term alternatives and short term improvements. He first discusses the short term improvements. The short term improvements do not address all the needs of the intersection but are less expensive and can be implemented on a shorter timeline.

He lists off short term features that could be added to the intersection to address pedestrian safety, bicycle connectivity, intersection complexity and intersection congestion.

When discussing bike connectivity, Greg explains that a 3 lane bridge with one lane being repurposed as a two way shared use path was discussed. This feature with the current geometry of the intersection would result in queues backing up into the Winooski circulator. This idea was eliminated as a consideration in the short term improvements but remains in the long term alternatives design.

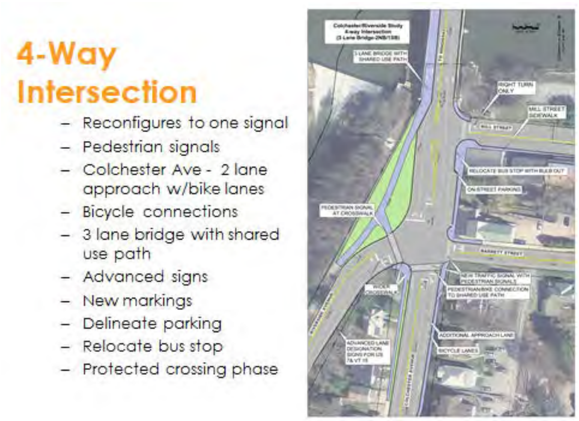
Bicycle connectivity is improved by widening sidewalks and pedestrian crossings over Riverside Avenue and Colchester Avenue to allow bicyclists traveling down Colchester Avenue to cross over to the Shared Use path.

**Long Term Alternatives**

Greg introduces the three long term Alternatives that will be outlined in the presentation. These alternatives include: A 4-Way Intersection, A 4-Way Intersection with a Separate Right Lane and a Roundabout. The long term alternatives are more expensive but have more significant changes to better address the needs of the intersection.

**Public meeting:**

**4-Way Intersection**




This alternative was modified from an alternative developed in the previous corridor study. This alternative requires simplifying the geometry to one signalized intersection with Riverside Avenue intersecting Colchester Avenue at a more of an angle. In addition to the discussed short term improvements this alternative would remove the Mill Street Signal the signal, add an additional northbound approach lane on Colchester Avenue and provide bike connection over to the shared use path. It would feature a three lane bridge with a shared use facility. The stop bar on the southbound approach of Colchester Avenue would move forward 200 feet to allow an additional lane after the bridge. One challenging feature to this alternative is the protected crossing phase over Riverside Avenue. This turn has a high volume of approx. 700 vehicles per hour. The necessary signalized pedestrian crossing at this location would significantly cut down on the capacity of the intersection. To address this challenge Greg introduces a feature in the next alternative: a separate right lane.

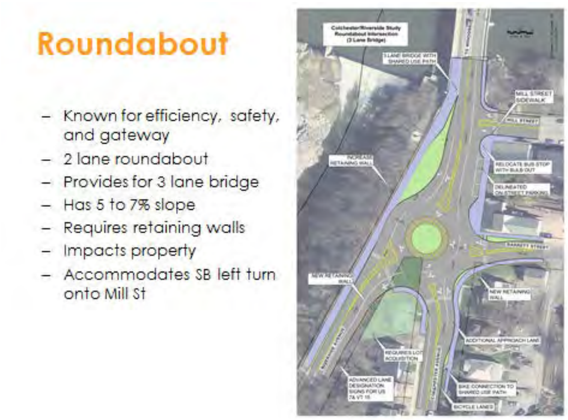
**4-Way Intersection with Separate Right Lane**


The additional lane slows traffic and provides additional warning for a crosswalk. This configuration requires vehicles to yield for pedestrians. Additional markings and crossing

**Public meeting:**

features are provided to encourage vehicles to slow down.

**Roundabout**

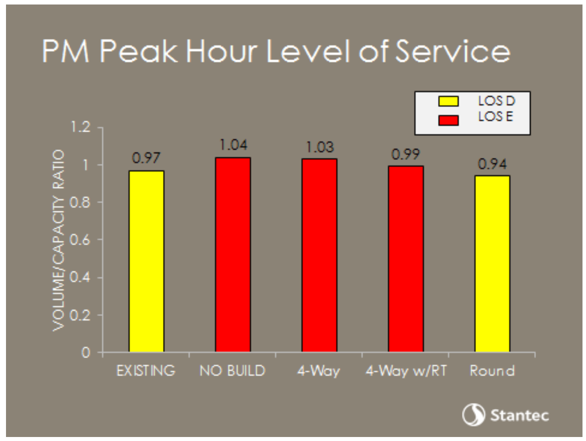



Greg introduces that a roundabout is being considered because of its reputation as an efficient and safe intersection design. It is considered a potential alternative to provide a more efficient gateway into Burlington. Traffic volumes in this area require a two lane roundabout design. A few movements allow one lane. This alternative includes a three lane bridge.

One challenge for this alternative is fitting the design into the project area. This design requires a 5-7% cross slope in some areas, increasing the existing retaining wall on the western side of the intersection and adding two additional retaining walls. The shaded property on the southern corner of the intersection would be significantly impacted requiring acquisition from the property owner. This property is considered historical which would further complicate and increase the cost of acquisition. The design would have to impede this property because the available area narrows as the intersection approaches the bridge.

**Public meeting:**

**PM Peak Hour Level of Service**




Greg introduces Rick Bryant from Stantec to the group. Rick Bryant is a Senior Project Manager at Stantec that specializes in traffic operations. He explains the amount of number crunching and analysis that goes into intersection design and simplifies it down to two values: The Intersection's Level of Service (LOS) and the volume capacity ratio (V/C). He explains the chart displayed on the screen. Yellow shows the alternatives that are graded at a LOS D and red shows the alternatives that are graded at a LOS E. He explains the volume capacity ratio as a value that represents how much volume is seen for the available capacity of the intersection. A V/C ratio of 1 means that the intersection is at capacity, serving as many cars as possible. As the V/C ratio creeps over 1, longer and longer queues are experienced.

Rick first discusses the intersections efficiency as it currently stands and explains that the analysis conducted on the draft alternatives are done with a projected growth of 5%. Using the 5% projected growth on the existing conditions to represent the 'No build alternative" shows a higher V/C ratio and a LOS E. The roundabout is the only alternative that improves the efficiency of the intersection. The other alternatives increase the safety of both pedestrians and bicycles through the intersection but these features also hinder the overall efficiency. Although the roundabout is the most efficient, northbound travelers on Colchester Avenue would still experience longer delays. Rick summarizes explaining that the efficiency would be close to existing with the first two alternatives and the roundabout would be the biggest improvement from a traffic perspective.

**Public meeting:**

**Evaluation Matrix**

## Evaluation Matrix

| CRITERIA | No Build | Short Term Improvements | Alternative 1 4-Way Intersection | Alternative 2 4-Way Intersection w/separate lane | Alternative 3 Roundabout |
|---|---|---|---|---|---|
| Construction Costs | $0 | $100,000 to $300,000 | $3,000,000 | $3,100,000 | $5, 000,000 |
| PURPOSE AND NEED | | | | | |
| Improves Pedestrian Safety | No | Yes | Yes | Yes | Yes |
| Provides Safer Bicycle Connectivity Winooski to Burlington | No | No | Yes – 3 lane bridge | Yes – 3 lane bridge | Yes – 3 lane bridge |
| Reduces Potential for Crashes | No | Yes | Yes | Yes | Yes |
| Reduces Intersection Complexity | No | No | Yes | Yes | Yes |
| Manages Peak Hour Congestion | No | No | Similar to Existing | Similar to Existing | Yes |
| IMPACTS | | | | | |
| ROW Impacts | None | None | 2000 sf | 2000 sf | 4000 sf/ 1 house |
| Historic Resources | None | None | None | None | Removes resource |

Stantec

Greg shows the alternative matrix and outlines the pros and cons of each alternative. He adds that people can take a closer look at both the evaluation matrix and the purpose and need statement which are posted in the back of the room.

**Open House- 40 Minutes**

## Open House- 40 Minutes

- Circulate among 4 tables:
  - Short Term Improvements
  - 4 Way Intersection
  - 4 way Intersection with Separate Right Lane
  - Roundabout
- Ask questions
- Offer comments
- Select Preferred Alternative

Stantec

Greg turns it over to Carolyn Radish from GPI to introduce the next section of the workshop. Carolyn encourages everyone to circle the room to mingle, ask question at each alternative station and leave comments on the boards provided. She recommends taking about 10 minutes at each station so that by the end of the 40 minutes everyone has been able to think about and understand each alternative. At the end the group will reconvene and summarize the findings of each station.

Carolyn explains that she will hand out blue stickers which she asks everyone to place on their preferred alternative.

Before the group transitions to the open house a few questions arise from the audience:

Jason Van Driesche of Local Motion asks if a single lane was considered for the

**Public meeting:**

roundabout. He wonders if a single lane roundabout's efficiency would more closely match the efficiency of the other two long term alternative. Rick addresses Jason clarifying that the 2 lane roundabout analysis yielded a 1.18 V/c ratio while the 1 lane roundabout yielded a 1.58 V/C ratio. This analysis eliminated the possibility of a one lane roundabout.

A concerned resident asks about the exit out of Mill Street. Greg clarifies that it is marked as a right turn exit only. Southbound travelers would have to take a right, maneuver through the Winooski circulator and approach the intersection from the north. The resident questions if that would add to traffic volumes but Greg confirms that it would only add about 10-15 cars in the PM and close to none in the AM.

One resident asked if the Grove street development was incorporated into the traffic analysis. It is assured that the projected growth was factored in.

A Mill Street resident voices his additional concern about the right turn only exit out of Mill Street.

A resident asked about the possibility of connecting Barrett and Mill Street. Greg responds explaining that there is an alternate exit at the rear of Mill Street. This drive is currently privately owned. Jason C. adds that there is a Chase Mill representative on the PAC and explains that using this drive will be discussed with her.

One participant questions if the roundabout would really just be moving that pinch point in traffic to a new location. Greg and Rick recognize that as a concern and explain that tradeoffs must be reviewed.

One resident of Colchester Avenue retells several experiences where someone trying to take a left onto Milstreet has blocked the intersection. This backs up traffic and temps travelers to move around waiting cars. This has resulted in many near sideswipes. She clarifies that a Mill Street and Barrett street signal is needed.

One resident asks about communication of this project with the town of Winooski. Widening the sidewalk over the bridge would only increase the AM congestion in the Winooski circulator.

Jason C. explains the CCRPC has worked with Winooski to examine ways to increase the capacity of the circulator but clarifies that Winooski is not interested in increasing capacity at this time. Eleni Churchill of the CCRPC clarifies that Winooski is focusing on safety.

One resident expresses annoyance of witnessing all the single passenger travelers. She emphasizes that carpooling should be encouraged.

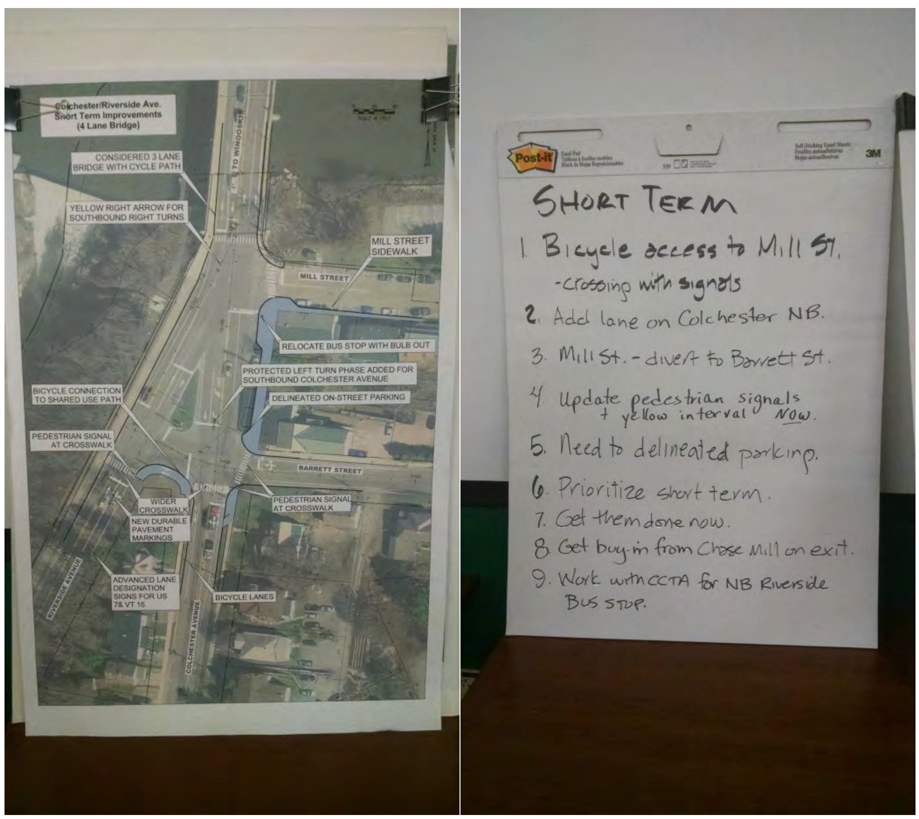
One resident asks if any quantification of the safety improvements effects on the intersection have been modeled.

Rick explains the use of The Highway Safety Manual. The Highway Safety Manual explains various features used to improve the safety of the intersection and provides means to calculate a percent crash reduction. Currently features outlined in the manual have been

**Public meeting:**

proposed for the intersection but the percent reduction has not yet been quantified.

**Summarize Open House**

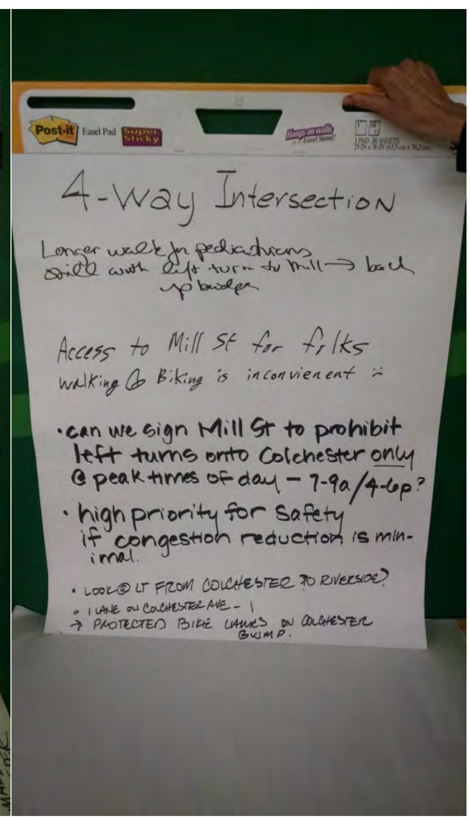

Following the open house, group leaders come up and summarize the comments and questions from each station.

Greg Edwards summarizes comments and questions that arose at the Short Term improvement's station. He outlines elements that were brought up as additional features

**Public meeting:**

that should be added to the proposed features or comments on how the features should be implemented:

1. Provide Bicycle access to Mill Street- potentially adding a crossing with signals
2. Add an additional lane traveling northbound on Colchester Avenue.
3. Add features to divert traffic from Mill Street to exit out of Barrett Street.
4. Update existing signal timing as well as incorporating pedestrian signals
5. Delineate parking on Colchester Ave between Barrett and Mill St.
6. Prioritize which features are most important to incorporate into the intersection first.
7. Implement the short term improvements now
8. Work with Chase Mill to provide an exit using the rear private drive.
9. Work with CCTA to provide a northbound Riverside Avenue bus stop.
10. Delineate road lanes through the intersection.

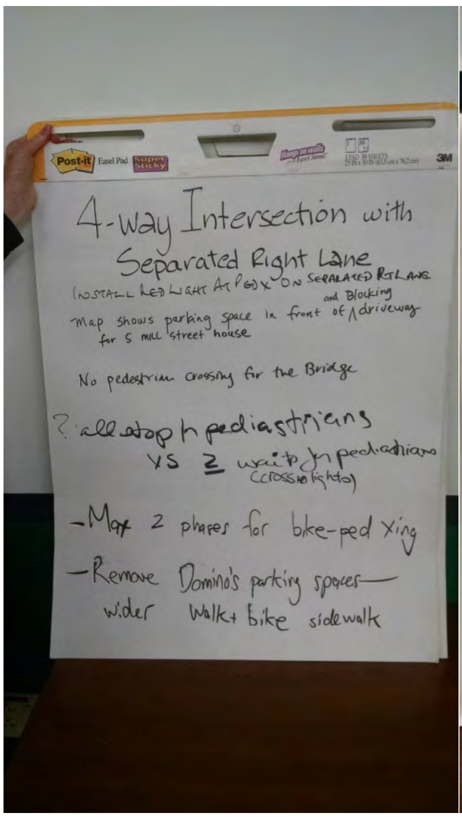



**Public meeting:**

Jason Charest discusses the comments from the 4-way intersection table. The 4-way intersection received 4 votes putting it in 3rd place for the preferred alternative.

Jason summarizes the comments explaining that reviewers were concerned about the longer crossing over Colchester Avenue and the unprotected left turn for travelers onto Mill Street. The unprotected left turn would back up traffic and would yield an unsafe crossing for pedestrians. One comment proposed prohibiting left turns onto Mill Street during peak hours. Jason shares that that option will be further examined. Jason comments that the main priority of this alternative is safety improvements, not congestion management.

One resident asks about the potential of prohibiting left turns onto Riverside Avenue. He is curious if there would be any benefit from that and recommends further examination as a potential option.



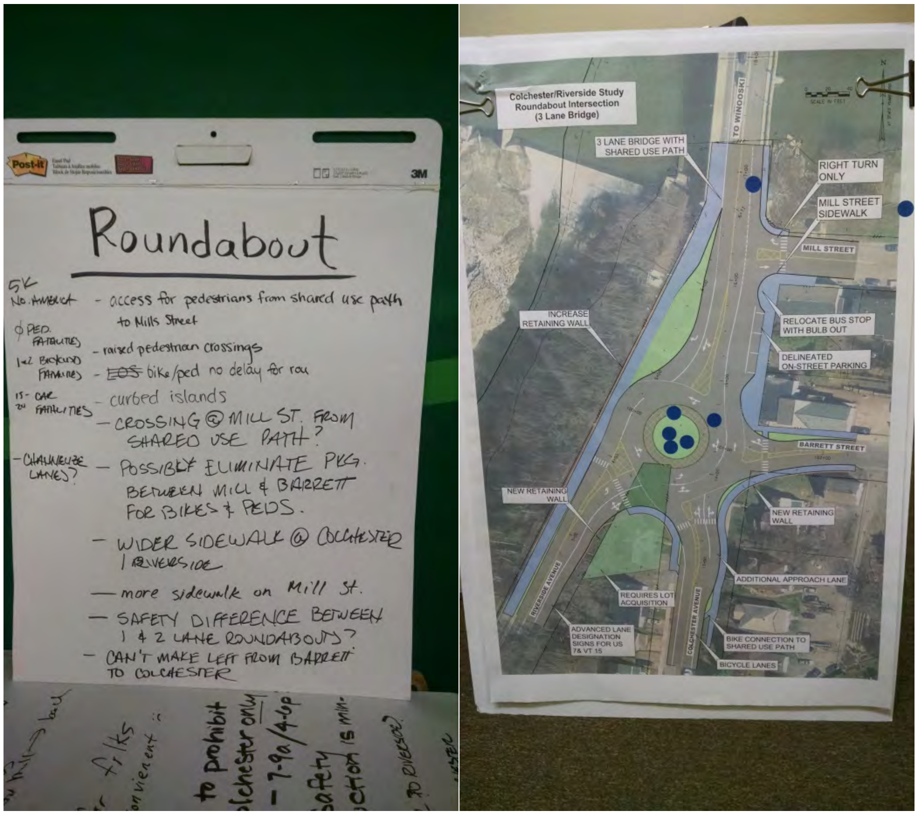


Rick follows up Jason's alternative with the 4-way Alternative with a Separate Right Lane. He explains that a lot of the similar topics were discussed but the alternative faired a little better with 10 votes. He expressed that many were interested in protecting the interests of businesses on Mill Street and maintaining parking in the area. Some shared their concerns about trucks making that left turn from Riverside Avenue.

The need for rapid flashing beacon to successfully slow traffic through the intersection and provide safe crossings for pedestrians was discussed. Some commented that safe crossings

**Public meeting:**

can only be provided if they are factored into the traffic phasing.




Carolyn summarizes the topics discussed at the roundabout station. This alternative received 7 votes. Many noted the lack of access for pedestrians that are trying to access Mill Street from the west side of the bridge. Incorporating this into the alternative was discussed. Ideas such as raised pedestrian crossings, curbed islands, providing a crossing at Mill Street to the shared use path, eliminating parking between Barrett and Mill street to provide a wider side walk or shared use path, and further channelizing the lanes with some form of curb were brought up to be considered into the design.

The overall safety and benefits of a roundabout were discussed at the station. There are 5,000 roundabouts in North America that have resulted in 0 pedestrian fatalities, 1-2 bicycle fatalities and 15-20 car fatalities. Some inquired about the difference in safety between 1 and 2 lane roundabouts. Roundabouts are considered a safe and efficient intersection design but it remains to be determined if this design works for the limitations and needs of this intersection.

When Carolyn finishes the final summary a few comments arise from the community members.

Jason of Local Motion proposes making Colchester Avenue one lane and adding a refuge island in the middle. This is accepted as something that can be looked at but would limit

**Public meeting:**

capacity and performance. Two lanes are proposed for this approach to increase capacity.

Sharon Bushor raises her concerns about eliminating the Mill Street turn. She feels this alternative would bring more cars into the neighborhoods and she would like to see more alternatives.

It is brought up that the BTV Walk Bike Plan is proposing protected bike lanes on Colchester Avenue. Adding a northbound lane on Colchester Avenue would interfere with this plan.

A community member asks about the cost and timeline of the project. He is curious of how committed the city is to making these changes and how soon the short term alternatives can be implemented. Greg Edwards clarifies that he cannot speak for the city's plans for the intersection.

Nicole Losch of Burlington DPW believes that the signals are to come soon but are not planned for this year. She is not 100% sure though and will look into the city's plan.

It is discussed that improving access for bicycles should be considered. This can be achieved by widening the sidewalks and removing the parking in front of Dominos.

Questions about one lane versus two lanes for a roundabout continue to come up.

The need to acquire a lot for the roundabout alternative is discussed. Multiple locations/positions were considered when placing the roundabout in the area. The two potential locations would require acquiring historical properties which would entail additional processes if federal funding is used. The ROW costs and the additional costs in acquiring these properties were not included in the cost estimate.

**Next Steps**



Greg explains that the next step for the project will include further development and

**Public meeting:**

evaluation of the alternatives.

Community members are encouraged to contact the CCRPC or leave comments on their website.

One resident recalls a conversation at a previous Grove Street housing development meeting sharing that money was being freed up in that project to go towards improving this intersection. He additionally asks where that money went and if it is allocated for scoping or construction? Nicole Losch informs the resident that the discussed money is funding the pedestrian signals for the intersection. Nicole will check on that timeline.

Tony summarizes his findings by commenting on roundabouts. He highlights the efficiency of maneuvering through the intersection and making that left turn onto Riverside. He believes this intersection eliminates congestion and highlights the ease of entry.

People argue that the volume will limit access into the roundabout for vehicles coming from Barrett Street into the intersection. Tony emphasizes that it would only require the vehicles going 15 feet and adds that you can add a signal to provide breaks to the flow into the intersection.

Greg begins to wind down the conversation by clarifying that Stantec and the CCRPC will take this info and further refine alternatives and bring it to the PAC meeting. From there a preferred alternative will be chosen and a final report will be produced.

Sharon asks when the community will be able to respond to the final alternative in order to tweak the final design.

Greg shares that that has not yet been discussed but the alternative presentation would be an opportunity to discuss the preferred alternative. Jason Charest adds that it was thought that the preferred alternatives would be presented to the Ward 1 NPA, DPW Commission and the TEUC prior to the City Council presentation. Sharon follows up that she would like the project process outlined online.

Diane closes the meeting by asking everyone to fill out the evaluation form and grab a flier and postcard near the door for further details.

The meeting adjourned at 9:00 PM
The foregoing is considered to be a true and accurate record of all items discussed. If any discrepancies or inconsistencies are noted, please contact the writer immediately.

**Stantec Consulting Services Inc.**

Nora Varhue, E.I.T.
Engineering Designer, Transportation
Phone: 802-864-0223
nora.varhue@stantec.com

Attachment: Attachment 1: Attendance List
Attachment 2: Evaluation Form Summary
Attachment 3: Additional Comments

**Colchester / Riverside Avenue Scoping Study**
**May 25, 2016 - Public Workshop**

**Summary of Comments**

| Comment | Proposed Resolution |
|---|---|
| **General** | |
| Encourage carpooling. | Report to include TDM techniques and on- going efforts such as travelsmartervt.org, Go Vermont". These were considered when only projecting 5% growth over 20 years. |
| Quantify and model the safety improvements effects. | The cost benefits of crash reduction have been added using assumed crash modification factors. |
| **Short Term Improvements** | |
| Provide pedestrian/bicycle connection to Mill and Barrett Streets | Currently includes crosswalk at end of the bridge. |
| Vehicles turning left onto Mill Street block the thru lane | To fully address this requires restricting left turns or adding a turn lane as part of future bridge improvement. |
| Add lane to Colchester Avenue NB | Discuss with PAC. To maintain proposed protected bike lanes, this will require roadway widening and moving curbs and sidewalk. May be considered a long term improvement? |
| Divert traffic from Mill Street to Barrett Street | Discuss with PAC. The Chase Mill rear driveway is a possibility. Making this exit only and restricting lefts on Mill Street will divert traffic but will not accommodate restricting left turns into Mill St. Another possibility is to improve the rear driveway by widening it to accommodate two-way traffic. |
| Prioritize improvements | Discuss with DPW |
| Delineate parking between Barrett and Mill Street | This is part of the short term improvement |
| Make short term improvements now. | Discuss with DPW. |
| Work with CCTA for NB Riverside bus stop. | Discuss with CCTA. |
| Delineate road lanes through the intersection | Added dotted lines when appropriate and adjust stop bar at Riverside Ave approach |
| | |
| **Alternative 1 - 4 way Intersection** | |
| Evaluate concerns with "Right only" out of Mill Street | Consider restricting in peak hours and discuss situation with Chase Mill owner to determine use of rear exit to Barrett street. |
| Improve Mill Street access for bikes/pedestrians | Revised plan to include crosswalk on north side of Colchester/Barret intersection. |
| Prohibit lefts from Mill street in peak hours? (7-9a / 4-6p) | Added note to the alternative plan to indicate this option. |

| Comment | Proposed Resolution |
|---|---|
| Concerned with lefts onto Mill St blocking through traffic | Alternative provides slight improvement over existing with some area provided for a left turning vehicle. Redirecting lefts to Chase Mill rear driveway via Barrett St. is a possibility or add left turn lane as part of a future bridge improvement. |
| Evaluate retaining 1 lane on Colchester Avenue northbound approach | This is a high volume approach which requires two lanes. A one lane approach is over capacity. |
| Provide protected bike lanes – to match the BTV Bike/walk plan | Revised plan to include protected bike lanes by removing the west side green belt. |
| Establish a high priority for safety if congestion reduction is minimal. | It is include in purpose and need and the alternative evaluation |
| Evaluate restricting left from Colchester to Riverside Ave | Discuss with PAC. Will likely divert some traffic to Barrett St. approach via Chase St. |
| **Alternative 2 – 4-way intersection with separated Right Lane** | |
| Install traffic signal for crosswalk on right turn lane | It is proposed initially the crosswalk be well marked and signed as a yield condition. If problematic additional control could be provided. |
| Change parking plan on Mill Street to allow access to 5 Mill Street driveway | Plans for all alternatives were revised to include drive opening |
| Add a north side crosswalk at Colchester and Barrett | Revised plan to include crosswalk on north side of Colchester/Barret intersection. |
| Remove Colchester Ave parking, between Barrett and Mill for wider sidewalk. | Discuss with PAC. |
| Provide a protected phase or all stop for pedestrians vs a leading interval phase for pedestrians | Due to the need to address traffic delay, it is proposed the initial operation include a leading interval operation for the pedestrian signals, similar to many intersections in Burlington. If problematic it can be adjusted to a protected phase. |
| Design maximum 2 phases for bike-ped crossing Colchester Ave | It is assumed this means going from Riverside to Mill Street. Added a north side crosswalk on Colchester Ave. |
| | |
| **Alternative 3 – Roundabout** | |
| Bike/Ped access to Mill street should be improved. | Revised plan to include crosswalk on north approach to the roundabout. |
| Provide wider and raised crosswalks. | Revised plan to include 12 foot wide crosswalks. Need to research more about raised crosswalks at roundabouts. |
| Provide crosswalk from shared use path to Mill Street | Revised plan to include north side crosswalk. |
| Eliminate parking between Mill and Barrett Streets for bike/pedestrians | Eliminated when north side crosswalk was added. |
| Create wider sidewalk on Riverside to Colchester | Revised plan to include 10 wide from Colchester to Riverside. |
| Provide curb islands | Revised plan to show curbed islands |

| Comment | Proposed Resolution |
| --- | --- |
| Add sidewalk on Mill Street | Extend sidewalk graphic on Mill street |
| Explain the safety difference between 1 and 2 lane roundabouts. | Will include safety concerns with 2 lane roundabouts in report. |
| Concerned cannot make a left from Barrett to Colchester. | Traffic analysis using Rodel shows v/c of .67 and 16 sec delay for Barret street approach and suggests the approach works well. |
| One participant questions if the roundabout would really just be moving the pinch point in traffic to a new location. | During the PM peak hour this alternative will provide greater volume traffic to the Winooski circulator for a short period. |
| 5000 roundabouts in No. America; 1 pedestrian fatality; 1-2 bicycle fatalities; 15-20 car fatalities. | No action necessary. |
| | |
| | |
| | |

# Colchester/Riverside/Barrett/ Mill Intersection Study

## PAC Meeting #3

## September 22, 2016

CHITTENDEN COUNTY RPC

BURLINGTON, VT PUBLIC WORKS

Stantec

# Tonight's Agenda

- Review Project Purpose and Need
- Describe short term and long improvements and changes since public workshop
- Review comparison of alternatives
- Discuss questions and next steps

# Study Tasks and Timeline

- Task 1: Data gathering ,existing conditions analysis; **January-February**
- Task 2: Local concerns public workshop; **March**
- Task 3: Alternatives development, PAC meeting, public workshop; **March – June**
- Task 4: Alternative evaluation, draft scoping report, PAC meeting ; **July- September**
- Task 5: Alternative presentation, final report; **October - December**

Stantec

# Project Purpose and Need

**Purpose:** The purpose of the Colchester/Riverside Ave project is to create a safer and more efficiently operating intersection that enhances the safety, mobility, and access for all users, while contributing to a livable and vibrant community.

**Project Needs:**

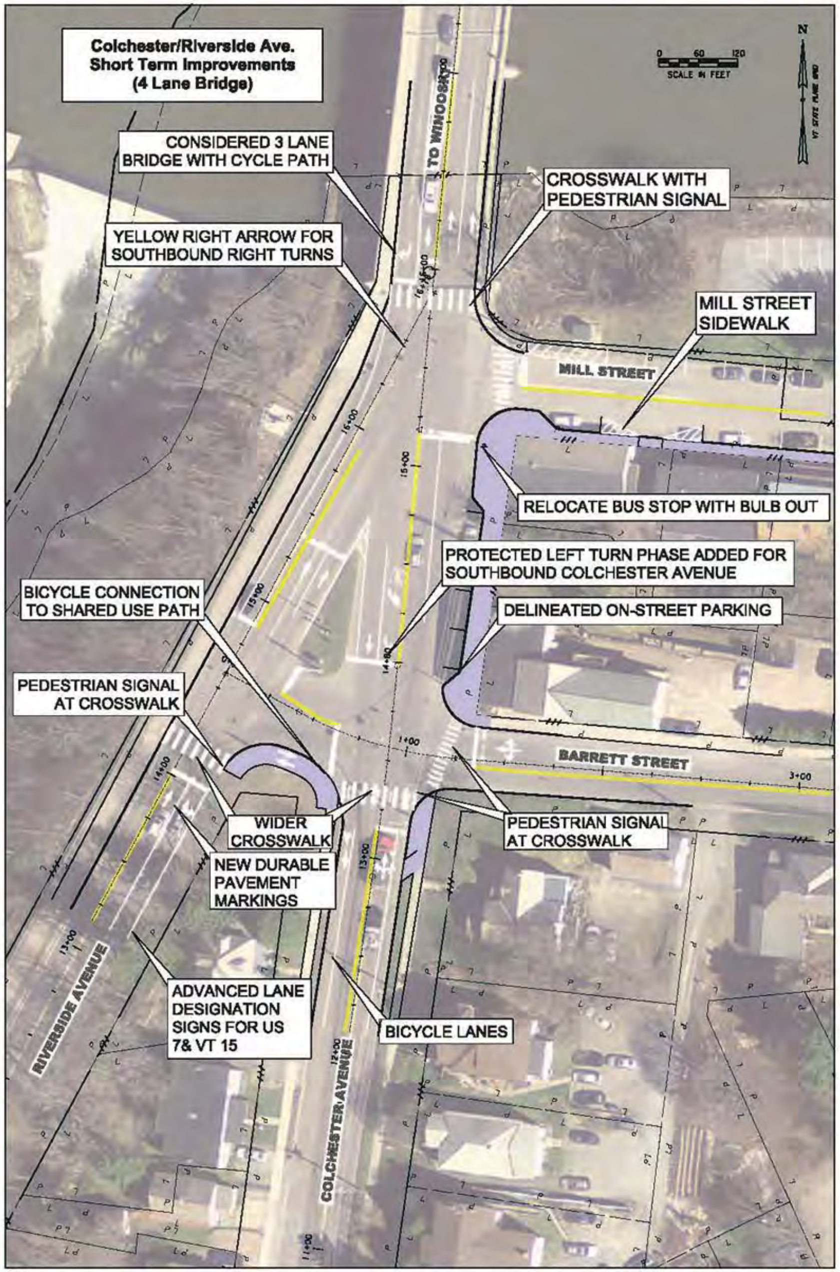
1. Improve safety and mobility for all users
   - Address pedestrian safety
   - Address safer bicycle connection, Winooski to Burlington
   - Address high crash rate at intersection
2. Simplify the intersection – reduce complexity
3. Reduce traffic congestion – manage lengthy queues.

Stantec

# Short Term Improvements

## Public comments

- Improve pedestrian/bike connection to Mill St.
- Concern with southbound left turns.
- Add lane to Colchester Avenue NB
- Divert traffic from Mill Street to Barrett Street
- Delineate parking between Barrett and Mill St




Stantec

# Short Term Improvements

## Intersection Performance

| | Existing (2015) | | | Future (2035) No Build | | | Future with Short Term Improvements | | |
|---|---|---|---|---|---|---|---|---|---|
| Peak Hour | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C | Delay | LOS |
| AM | 0.69 | 21.9 | C | 0.74 | 24.4 | C | 0.83 | 27.6 | C |
| PM | 0.98 | 50.8 | D | 1.05 | 64.2 | E | 1.10 | 68.9 | E |

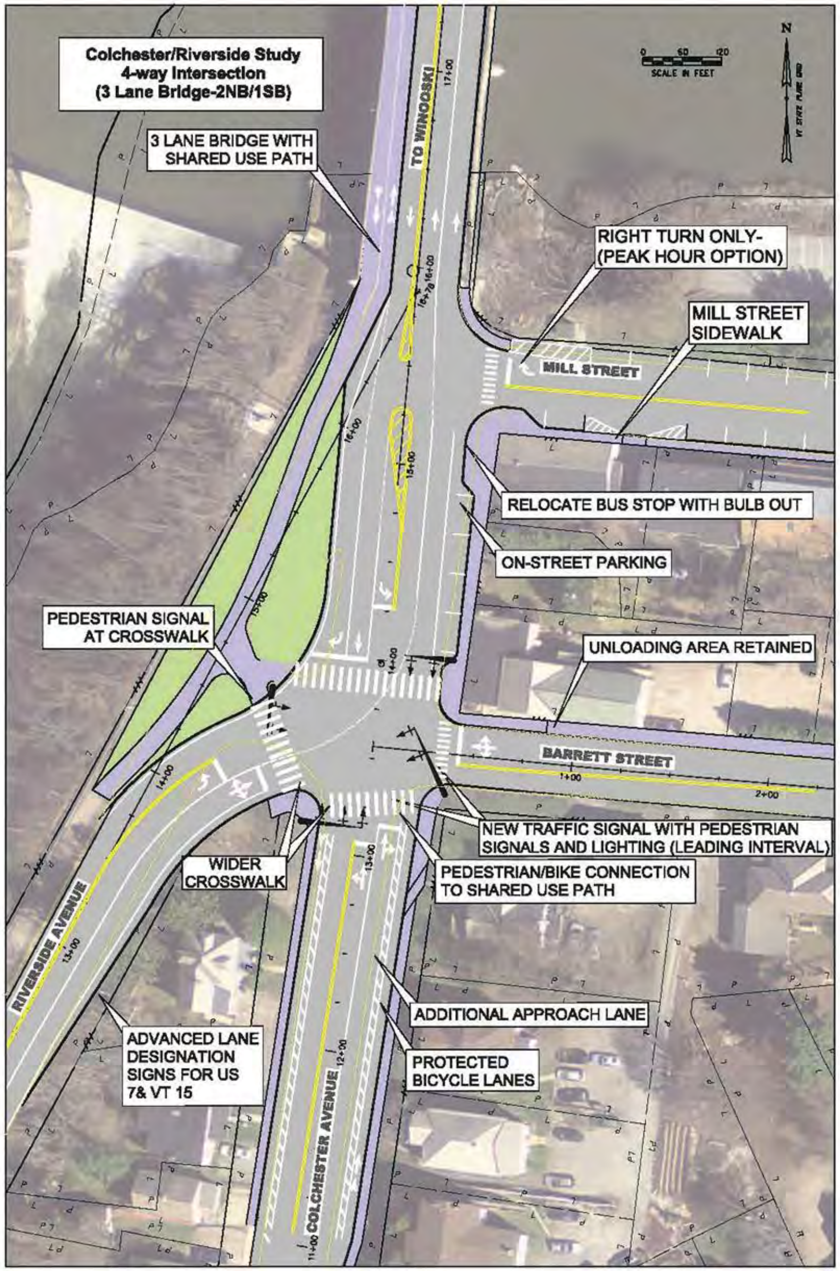
Stantec

# Long Term Alternatives

- 4-Way Intersection
- 4-Way Intersection with Separate Right Lane
- Roundabout

# 4-Way Intersection

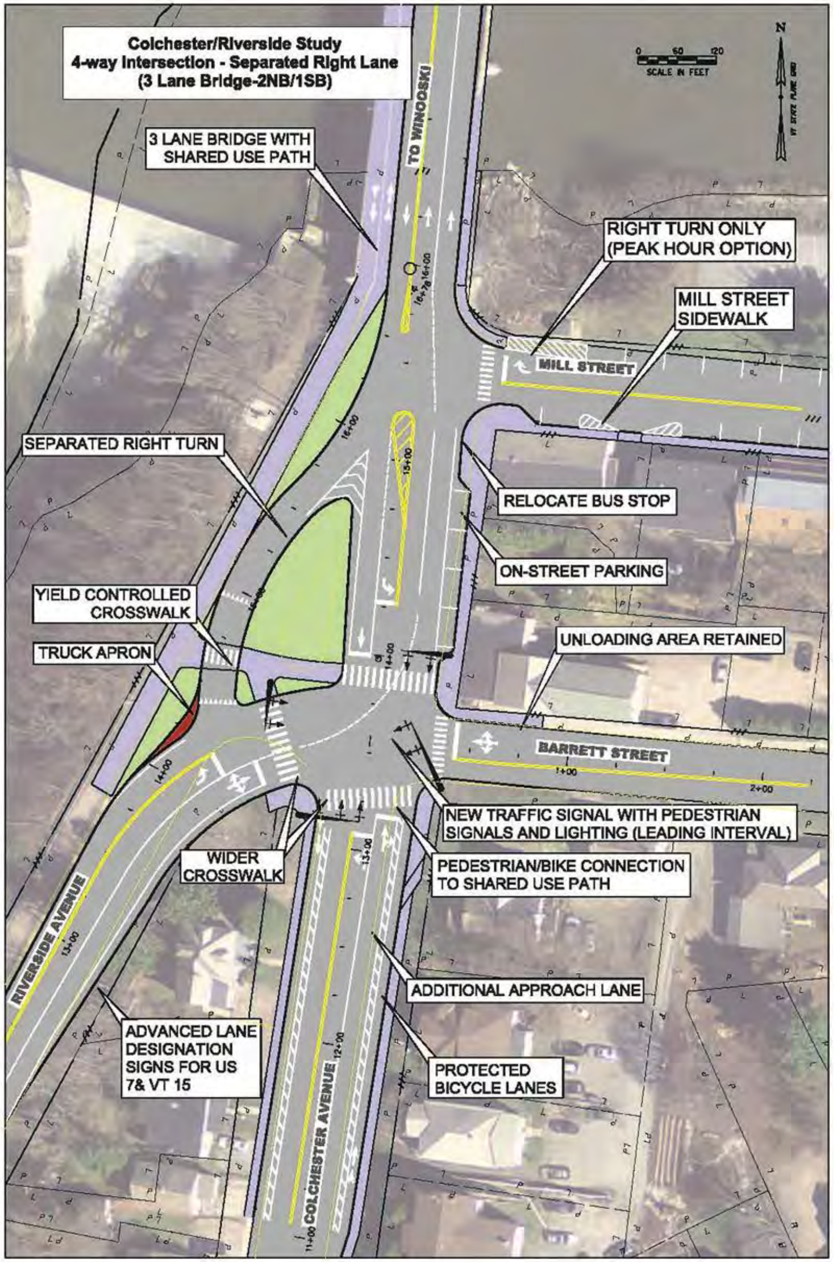
- Reconfigures to one signal
- Pedestrian signals
- Colchester Ave - 2 lane approach w/bike lanes
- Bicycle connections
- 3 lane bridge with shared use path
- Advanced signs
- New markings
- Delineate parking
- Relocate bus stop
- Protected crossing phase




Stantec

# 4-Way Intersection w/ Right Lane

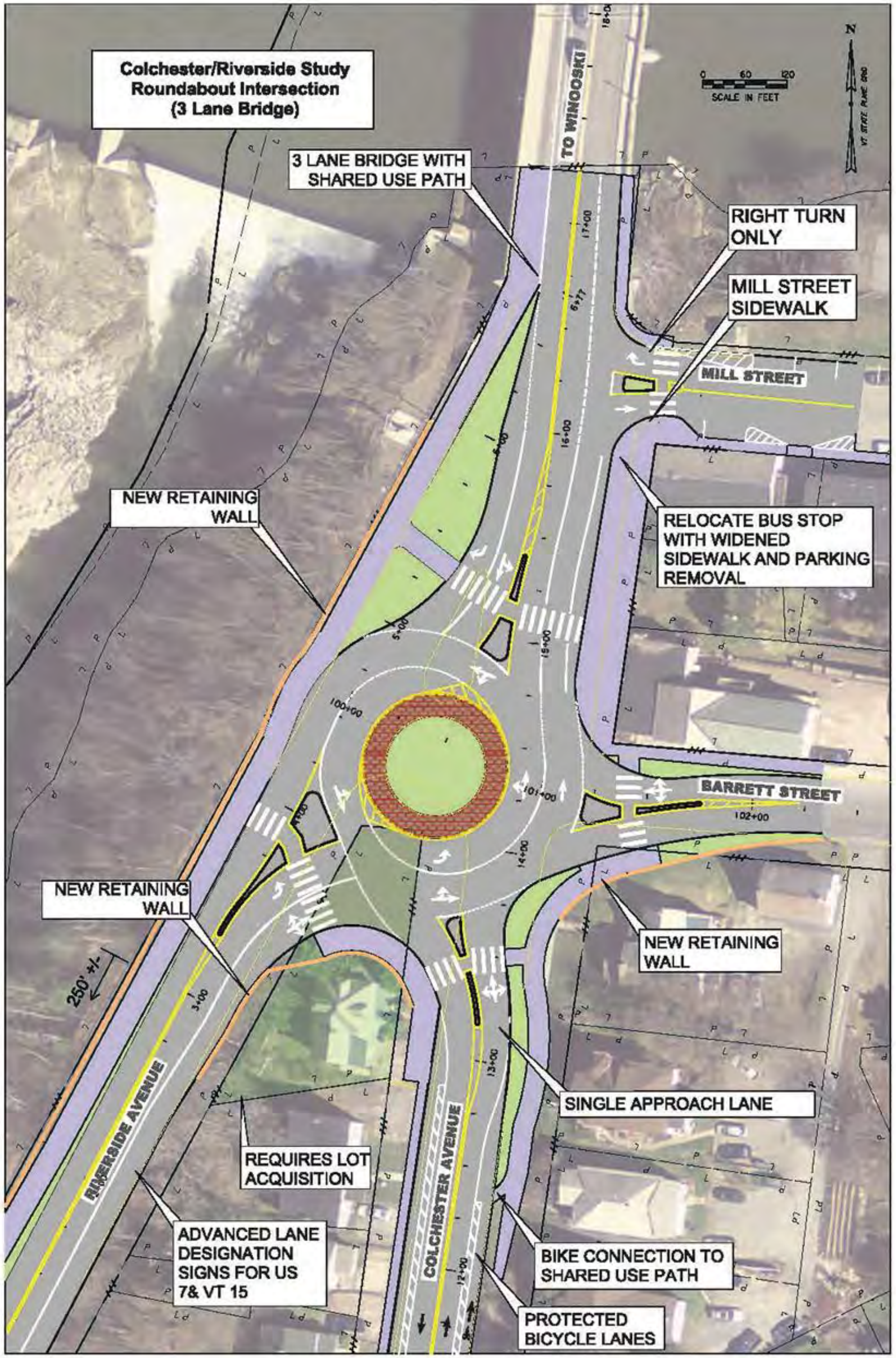
- Same improvements as 4 way
- Pedestrian signals at 4 way
- Right lane geometry promotes yield to pedestrians and improves traffic capacity.




Stantec

# Roundabout

- Known for efficiency, traffic calming, safety, and gateway
- 2 lane roundabout
- Provides for 3 lane bridge
- Has 5 to 7% slope
- Requires retaining walls
- Impacts property
- Accommodates SB left turn onto Mill St.



# Intersection Performance

| Alternative | AM Peak Hour | | | PM Peak Hour | | |
|---|---|---|---|---|---|---|
| | V/C[1] | Delay[2] | LOS[3] | V/C[1] | Delay[2] | LOS[3] |
| Existing (2015) No Build | 0.69 | 21.9 | C | 0.98 | 50.8 | D |
| Future (2035) No Build | 0.74 | 24.4 | C | 1.05 | 64.2 | E |
| Future with Alternative 1 Improvements | 0.83 | 28.7 | C | 1.00 | 70.5 | E |
| Future with Alternative 2 Improvements | 0.75 | 24.0 | C | 0.99 | 70.9 | E |
| Future with Alternative 3 Improvements | 0.36 - 0.88 | 2.5 - 20 | A - C | 0.67 - 1.09 | 16 - 47 | C - E |

Stantec

# Safety Analysis

1. **Crashes** = Crash Rate X Volume
2. **Annual Cost of Crashes** = Crashes X Cost per Crash
3. **Net Present Value** assumes 20-year life and three percent interest

Stantec

# Safety Comparison

| Location/Performance Measure | Baseline (Existing Conditions) | Alternative 1 (Four-way, Signalized Intersection) | Alternative 2 (Four-way with Bypass) | Alternative 3 (Modern Roundabout) |
|---|---|---|---|---|
| **Combined (three locations)** | | | | |
| Present Value of Crashes | $12,717,000 | $7,139,000 | $5,480,000 | $3,373,000 |
| Savings Relative to Existing | - | $5,578,000 | $7,237,000 | $9,344,000 |

# Evaluation Matrix

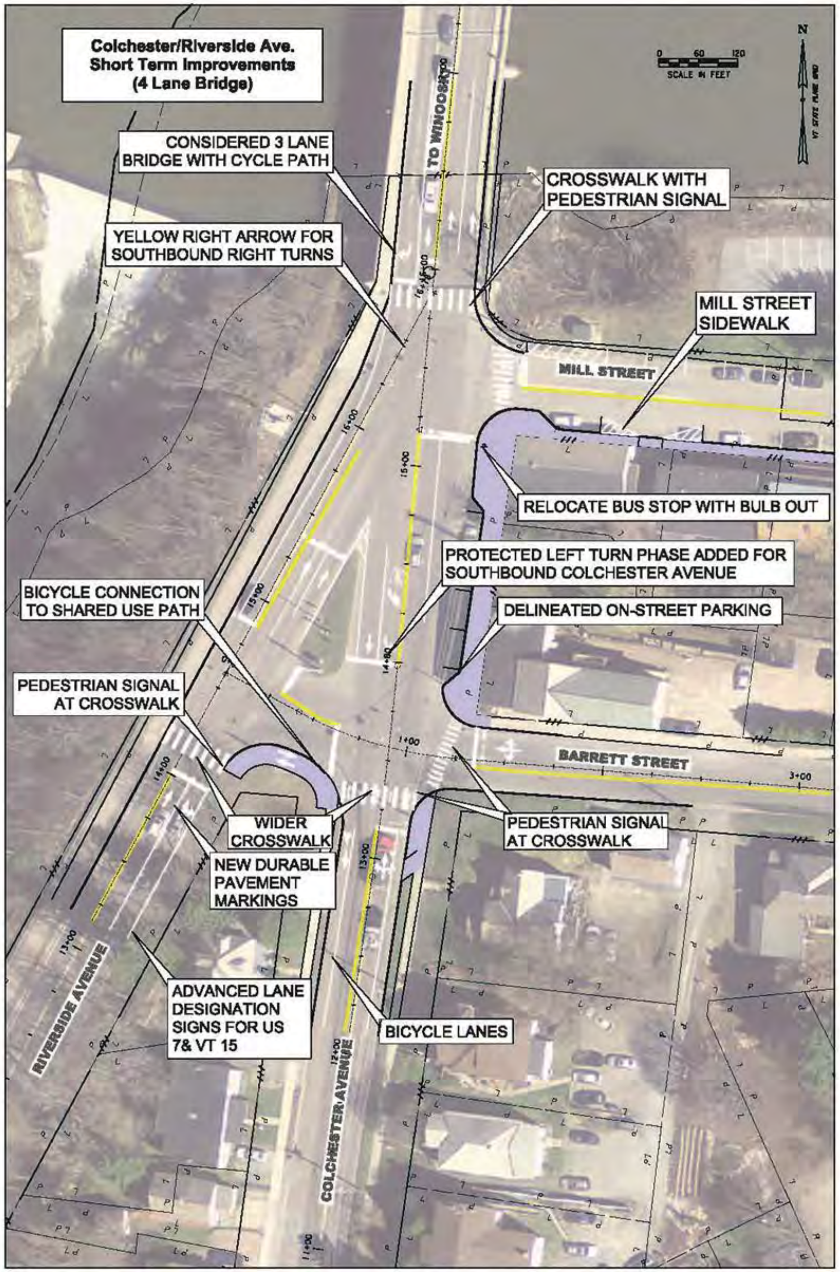
| CRITERIA | No Build | Short Term Improvements | Alternative 1<br>4 -Way Intersection | Alternative 2<br>4-Way intersection w/separate lane | Alternative 3<br>Roundabout |
|---|---|---|---|---|---|
| **Project Costs** | **$0** | **$150,000 to $825,000** | **$3,300,000** | **$3,430,000** | **$6, 700,000** |
| **PURPOSE AND NEED** | | | | | |
| **Improves Pedestrian Safety** | **No** | **Some** | **Better** | **Better** | **Best** |
| **Provides Safer Bicycle Connectivity Winooski to Burlington** | **No** | **No** | **Yes – 3 lane bridge** | **Yes – 3 lane bridge** | **Yes – 3 lane bridge** |
| **Reduces Potential for Crashes**<br>**Estimated Safety Savings** | **No**<br>**$0** | **Some**<br>**N/A** | **Better**<br>**$5,578,000** | **Better**<br>**$7,237,000** | **Best**<br>**$9,344,000** |
| **Reduces Intersection Complexity** | **No** | **No** | **Yes** | **Yes** | **Yes** |
| **Manages Peak Hour Congestion** | **No** | **No** | **No** | **No** | **Yes** |
| **IMPACTS** | | | | | |
| **ROW Impacts** | **None** | **None** | **1600 sf** | **1600 sf** | **4000 sf/ 1 house** |
| **Historic Resources** | **None** | **None** | **None** | **None** | **Removes 4(f) resource** |

Stantec

# Short Term Improvements

## Public comments

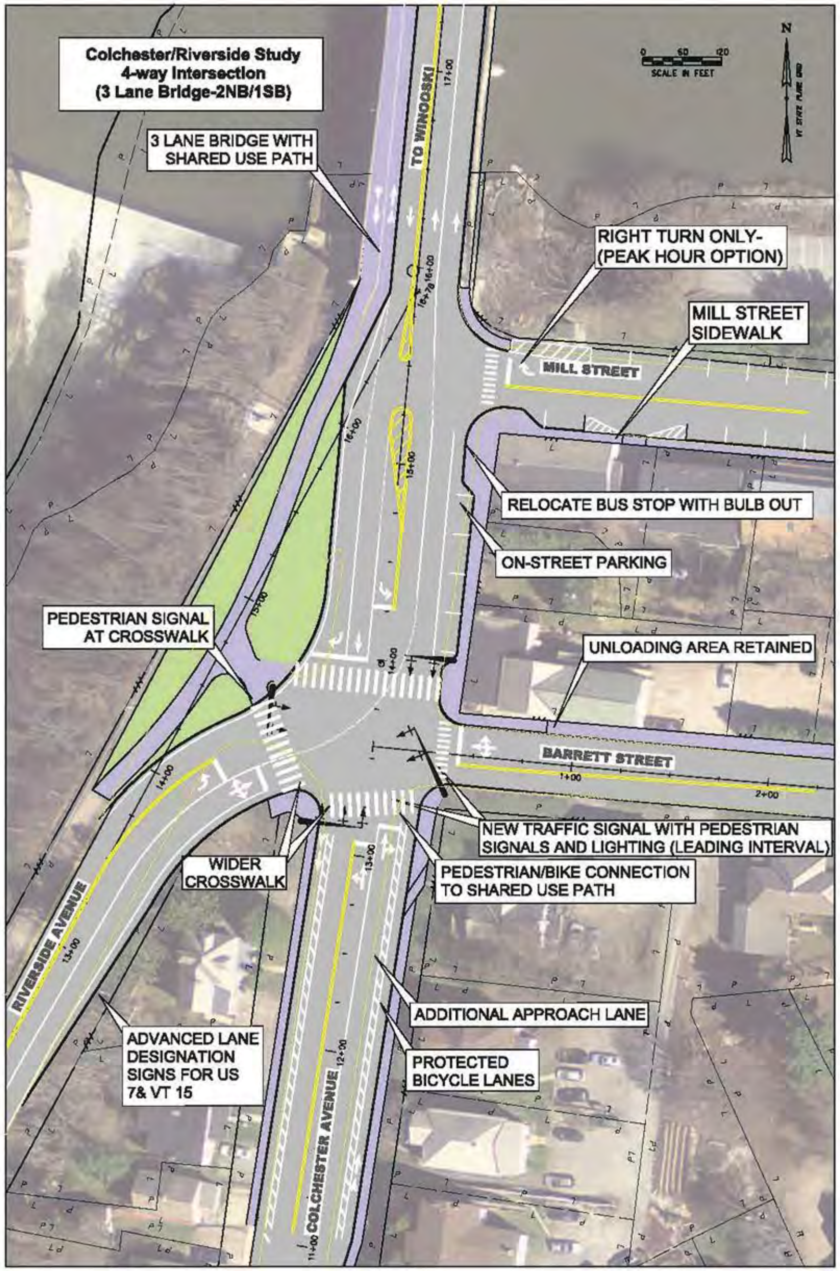
- Improve connection to Mill Street.
- Concern with southbound left turns.
- Add lane to Colchester Avenue NB
- Divert traffic from Mill Street to Barrett Street
- Delineate parking between Barrett and Mill St
- Delineate road lanes through the intersection




Stantec

# 4-Way Intersection

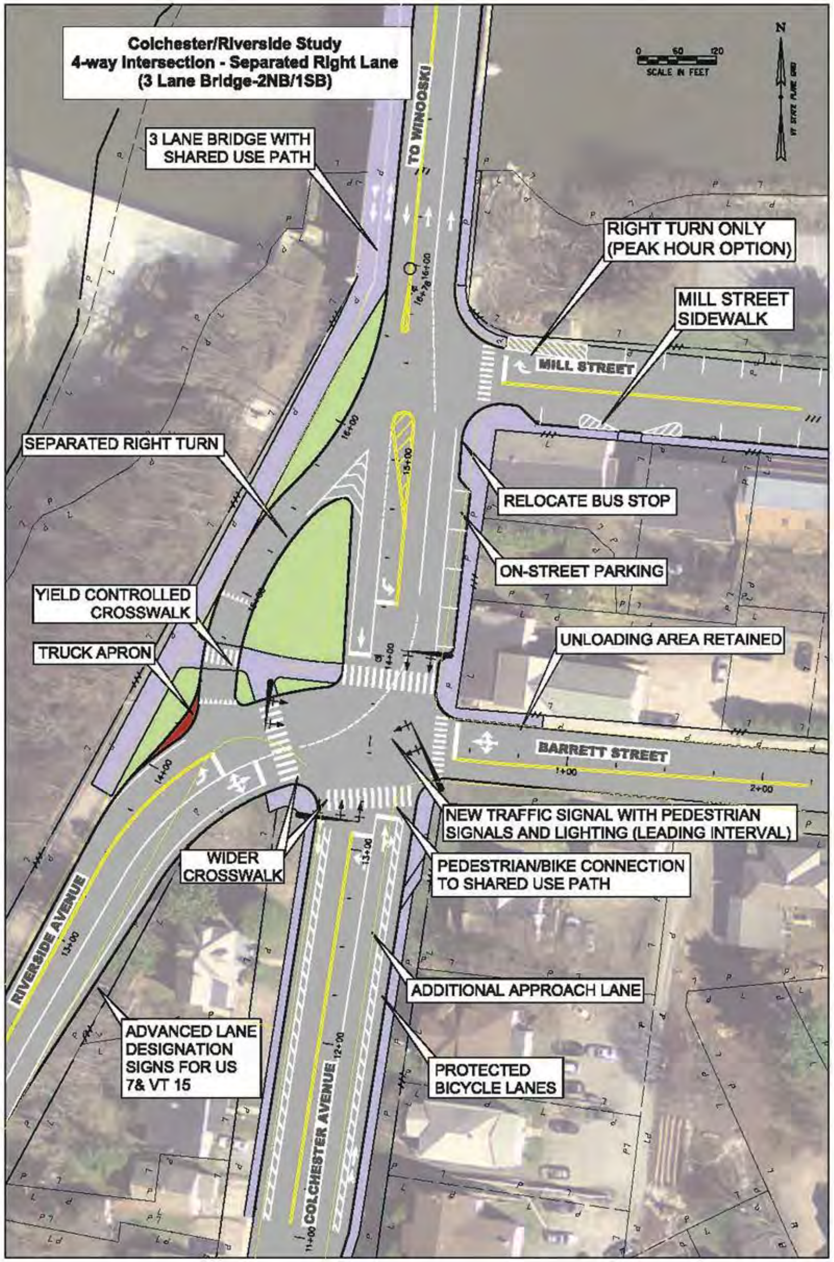
- Evaluate concerns with "Right only" out of Mill St.
- Prohibit lefts from Mill street in peak hours? (7-9a / 4-6p)
- Improve Mill St. access for bikes/pedestrians
- Concerned with lefts onto Mill St blocking thru traffic
- Evaluate retaining 1 lane on Colchester Avenue NB
- Provide protected bike lanes to match the BTV Bike/walk
- Evaluate restricting left from Colchester to Riverside Ave




Stantec

# 4-Way Intersection w/ Right Lane

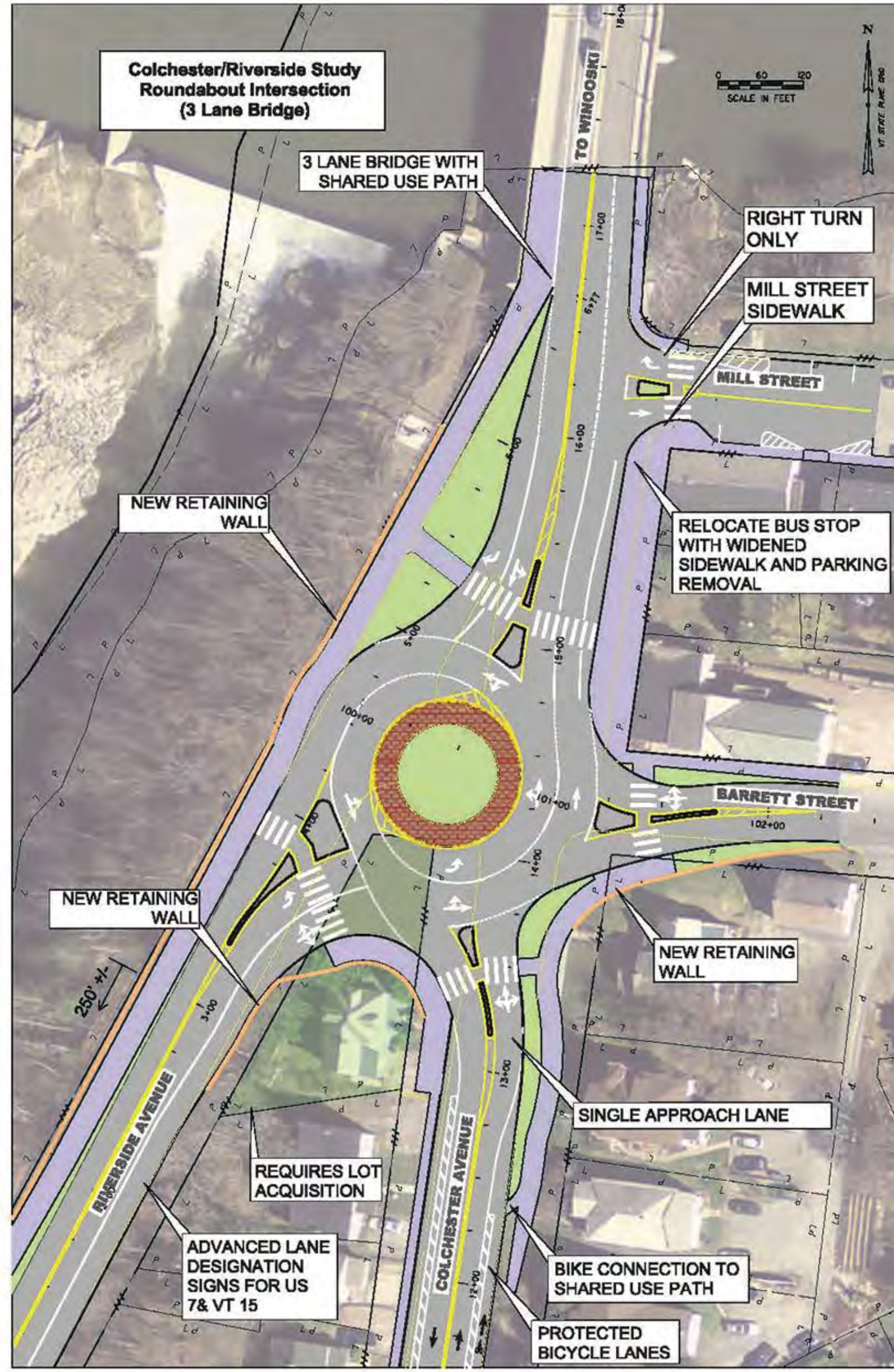
– Install traffic signal for crosswalk on right turn lane
– Add a north side crosswalk at Colchester and Barrett
– Remove Colchester Ave parking, between Barrett and Mill for wider sidewalk.
– Provide a protected phase or all stop for pedestrians vs a leading interval phase for pedestrians




Stantec

# Roundabout

- Bike/Ped access to Mill street should be improved
- Provide wider and raised crosswalks
- Eliminate parking between Mill and Barrett Streets for bike/pedestrians
- Create wider sidewalk on Riverside to Colchester
- Provide curb islands
- Add sidewalk on Mill Street
- Explain the safety difference between 1 and 2 lane roundabouts
- Concerned cannot make a left from Barrett to Riverside



# 4-Way Intersection

## Intersection Performance

| | Existing (2015) No Build | | | Future (2035) No Build | | | Future with Alternative 1 Improvements | | |
|---|---|---|---|---|---|---|---|---|---|
| Peak Hour | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C | Delay | LOS |
| AM | 0.69 | 21.9 | C | 0.74 | 24.4 | C | 0.83 | 28.7 | C |
| PM | 0.98 | 50.8 | D | 1.05 | 64.2 | E | 1.00 | 70.5 | E |

Stantec

# 4-Way Intersection with Separate Right Lane

## Intersection Performance

| | Existing (2015) | | | Future (2035) No Build | | | Future with Alternative 2 Improvements | | |
|---|---|---|---|---|---|---|---|---|---|
| Peak Hour | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C | Delay | LOS |
| AM | 0.69 | 21.9 | C | 0.74 | 24.4 | C | 0.75 | 24.0 | C |
| PM | 0.98 | 50.8 | D | 1.05 | 64.2 | E | 0.99 | 70.9 | E |

Stantec

Stantec

# Meeting Notes

**Project Advisory Committee Meeting #3**

Colchester/Riverside Avenue Scoping Study/ 195311163

---

| | |
|---|---|
| Date/Time: | September 22, 2016 /5:30 pm |
| Place: | CCRPC |
| Attendees: | Jason Charest(CCRPC), , Sharon Bushor (Ward 1 City Councilor), Jason Van Driesche (Local Motion), Nicole Losch (Burlington DPW), Greg Edwards (Stantec), Rick Bryant (Stantec), Wayne Senville (Ward 1 NPA Representative), Linda Letourneau (V/T Commercial - Chace Mill Property Manager), Peter Keating (CCRPC), Richard Hillyard(Ward 1 NPA Representative), David Armstrong (CCTA), Sandy Thibault (CATMA, Hill Institutions), Eleni Churchill (CCRPC), Meagan Tuttle (Burlington Staff) |
| Absentees: | Alexander Sampson (Winooski Public Works), Kelly Stoddard Poor (AARP) |
| Distribution: | Attendees, Absentees |

---

## Meeting Summary

Purpose of meeting was to receive comments on the draft report chapter describing alternatives. Alternatives were discussed and additional information requested. Follow-up meeting required.

## Meeting Minutes

Proposed Process Going Forward

- Alternatives will be presented to the Ward 1 NPA and the Public Works Commission. Finally, the City Council will be asked to approve a recommended plan.

Short Term Plan

- Sharon Bushor:
  - Asked if any state funding is committed to the short term plan. (No. The City will be funding the short term changes.)
  - Limits of bike lane on Colchester Avenue? (The purpose of the bike lanes on this project is to demonstrate what can be done within the existing curbs and can be compatible with the City Bike/Ped plan. The limts of this project do not effect on street parking but the BTV Walk/Bike concept and conflicts with on-street parking must be resolved with the BTV Walk/Bike concept.)
  - Clariification of three lane bridge proposal. (Two lanes northbound and one lane southbound. Multi-use path added on west side.)
- Jason Van Driesche:
  - Manhole in sidewalk is slick when wet. Unsafe for bikes. Cover with textured material

for safety.
   - Consider widening the sidewalk on the west side of the bridge by narrowing lanes to 10 feet. (Probably not possible since no shoulders available to as buffer from curb for 10 foot lanes.)
   - Add “cross bike” on Colchester Avenue south of intersection adjacent to the crosswalk. Paint green to better define bike route. (Extra wide crosswalk is proposed to accommodate multiple modes.)
- Sharon:
   - Upgrading pedestrian crossings should be the highest priority and completed as soon as possible.
   - Left turn movements into Mill Street cause back-ups under existing conditions. Back-ups may worsen with three-lane bridge. Pros and cons of prohibiting left turns was discussed.
- Chase Mill:
   - Opposed to any turn restrictions at Colchester Avenue. Rear access to Patchen Road is not suitable for two-way traffic. It is often closed to prevent cut-through (entering) traffic. When open it is intended to serve exiting traffic.
   - Access drive on the south side of the Mill is narrow and proximate to apartments owned by Al Senecal. Apartment residents may not want increased traffic on this driveway.
- Jason van Driesche:
   - Jason asked that the consultant team analyze operations at the Mill Street intersection assuming that the signal is removed and that access is restricted to right-turns only. (Removal of left turns would not allow the signal to be removed.)
- Sharon:
   - Would like to meet with other Mill Street residents and landowners prior to implementing any turn restrictions to/from Mill Street.

- Eleni Churchill:
  - Has Winooski been consulted regarding three-lane bridge proposal? (No. It may be possible to maintain four-lanes at north end of bridge.)
  - Separate study will be needed to address issues on the Winooski side of the bridge.
  - A pedestrian bridge study should begin in January. Sharon concerned that the two studies are not being conducted concurrently.
- CATMA:
  - How will pedestrians using the relocated bus stop cross Colchester Avenue? (Must use crosswalks at Barrett Street.)
- Nicole Losch:
  - Proposed crosswalk north of Mill Street may not be feasible. Space for pedestrian signal poles is limited. Wheelchair ramps would interrupt grades along the existing shared-use path. Utility manholes may also conflict with ramps.
  - Concerned that even if the crosswalk is viable in the short term it may not be viable in the long term when signals are removed from this location. Also concerned about possible public reaction should the crosswalk be built now but removed later as part of the long-term plan. (Better to never have the crosswalk than to have it then take it away?)
- Sharon:
  - Supports short term measures as the timing for long-term measures is uncertain.
- Richard Hillyard:
  - Was right turn lane considered for Barrett Street? (Yes. Concerns raised about need for roadway widening and impact to businesses with loss of on-street parking and loading zone.)
- Chase:
  - Add advance signal phase to aid southbound left turns into Mill Street.
- Jason Charest:
  - Consider moving crosswalk to south side of Mill Street if not feasible on north side. (Crossing would be much longer. Could create conflicts with through movements from Mill Street.)

- Jason Van Driesche:
    - Extend Colchester Avenue bike lanes further north (Barrett to Mill). Space appears to be available at least on east side.
- Nicole:
    - Make sure through traffic can still pass a stopped bus if bike lanes extended.
    - Not sure if sidewalks can be added to Mill Street without removing parking. (Space is available as shown on the plan except at the west end of the street where some parking would be removed.)
    - Durable pavements markings can only be used with new pavement. Unless overlays are proposed durable markings may need to be removed from the plan.
- Sharon:
    - What is transit ridership at this location? What are origins and destinations? Should/could a shelter be provided? (GMT can look up most recent ridership data.)

Long Term Plans

- Stantec:
    - Alternative 1 has been modified to include a crosswalk on Colchester Avenue north of Barrett.
- Wayne:
    - Has a three-lane bridge with an alternating flow center lane been considered? (No. Flows are fairly balanced during both peaks. Not much advantage to reversing the lanes. Lane widths may also be too narrow for this operation.)
- Jason Van Driesche:
    - Tighten southbound right-turn radius at Barrett Street to slow traffic and allow safer bike/ped crossings. Add truck apron if needed.
    - Widen proposed multi-use path between bridge and Barrett. Keep consistent, wide width. (Pinch point is at southern end of bridge and may be made worse by proposed pedestrian crossing at this location.)
- Wayne:
    - How do Alts 1 and 2 differ from a safety perspective?

- Net present value of crashes calculations are suspect since reliable crash modification factors specific to multilane roundabouts are not available. (Calculations admittedly are not precise but indicate relative performance of each alternative.)
- Can pedestrian safety be measured by other criteria? Length of pedestrian crossings? Number of signal controlled crossings? Conflicting traffic volumes in crosswalks? (Will consider.)

- Richard:
  - Roundabout does not need to be round. Does an elongated roundabout work better here?

Evaluation Matrix

- Jason V:
  - Duration of construction should be indicated. Construction will disrupt traffic flow and hurt local businesses.
- Nicole:
  - Intersection complexity should be mentioned. Alternative 1 is more complex than Alternative 2.
  - Scoring relative to operations should be reconsidered. What level of service, volume-to-capacity or delay thresholds are being used as criteria?
  - Scoring for bikes should be the same for all if the multi-use path on the bridge is common to all alternatives.
- CMP:
  - Add category for gateway/aesthetics.
- Biker (sitting next to Sharon):
  - Prefers Alternative 3. Should have positive impacts on safety by slowing traffic coming down the hill.
- CATMA:
  - Concerned that Alternative 3 results in two closely spaced traffic circles, one in Burlington and one in Winooski.
- Sharon:

- Can we incrementally implement Alternative 1 or 2 as funding becomes available? Which proposals included in the long term plans could be done early in advance of the others? (Eleni indicated that funding for the long term plan is at least seven years away. 80/20 state/local split expected unless categorized as a safety improvement in which call all state funding would be used.)

- Wayne supports phased implementation with monitoring of performance after individual elements are put in place.

- Nicole:

    - Are costs for short term improvements deducted from estimates for long term improvements? (No. Reconstruction of the short term improvements would take place when the long term plans are built.)

Next Steps

- Suggestions made included: straw poll among current alternatives; choose between a signal alternative or a roundabout; and, circulate an itemized list of possible improvements to committee members and let them vote on them individually.

- Jason Charest:

    1. Review short term proposals with DPW to confirm feasibility. Certain proposals may be deleted or deferred to the long term plans.

    2. Examine Alternatives 1 and 2 to determine if any proposed actions could be incorporated into the short term plan.

    3. Refine the long term alternatives based on comments received and update/expand the evaluation matrix.

    4. Expand report narrative to better describe the pros and cons of each alternative.

- Committee members asked to forward any written comments on the draft alternatives report chapter in one week.

The meeting adjourned at 8:00 pm

The foregoing is considered to be a true and accurate record of all items discussed. If any discrepancies or inconsistencies are noted, please contact the writer immediately.

**Stantec Consulting Services Inc.**

Rick Bryant
Senior Project Manager
Phone: (802) 497-6327
Fax: (802) 864-0165
Rick.Bryant@stantec.com

c:\documents and settings\rick\desktop\2014-05-20_corey.docx

Stantec

# Meeting Notes

**Project Advisory Committee Meeting #4**

Colchester/Riverside Avenue Scoping Study/ 195311163

| | |
|---|---|
| Date/Time: | November 10, 2016 /5:30 pm |
| Place: | CCRPC |
| Attendees: | AttendeesJason Charest(CCRPC), Sharon Bushor (Ward 1 City Councilor), Jason Van Driesche (Local Motion), Nicole Losch (Burlington DPW), Greg Edwards (Stantec), Rick Bryant (Stantec), Wayne Senville (Ward 1 NPA Representative), Linda Letourneau (V/T Commercial - Chace Mill Property Manager), Richard Hillyard (Ward 1 NPA Representative), David Armstrong (GMT), Sandy Thibault (CATMA, Hill Institutions), Eleni Churchill (CCRPC), Meagan Tuttle (Burlington Staff) |
| Absentees: | Alexander Sampson (Winooski Public Works), Kelly Stoddard Poor (AARP) |
| Distribution: | Attendees, Absentees |

## Meeting Summary

Purpose of meeting was to address comments from PAC Meeting #3, present updated plans and select a preferred alternative.

## Meeting Notes

Stantec Presentation

- The attached plans and information were provided in a handout by email prior to the meeting and in hard copy form at the meeting. Revisions to the plans were presented and comments were deferred until the end of presentation.
- A mid-term alternative was presented to address the PAC's previous question regarding what long term improvements could be considered as an initial phase in the instance constructing the long term was problematic. A mid-term alternative was proposed that consisted of the construction of the additional northbound approach lane on Colchester Avenue in addition to the short-term improvements. The mid-term improvements would compliment and contribute to Alternatives 1 and 2 but not alternative 3.
- Stantec will check "call out" on plans regarding removal of on-street parking and make it clear where parking is to remain on Barrett Street and Colchester Avenue.
- Questions asked regarding the location for the beginning of the second lane on Colchester Avenue northbound.

PAC members comments on the short term and long term improvements.

- Sharon Bushor:

- Stressed the short term improvements for the pedestrians and bicycles should be pursued. It was pointed out the short term improvements, although subject to funding, are a given and are not excluded by pursuing the long term alternatives.
- It was also pointed out The City will be funding the short term improvements.

- Wayne Seville
  - He indicated he is hesitant to support Alternative 3, the roundabout, due to the historic impacts and the pedestrian and bicycle safety concern with the 2 lane roundabout operation.
  - He suggested considering the mid-term improvements as part of the short term.

- Jason Van Driesche:
  - Also was concerned with the pedestrian and bicycle safety of the 2 lane roundabout.
  - He indicated the roundabout as too large of a scale given the context of the area and does not provided the desired gateway to the City.
  - With Alternative 2, he had a concern with the bike crossing the separated right turn lane and suggested considering providing a bike lane.
  - Also felt Alternative 2 promotes higher vehicle speeds for right turns.
  - It was pointed out Alternative 2 was developed to address the delay and queuing of the northbound right turns associated with Alternative 1. In Alternative 1 these turns are restricted during the pedestrian crossing phase and it is more likely to have queues extending onto the bridge. Alternative 2 indicates shorter queues and is therefore more compatible with a three lane bridge concept. This finding should be included in the report.
- Dave Armstrong
  - Indicated the roundabout is a ridiculous alternative due to its scale and impacts.
  - He preferred Alternative 1 since it is less complex.
  - He felt traffic simulations or 3D models would assist with evaluating alternatives.
  - Since analyses have already been completed for 3-lane and 4-lane bridge conditions this work can be folded into the bridge study.
- Eleni Churchill:
  - Indicated Alternative 2 would better accommodate traffic than Alternative 1.
  - Others indicated Alternative 1 is more attractive as it provides for a pocket park. Another concern cited is the proximity of the separated right turn lane of Alternative 2 to the shared-use path. Greater separation should be provided.
  - She indicated a scoping study for the Winooski River bridge was expected in 2017. This would include the analysis and evaluation of the lane needs on the bridge, 3 or 4 lanes.
  - It was recognized the result of the bridge scoping may influence a decision for selecting between Alternatives 1 and 2.
- Sandy Thibault:

   - Did not support a roundabout due to impacts.
- Richard Hillyard:
   - Expressed concern with the amount of expense and impact afforded to accommodate bicycles and stressed the need to address issues with implementing the short term improvements.
   - He suggested refreshing the pavement markings regularly would be great safety improvement.
- Sharon Bushor:
   - Indicated without knowing the results of the upcoming bridge study, there was not enough information to choose between Alternatives 1 and 2. However, there was general agreement that the roundabout should no longer be considered and that the mid-term alternative be supported as either a stand-along project or as a first phase of Alternative 1 or 2.
- Jason Van Driesche:
   - Suggested that the reconfiguration of the sidewalk and parking on the east side of Colchester be revaluated for the mid-term alternative so that this area does is not reconstructed twice.
- Conclusion:
   - All supported the pursuing the short term improvements as soon as possible to address safety issues. All supported eliminating the roundabout from consideration as a preferred alternative and indicated the 4 way signalized intersection alternatives, Alternative 1 or 2, should be considered as the preferred alternative. The decision of Alternative 1 or 2 as the preferred alternative will be determined based on the results of the Bridge scoping study. If there is a benefit to phasing the long term improvements, then the mid-term improvements should be pursued.

The meeting adjourned at 7:00 pm

The foregoing is considered to be a true and accurate record of all items discussed. If any discrepancies or inconsistencies are noted, please contact the writer immediately.

**Stantec Consulting Services Inc.**

Greg Edwards
Project Manager
Phone: (802) 497-6398
Fax: (802) 864-0165
Greg.Edwards@stantec.com

**Edwards, Greg**

**From:** Jason Van Driesche <jason@localmotion.org>
**Sent:** Monday, December 05, 2016 2:42 PM
**Cc:** Jason Charest; wsenville@gmail.com; pompeyhccc@hotmail.com; Bushor, Sharon F.; darmstrong@cctaride.org; Sandy Thibault - CATMA (sandy@catmavt.org); Kelly Stoddard Poor (kstoddardpoor@aarp.org); Nicole Losch (NLosch@burlingtonvt.gov); mtuttle@burlingtonvt.gov; Edwards, Greg; Eleni Churchill; Luther, Thad; asampson@winooskivt.org; Varhue, Nora; linda@vtcommercial.com; Bryant, Richard; Peter Keating
**Subject:** Local Motion additional ideas for Colchester-Riverside-Barrett short-term improvements
**Attachments:** Colchester Barrett Riverside short-term bike safety improvements - v2.pdf

Hello advisory committee members,

**I'm writing to share with you some additional ideas that Local Motion worked up to further improve walk and bike safety at the Colchester-Riverside-Barrett intersection.** As the scoping study has come to a close, these recommendations will not change the short-term alternative as presented in the report. Rather, they will be included in the appendix of the report as supporting documentation. Our hope is that they will be useful as the City moves ahead with designing and implementing short-term improvements.

**As you'll see, we have suggested <u>no</u> changes to the number or overall configuration of vehicle travel lanes, crosswalks, or on-street parking.** This proposal should therefore have no impact on modeled intersection performance. Our recommendations fall into three general categories:

1. **Narrowing of travel lanes to standard widths (10', 11', or 12', depending on context).** This improves both pedestrian and bike safety by discouraging speeding, making vehicle movements more predictable (i.e., all cars in a single line, with no squeezing by on the right), shortening pedestrian crossing distances, and making space for on-street bike infrastructure. It will likely reduce vehicle crash rates as well by discouraging speeding and unpredictable movements.
2. **Applying tighter *built* curb radii at intersections where the *effective* turning radiii (shown with red dashed lines) allow for sharper curbs without impeding vehicle movements.** This functions to improve pedestrian safety by shortening crossing distances and reducing vehicle turning speeds. It will likely improve the viability of commercial establishments as well by creating substantially larger pedestrian spaces along storefronts.
3. **Making extensive use of green paint to indicate preferred paths of bicycle travel.** This functions to improve bicyclist safety by highlighting for motorists where to expect bicyclists as well as by encouraging bicyclists to use a single (and therefore more predictable) path of travel.
   *<u>Note</u>: We are aware that the City of Burlington has not yet adopted a policy of using green paint in this way. Given both state and national guidance regarding green paint, we will continue to encourage the City to adopt such a policy (and to apply it immediately to particularly dangerous intersections like this one).*

I enjoyed the opportunity to work with you all on ideas for improving this dangerous intersection, and hope we have the opportunity to see some of these ideas implemented in the near future.

Best,
Jason

--
Jason Van Driesche
Deputy Director, Local Motion
1 Steele St., Burlington, VT 05401
o: 802-861-2700 ext. 109
m: 802-735-7271

**Resolution Relating to**

INTERSECTION SCOPING STUDY OF COLCHESTER AVENUE, RIVERSIDE AVENUE, BARRETT STREET, MILL STREET

**RESOLUTION________**

Sponsor(s): Transportation, Energy, Utilities Committee
Introduced: ____________________
Referred to: ____________________
______________________________
Action: ________________________
Date: __________________________
Signed by Mayor: ________________

## CITY OF BURLINGTON

In the year Two Thousand Nineteen …………………………………………………………………………

Resolved by the City Council of the City of Burlington, as follows:

That WHEREAS, the 2011 Colchester Avenue Corridor Study presented a high-level plan for future transportation infrastructure along Colchester Avenue, including a recommendation to address the safety, congestion, and pedestrian and bicycle issues at the Colchester Avenue, Riverside Avenue, Barrett Street, Mill Street intersection; and

WHEREAS, the Chittenden County Regional Planning Commission provided funding and support to initiate a Scoping Study to evaluate potential improvements in 2016; and

WHEREAS, a Project Advisory Committee was established at the onset to include community leaders, neighborhood representatives, and community members in the decision-making process with local and regional staff; and

WHEREAS, the *Purpose and Need for the Scoping Study* was established by the Project Advisory Committee after input from the public at community meetings, which included defining a safer intersection that enhances mobility and access for all users while contributing to livable and vibrant communities and ensuring efficient operations, addressing the need to improve safety and mobility for all users of the intersection, simplifying the intersection, enhancing the gateway to Burlington, and managing traffic congestion; and

WHEREAS, the Project Advisory Committee considered community input on the short-term improvements and three medium-term improvements before supporting the short-term improvements and medium-term Alternative 1 as the preferred alternative for intersection improvements; and

WHEREAS, the Transportation, Energy and Utilities Committee (TEUC) of the City Council has reviewed and supports the short-term improvements and Alternative 1 for intersection improvements;

NOW, THEREFORE, BE IT RESOLVED that the City Council directs the Department of Public Works to add this project to the City's capital project list and pursue implementation of the preferred short-term and medium-alternatives, keeping the City Council's TEUC and project area Councilors informed of this work.

**City of Burlington**
Department of Public Works

Technical Services Engineering Division
645 Pine Street, Suite A
Burlington, VT 05402
P 802-863-9094 / F 802-863-0466 / TTY 802-863-0450
www.burlingtonvt.gov/DPW

# Memo

*Date:* *December 28, 2018*

*To:* *Transportation, Energy, & Utilities Committee*

*From:* *Nicole Losch, PTP, Senior Planner*

*CC:* *Jason Charest, PE, Senior Transportation Planning Engineer, CCRPC*

*Subject:* *Intersection Scoping Study Recommendations for Colchester Avenue / Riverside Avenue / Barrett Street / Mill Street*

## Recommended Action

The Department of Public Works (DPW) respectfully requests the Transportation, Energy, and Utilities Committee approve the following motion:

To accept the Intersection Scoping Study of Colchester Avenue / Riverside Avenue / Barrett Street / Mill Street and endorse the Advisory Committee's selection of the short-term improvements and Alternative 1 as the preferred alternative to advance for funding and construction; and to recommend the City Council accept and endorse the same through Resolution.

## Summary

The City of Burlington has partnered with the Chittenden County Regional Planning Commission (CCRPC) to complete a scoping study of the intersection of Colchester Avenue / Riverside Avenue / Barrett Street / Mill Street, as recommended in the 2011 Colchester Avenue Corridor Study. The scoping study was led by Stantec and was advanced with the support of an Advisory Committee. The purpose of this study was to develop alternatives for improvements to this intersection. Through public meetings and Advisory Committee meetings:

- Short-term improvements (0 – 3 years) were selected to include a new crosswalk, pedestrian traffic signals, wider crosswalks, and signal system changes to include the addition of a protected left-turn phase for southbound traffic on Colchester Avenue turning onto Barrett Street;

- Three medium-term improvements (3 – 10 years) were evaluated: two variations of a 4-way signalized intersection and a full roundabout;
    - Alternative 1, a 4-way signalized intersection, is recommended as the preferred alternative.

This study was coordinated with the scoping study of the adjacent Winooski River bridge.

The final draft report and supporting information is available online at:

https://www.ccrpcvt.org/our-work/transportation/current-projects/scoping/colchester-riverside-intersection-scoping-study/

---

**<u>Transportation, Energy and Utilities Committee of the City Council</u>**
**Tuesday, January 08, 2019 5:30 PM**

**Burlington Department of Public Works – Front Conference Room**
**645 Pine Street – Burlington, VT**

**–AGENDA–**

**1. Agenda**

Chair Tracy calls to order at 5:34PM

Cnclr Bushor makes motion; Hartnett seconds; Unanimous

**2. Minutes of 10/24/2018**

Bushor: under B discussion, item # 8. Didn't understand, 8th line down, 'looked at conditions that drove worse to worse … focused on local nature streets w/ no transpo needs." Needs clarification what this means.

Norm will circle back w/ PP.

Norm: Greenbelt, occupancy of parking, local vs arterial. I will circle back w/ PP.

Bushor: Important to understand w/ clarification. Moves minutes

Seconded by Hartnett

**3. Public Forum**

Richard Hillyard: Resident of W1, Active on NPA. We had a pedestrian tragedy over Xmas period on North Ave. One of our NPA members produced FPF posting asking what is W1 NPA doing to support ped safety, etc. Highlights something we have tried to address, that there is a gap between city formally recognizing a safety problem (of whatever sort), not about Chapin or DPW directly, there is a lead time for traffic engineering … 4 to 5 years -- perfectly understandable. We addressed a problem on East Ave, Traffic calming, 2 years ago. Engaged police to see what traffic enf could take place. Anecdotal evidence, East Ave is a racetrack, little sign of ENF, no traffic calming. In response, BPD officer wrote that the residents of East are correct in assessment. Issued $1700 in tickets. Two residents went through stop sign, speeding, cyclicsts waiting to cross. Highlighted issue in this ward, just as residents of North Ave did. Three of our members went to Police Commission, challenged Chief del Pozo. If a safety issue identified, what do we do as a city to mitigate problems before DPW can do a study, recommend a fix. Brought up at NPA mtg in Sept, this is going to be a problem, we need to address it. We need to address it as a city. Chief said we are reluctant to dedicate resources to traffic ENF, loathe to expend a lot of resources on traffic details. Speed radar signed installed, quickly failed and hasn't been replaced. We need to mitigate chances of an accident happening. We've done everything we can do as an NPA.

Richard: the other thing, in Oslo - capital of Norway. Just in process of dispensing with last 700 downtown parking spaces. Something to think about, when doing something environmentally rather than building a few stories of car parking.

Bushor: Question as followup from forum. Regarding speed radar sign. I can validate almost everything Richard and police have said, very close to stop sign. I yell at drivers that go through stop sign. Incredibly frustrating, drivers seem oblivious to stop sign. Very visible sign. This is my ward, very familiar with section. I do think that we don't have all the money, but you will talk about prioritization. Pedestrian lights are incredibly effective. Lot of places in city need them.

**4. Intersection Scoping Study Recommendations for Colchester Avenue / Riverside Avenue / Barrett Street / Mill Street**

a. Nicole Losch, DPW presenting
b. 15-minute duration
c. Action: Action requested.

Nicole: Memo included
Chapin: Introduces Jason, CCRPC
Nicole: RPC partner, Bushor and Richard also on advisory committee.
Just wrapped up intersection scoping, quick intro to process. :::Nicole presents presentation:::

Bushor: Important for other two members to see what tipped scale for Alt 2, show picture. This seemed to create an unsafe intersection, a vulnerability. (Asks Richard and Jason)

Jason: You've hit the sticking point for disliking this alternative. Members on the committee uncomfortable with slip lane across sidewalk and the ped experience having to cross two crosswalks. Liked traditionality of Alt 1. Just one crossing, and completely signalized.Only other thing is people like the opportunity of green space in Alt 1 and not having right turn lane.

Harnett: What's there now

Nicole: don't have crosswalk across northern barrett, or bridge on this side of mill st intersection.

Bushor: It's a nightmare, you really can't cross by the bridge
Harnett: Where was the pedestrian killed.
Jason: Barrett crosswalk
Bushor: I'll move the motion
Tracy: Looks great, thank you for your work
Richard H: I'd like to add a few things, outside scope of presentation. First is Mill St, nice little busienss incubator, promising businesses. There is no elegant way of dealing with that junction at this stage. My view is that the city to decide what it wants with Mill St, or potentially a safety issue going forward unresolved. Other thing is that part of Barrett onto Colchester junction is constrained a little by the Dominos operation. To me, it is a sacred cow, 18 wheelers, parking there, protected b/c it's a historic building dressed up as pizza parlor.
Bushor: historic commercial
Richard H: Does not help that the business there obviates against a more elegant junction. Don't know how long the city wants to tolerate that.
Harnett: Most cars parked there are delivery cars
RH: 18 wheeler delivery trucks. Not good all teh way further up Barrett. Two things I'd say the city needs to figure out. Elegant gateway into city is wonderful, with bridge replacement will be great. Couple things hanging out.
Hartnett: Have we run this by Winooski Public Works or City Council?
Bushor: No, not part of Winooski, they were offered an opportunity
Hartnett: will impact residents
Jason: if they decide they want to
Bushor: Odd b/c on Winooski side, right on top of water/bridge/road they planned this hotel
Jason: that has moved, not going to be planned in that location
Hartnett: do we work well w/ Winooski
Norm: partnered on bridge repair
Nicole: great working relationship, and talked with their staff today on some of these recommendations. Gave them an idea to look at pavement markings going into Winooski side.

Harnett: probably one of the most dangerous intersections in the city in years, from bikes to walkers, even now.
Bushor: Move to accept intersection scoping study and do you want me to read whole thing. Move to accept intsection scoping study…. (reads language)
Harnett: Second
::Passes Unanimous.::

**5. FY 2020 Chittenden County Regional Planning Commission's Unified Planning Work Program Projects**

a. Nicole Losch, DPW presenting

b. 15-minute duration

c. Action: Action requested.

Nicole: we work through RPC UPWP, due every January. Transportation link. Work w/ other city dep'ts on projects we should apply for for upcoming year. Requires public forum and community. Updates since memo went out.

Nicole: The one project we know we're including Winooski Ave Transpo Study, continuing to list that. Will be partnering w/ S Burl on Queen City Park Rd and Bridge - to improve ped safety and bridge. App will be submitted by S Burl, we wills upport. Not requiring local match as it is regional We also include several small requests on inspections and coutns: pavement inspections (⅓ of system every year), parks facilities being added into pavement inspection, we always submit list of traffic coutns, ped and bike counts, will continue including. Under tech assistance category, may require match depending on hours estimated for project: landfill led by CEDO and PZ - will likely not pursue. Some work has been done on Accessory dwelling units.

:::notes not take::::
Nicole: As we submit, we prioritize. We do have suggested motion at beginning of memo. Relates to supporting the process and local match allocation.

Bushor: There are two, my personal favorites. Sidewalk gap analysis, responsive to residents who talk about sidewalks all the time. I oversee a lot of things in the blood bank, what we come to know, sometimes you can't see your own shortcomings. When you say 'in-house' it's most apprbody orpiate, other times good to get someone else to look at it. I would like to see improvement in approach on sidewalk repair. Hoped this would begin that foundation. Based on what you said, you said new and not existing sidewalks. It's not that I don't care about new, I just want focus on repairing existing sidewalks. Should be considered as an item on this list.

Chapin: We discussed that

**City of Burlington**
Department of Public Works

Technical Services Engineering Division
645 Pine Street, Suite A
Burlington, VT 05402
P 802-863-9094 / F 802-863-0466 / TTY 802-863-0450
www.burlingtonvt.gov/DPW

*Date:* *March 18, 2019*

*To:* *City Council*

*From:* *Nicole Losch, PTP, Senior Planner*

*CC:* *Jason Charest, PE, Senior Transportation Planning Engineer, Chittenden County Regional Planning Commission*

*Subject:* *Intersection Scoping Study for Colchester Avenue / Riverside Avenue / Barrett Street / Mill Street*

---

The City of Burlington has partnered with the Chittenden County Regional Planning Commission (CCRPC) to complete a scoping study of the intersection of Colchester Avenue / Riverside Avenue / Barrett Street / Mill Street, as recommended in the 2011 Colchester Avenue Corridor Study. The scoping study was led by Stantec and was advanced with the support of a Project Advisory Committee. The purpose of this study was to develop alternatives for improvements to this intersection. Through public meetings and Advisory Committee meetings:

- Short-term improvements (0 – 3 years) were selected to include a new crosswalk, pedestrian traffic signals, wider crosswalks, and signal system changes to include the addition of a protected left-turn phase for southbound traffic on Colchester Avenue turning onto Barrett Street;
- Three medium-term improvements (3 – 10 years) were evaluated: two variations of a 4-way signalized intersection and a full roundabout;
    - Alternative 1, a 4-way signalized intersection, is recommended as the preferred alternative.

This study was coordinated with the scoping study of the adjacent Winooski River bridge.

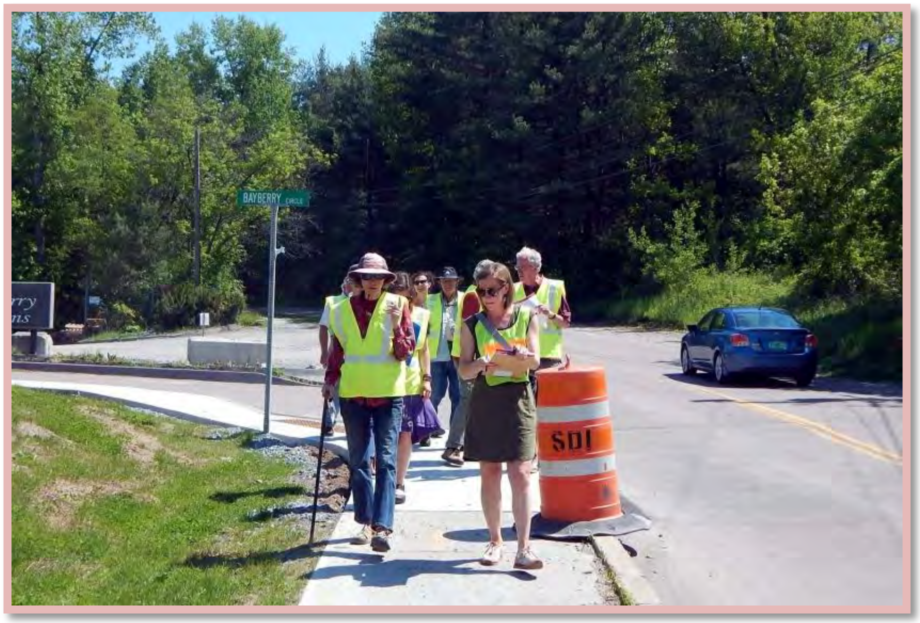
The final draft report and supporting information is available online at:

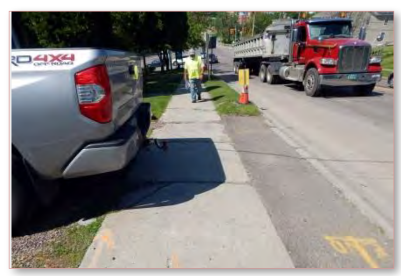
https://www.ccrpcvt.org/our-work/transportation/current-projects/scoping/colchester-riverside-intersection-scoping-study/

The Department of Public Works and the CCRPC will provide a brief introduction to the Scoping Study and request that City Council approve a Resolution that endorses the Advisory Committee's selection of the short-term improvements and Alternative 1 as the preferred alternative to advance for funding and construction.  The Council's Transportation, Energy & Utilities Committee received a briefing on this scoping project and unanimously voted to advance the resolution to the full City Council at its January 2019 meeting.

# Age Friendly Burlington

***Livable Communities for All Generations***



Burlington Centennial Neighborhood Walk Audit

Survey Results – May 30, 2018

AARP®
Real Possibilities

## Introduction

The 50-plus population is the fastest growing age group in the nation and is projected to increase by 23 million, or 21 percent, by the year 2030. Given the aging baby boomers, older adults will continue to be a significantly large proportion of the population for years to come. In Vermont, adults age 65-plus make up 15 percent of the total state population- and rising. The continued growth in the older adult population must be considered as these adults strive to maintain their independence and quality of life as they age.

The growing population over 50 represents both a transformative force by itself and a net asset to the city of Burlington. In 2006, AARP Vermont launched the Burlington Livable Community Project, a collaborative approach to planning for the demands an aging population will place on Burlington as a city, its residents, and its resources while recognizing how older adults will continue to fuel economic activity far longer than past generations have. Today, AARP Vermont's efforts for a "Livable Burlington" aim to provide direction, assess needs and resources, and develop recommendations in the areas of housing, transportation and mobility, and community engagement. In support of this effort, in May of 2018, AARP Livable Community Volunteer Team organized a neighborhood walk-audit to gauge concerns and needs as residents strive to stay in their homes and communities as they age.

The team set out on May 30, 2018 to conduct a walk audit to further the goals outlined in the action plan under outdoor spaces and buildings. AARP staff, volunteers, committee members of AARP Livable Community Volunteer Team along with community members, and State and City staff surveyed the intersections, sidewalks, and crosswalks in Burlington to shed light on the opportunities to enhance pedestrian access, improve health and further efforts to make Burlington an age friendly community. The survey reveals gaps in the town's pedestrian infrastructure and stresses the importance of designing safe and accessible roadways for all users of all ages. The following report provides an analysis of the data collected in the Centennial Neighborhood of Burlington.

There are positive attributes of this area such as beautiful vegetation and a vibrant park however, the issues of accessibility are truly scary to all members of this community. Large trucks occupying multiple lanes while turning, great difficulty in crossing the street in several places, and a lack of signals affect everyone of all ages who need to navigate through the designated area, whether by car, bicycle, or on foot. This report articulates those concerns of community members and provides recommendations on how to improve the livability of the Centennial Community for all generations.

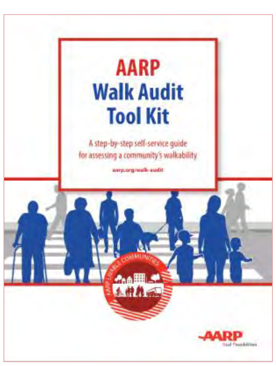
## Complete Streets

Vermont adopted a Complete Streets law in 2011, which has changed the approach to our state's roadways – it requires town and city officials to consider all users when planning, designing, constructing and maintaining our roadway – to include pedestrians, bicyclists and transit riders. AARP Vermont places the implementation of this law as a high priority as we work to further our mission to champion more livable, age-friendly communities. By utilizing planning language such as "complete streets" that considers access and mobility – communities can ensure residents have a healthy, more livable community.


Building vibrant, walkable, and healthy communities is a complex and many-layered process. There are many different factors to take into account including safety and enjoyment of all methods of travel, infrastructure quality, and ease of access to different modes. Mixed-use development within town centers can increase housing affordability, economic diversity, and accessible amenities. When coupled with an interconnected system of sidewalks, and bicyclist and pedestrian infrastructure it supports a vibrant livable community. Adopting planning language in your Town Plan, Zoning and Bylaws to promote mixed-use development, bike and pedestrian facilities will support healthy, active living for people of all ages and ability.

## Methodology

AARP's Sidewalk and Streets Survey Tool was used to conduct the walk audit on Wednesday, May 30, 2018 from 2:30 p.m. to 4:30 p.m. with 12 participants. There were 4 community members, 1 Department of Public Works representative, 2 Regional Planning Commission representatives, 1 individual from Vermont Department of Health, and 4 AARP Staff and Volunteers. The AARP survey tool was designed in collaboration with members of the Institute of Transportation Engineers.




During the walk audit, the condition of sidewalks along the roadway were examined and photographed, with some emphasis on the following:

- Crosswalks and Crossing Signals
- Pedestrian Safety
- Sidewalks
- Important signage
- Driver behavior

## Walk Audit Results


The 12 participants took part on the May 30, 2018 walk audit of Burlington's Centennial Neighborhood beginning at the Bayberry Commons on Grove Street, north on Grove, left onto Chase Street turning into Barrett Street to the 5-way intersection prior to the bridge, north on Colchester Ave, left onto Chase Street, and right onto Grove Street to return to Bayberry Commons:

On the walk audit the participants noted the following results:

The Centennial Neighborhood is attractive and inviting along the Chase Mill Bridge for both motorists and pedestrians; there is a variety of services and amenities available and the river path provides a wonderful asset for the community. Pedestrian infrastructure, however, was rated from fair to poor in regards to crossing, safety, and sidewalk conditions. The three problem intersections are highlighted in the map.

**Overall Findings:** The participants found the intersections that were surveyed to be in **fair condition** for the walkability of the neighborhood. Few amenities were found that supported access for people with disabilities, such as audible signals and textured curb cuts. Pedestrian safety should be improved and traffic calming measures are needed to address the heavy flow of motorists.

Driver Behavior: Rated as **fair**. Speed was a concern as was drivers rolling through stop signs, not stopping behind crosswalks. The traffic noise was at a good level and did not prohibit enjoyment and added to the comfort and appeal of the neighborhood. We observed a mix of some drivers yielding to pedestrians and many who did not yield. Several large trucks were observed turning at the intersection of Chase Street and Grove Street. They required all lanes to navigate turns in both directions

Drivers at Grove Street and Chase Street rolled through the stop sign at all three intersections. The drivers would also stop past the stop line on Grove Street. It was noted that drivers on all streets were traveling faster than the mandated 25 MPH.

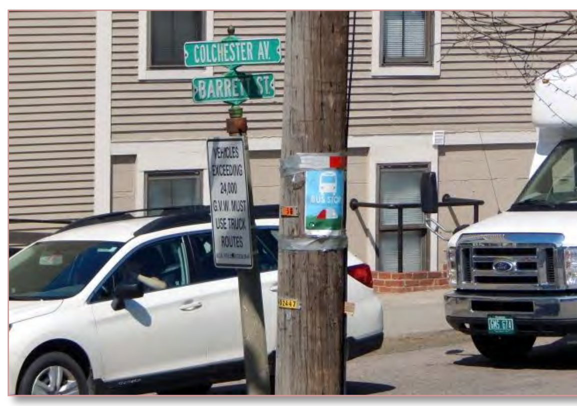
<u>Observations and Recommendations</u>

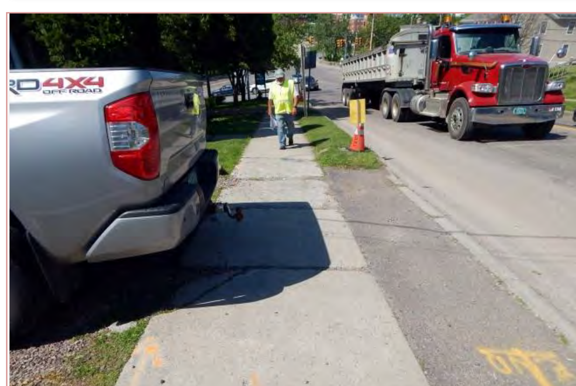
- Stop sign is too far away from pedestrian crossing at Grove Street and Chase Street junction.
- Explore uses of traffic calming.

Comfort & Appeal: Predominantly rated as **fair** but some individuals considered it **good**. The overall comfort and appeal is a picturesque neighborhood with lots of trees, a nice pocket park at Chase Street and along Grove Street, but many of the assets and amenities can be difficult to access because of the street debris, lack of lights at intersections, and no rain/snow shelters at the bus stop.

<u>Observations and Recommendations</u>

- Excellent pedestrian crossing signage and benches at Schmanska Park, but park is not handicap accessible. because of curb cut-out at entrance
- Most greenspace was private property, but provided excellent shade and was well maintained.
- **There are no benches or places for people to rest along the sidewalk or for any of the bus stops.**
- There were no waste or recycle bins along the route except in Schmanska Park. There was a noticeable amount of debris along the sidewalk, such as recycle bins that were difficult to get by.
- The bus sign was taped to a utility pole notifying users the stop was discontinued.
- Public transit stops are in key locations, but there was no bus sign at the bus stop or crosswalks to allow safe passage from the bus.
- Way-finding signs are very useful and add to the comfort and appeal.



Intersections & Crossings: rated as **poor**.  We observed a few tricky intersections for pedestrians and motorists alike.

<u>Observations and Recommendations</u>

- Safer intersections for pedestrian crossing are a top priority.
- Crosswalk paint was faded providing poor visibility at many crosswalks and lacked truncated domes.
- No push-to-walk signals are available on Colchester Avenue, Chase Street, and only on 2 pedestrian crossing sections near Schmanska Park on Grove Street.
- There are no pedestrian signals or audible signals to protect pedestrians from the Colchester/Barrett/Riverside/Bridge intersection. Pedestrians are left to dodge oncoming traffic between lights and breaks in the traffic pattern.
- Bicycle path ends near the intersection of Chase Street, Riverside Drive, and Colchester Avenue and there is no safe route for bicyclists to cross the road. The sidewalk is the only safe path down by Riverside Drive.
- Lack of clearly marked crosswalks, pedestrian signals, and truncated domes makes it extremely dangerous and difficult for accessibility and safe travel.
- At the intersection of Chase Street and Grove Street, heavy traffic – 36 vehicles – including 4 pick-ups and 3 large vans, made it difficult and unsafe to cross especially at school drop-off time.

Sidewalks: Rating of **fair**. The condition of sidewalks and streets can make life much easier or much more difficult for pedestrians, particularly those who cannot or do not own or drive cars. The sidewalk conditions along this walk were widely diverse.

Observations and Recommendations

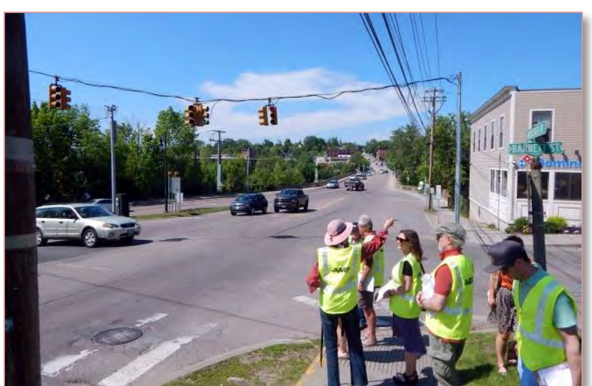
- Sidewalks along Grove Street from Bayberry Commons to the intersection of Chase Street were in good condition but lacked truncated domes. However, the sidewalk was only along one side of the road.
- Sidewalk into Schmanska Park was not accessible.
- There are several curb cuts that lack textured markings for people with visual impairments.
- The sidewalk along Colchester Ave, Barrett Street, and Chase Street needs repair.




## Conclusion

***Why does Walkability matter?*** Walkable communities provide residents with economic and health benefits. By designing the community to allow for housing and local businesses to be within walking distance (i.e. ½ to 1 mile), residents have the option of walking to and from destinations rather than depending on a personal automobile. There is a direct correlation between walkable communities and housing values in those communities. The Walking the Walk study found that homes located within a walkable community commanded a price premium of $4,000 to $34,000. The health benefits associated with walkability include lower rates of disease due to reduced obesity rates and cardio activity, as well as considerably psychological benefits.

Connectivity of sidewalks, safety of crosswalks, and availability of seating are all elements worthy of consideration when reviewing the current infrastructure and future needs of Burlington. Pedestrian safety in this neighborhood is severely lacking and needs improvement. Making safety of pedestrians a priority will help support a more age friendly Burlington.



## Recommendations

1. Install signage, push-to-walk, and audible signals for safer pedestrian crossing at the intersection of: Barrett Street and Colchester Ave, Barrett Street and Riverside Ave, Colchester Ave and Chase Street, Chase Street and Grove Street.
2. Provide benches and places to rest along Colchester Ave, especially around bus stops. This will further enhance comfort and appeal.
3. Improve pedestrian accessibility and safety by installing truncated domes at cross walks.
4. Explore prohibiting trucks from using Chase Street to Grove Street, and enforce the law prohibiting large trucks traveling side streets.

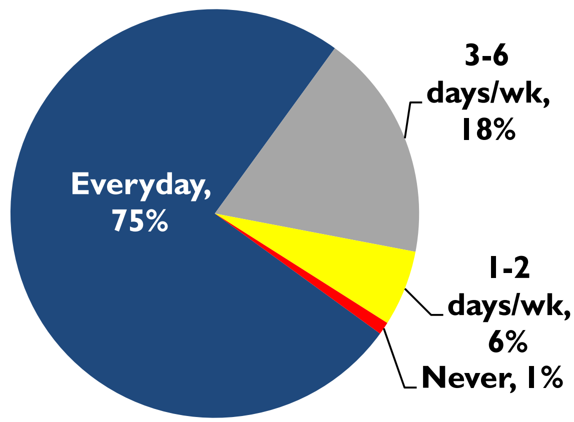
5. Adopt traffic calming measures such as plantings to enhance safety, comfort and appeal.
6. Traffic calming measures are needed along entire route where driver behavior is poor and speed is a concern when crossing the street.
7. Increase signage along the roads for pedestrians, particularly in areas where crosswalks are highly worn.

8. Consider rapid flashing beacons and pedestrian signals at key crosswalks.
9. Consider a tabletop intersection at Grove St. and Chase St. to reduce vehicular speed.
10. At crosswalks with a "walk" button, there needs to be a "no turn on red" arrow to ensure cars yield to pedestrians.
11. The city of Burlington should invest in a scoping study of Grove St., Chase St., Colchester Ave., and Barrett St. to address the various barriers to safe mobility and connectivity.

## Burlington Citywide Livability Data[1]

Frequency of Outings and Current Modes of Transportation Nearly (93%) all Burlington residents age 45-plus say they get out of their home every day or three to six days a week, in a typical week. The frequency of leaving their home decreases with age.

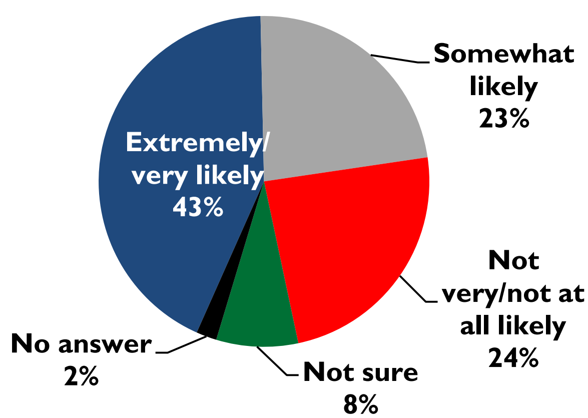
**Frequency of Outings in a Typical Week Among Burlington Residents**
**(n=500)**




*Walking*

Many Burlington residents age 45-plus say they would walk in their community if there were better conditions for pedestrians. Over two in five respondents say they would be extremely or very likely to walk if there were better sidewalks and crosswalks for pedestrians, and about another quarter says they would be somewhat likely to walk.

**Likelihood that Burlington Residents Would Walk if Conditions Were Better for Pedestrians**
**(n=500)**

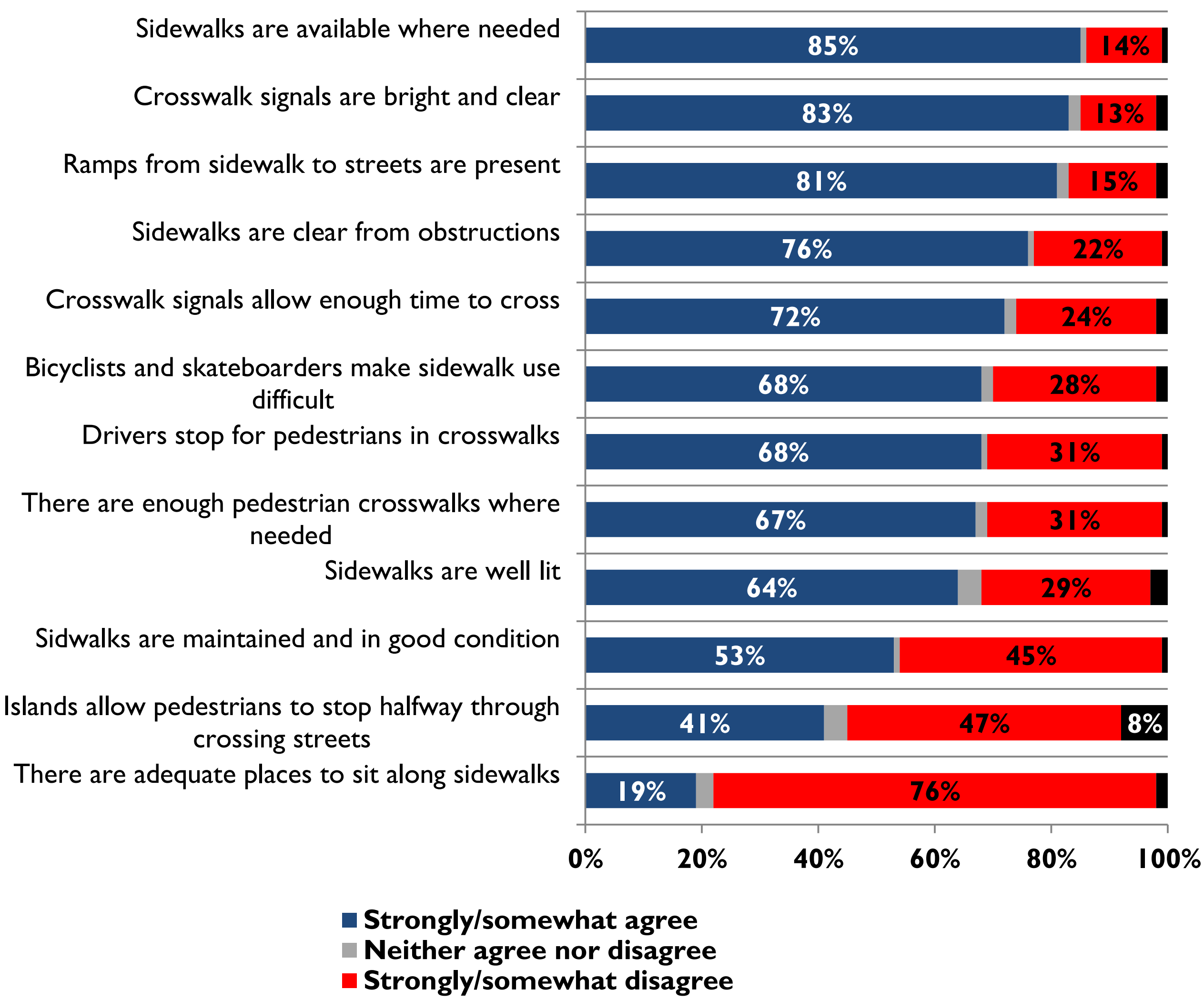



[1] Joanne Binette, *The Path to Livability: A Citizen Survey of Burlington, Vermont*. (AARP, 2015), 9, 14, 15, 17.

*Pedestrian Accessibility*

A large majority of Burlington residents also agrees that Burlington has sidewalks that are free from obstruction and crosswalk signals that allow enough time for pedestrians to cross. About two-thirds agree that drivers stop for pedestrians in crosswalks, there are enough pedestrian crosswalks where they are needed, and sidewalks are well lit. While about half agree that sidewalks are well maintained and in good condition, nearly the same proportion disagree with this statement.

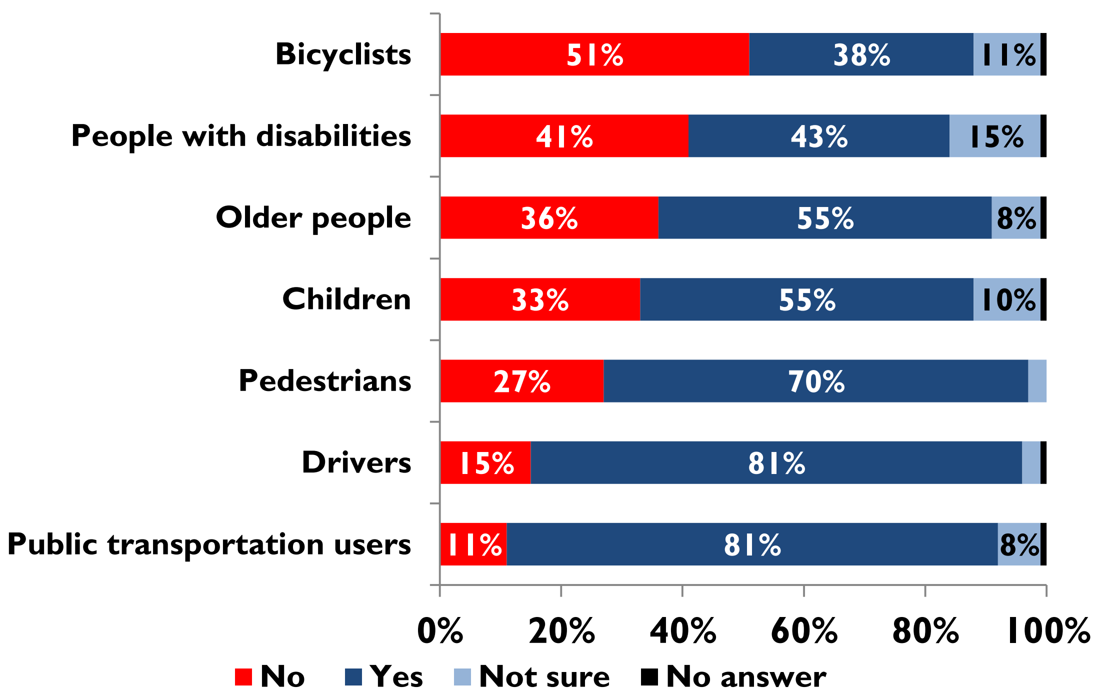
**Level of Agreement about Walking Conditions in Burlington**
**(n=342, respondents who say they walk)**



*Street Safety*

Burlington residents age 45-plus believe there are street safety issues for bicyclists, people with disabilities, and older people.  Half of Burlington residents believe the streets of Burlington are not safe for bicyclists. Two in five feel the streets are not safe for people with disabilities, and about a third say streets are not safe for older people and children. On the other hand, about two in five believe the streets are safe for bicyclists and people with disabilities; and over half feel streets are in fact safe for older adults and children.

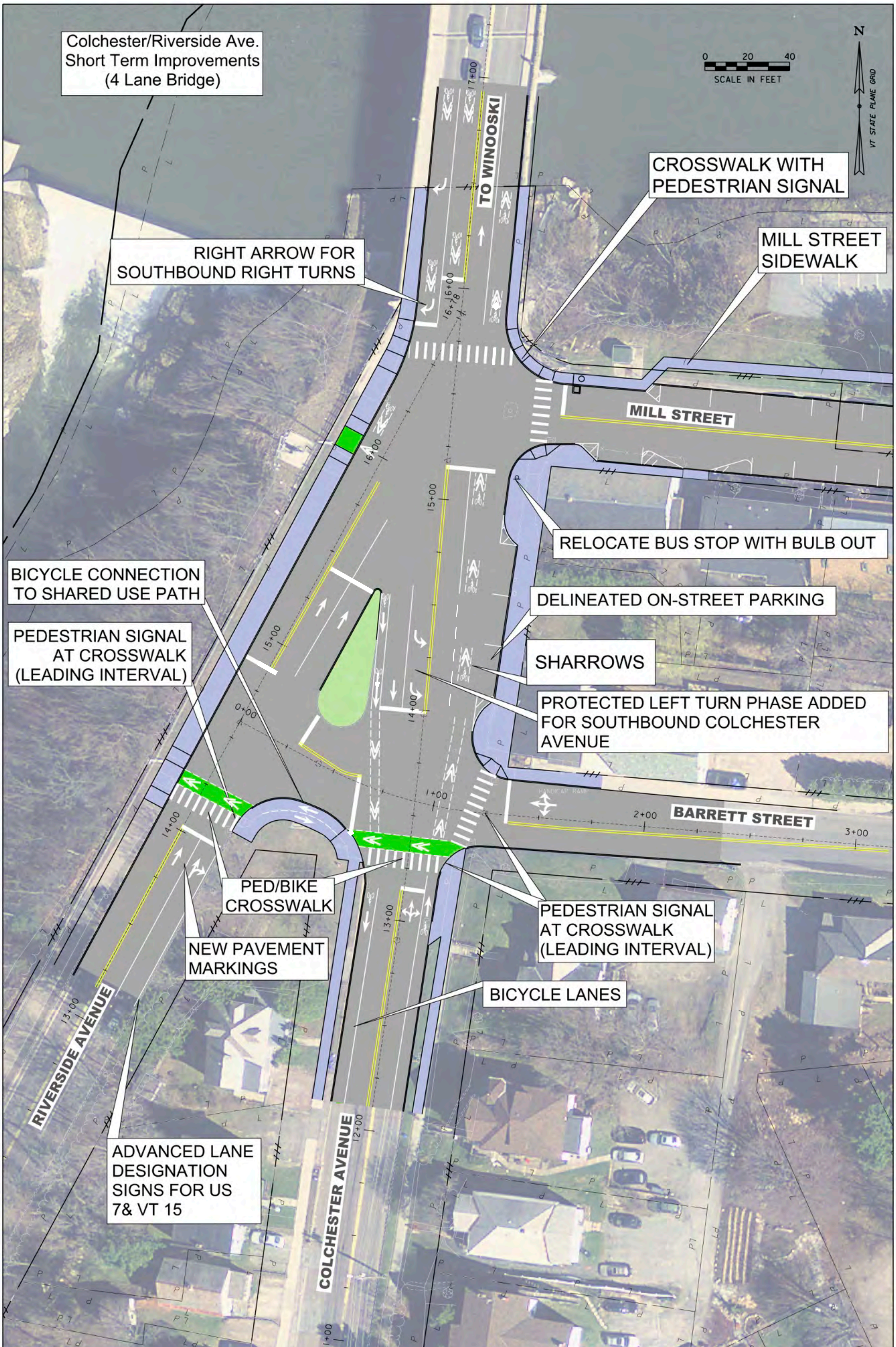
**Do Burlington Residents Believe the Streets Are Safe for Residents?**
**(n=500)**



# Colchester, Barrett, & Riverside

## CURRENT DRAFT OF PROPOSED SHORT-TERM IMPROVEMENTS

*November 2016*

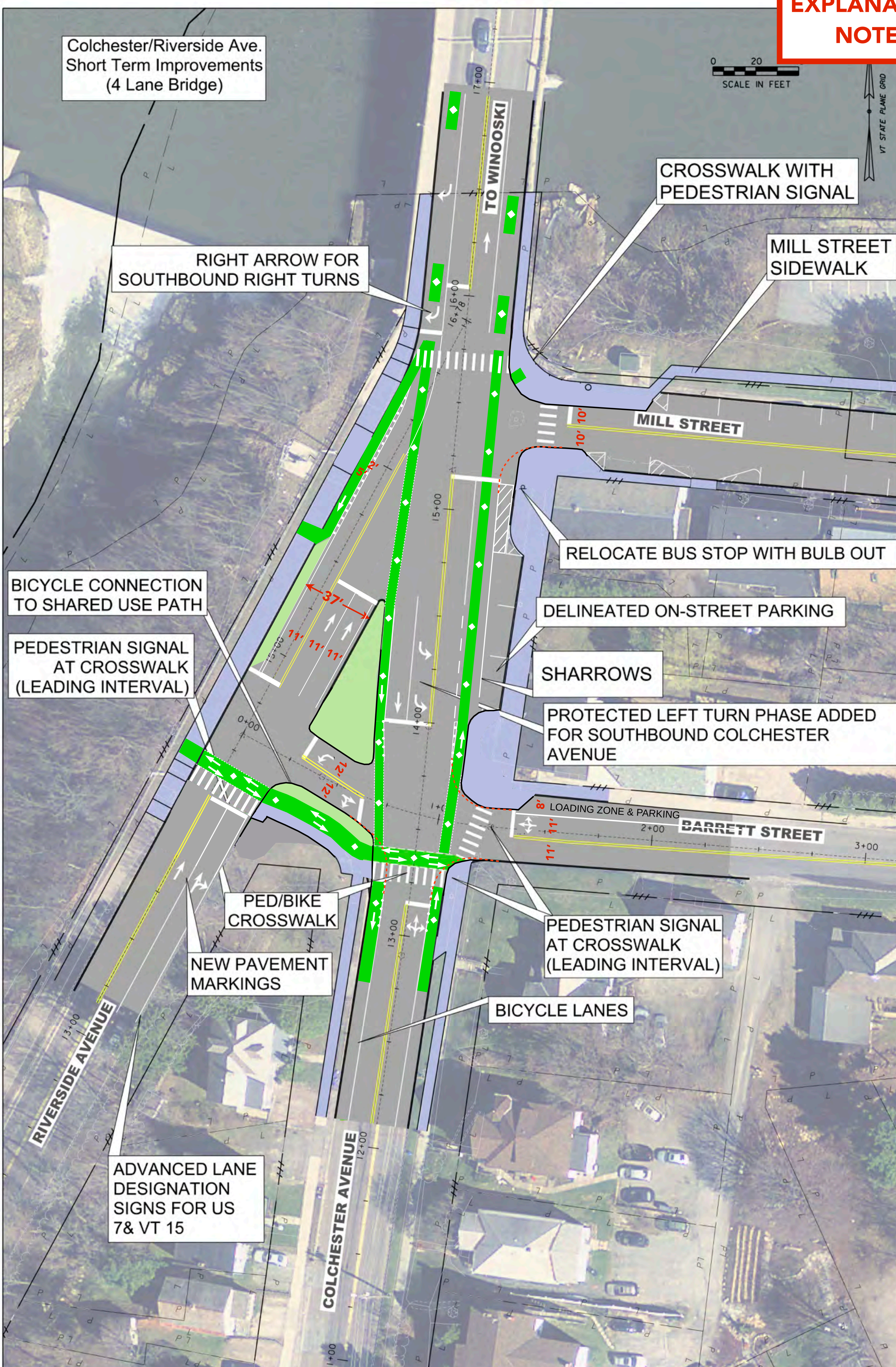


# Colchester, Barrett, & Riverside

## ADDITIONAL MODIFICATIONS TO SHORT-TERM DESIGN TO FURTHER IMPROVE PEDESTRIAN & BIKE SAFETY

*November 2016*

WITHOUT EXPLANATORY NOTES

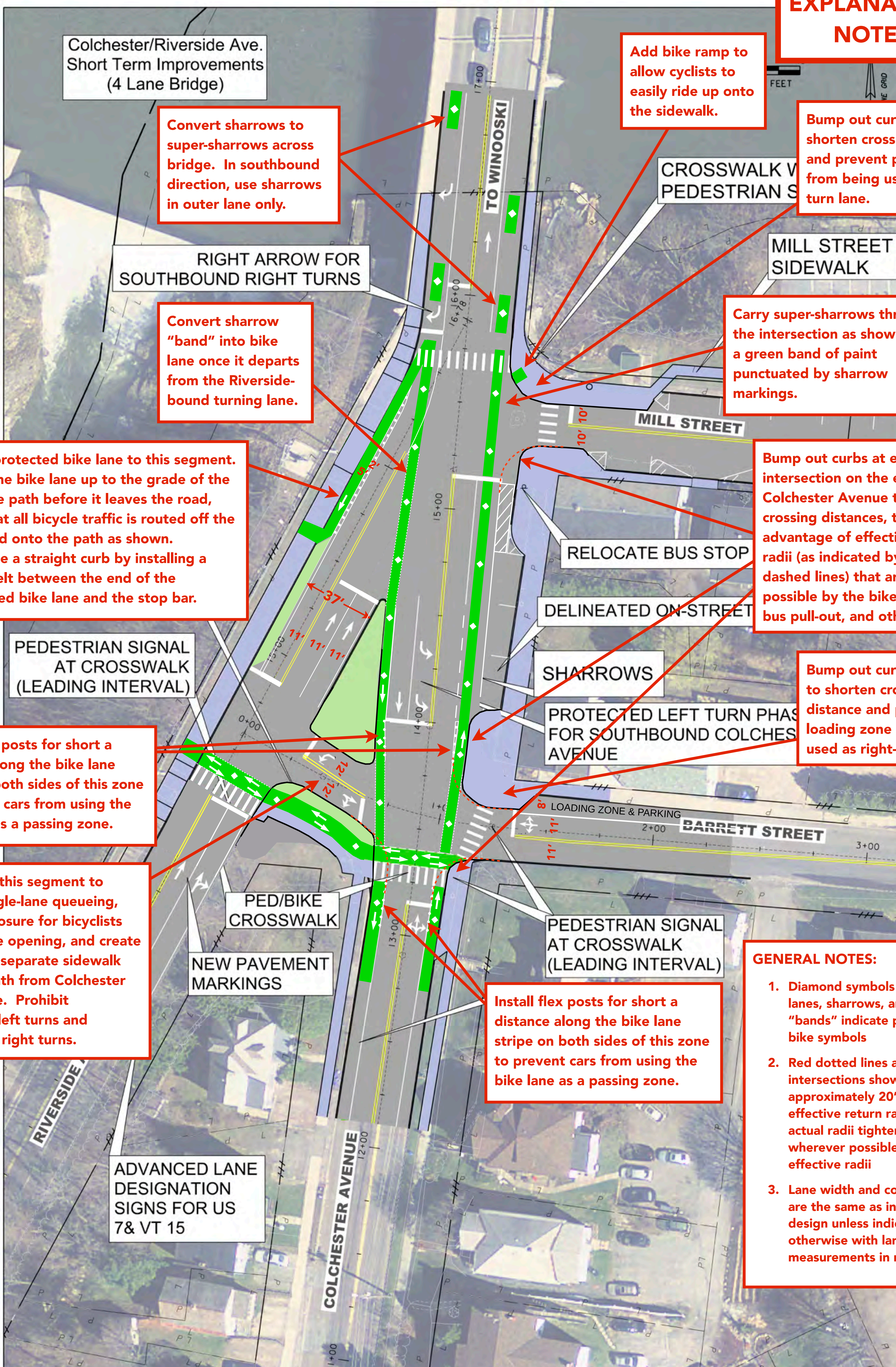


# Colchester, Barrett, & Riverside

## ADDITIONAL MODIFICATIONS TO SHORT-TERM DESIGN TO FURTHER IMPROVE PEDESTRIAN & BIKE SAFETY

*November 2016*

**WITH EXPLANATORY NOTES**




**GENERAL NOTES:**

1. Diamond symbols in bike lanes, sharrows, and sharrow "bands" indicate placement of bike symbols
2. Red dotted lines at intersections show approximately 20'-25' effective return radii, with actual radii tightened wherever possible within the effective radii
3. Lane width and configuration are the same as in the original design unless indicated otherwise with lane measurements in red

# APPENDIX M

## Historic / Archeology Assessment

# ARCHEOLOGICAL RESOURCE ASSESSMENT

## Riverside Avenue-Colchester Avenue Intersection Scoping Study

City of Burlington
Chittenden County, Vermont

HAA # 4961-11

**Submitted to:**
Stantec
55 Green Mountain Drive
South Burlington, Vermont 05403-7824

**Prepared by:**
Hartgen Archeological Associates, Inc.

P.O. Box 81
Putney, VT 05346
p +1 802 387 6020
f +1 802 387 8524
e hartgen@hartgen.com

www.hartgen.com

An ACRA Member Firm
www.acra-crm.org

September 2016

## MANAGEMENT SUMMARY

Involved State and Federal Agencies: *Vermont Agency of Transportation, Federal Highway Administration*
Phase of Survey: *Archeological Resource and Historic Preservation Assessment*

## LOCATION INFORMATION

Municipality: *City of Burlington*
County: *Chittenden County, Vermont*

## SURVEY AREA

Length: *560 feet (171 m)*
Width: *286 feet (87 m)*
Acres: *2.89 acres (1.17 ha)*

## RESULTS OF RESEARCH

Archeological sites within one mile: *14*
Surveys in or adjacent: *2*
NR/NRE sites in or adjacent: *1*
Precontact Sensitivity: *low*
Historic Sensitivity: *moderate*

## RECOMMENDATIONS

Extensive disturbance from road, utility and building construction has reduced the archeological potential of the APE. However, there is one area of known historic features associated with a 19th-century flour mill that is outside of but directly adjacent to the APE that needs to be protected during any construction. In addition, one lawn area associated with 460 Colchester Avenue has the potential to retain archeological deposits and should be examined with Phase IB archeological investigation if it is to be disturbed during construction.

Report Authors: *Thomas R. Jamison*
Date of Report: *September 2016*

## TABLE *of* CONTENTS



### Map List



### Photograph List

## Table List

# ARCHEOLOGICAL RESOURCE ASSESSMENT

## 1 Introduction

Hartgen Archeological Associates, Inc. (Hartgen) conducted an Archeological Resource Assessment for the proposed Riverside Avenue-Colchester Avenue Intersection Scoping Study Project located in the City of Burlington, Chittenden County, Vermont (Map 1). The project requires approvals by the Vermont Agency of Transportation (VTrans) and the Federal Highway Administration (FHWA). This investigation was conducted to comply with Section 106 of the National Historic Preservation Act of 1966, as amended and will be reviewed by the VTrans archeology officer. This investigation adheres to the Vermont State Historic Preservation Office's (SHPO) *Guidelines for Conducting Archeology in Vermont* (2002).

## 2 Project Information

A site visit was conducted by Thomas R. Jamison on August 24, 2016 to observe and photograph existing conditions within the Project Area. The information gathered during the site visit is included in the relevant sections of the report.

### 2.1 Project Location

The project is located in Burlington's Ward 1, in the northeast corner of the city along the south side of the Winooski River directly across from the City of Winooski (Map 2).

### 2.2 Description of the Project

Four alternative designs have been developed for the project (Appendix 1). They include the following:

- Short Term Improvements (4 lane bridge)
- 4-way Intersection (3 lane bridge – 2NB/1SB)
- 4-way Intersection – Separated Right Lane (3 lane bridge – 2NB/1SB)
- Roundabout Intersection (3 lane bridge)

These alternatives all include modifications along the following alignments (Map 2):

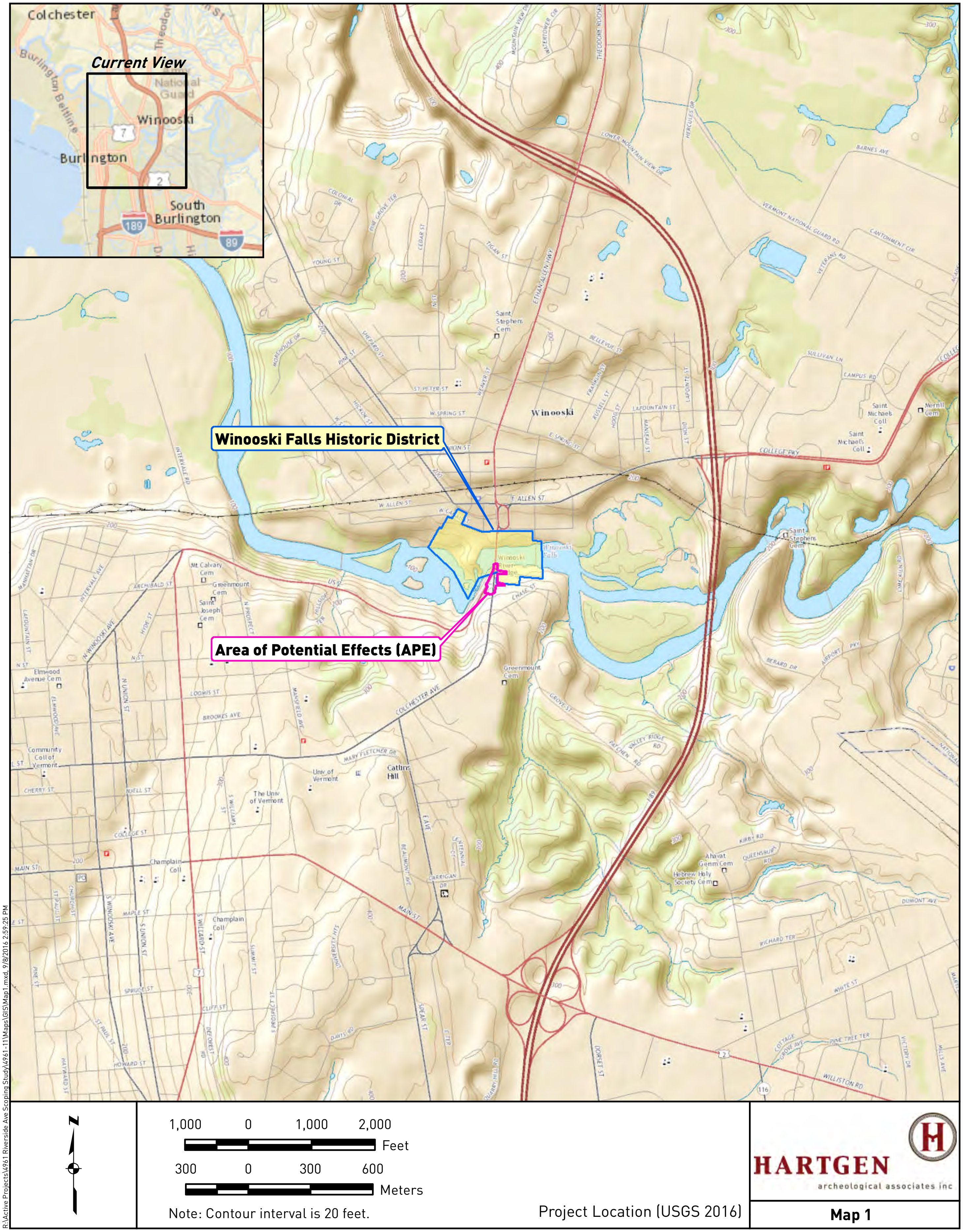
- Riverside Avenue: extending from the south end of the Winooski River bridge 540 feet (165 m) to the south
- Colchester Avenue: from the intersection with Riverside Avenue extending 457 feet (139 m) to the south
- Mill Street: extending from the intersection with Colchester Avenue 212 feet (65 m) to the east
- Barrett Street: extending from the intersection with Colchester Avenue 226 feet (69 m) to the east

### 2.3 Description of the Area of Potential Effects (APE)

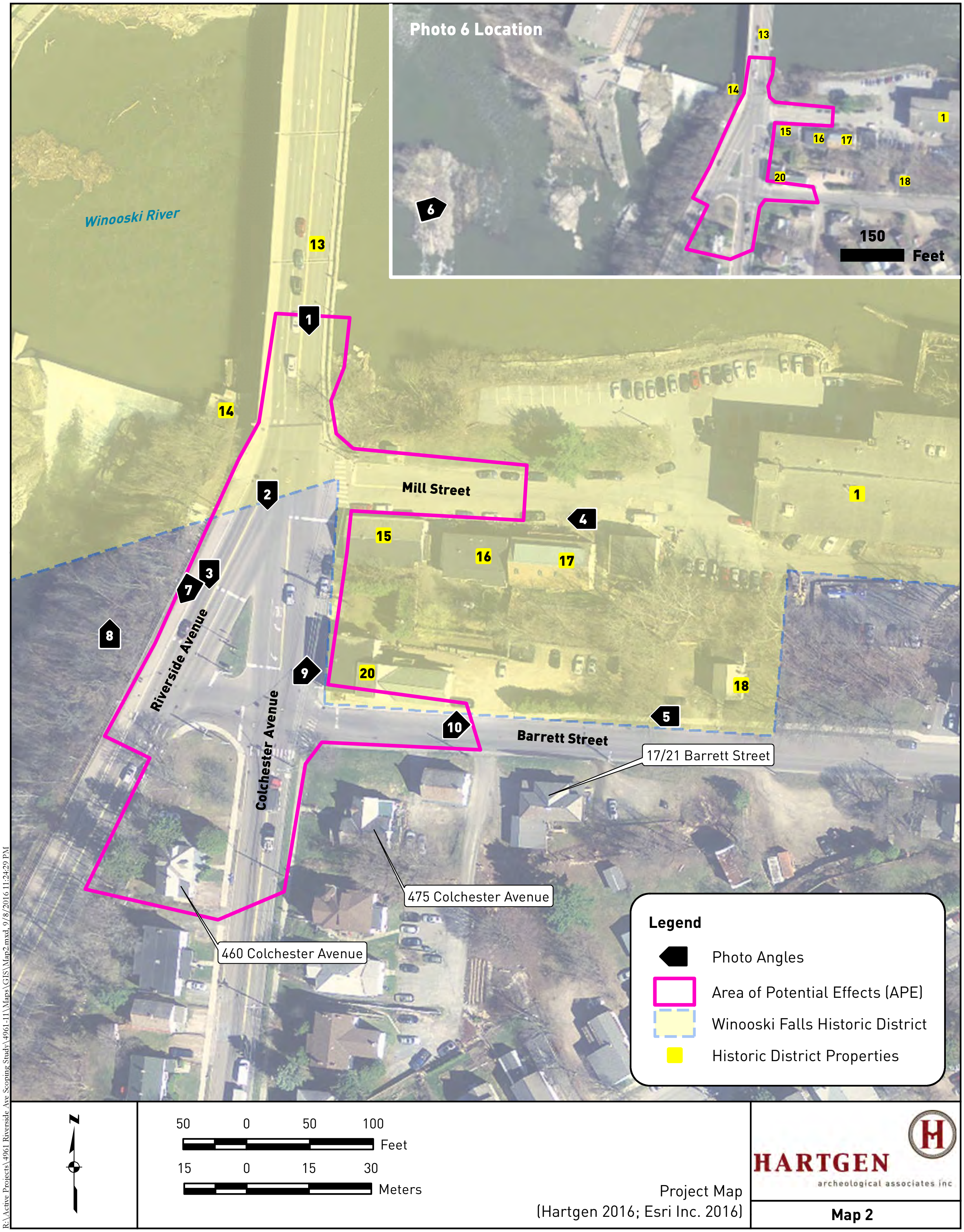
The area of potential effects (APE) includes all portions of the property that will be directly or indirectly altered by the proposed undertaking. Based on the proposed effects listed above, the APE includes approximately 2.89 acres (1.17 ha).

## 3 Environmental Background

The environment of an area is significant for determining the sensitivity of the Project Area for archeological resources. Precontact and historic groups often favored level, well-drained areas near wetlands and waterways. Therefore, topography, proximity to wetlands, and soils are examined to determine if there are landforms in the Project Area that are more likely to contain archeological resources. In addition, bedrock formations may contain chert or other resources that may have been quarried by precontact groups. Soil conditions can provide a clue to past climatic conditions, as well as changes in local hydrology.




R:\Active Projects\4961 Riverside Ave Scoping Study\4961-11\Maps\GIS\Map1.mxd, 9/8/2016 2:59:25 PM




Project Map
(Hartgen 2016; Esri Inc. 2016)

Map 2

R:\Active Projects\4961 Riverside Ave Scoping Study\4961-11\Maps\GIS\Map2.mxd, 9/8/2016 11:24:29 PM

### 3.1 Present Land Use and Current Conditions

The project area is a mostly residential section along Colchester Avenue with a few small businesses in the area between Barrett Street and Mill Street (Photos 1 to 5). The section of Riverside Avenue in the APE is lined with green space with no structures fronting that road, although the structures along Colchester Avenue back up to Riverside Avenue. In most places, the streets are bounded by concrete sidewalks with concrete curbing. However, both sides of Mill Street, the south side of Barrett Street and the east side of Riverside Avenue do not have sidewalks. A small wedge shaped island is located in the middle of the intersection of Colchester and Riverside Avenues.


Photo 1. Project APE from the bridge over the Winooski River. View to the south.

Photo 2. Intersection of Riverside Avenue (right) and Colchester Avenue (left). View to the south.


Photo 3. Riverside Avenue on the right and Colchester Avenue on the left. View to the south.

Photo 4. Mill Street. View to the west.


Photo 5. Barrett Street. View to the west.

### 3.2 Soils

Soil surveys provide a general characterization of the types and depths of soils that are found in an area. This information is an important factor in determining the appropriate methodology if and when a field study is recommended. The soil type also informs the degree of artifact visibility and likely recovery rates. For example, artifacts are more visible and more easily recovered in sand than in stiff glacial clay, which will not pass through a screen easily.

The soils of the project area are primarily the Adams and Windsor loamy sands deposited by glaciofluvial action on the terraces currently along the Winooski River. These deposits were laid down by the glacial meltwater precursor to the Winooski River. The one part of the APE that falls outside these deposits is the area along Mill Street and extending across Riverside Avenue to the west that is defined as fill related to the historic development of that area.

Table 1. Soils in Project Area

| Symbol | Name | Textures | Slope | Drainage | Landform |
|---|---|---|---|---|---|
| AdB | Adams and Windsor | Loamy sands | 5-12% | Somewhat excessively drained | Glaciofluvial deposits |
| Fu | Fill land | Sandy gravelly loam | n/a | n/a | n/a |

### 3.3 Bedrock Geology

The bedrock in the immediate project area is the Winooski dolomite, exposed as ledges in the river adjacent to the APE. To the east is the Danby formation and to the west is Monkton quartzite (Ratcliffe 2011). The Danby formation consists of vitreous quartzite interbedded with sandy dolostone. Although none of these formations have been documented as being exploited during the precontact period, the Danby formation and the Monkton quartzite could have provided materials for formal stone tools and all the bedrock in the area could have been utilized for groundstone tools or fragments may have been used on an expedient basis.

### 3.4 Physiography and Hydrology

The project area gradually slopes down from south to north as Colchester Avenue approaches the river. The alignments of Riverside Avenue and Barrett Street are basically level with Mill Street sloping down to the east from Colchester Avenue. The area between Colchester Avenue and Riverside Avenue slopes down to the west toward the river. West of Riverside Avenue, the landscape drops off precipitously to the river. Steep slopes and cliffs line the river along this section of Riverside Avenue.

The only waterway in the area is the Winooski River that passes along the north and west sides of the APE. The APE is located at the first falls in the river from Lake Champlain, rising from about 100 feet (30.5 m) above mean sea level (amsl) below the falls to 137 feet (41.8 m) above the falls east of the bridge and then to 154 feet (47 m) further to the east above a smaller set of falls.

## 4 Documentary Research

Hartgen conducted research at the Vermont Division for Historic Preservation (VDHP) to identify previously reported archeological sites, State and National Register (NR) properties, properties determined eligible for the NR (NRE), and previous cultural resource surveys.

### 4.1 Archeological Sites

The archeological site files at VDHP contained 14 sites within one mile (1.6 km) of the project area (Table 2). Previously reported archeological sites provide an overview of both the types of sites that may be present in the APE and the relationship of sites throughout the surrounding region. The presence of few reported sites, however, may result from a lack of previous systematic survey and does not necessarily indicate a decreased archeological sensitivity within the APE.

Thirteen of the sites date to the precontact era. They include sites dating from the Early Archaic (c. 7050 to 5550 BC) through the Late Woodland (c. AD 1050 to 1600). In addition, one of these sites appears to have a Late Paleoindian component. These sites range from simple flake scatters to complex stratified sites and burials. There is only one historic site reported for the project vicinity, a 19th-century foundry that was located across the river in Winooski. However, 19th- and 20th-century flour and textile mill foundation remains have been identified along the west edge of the APE slightly south of the bridge to Winooski (Wilson 1992). These foundations have apparently not been assigned site numbers.

Table 2. Vermont Archeological Inventory (VAI) sites within one mile (1.6 km) of the Project Area

| VAI Site No. | Site Identifier | Description | Proximity to Project Area |
|---|---|---|---|
| VT-CH-0046 | Winooski | Late Archaic, Middle Woodland, ceramics, lithics, botanical and faunal remains, features | 1 mi/1.6 km NW |
| VT-CH-0075 | Zedeck | Unknown precontact, chert and quartzite flakes, bone fragments | 1 mi/1.6 km W |
| VT-CH-127 | | Early and Middle Woodland, ceramics, quartzite, quartz, chert, rhyolite flakes, Meadowood, Fox Creek and Levanna projectile points, calcined bone, butternut shell | 0.2 mi/0.33 km W |
| VT-CH-128 | | Middle Woodland, chert flakes, ceramics, calcined bone | 0.32 mi/0.51 km W |
| VT-CH-129 | | Woodland, chert and quartzite flakes, ceramic fragments | 0.38 mi/0.61 km W |
| VT-CH-132 | | Late Archaic, Otter Creek projectile points found by collector | 1 mi/1.6 km NW |
| VT-CH-283 | Stevens Foundry | Mid to late 19th-century foundry | 0.2 mi/0.32 km N |
| VT-CH-285 | Niquette Burial | Unknown precontact, Native American burial | 0.76 mi/1.2 km NW |
| VT-CH-663 | Mansfield | Unknown precontact, chert, quartzite and quartz flakes, calcinced bone | 0.68 mi/1.09 km SE |
| VT-CH-789 | | Unknown precontact, quartzite flakes | 0.81 mi/1.3 km SW |
| VT-CH-900 | Upper Falls | Late Paleoindian, Archaic and Woodland, features and artifacts | 0.45 mi/0.72 km NE |
| VT-CH-0990 | | Unknown precontact, chert and quartzite flakes, chert utilized flake, fire cracked rock , hearth feature | 0.32 mi/1.13 km W |
| VT-CH-1110 | | Middle Woodland, ceramics, Levanna projectile point, hearth features | 0.77 mi/1.23 km W |
| VT-CH-1171 | | Middle Woodland, isolated find of Fox Creek stemmed projectile point | 1 mi/1.6 km NE |

## 4.2 Historic Properties

An examination of the files at VDHP identified one NR property, no NRE properties and no properties previously determined to be ineligible within the APE (Table 3). The one NR property is the Winooski Falls Historic District that includes several structures along Barrett and Mill Streets and one archeological site within the current APE. The Winooski Falls Historic District is focused on the late 19th- to early 20th-century textile mills and workers housing located on either side of the Winooski River and includes the archeological remains of a flour mill adjacent to the south end of the bridge and west of Riverside Avenue. The limits of the historic district and NRHD numbers of contributing structures adjacent to the APE are shown on Map 2.

Within the historic district nine structures are adjacent to the APE. They are listed in Table 3. Structure 15 is currently being rehabilitated and has had a story added to give it a two story façade facing Colchester Avenue.

Table 3. Inventoried properties within or adjacent to the APE

| NRHD No. | Property Name/Address | Description of Building |
|---|---|---|
| | Winooski Falls Historic District | 19th- to 20th-century textile mills and worker's housing |
| 1 | Chace Mill/1 Mill Street | 1892 brick cotton mill building |
| 13 | The Winooski Bridge | 1928 poured concrete and steel bridge |
| 14 | Burlington Flouring Company Grist Mill Site | c. 1823, 1854, 1927 brick foundation remains of mill and associated structures |
| 15 | Duncan Blacksmith Shop/495-497 Colchester Avenue | c. 1841, 1928 brick veneer former store and blacksmith shop, currently being rehabilitated with an added story |
| 16 | I. S. Dubuc Tenement Building/5-11 Mill Street | c. 1912 two story flat roofed former tenement |
| 17 | Burlington Cotton Company Tenement Building/13-19 Mill Street | c. 1853, 1874 wooden vernacular worker's housing |
| 17a | 21 Mill Street | 1972 garage and workshop, non-contributing |
| 18 | Burlington Cotton Company Tenement Building/32 Barrett Street | c. 1853 Greek Revival worker's housing |
| 20 | Hickcock-Burlington Cotton Company Tenement Building/485 Colchester Avenue and 8-10 Barrett Street | 1811, 1853, 1924, 1961 vernacular former store, tavern, tenement |

### 4.3 Previous Surveys

On file at VDHP are two previous surveys within the immediate vicinity of the Project (Table 4). Both of these surveys identified areas of archeological potential, specifically, the area west of Riverside Avenue and south of the bridge where several 19th- to 20th-century mill foundations are located. Wilson's background research identified the location of several mills that were once along the west side of Riverside Avenue adjacent to the APE (Wilson 1992). The Arnott et al. study was a broad review of proposed transportation upgrades between Burlington, Winooski and South Burlington and only briefly mentions the mill foundations in the project area (Arnott, et al. 1995).

Table 4. Relevant previous surveys within or adjacent to the Project

| Year | Investigator | Methodology | Results | Notes |
|---|---|---|---|---|
| 1992 | Wilson (UVM-CAP) | Site visit and background research | Areas of archeological potential and disturbance/filling identified | Identified location of several historic mill foundations adjacent to the west side of Riverside Avenue |
| 1995 | Arnott et al. | Historical and archeological research | Identified general areas of archeological potential | Did not address APE in detail, but mentioned mill foundations adjacent to Riverside Avenue |

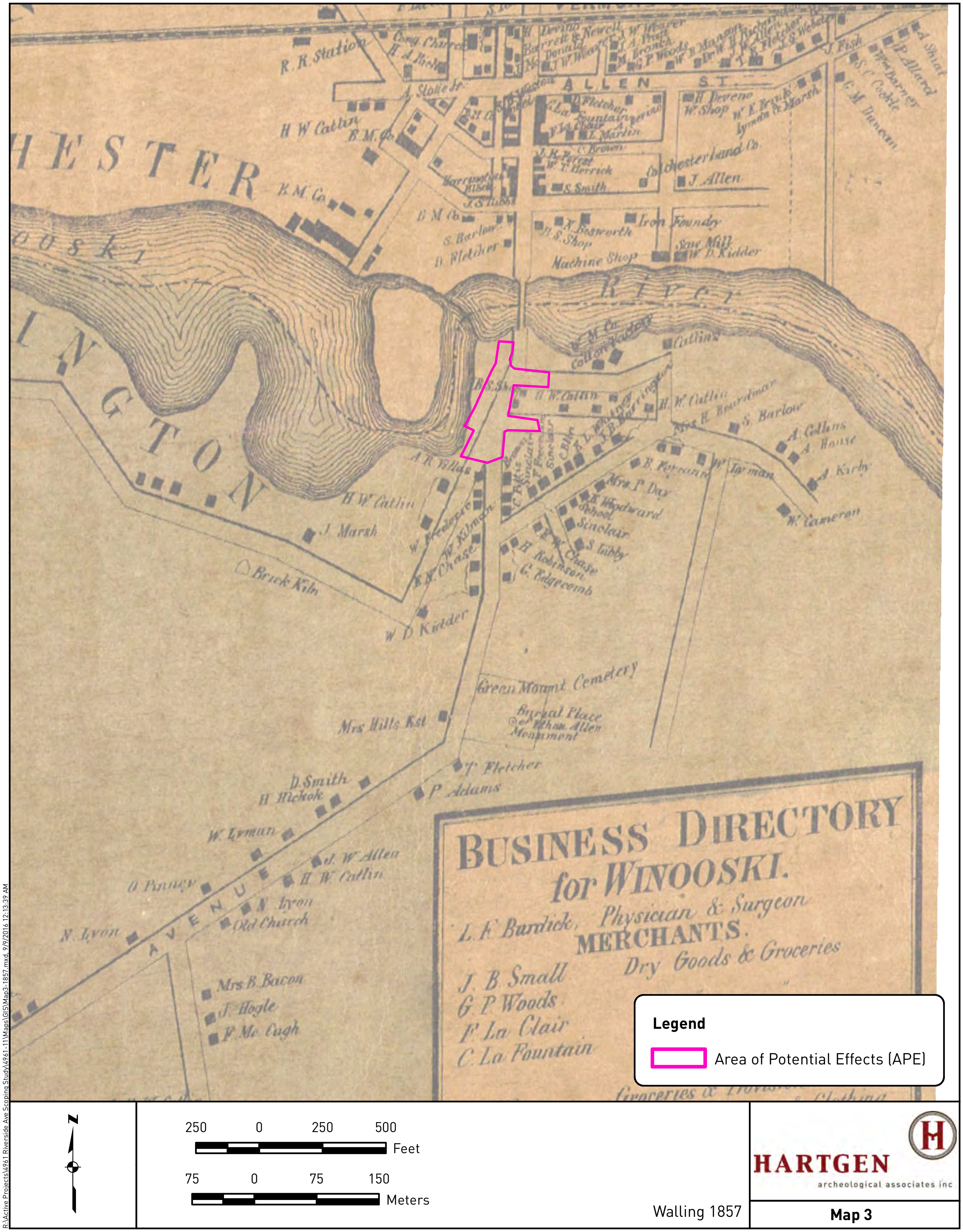
## 5 Historical Map Review

As a densely occupied industrial zone, the project area is well documented on historic maps. The current street layout was established by 1857 (Walling 1857) with a blacksmith shop (NRHD #15) at the south corner of Mill Street and Colchester Avenue, an unlabeled structure south of it, the Woolen Mill Co. Cotton Factory at the end of Mill Street and several residences extending south along Colchester Avenue (Map 3). One residence labeled A. R. Villas is shown in the point of the intersection of Riverside and Colchester Avenues. The 1869 Beers map of the area, however, depicts a structure with the same label to be located further to the south, a probably more accurate depiction of its location (Map 4). The 1869 map also shows the blacksmith shop (NRHD #15), a structure labeled C. P. W & Co. at the northeast corner of Barrett Street and Colchester Avenue (NRHD #20) and several City Flouring Mill and Burlington Woolen Mill structures along the west side of Riverside Avenue south of the bridge (NRHD #14).

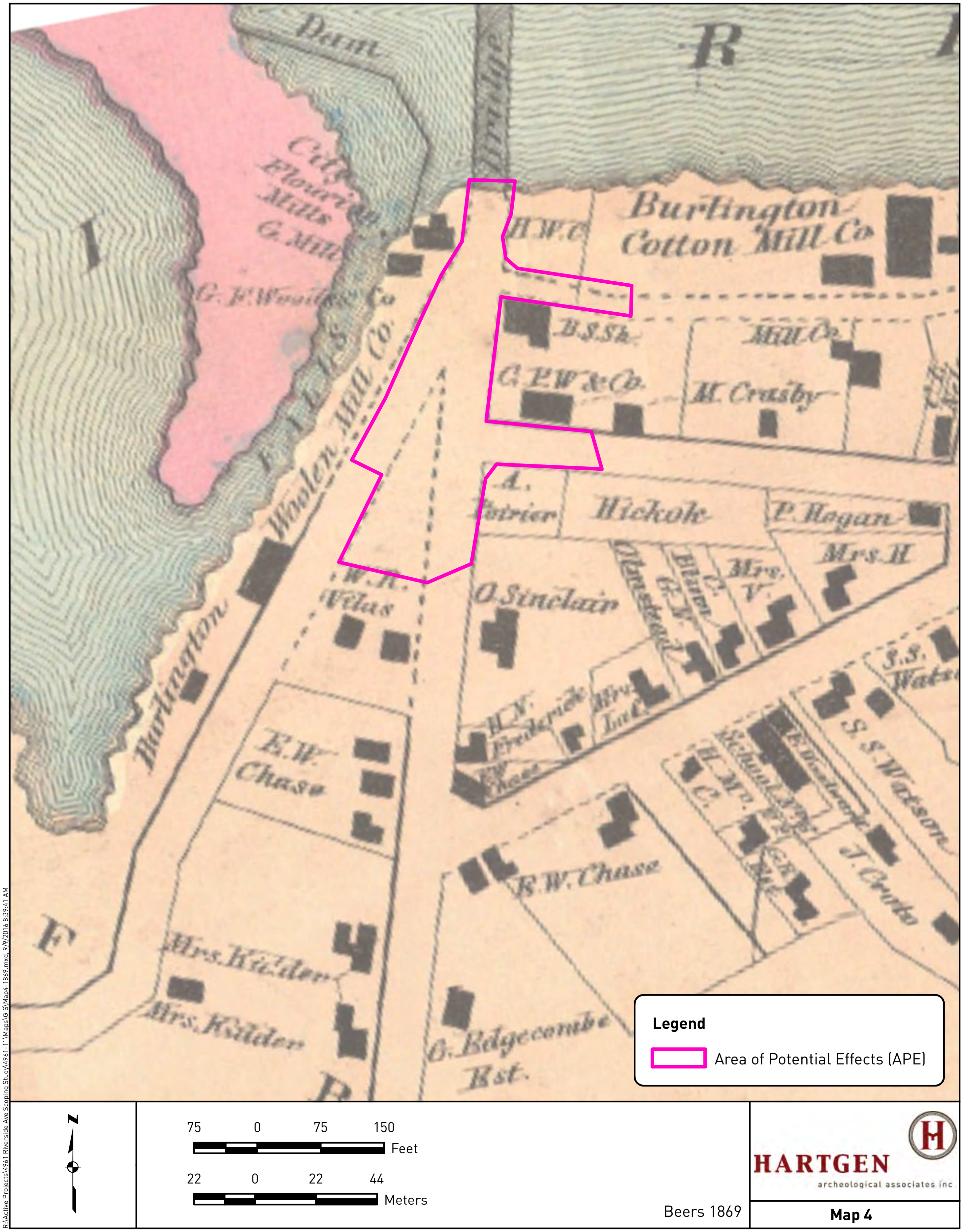
The Sanborn maps of the area provide even greater detail. From 1889 to 1900 the structures are much like those shown in 1869 (Sanborn Map Company 1889). Map 5 depicts the project area in 1889 and shows the continued presence of the Burlington Flouring Company buildings (NRHD #14) and the early configuration of the Burlington Cotton Mills buildings (now the Chace Mill area; NRHD #1). NRHD #20 is shown as a tenement building with a small residence and two sheds to the east. No structure is depicted on the lot at the point of the intersection of Riverside and Colchester Avenues (460 Colchester Avenue) or on the south side of Barrett Street where #17 and 21 Barrett is located.

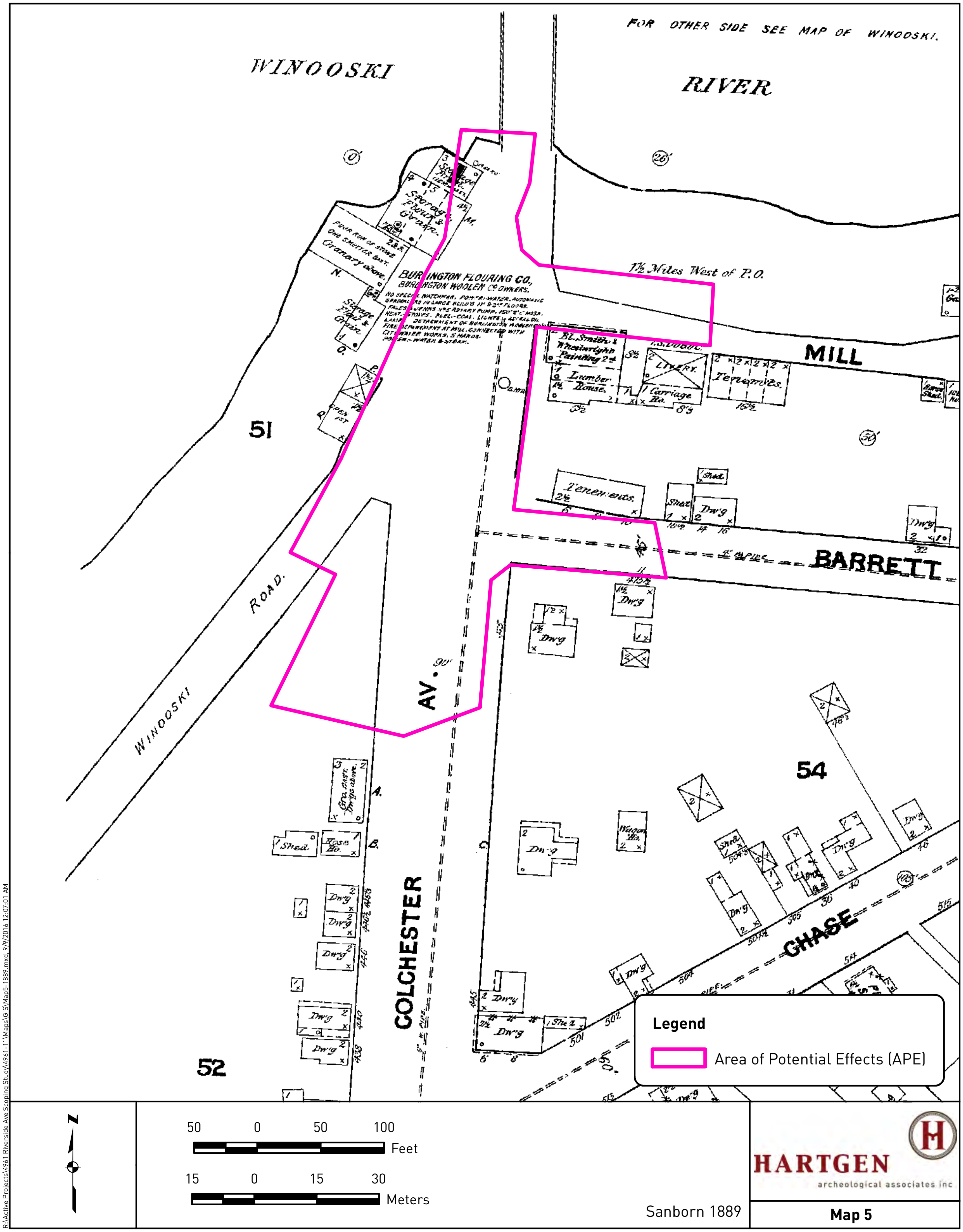
From 1906 to 1926 a few structures were added or modified. The 1926 Sanborn map shows the current 1892 Chace Mill building (NRHD #1), an addition to NRHD #20 and the presence of the structure at 460 Colchester Avenue (Map 6). In addition, a no longer extant structure labeled garage has been added between NRHD #15 and 20.

The Burlington Flouring Company buildings were still standing in 1926 and were labeled Johnson Grain Company. But they were removed sometime before 1942 when that location is vacant (Map 7).

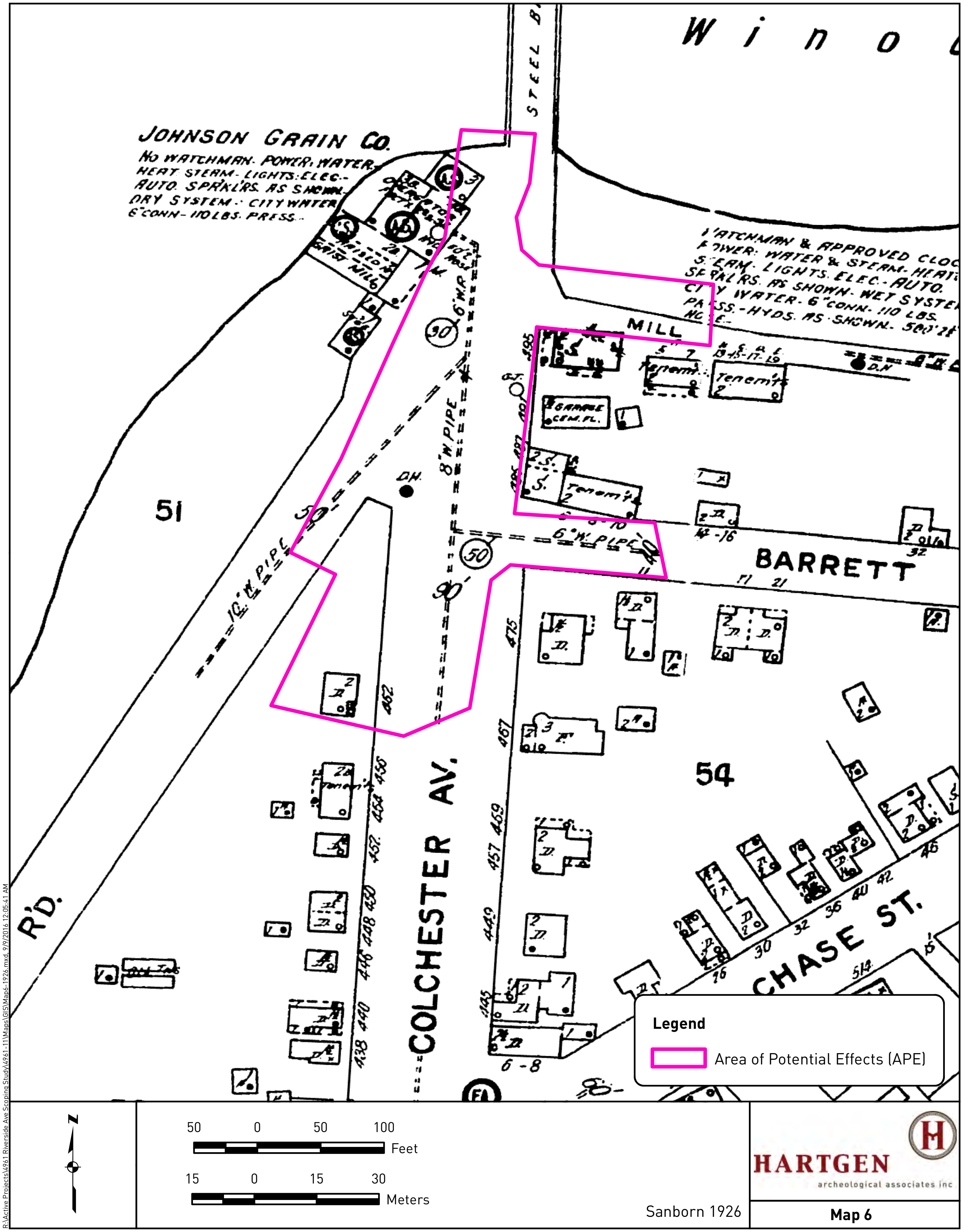



R:\Active Projects\4961 Riverside Ave Scoping Study\4961-11\Maps\GIS\Map3-1857.mxd, 9/9/2016 12:13:39 AM

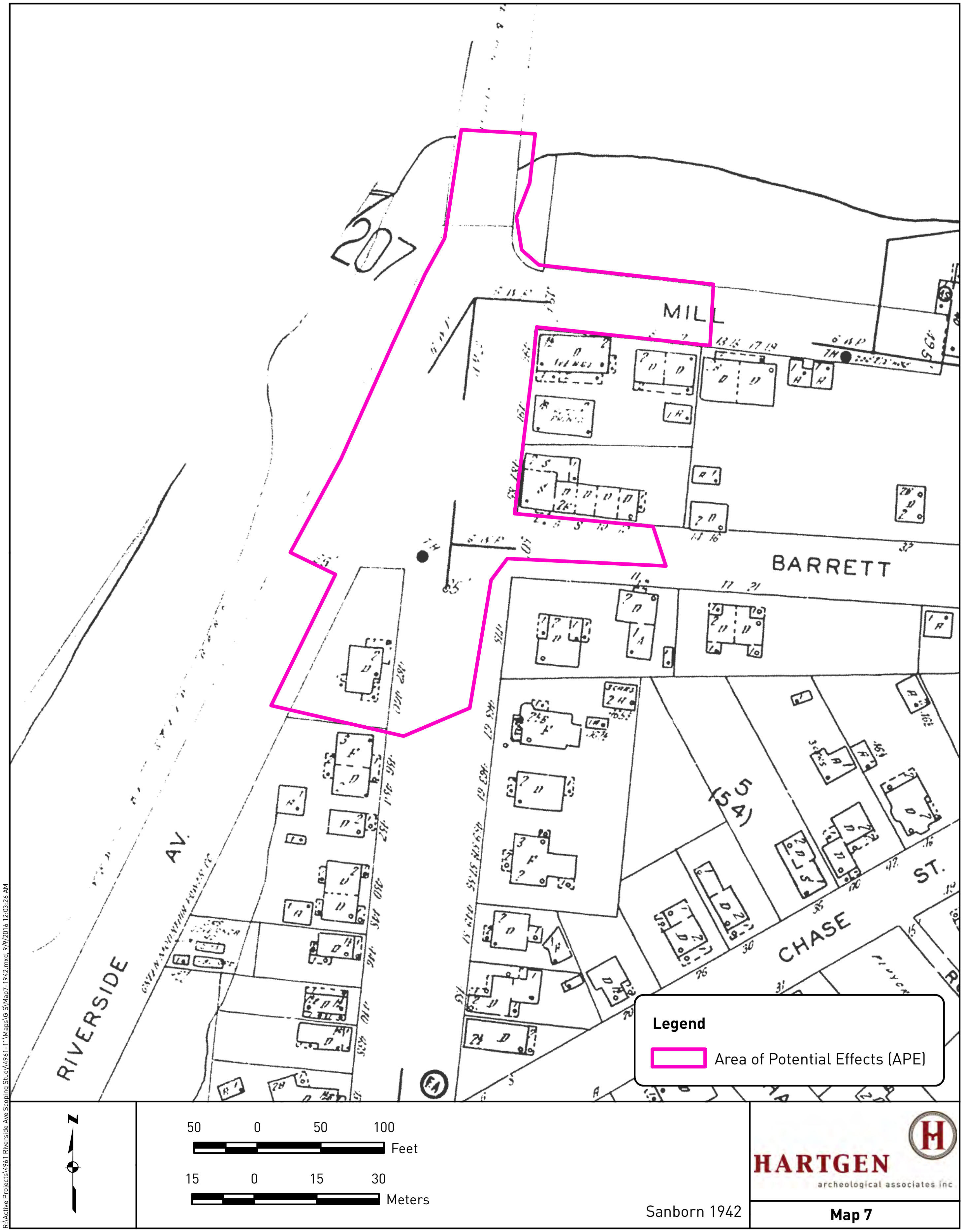

Dam
R
Bridge
City Flouring Mills G. Mill
G. F. Woodite Co
FALLS
Woolen Mill Co.
Burlington
H.W.C
Burlington Cotton Mill Co
B.S.Sh.
Mill Co
C.P.W. & Co.
M. Crosby
A. Poirier
Hickok
P. Hogan
Mrs. H
W.R. Vilas
O. Sinclair
Olmstead
Mrs. V.
S.S. Watson
H.N. Frederick
E.W. Chase
Chase
E.W. Chase
S. S. Watson
J. Crotts
Mrs. Kidder
Mrs. Kidder
G. Edgecombe Est.
F
Legend
Area of Potential Effects (APE)
N
75 0 75 150 Feet
22 0 22 44 Meters
Beers 1869
HARTGEN archeological associates inc
Map 4




R:\Active Projects\4961 Riverside Ave Scoping Study\4961-11\Maps\GIS\Map5-1889.mxd, 9/9/2016 12:07:01 AM




R:\Active Projects\4961 Riverside Ave Scoping Study\4961-11\Maps\GIS\Map6-1926.mxd, 9/9/2016 12:05:41 AM


MILL
BARRETT
RIVERSIDE AV.
CHASE ST.
Legend
Area of Potential Effects (APE)
50 0 50 100
Feet
15 0 15 30
Meters
N
Sanborn 1942
HARTGEN
archeological associates inc
Map 7
R:\Active Projects\4961 Riverside Ave Scoping Study\4961-11\Maps\GIS\Map7-1942.mxd, 9/9/2016 12:03:26 AM

# 6 Archeological Discussion

## 6.1 Precontact Archeological Sensitivity Assessment

Completion of the VDHP Environmental Predictive Model provides a measure of the precontact archeological sensitivity of the project area (Appendix 1). The Project Area is sensitive for proximity to the Winooski River, the falls of the river and the associated travel corridor. Points were also added for the Project Area being on glacial outwash terrace and due to the high number of precontact sites in the vicinity. The score was reduced due to the extensive disturbance in the APE. The Project Area has a score of 44. A score of 32 and above is considered to indicate precontact sensitivity.

## 6.2 Historic Archeological Sensitivity Assessment

The historic sensitivity of an area is based primarily on proximity to previously documented historic archeological sites, map-documented structures, or other documented historical activities (e.g. battlefields).

The falls of the Winooski River have been a very important location from precontact times through to the present. Historically, they were the locus of 18th-century settlement by Ira Allen and other early settlers across the river from the project area where they built a fort in 1772 (Rann 1886:555). During the Revolution the settlement was abandoned. After the war, Allen returned and reportedly built the upper dam, two saw mills, a grist mill, two forges and a furnace for smelting bog iron (Rann 1886:555). As the area developed during the early 19th century, textile mills came to dominate the local economy as represented by the Chace Mill (NRHD #1) at the east end of Mill Street (Boyd and Brevoort 1978). These developments are reflected in much of the built environment of the area including mill structures, mill worker housing and associated services. The historic archeological sensitivity of the area relates to features and deposits that are likely in undisturbed areas surrounding historic structures, particularly in back and side yard areas (Borstel 2005).

## 6.3 Archeological Potential

Archeological potential is the likelihood of locating intact archeological remains within an area. The consideration of archeological potential takes into account subsequent uses of an area and the impact those uses would likely have on archeological remains.

Despite this moderate score for precontact sensitivity, the project APE has seen such intensive development from road and structure construction that the potential for precontact archeological deposits to remain is very low. Historic archeological potential is present around the historic structures adjacent to the APE and adjacent to the west side of Riverside Avenue adjacent to the APE.

Particular areas of historic archeological potential are located along the west side of Riverside Avenue extending from the Winooski Bridge south about 680 feet (207 m), more than the entire length of the APE in this area. This area is known to have hosted a variety of flour and textile mill facilities, as seen on Map 4 and Map 5. Most of these structures were gone by the late 19th century, but foundation remains are present (Photo 6 to Photo 8). One other area of archeological potential is the lawn north of #460 Colchester Avenue at the point between Colchester and Riverside Avenues (Photo 9). This area has some disturbance from utility installation and landscaping, but there remains some archeological potential.

The area of a proposed retaining wall adjacent to #475 Colchester Avenue on the south side of Barrett Street (Photo 10) has likely been heavily disturbed by being cut down when Barrett Street was developed and has no potential for significant archeological deposits. Any other areas within the APE adjacent to historic structures have been heavily disturbed by sidewalk, road and utility installation and are not considered to have any significant archeological potential.

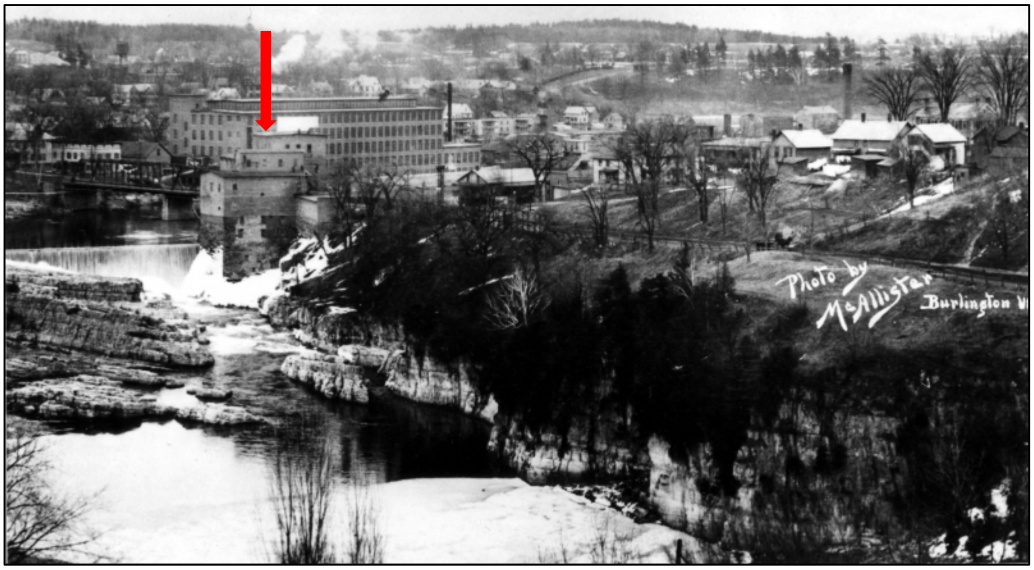



Photo 6. Winooski Falls area in 1920. Note the Burlington Flouring Company/Johnson Grain Company buildings (NRHD #14) adjacent to the dam in the middle left (arrow). View to the east (Landscape Change Program).

Photo 7. West side of Riverside Avenue from Winooski Bridge. Note vegetation outside of the guard rail that covers a narrow level area and the steep drop to the river. View to the south.

Photo 8. Stone foundation, associated with the flour mill, visible west of Riverside Avenue. View to the north.

Photo 9. 460 Colchester Avenue. Note lawn extending from the house that is hidden by trees. View to the south.

Photo 10. Corner of Colchester Avenue and Barrett Street, proposed location of retaining wall in round about alternative. View to the southwest.

### 6.4 Archeological Recommendations

Two areas of archeological potential are within or adjacent to the APE. The most significant is the area of the 19th- to 20th-century flour mill that stood at the south end of the Winooski Bridge west of Riverside Avenue. This area of archeological potential appears to lie outside of the project APE. Care should be taken to assure that no disturbance will take place outside of the existing guardrail along the west side of the sidewalk along Riverside Avenue.

The second area of archeological potential is the lawn area at #460 Colchester Avenue. This area will be entirely disturbed with the roundabout alternative. Phase IB archeological survey is recommended for that area if that alternative is chosen for the project.

The remainder of the project APE has been heavily disturbed and is not recommended for further archeological review. If project plans change from the proposed alternatives, further archeological review may be warranted.

## 7 Bibliography

Arnott, Sigrid, Heather Esser and Jackie Sluss

1995 *Burlington Area Tri-center Transit Study, Archaeological and Historic Resources, Technical Memorandum*, Minneapolis, Minnesota. On file at BRW, Inc.

Beers, Frederick W.

1869 *Atlas of Chittenden County, Vermont*. F. W. Beers, A. D. Ellis & G. G. Soule, New York.

Borstel, Christopher L.

2005 *Historic Front Yards and Transportation Archaeology in Vermont: Retrospect and Prospect*, Montpelier, VT. On file at Vermont Agency of Transportation.

Boyd, Hugh A. and Roger Brevoort

1978 *Winooski Falls Historic District National Register Nomination*, Burlington, Vermont. On file at University of Vermont.

Esri Inc.

2015 World Imagery. Esri, Inc., Redlands, California, http://services.arcgisonline.com/ArcGIS/rest/services/World_Topo_Map/MapServer.

Jack H. Wilson, Jr.

1992 *Field Inspection for Route 7 Improvements, Riverside Avenue, Burlington, addressed to William Sargent, Agency of Transportation, July 10, 1992*, Burlington, Vermont. On file at University of Vermont Consulting Archaeology Program.

Rann, William S.

1886 *History of Chittenden County, Vermont*. D. Mason & co., Syracuse, N.Y.,.

Ratcliffe, N. M., R. S. Stanley, M. H. Gale, P. J. Thompson and G. J. Walsh

2011 Bedrock Geologic Map of Vermont: U.S. Geological Survey Scientific Investigations Map 3184, 3 Sheets, scale 1:100,000. Vermont Geological Survey, Waterbury, Vermont.

Sanborn Map Company

1889 *Burlington, Vermont, Sheet 2, June 1889*. Sanborn Map Company, New York, NY.

1926 *Burlington, Vermont, Sheet 34, April 1926*. Sanborn Map Company, New York, NY.

1942 *Burlington, Vermont, Sheet 48, April 1942*. Sanborn Map Company, New York, NY.

United States Geological Survey (USGS)

2015 USGS The National Map Topo Base Map - Large Scale. USGSTopo (MapServer), The National Map Seamless Server, USGS, Sioux Falls, South Dakota, http://services.nationalmap.gov/arcgis/rest/services/USGSTopoLarge/MapServer.

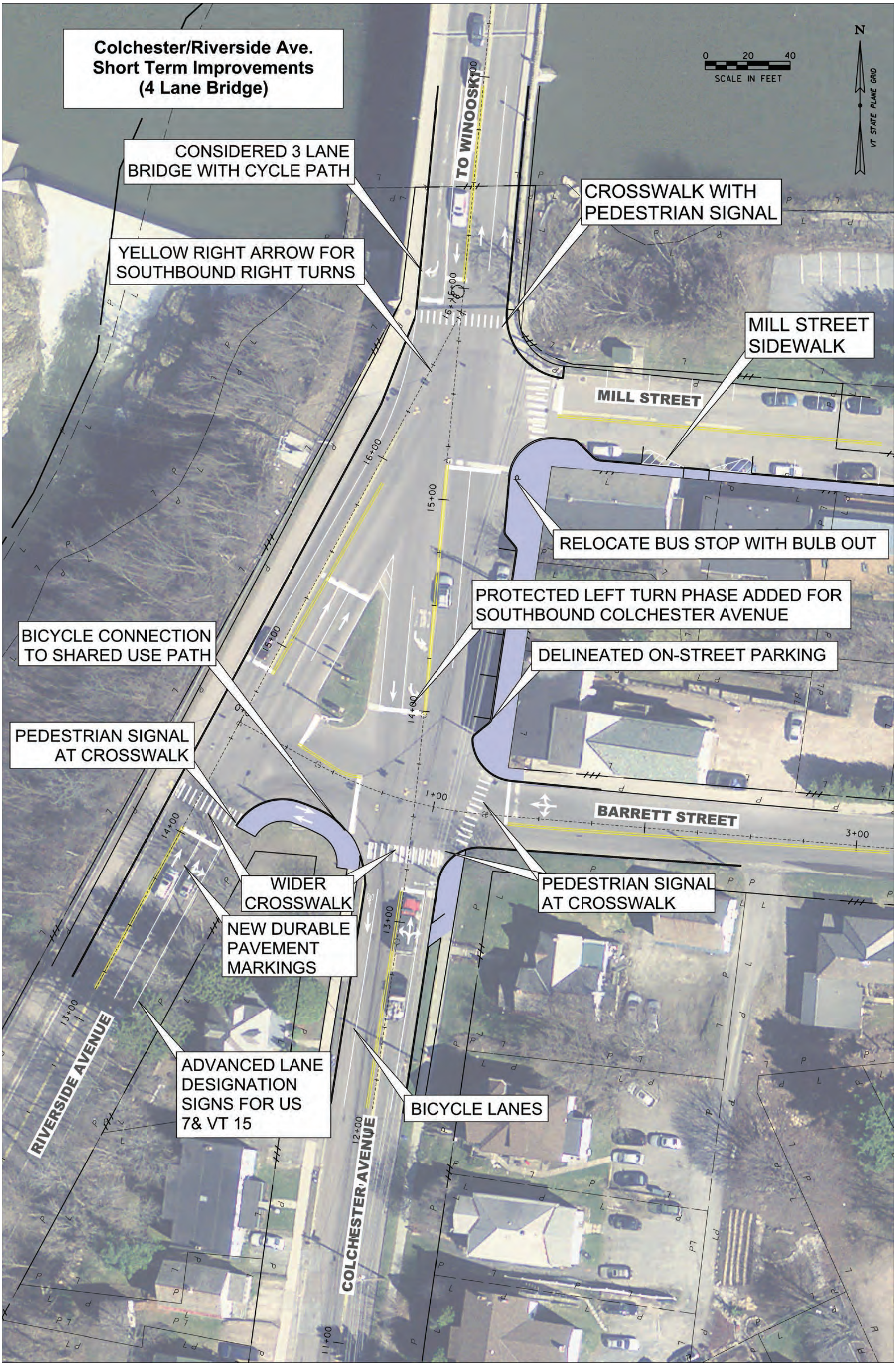
Vermont Division for Historic Preservation

2002 *The Vermont State Historic Preservation Office's Guidelines for Conducting Archeology in Vermont*. Vermont Division for Historic Preservation, Montpelier, VT.

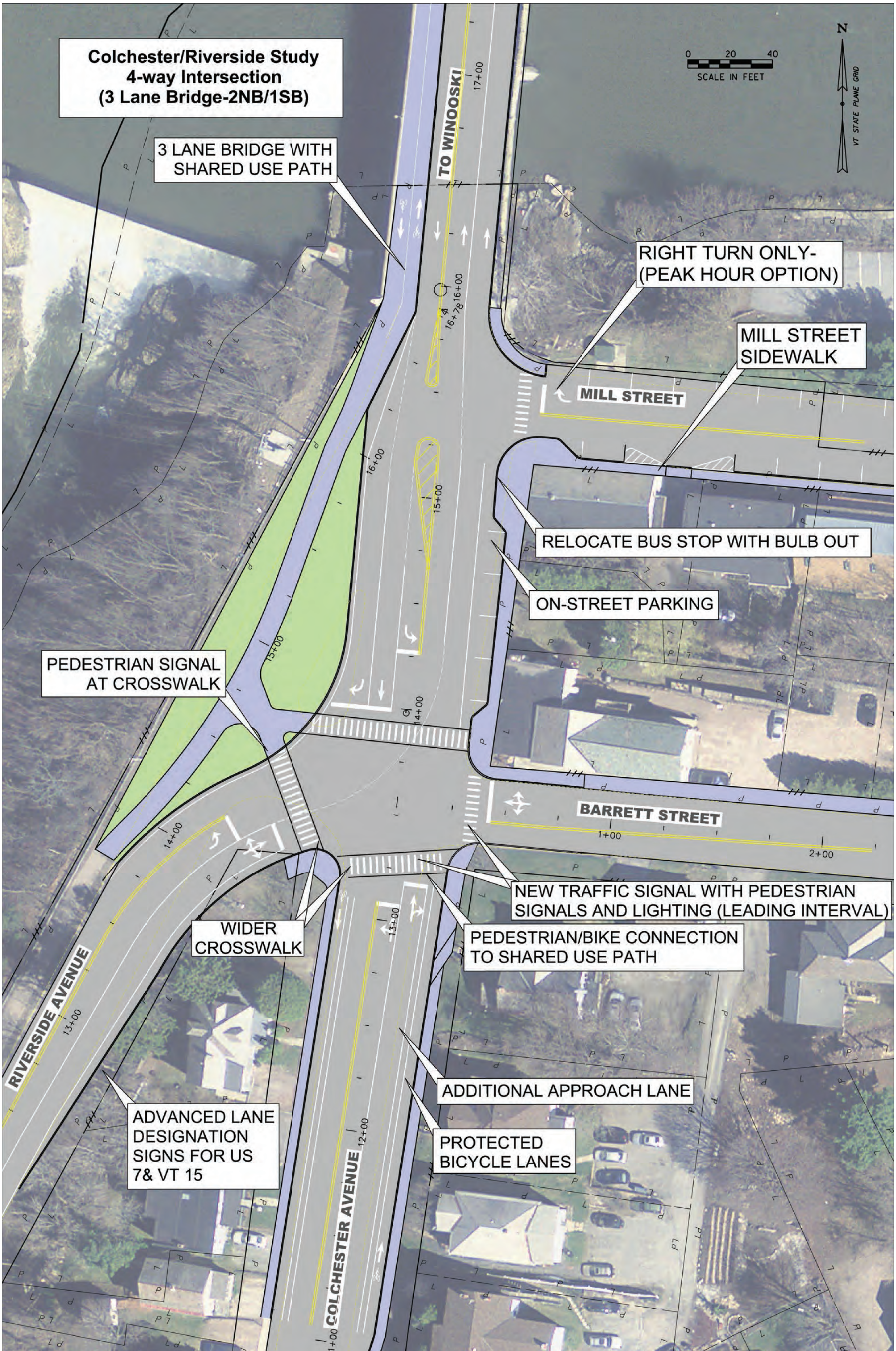
Walling, Henry Francis

1857 *Map of Chittenden County, Vermont: From Actual Surveys*. Baker, Tilden & Co., New York.

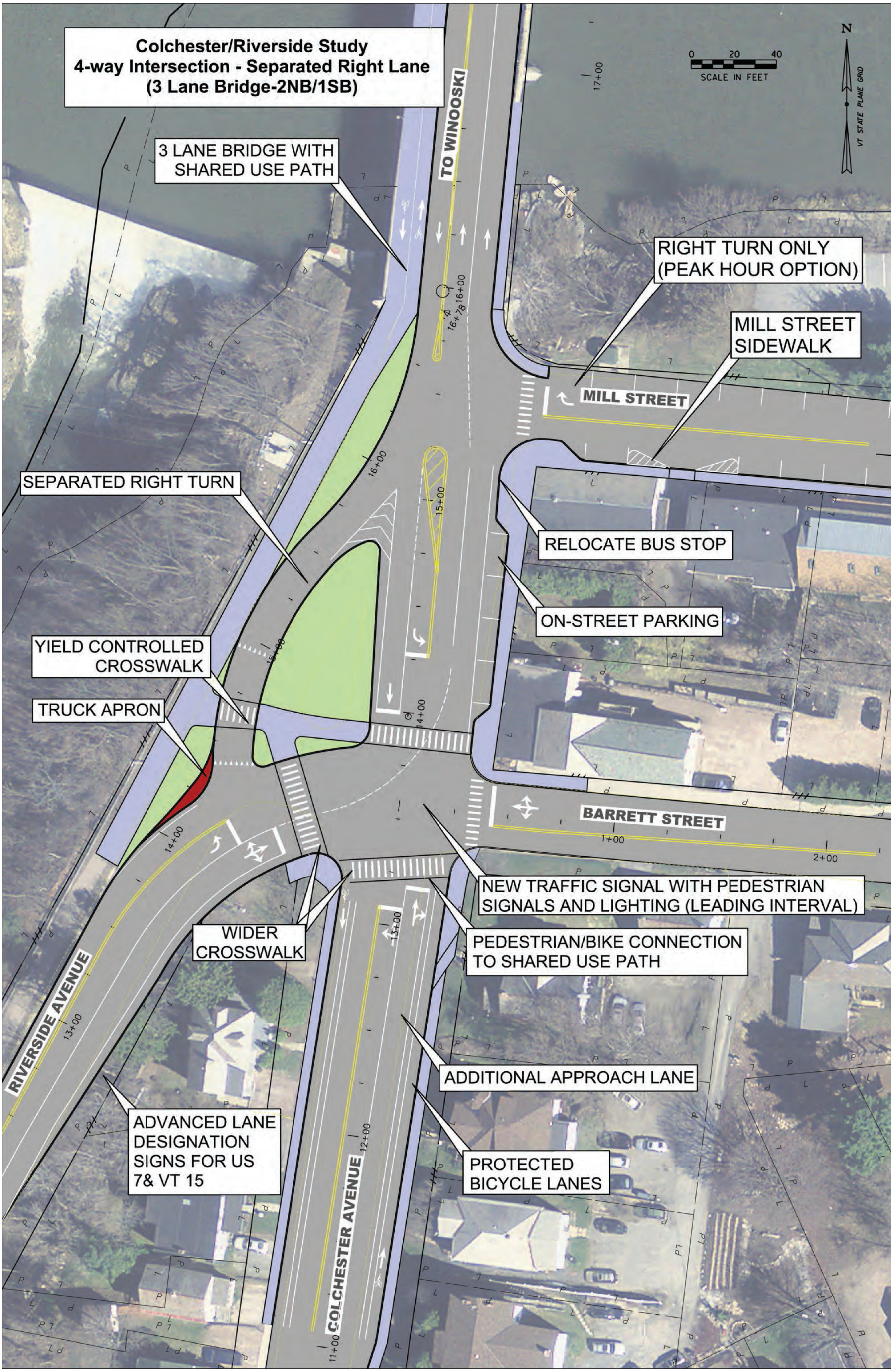
# Appendix 1: Project Alternative Plans

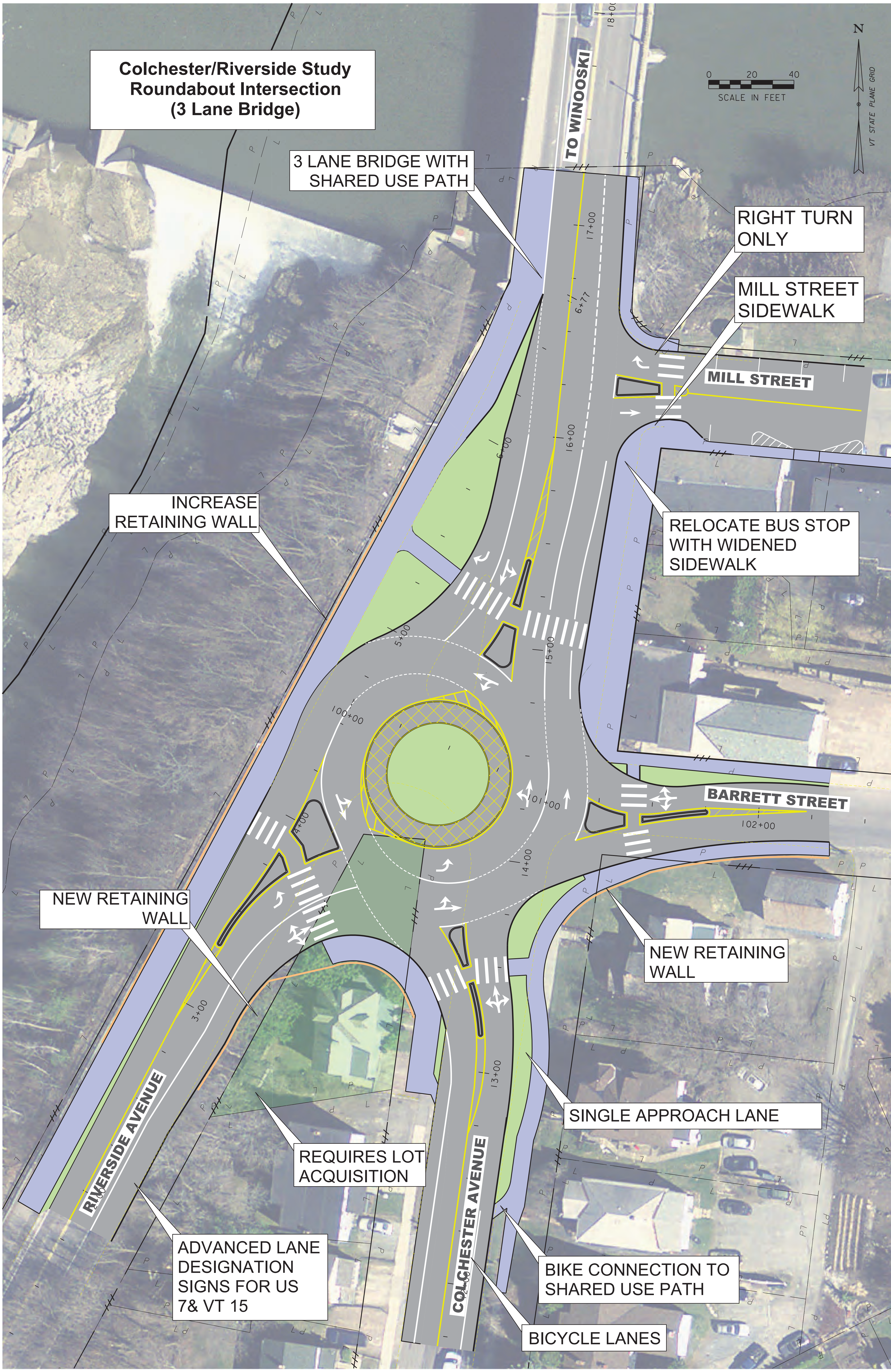


Colchester/Riverside Ave.
Short Term Improvements
(4 Lane Bridge)
0 20 40
SCALE IN FEET
N
VT STATE PLANE GRID
TO WINOOSKI
CONSIDERED 3 LANE BRIDGE WITH CYCLE PATH
CROSSWALK WITH PEDESTRIAN SIGNAL
YELLOW RIGHT ARROW FOR SOUTHBOUND RIGHT TURNS
MILL STREET SIDEWALK
MILL STREET
RELOCATE BUS STOP WITH BULB OUT
PROTECTED LEFT TURN PHASE ADDED FOR SOUTHBOUND COLCHESTER AVENUE
DELINEATED ON-STREET PARKING
BICYCLE CONNECTION TO SHARED USE PATH
PEDESTRIAN SIGNAL AT CROSSWALK
BARRETT STREET
WIDER CROSSWALK
PEDESTRIAN SIGNAL AT CROSSWALK
NEW DURABLE PAVEMENT MARKINGS
ADVANCED LANE DESIGNATION SIGNS FOR US 7& VT 15
BICYCLE LANES
RIVERSIDE AVENUE
COLCHESTER AVENUE



Colchester/Riverside Study
4-way Intersection
(3 Lane Bridge-2NB/1SB)
SCALE IN FEET
0 20 40
N
VT STATE PLANE GRID
TO WINOOSKI
3 LANE BRIDGE WITH SHARED USE PATH
RIGHT TURN ONLY- (PEAK HOUR OPTION)
MILL STREET SIDEWALK
MILL STREET
RELOCATE BUS STOP WITH BULB OUT
ON-STREET PARKING
PEDESTRIAN SIGNAL AT CROSSWALK
BARRETT STREET
NEW TRAFFIC SIGNAL WITH PEDESTRIAN SIGNALS AND LIGHTING (LEADING INTERVAL)
WIDER CROSSWALK
PEDESTRIAN/BIKE CONNECTION TO SHARED USE PATH
RIVERSIDE AVENUE
ADDITIONAL APPROACH LANE
PROTECTED BICYCLE LANES
ADVANCED LANE DESIGNATION SIGNS FOR US 7& VT 15
COLCHESTER AVENUE


Colchester/Riverside Study
4-way Intersection - Separated Right Lane
(3 Lane Bridge-2NB/1SB)
0 20 40
SCALE IN FEET
N
VT STATE PLANE GRID
TO WINOOSKI
3 LANE BRIDGE WITH SHARED USE PATH
RIGHT TURN ONLY (PEAK HOUR OPTION)
MILL STREET SIDEWALK
MILL STREET
SEPARATED RIGHT TURN
RELOCATE BUS STOP
ON-STREET PARKING
YIELD CONTROLLED CROSSWALK
TRUCK APRON
BARRETT STREET
NEW TRAFFIC SIGNAL WITH PEDESTRIAN SIGNALS AND LIGHTING (LEADING INTERVAL)
WIDER CROSSWALK
PEDESTRIAN/BIKE CONNECTION TO SHARED USE PATH
RIVERSIDE AVENUE
ADDITIONAL APPROACH LANE
ADVANCED LANE DESIGNATION SIGNS FOR US 7& VT 15
PROTECTED BICYCLE LANES
COLCHESTER AVENUE



Colchester/Riverside Study
Roundabout Intersection
(3 Lane Bridge)
TO WINOOSKI
0 20 40
SCALE IN FEET
N
VT STATE PLANE GRID
3 LANE BRIDGE WITH
SHARED USE PATH
RIGHT TURN
ONLY
MILL STREET
SIDEWALK
MILL STREET
INCREASE
RETAINING WALL
RELOCATE BUS STOP
WITH WIDENED
SIDEWALK
BARRETT STREET
NEW RETAINING
WALL
NEW RETAINING
WALL
SINGLE APPROACH LANE
REQUIRES LOT
ACQUISITION
RIVERSIDE AVENUE
COLCHESTER AVENUE
ADVANCED LANE
DESIGNATION
SIGNS FOR US
7& VT 15
BIKE CONNECTION TO
SHARED USE PATH
BICYCLE LANES

# Appendix 2: VDHP Environmental Predictive Model

VERMONT DIVISION FOR HISTORIC PRESERVATION

# Environmental Predictive Model for Locating Precontact Archeological Sites

**Project Name** Riverside/Colchester Avenue Intersection **County** Chittenden **Town** Burlington
**DHP No.** ________________ **Map No.** ________________ **Staff Init.** ________ **Date** August 30, 2016
**Additional Information** ____________________________________________

| Environmental Variable | Proximity | Value | Assigned Score |
|---|---|---|---|
| **A. RIVERS and STREAMS (EXISTING or RELICT)**: | | | |
| 1) Distance to River or Permanent Stream (measured from top of bank) | 0- 90 m<br>90- 180 m | 12<br>6 | 12 |
| 2) Distance to Intermittent Stream | 0- 90 m<br>90-180 m | 8<br>4 | ______ |
| 3) Confluence of River/River or River/Stream | 0-90 m<br>90 –180 m | 12<br>6 | ______ |
| 4) Confluence of Intermittent Streams | 0 – 90 m<br>90 – 180 m | 8<br>4 | ______ |
| 5) Falls or Rapids | 0 – 90 m<br>90 – 180 m | 8<br>4 | 8 |
| 6) Head of Draw | 0 – 90 m<br>90 – 180 m | 8<br>4 | ______ |
| 7) Major Floodplain/Alluvial Terrace | | 32 | ______ |
| 8) Knoll or swamp island | | 32 | ______ |
| 9) Stable Riverine Island | | 32 | ______ |
| **B. LAKES and PONDS (EXISTING or RELICT)**: | | | |
| 10) Distance to Pond or Lake | 0- 90 m<br>90 -180 m | 12<br>6 | _____ |
| 11) Confluence of River or Stream | 0-90 m<br>90 –180 m | 12<br>6 | _____ |
| 12) Lake Cove/Peninsula/Head of Bay | | 12 | ______ |
| **C. WETLANDS**: | | | |
| 13) Distance to Wetland (wetland > one acre in size) | 0- 90 m<br>90 -180 m | 12<br>6 | ______ |
| 14) Knoll or swamp island | | 32 | ______ |
| **D. VALLEY EDGE and GLACIAL LAND FORMS**: | | | |
| 15) High elevated landform such as Knoll Top/Ridge Crest/ Promontory | | 12 | _____ |
| 16) Valley edge features such as Kame/Outwash Terrace** | | 12 | 12 |

| | | | |
|---|---|---|---|
| 17) Marine/Lake Delta Complex** | | 12 | _____ |
| 18) Champlain Sea or Glacial Lake Shore Line** | | 32 | ______ |
| **E. OTHER ENVIRONMENTAL FACTORS:**<br>19) Caves /Rockshelters | | 32 | _____ |
| 20) [ X] Natural Travel Corridor<br>[ ] Sole or important access to another drainage<br>[ ] Drainage divide | | 12 | 12 |
| 21) Existing or Relict Spring | 0 – 90 m<br>90 – 180 m | 8<br>4 | _____ |
| 22) Potential or Apparent Prehistoric Quarry for stone procurement | 0 – 180 m | 32 | _____ |
| 23) ) Special Environmental or Natural Area, such as Milton acquifer, mountain top, etc. (these may be historic or prehistoric sacred or traditional site locations and prehistoric site types as well) | | 32 | _____ |
| **F. OTHER HIGH SENSITIVITY FACTORS**:<br>24) High Likelihood of Burials | | 32 | _____ |
| 25) High Recorded Site Density | | 32 | 32 |
| 26) High likelihood of containing significant site based on recorded or archival data or oral tradition | | 32 | _____ |
| **G. NEGATIVE FACTORS**:<br>27) Excessive Slope (>15%) or Steep Erosional Slope (>20) | | - 32 | _____ |
| 28) Previously disturbed land as evaluated by a qualified archeological professional or engineer based on coring, earlier as-built plans, or obvious surface evidence (such as a gravel pit) | | - 32 | -32 |

** refer to 1970 Surficial Geological Map of Vermont**

**Total Score**: 44

**Other Comments :**

**0- 31 = Archeologically Non- Sensitive**
**32+ = Archeologically Sensitive**

# HISTORIC RESOURCES IDENTIFICATION

## RIVERSIDE AVE-COLCHESTER AVE INTERSECTION SCOPING STUDY

## CITY OF BURLINGTON, CHITTENDEN COUNTY, VERMONT

HARTGEN

archeological associates inc

www.hartgen.com

# Historic Resources Identification, Riverside Avenue-Colchester Avenue Intersection Scoping Study, City of Burlington, Chittenden County, Vermont

## Submitted to:

Greg Edwards, PE, ENV SP
Senior Principal
Stantec
55 Green Mountain Drive
South Burlington, VT 05403

## Submitted by:

Walter R. Wheeler
Senior Architectural Historian
Hartgen Archeological Associates, Inc.
1744 Washington Avenue Extension
Rensselaer, New York 12144

October 2016

# TABLE OF CONTENTS

## LIST OF FIGURES

# INTRODUCTION

Hartgen Archeological Associates, Inc. (Hartgen) conducted an historic resources identification survey for the proposed Riverside Avenue-Colchester Avenue Intersection Scoping Study Project located in the City of Burlington, Chittenden County, Vermont. A site visit was conducted by Walter R. Wheeler and Roberta S. Jeracka on 7 September 2016. Information gathered during the site visit is included in the relevant sections of this report.

# PROJECT LOCATION AND DESCRIPTION

The project is located in Burlington's Ward 1, in the northeast corner of the city, along the south side of the Winooski River, directly across from the commercial district of the City of Winooski (Maps 1 and 2).

Four alternative designs have been developed for the project (Appendix 1). They include the following:

- Short Term Improvements (4 lane bridge)
- 4-way Intersection (3 lane bridge – 2NB/1SB)
- 4-way Intersection – Separated Right Lane (3 lane bridge – 2NB/1SB)
- Roundabout Intersection (3 lane bridge)

These alternatives all include modifications along the following alignments:

- Riverside Avenue: extending from the south end of the Winooski River bridge 540 feet (165 m) to the south
- Colchester Avenue: from the intersection with Riverside Avenue extending 457 feet (139 m) to the south
- Mill Street: extending from the intersection with Colchester Avenue 212 feet (65 m) to the east
- Barrett Street: extending from the intersection with Colchester Avenue 226 feet (69 m) to the east

The area of potential effects (APE) includes approximately 2.89 acres (1.17ha). The roundabout alternate would require the removal of the house at 460 Colchester Avenue.

The project requires approvals by the Vermont Agency of Transportation (VTrans) and the Federal Highway Administration (FHWA). This investigation was conducted to comply with Section 106 of the National Historic Preservation Act of 1966, as amended and will be reviewed by the VTrans Historic Preservation Officer.

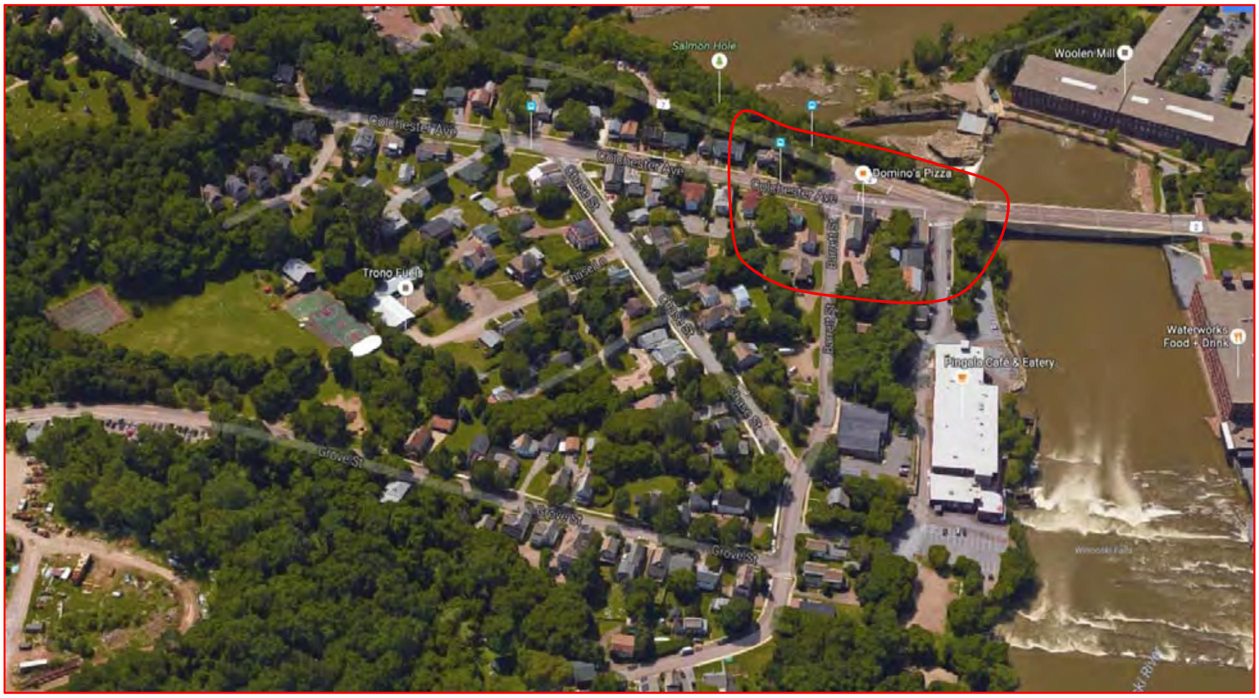



**Figure 1. Aerial view, looking west, showing the relationship of the project area (outlined in red) to mill complexes and downtown Winooski, at right (adapted from Google Earth imagery).**

## HISTORICAL BACKGROUND

The falls of the Winooski River have been an important location from precontact times through to the present. Historically, they were the locus of 18th-century settlement by Ira Allen and other early settlers across the river from the project area where they built a fort in 1772 (Rann 1886:555). During the Revolution the settlement was abandoned. After the war, Allen returned and with his brothers Ethan and Levi, they started the Onion River Company at the falls and reportedly built the upper dam, two saw mills, a grist mill, two forges and a furnace for smelting bog iron (Rann 1886:555; Visser and Larson 1993). Much of the lands and business interests on the Burlington side of the falls had been transferred to Moses Catlin (a relative by marriage to Ira Allen) by the end of the 18th century, due to business failures. Catlin and his brothers Lynde and Guy constructed a grist and wool-carding mill on the site of the present Chase mill building. Additional manufacturing concerns, including a distillery, paper mill, patent oil mill, and cut nail manufactory, located in the neighborhood during the first decades of the 19th century (Visser and Larson 1993).

**Figure 2. *Winooski Falls near Burlington*, Drawing, 1840. Project area is located at right in this view. The covered bridge over the Winooski is seen at center right (www.uvm.edu).**

Development of mill sites occurred simultaneously on both sides of the Winooski River, and the two fledgling communities which grew up around these industrialized sites were connected from an early date by a covered bridge (Figure 2). The near-total absence of institutional structures—a small schoolhouse was located on Chase Street but there were no churches or public buildings located on the Burlington side of the river—and the fact that the neighborhood was separated from the rest of the City of Burlington by steep changes in topography and the early presence of a cemetery (Greenmount Cemetery), strongly suggests that residents on the south side of the waterway were historically more closely affiliated with their neighbors to the north in Winooski, than to their fellow Burlingtonians.

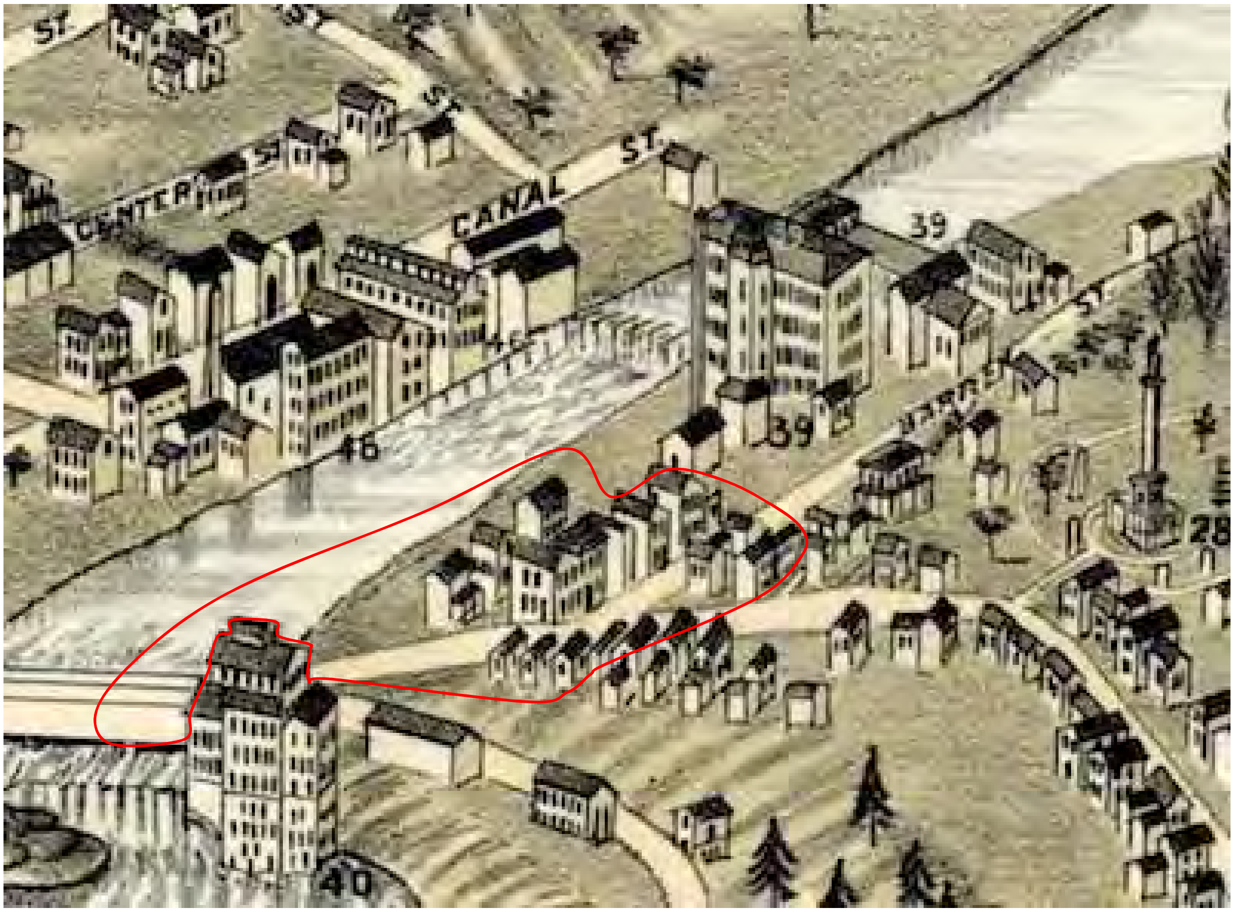



**Figure 3. Detail from Burlington and Winooski, a birdseye view published in 1877 (Meilbeck 1877). The red outline roughly demarks the project APE.**

During the course of the 19th century textile mills came to dominate the local economy (Boyd and Brevoort 1978). This trend continued into the latter 19th century, with the "cotton famine" of the 1860s resulting in a dramatic expansion of the textile mills on both sides of the river. Earlier industries including flour and plaster milling became less profitable, contemporaneously with the expansion of the cotton textile industry.

As a densely-occupied industrial zone, the project area is well documented on historic maps. Hill Street, Barrett Street, Chase Street and Chase Lane were all established by 1857, as were principal north-south roads Colchester and Riverside avenues (Walling 1857). Grove Street was established but no houses had been constructed on it at that time. Houses were initially concentrated along Chase Street and Colchester Avenue, closest to the mills; during the course of the 19th century a series of short streets were established off of these principal public ways.

Large numbers of French Canadian and Irish workers settled in the area to take advantage of the employment opportunities presented by the mills, and a large Catholic church (St. Francis Xavier) was constructed on the Winooski side of the river to serve their spiritual needs in the 1870s. An iron bridge was built over the Winooski River, replacing the earlier covered wood span, in the 1880s. Continuing success brought construction of newer, larger and more modern mill facilities, including the Chase mill (1892, Figure 4). The industry continued to thrive into the 1920s, when the dual disasters of the 1927 flood and 1929 stock market crash put an end to its long period of success. The flood resulted in the destruction of the two dams located on the river, destroyed the Winooski bridge, and extensively damaged the mills (Visser and Larson 1993). The crash of 1929 resulted in a changing business environment, which, together with the cheap availability of air conditioning, sent much of America's textile businesses to the south. The last major mill concern, the American Woolen Company, closed in 1954.


**Figure 4. The Chase Mill, looking east, 2016.**

The presence of these thriving industries resulted in the construction of dwellings and shops in close proximity to the mills, including structures which were built by manufacturers as tenements for their workers. Although some housing was constructed by mill owners (Figure 37), the greater number of dwellings appear to have been built by individuals, or as rental properties by private owners. The earliest dwellings were typically wood-frame vernacular cottages (Figure 5). Although most of the earliest of these structures are now gone, many remain which date to the mid-19$^{th}$ to the early 20$^{th}$ centuries (Figures 5 and 8 thru 10). A small number of duplex, apartment, and tenement housing was constructed in the vicinity of the mills, but no large-scale development (such as is encountered in many New England mill towns, and to some degree on the Winooski side of the river) was undertaken. Houses constructed later in the 19$^{th}$ century occasionally partook of historicist styles popular during that period, and generally reflect the prosperity of the locale through their increased size and pretention.

**Figure 5. View on Chase Street, looking southeast, 2016. Mechanic's cottages and a vernacular house with details inspired by the gothic revival are seen in this view, which typifies the mid-19th century housing stock in the neighborhood.**

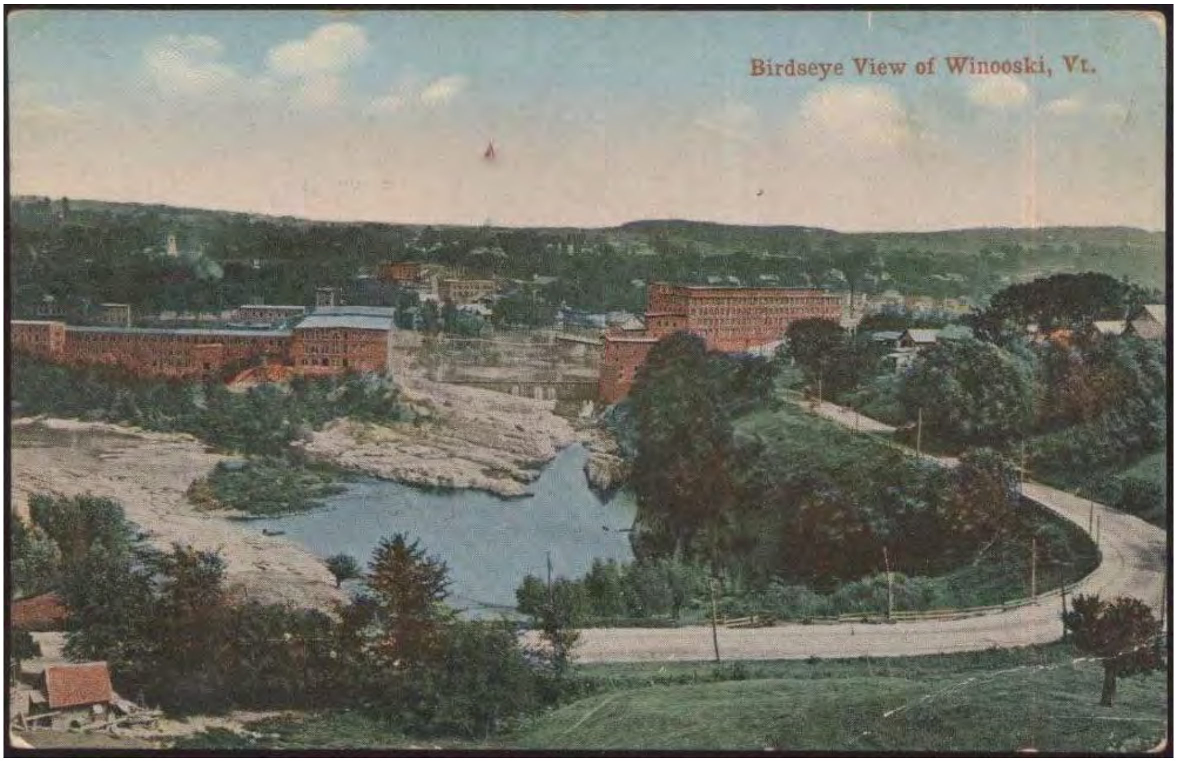



**Figure 6. View taken from the same location as that in figure2, c. 1905. The project area is at right. Road winding along right and at bottom of this image is Riverside Avenue, formerly Winooski Road (Private Collection).**

**Figure 7. Winooski Bridge destroyed in 1927 flood. A portion of the now-razed Burlington Flouring Company mill is seen at left in this view toward Winooski (Private Collection).**

**Figure 8. View south on Colchester Avenue, 1 September 1929 (McAllister photograph, http://www.uvm.edu/~hp206/2005oldnorthend/Innamorati/pair10.html).**

**Figure 9. Looking north on Colchester Avenue, c. 1930 (http://www.uvm.edu/~hp206/2005oldnorthend/Innamorati/pair6.html).**

**Figure 10. Looking north on Colchester Avenue, c. 1960 (www.delcampe.net).**

# STREETSCAPE VIEWS


**Figure 11. A similar view, looking north, 2016. This view particularly highlights the close association between downtown Winooski (seen in the center distance) and the project area.**

**Figure 12. Looking south-southeast from the south end of the Winooski Bridge up Colchester and Riverside avenues, 2016.**

**Figure 13. Looking south-southwest from the northeast corner of Barret Street and Colchester Avenue, 2016.**

**Figure 14. Looking west on Mill Street, 2016.**

**Figure 15. Looking southeast at the corner of Colchester Avenue and Barrett Street, 2016.**

# ARCHITECTURAL DESCRIPTIONS

## Winooski Bridge (NRL)


**Figure 16. 4 August 1928 opening day of the bridge. (http://cashmanhistory.com/showmedia.php?mediaID=25964&medialinkID=61637 accessed 27 September 2016).**

The Winooski Bridge is a poured concrete and steel deck plate girder bridge, constructed in 1928 (Figures 17 thru 19). It replaced an earlier span located along the same alignment, which was destroyed during flooding in 1927. The deck of the present bridge is at a higher elevation; fill at the south approach necessitated the removal of some structures, and resulted in the partial burial of 495-97 Colchester Avenue (Figure 32).

A contemporary newspaper article provides a description of the span:

> "The contract for the erection of a reinforced concrete ridge [sic] which now crosses the Winooski river near the lime kilns and is known as the "high bridge," has been awarded to James E. Cashman. The bridge is to be 278 feet in length and 20 feet wide on the inside. The entire structure will be of cement construction and will be 76 feet above the river. This height is necessary in order to have the bridge clear the railroad track at the

> proper elevation, for an overhead pass is to be a part of the work. The historic old structure now spanning the river was erected at least 100 years ago and did duty until it was condemned, within a few months…. The new bridge is to be a handsome affair, according to the specifications, and will be something of an attraction for sightseers, on account of its height above the river. The arch upon which it is to be supported across the river will have a span of 93 feet. Mr. Cashman will put a large force of men on the work at once, as the time set for its completion is October next." (http://cashmanhistory.com/showmedia.php?mediaID=25972&medialinkID=61645 accessed 27 September 2016).

The bridge remains essentially as originally constructed, except for the replacement of original standards with modern "cobra headed" lamps, noted in the National Register nomination for the boundary expansion of the Winooski Falls Mill Historic District (Visser and Larson 1993). These were more recently replaced with lamps whose design is more compatible with that of the bridge.

**Figure 17. Winooski Bridge, looking northwest, 2016.**

**Figure 18. Winooski Bridge, detail looking north showing railing and lamp standard, 2016.**


**Figure 19. Bridge plaque, 2016.**

## 11 Barrett Street

The house at 11 Barrett Street was constructed between 1869 and 1889 (Map 4). It is a one-and-one-half story wood-frame side-gable dwelling, three bays wide on its principal (street) elevation, with a central passage and end chimneys (Figures 20 and 21). Gable end elevations feature two windows on the first and second floors. It is covered with aluminum siding and sits on a parged stone foundation. Mapping from 1906 to 1942 depicts a one-story frame addition to this structure, which no longer stands. A door in the west elevation is probably indicative of the structure having been divided into two apartments at a more recent date, although it was initially constructed as a single-family dwelling.

**Figure 20. 11 Barrett Street, looking southwest, 2016.**

**Figure 21. 11 Barrett Street, looking south-southeast, 2016.**

## 17-21 Barrett Street

The duplex dwelling at 17-21 Barrett Street was constructed between 1894 and 1906 (Map 4; Sanborn 1894). It is a two-story wood-frame side-by-side clapboarded duplex with slate-covered hipped roof (Figure 22). One-story covered porches are located in the angle between a projecting central pavilion and the main body of the dwelling. Principal windows are double hung, with paired windows of this type used on the first and second floors of the projecting central portion of the building. The building sits on a rusticated concrete block foundation. Design and materials used in this structure (in particular the rusticated block foundation) make an early 20$^{th}$ century date of construction likely. A one-story wood-frame wing was added to the southwest corner of the building after 1942 (Map 4).

**Figure 22. 17-21 Barrett Street, looking southeast, 2016.**

## 454-56 Colchester Avenue

The building at 454-56 Colchester Avenue was built between 1869 and 1889 (Map 4). The 1889 Sanborn map indicates that a grocery store was located in the basement of this building at that time, with "dwellings above" (Sanborn 1889). The 1894 Sanborn map simply note it as a dwelling. The insurance mapping from 1912 describes the building as "tenements" (Sanborn 1912).

The structure is a two-story rectangular wood-framed building, banked into its sloping site so that the northern end of the building is three stories in height (Figure 23). It has a nearly flat roof, and is seven bays wide. The narrow eaves and cornice of the roof are supported on small paired brackets. Two principal entries on the first floor are sheltered by a covered porch which extends across the central three bays on the street elevation. A secondary entrance, perhaps initially used by the basement commercial space, is located on the north elevation. Both north and south elevations are two bays wide. All windows consist of two-over-two double-hung sash.

**Figure 23. Looking west-southwest at 454-56 Colchester Avenue, 2016.**

## 460 Colchester Avenue

The dwelling at 460 Colchester Avenue was constructed between 1912 and 1919 (Map 4; Sanborn 1912). Although it appears to have been initially constructed as a single-family dwelling, it is presently divided into apartments (Figures 24 and 25).

The house is wood-framed, and is rectangular in plan. A truncated pyramidal roof with dormers intersecting with a gable roof crowns a façade sheathed with clapboards at the first floor level and shingles on the second floor. A one-story covered porch wraps around the northeast corner of the house; its roof is supported on turned Tuscan columns. Fenestration chiefly consists of double-hung undivided sash; fixed undivided sash with a transom lights one of the rooms on the east façade, however. Late-20$^{th}$ century alterations include changes to the fenestration on the east façade, where two sliding sash have been installed, and on the north façade where a wide tripartite window has been inserted within the area sheltered by the porch.

**Figure 24. Looking south at 460 Colchester Avenue, 2016.**

**Figure 25. Looking west at 460 Colchester Avenue, 2016.**

## 467 Colchester Avenue

The dwelling at 467 Colchester Avenue was constructed between 1919 and 1926 (Map 4). It was designated as "flats" type apartments on the Sanborn map of the latter year, its first appearance on mapping (Sanborn 1926).

The building is two stories in height, rectangular in plan with a prominent six-sided tower located at its northwest corner. It is banked into its site so that portions of the basement are at grade and can be occupied as an apartment. The main body of the house is covered with a hipped roof, which features a shed-roofed dormer in its southern slope. A two-story enclosed porch with gable roof is the most prominent feature of the street (west) façade. The building is currently sheathed with vinyl siding. It retains its original three-over-one double hung sash.

**Figure 26. Looking east at 467 Colchester Avenue, 2016.**

**Figure 27. Looking northeast at 467 Colchester Avenue, 2016.**

## 475 Colchester Avenue

The house at 475 Colchester Avenue first appears on mapping in 1889. Previous to that, in 1869 the lot now occupied by the house was owned by "J. Potrier" (Beers 1869). The house was likely constructed in the 1870s.

It is a one-and-a-half story wood-frame "upright and wing" type vernacular house sheathed with aluminum siding. The principal sections of the house, originally constructed on a "T" plan, are covered with gable roofs. A later one-story addition, filling the northeast corner of the plan, has a shed roof. An enclosed one-story gable-roofed porch extends across the two-bay wide façade of the "upright" portion of the building; it appears to have been constructed in the 20th century. A covered porch with shed roof shelters the entrance to the "wing" portion of the house, and has a recently replaced turned baluster railing. The house occupies a stone foundation, and brick or block chimneys surmount the three gabled elevations. All windows are double-hung undivided sash.

**Figure 28. Looking east-southeast at 475 Colchester Avenue, 2016.**

**Figure 29. Looking southwest at 475 Colchester Avenue, 2016.**

## 485 Colchester Avenue/ 8-10 Barrett Street (NRL)

Visser and Larson provided a comprehensive description of this building and its evolution in their National Register nomination for a boundary increase to the Winooski Falls Mill Historic District, which is extensively quoted, below. They identified the structure as the "Hickock-Burlington Cotton Company Tenement Building" (Visser and Larson 1993).

Visser and Larson found that components of this three-part structure were built as early as 1811, with additions in 1853. The westernmost portion of the building, along Colchester Avenue, was constructed in 1924 and was subsequently razed in 1993 (Map 4; Visser and Larson 1993). They described the building and its history as follows:

> "The two-story-high main block is sheathed with wooden clapboards and covered by a slate-shingled, gable roof. On the main block's east side, a 2-story, clapboarded wing extends along Barrett Street and is covered by a slated gable roof whose ridgeline is perpendicular to the ridgeline of the main block's roof. …The exterior appearance of the main block and east wing has changed little since 1853, when the main block's southern half was removed to allow space for the construction of Barrett Street and the building was converted into a tenement. The original structure sits on a high foundation built of local limestone and poured concrete on the south and east and nearly a full story of concrete blocks on the north. The main block and east wing's north and south facades contain six unevenly spaced bays and its east facade contains three bays. The building's 2/2 windows with their plain trim and simple projecting caps date from the 1853 renovations when the east wing was raised to two stories and the entire building received new wooden clapboards, windows and cornice trim. The only windows not dating from this period are a boarded over window in the attic's north gable…and two second-story windows above the west addition, which were filled with small, fixed-sash windows in 1924. The building's cornice and gable trim feature wide sloping soffits without gable returns, which are typical of mid-19th century vernacular buildings in the area.…The Hickock-Burlington Cotton Company Tenement Building is probably one of the oldest surviving buildings at Winooski Falls. The structure was originally constructed to serve as a store for Reuben Harmon in 1811. Although Harmon lost the store to creditors less than seven months after it opened, the building continued to serve as a store and tavern during the early commercial development of Winooski Falls. By the 1830s, the building had come under the ownership of Burlington merchant Oziah Buell, who rented it out as a tavern, store, and dwelling. Upon Buell's death, the building was inherited by his daughter, Maria Buell Hickock, who with her husband, Merchant's Bank president Henry Hickock, converted the building into a tenement after moving the southern half of the main block next door to allow for the construction of Barrett Street in 1853. In 1866, the Burlington Woolen Company acquired the building for worker housing, and it served as a multi-family tenement through the 1960s. The most notable change to the building after 1866 was the construction in 1924 of the west addition, which housed a fruit and grocery store until the early 1960s. Significant alterations to the addition in 1961 made it noncontributing and this part was demolished in 1993. The building was in the process of being rehabilitated in 1993." (Visser and Larson 1993)

Rehabilitation in 1993 also included the removal of a gable-roofed porch, believed to have dated to the 1960s, which was located on the Barrett Street elevation. The fenestration pattern on the Barrett Street elevation was altered; three doors on this elevation were removed and replaced with windows. In place of the razed 1924 west addition, a two-story wood-framed flat-roofed structure was built. It is five bays wide on Colchester Avenue, and two bays deep along Barrett Street, and has a storefront with display windows on both elevations at the first floor level. A small bracketed cornice extends along the top of the Colchester Avenue façade (Figures 30 thru 32).


**Figure 30. View looking northeast, August 1986 (Thomas D. Visser, from the 1993 National Register boundary expansion nomination form).**


**Figure 31. Looking northeast at 485 Colchester Avenue/ 8-10 Barrett Street, 2016.**

**Figure 32. Looking northwest at 485 Colchester Avenue/ 8-10 Barrett Street, 2016.**

## 495-97 Colchester Avenue (NRL)

Identified in the boundary increase nomination form for the Winooski Falls Historic District as the "Duncan Blacksmith Shop" with initial construction date as c. 1841.

As originally built, this structure was a gable-entry commercial building of two-and-a-half stories in height. Visser and Larson provide a history of the building's use up to the early 20th century:

> "The building was originally constructed as a store between 1841 and 1846 to serve the rapidly expanding manufacturing and commercial center developing around Winooski Falls. From 1851 to 1882, the building was a forge and blacksmith shop operated by Albert and George Duncan. In 1883, the shop was purchased by I. S. Dubuc, who continued to use the building as a blacksmith and wheelwright shop with a painting shop on the second floor. By 1889, Dubuc had expanded his operations and built lumber drying sheds, which were connected with a carriage house to the south and a livery next door. Insurance maps indicate the building was used to sell second hand goods from 1894 until about 1912, when Dubuc converted the building into a grocery store" (Visser and Larson 1993).

Alterations to the topography undertaken to create an approach to the Winooski bridge in 1928 buried the first floor of this structure, reducing its exterior height to one-and-a-half stories. During the past two years the present owner has undertaken a project to jack up the upper floor of the structure, disassemble the buried first floor of this building, construct a new foundation extending up to the present elevation of Colchester Avenue, and insert a new first floor between the two (Figure 29). The goal has been to return the building essentially to its appearance and relationship to the surrounding topography as it was in the 19th century. To this end, the fenestration pattern of the original first floor has been replicated in the remodeled building, and the original materials have been used wherever possible. This work is nearly complete (Figure 30).

In its present configuration, the building is a two-and-one-half story brick-veneered concrete and block masonry (at the basement and first floor levels, respectively) and wood frame (at the second floor level) gable-entry vernacular commercial building. The building is three bays wide on its Colchester Avenue face; the central bay contains a loading door at the second floor level. The Mill Street elevation is five bays wide at the second floor level; first floor fenestration is irregularly spaced, and consists of four windows and a double-door entry.

The south elevation was not visible at the time of the site visit due to construction activity; in 1993 it was described as "composed of a second story at street level with four unevenly spaced windows separating entrances near each end. The facade is screened by a two story, four bay, shed-roofed porch, which was added between 1894 and 1900 and features turned Tuscan columns rising from its second story railing. An additional bay supported by a manufactured, wrought iron post was more recently added to the west end, allowing access to the street. Covered storage areas sheathed with wooden shingles were added on the porch's first story, between which rise two sets of wooden stairs" (Visser and Larson 1993). It is likely that the configuration of the porch (which was partially visible at the time of the site visit) has been modified somewhat by the recent alterations undertaken to the building. The east elevation, which previously had porches attached to it, has two windows at each floor level, and an entry at the basement level.

In place of display windows visible in 20th century photographs of the Colchester Avenue elevation (Figure 28), a central door flanked by single windows has been installed in the new first floor. These windows are double-hung 6-over-six sash; the remainder of the windows in the building are also double-hung, but are 2-over-2 sash. Divisions of the interior created to convert the building into apartments have been removed, leaving an open plan. It is anticipated that the building will be used for commercial purposes and office space.


**Figure 33. View looking east, showing 495-97 Colchester Avenue previous to 1927.**


**Figure 34. Lifting the second floor of 495-97 Colchester Avenue, c. 2015. View looking southwest.**

**Figure 35. View looking southeast at 495-97 Colchester Avenue, 2016.**

## 5-11 Mill Street (NRL)

Identified by Visser and Larson in their 1993 National Register nomination form as the “I. S. Dubuc Tenement building” and assigned a construction date of c. 1912.

A two-story wood-frame multi-family dwelling sheathed with clapboards and having a flat roof. The Barrett Street elevation features four windows across both the first and second floors; the south elevation has nearly identical fenestration. East and west elevations are two bays wide. All windows are double hung undivided sash, which replace earlier two-over-two sash. The entrance is located on the south side of the building; access to the second floor apartments is via a stair which rises in a covered two-story porch which extends the full length of the south elevation. A simple bracketed cornice of small scale faces a short parapet wall on the north, east and west facades. The modest detailing and economical construction techniques utilized in this building are a reflection of its initial use as tenement housing.

Visser and Larson note that it was constructed contemporaneously with the Champlain Mill across the river and that its construction reflects the increasing demand for economical housing that attended the expansion of the mills (Visser and Larson 1993).

**Figure 36. View looking southeast toward 5-11 Mill Street, 2016.**

**Figure 37. View looking southeast at 5-11 Mill Street, c. 2013 (Google Streetview).**

## 13-19 Mill Street (NRL)

This structure was identified by Visser and Larson as the "Burlington Cotton Company Tenement Building" in their 1993 National Register nomination form. Their research determined that it was constructed c. 1853 and in 1874. Originally located on a different site, this building may have originally been built "as a mill building or storage facility" for the Winooski Mill Company. Visser and Larson found that "City records refer to it as an "old building" when it was moved to its present site and converted into four tenements by the Burlington Cotton Company in 1874. The building continued to be owned by the adjacent cotton mill until 1928" (Visser and Larson 1993).

Currently serving as an eight-unit apartment house, the structure is a wood-framed building of two stories with side-gable roof. The Mill Street elevation is 10 bays wide on both the first and second floors; east and west elevations are two bays wide.

Alterations and additions undertaken after 1993 include removal of the asbestos shingles that formerly sheathed the building and their replacement with clapboards (possibly these are a restoration of the original clapboards). A two-story porch constructed between 1935 and 1941 was removed and a new two-story porch was constructed to shelter the paired entry doors at the first and second floor levels. A shed-roofed dormer, extending much of the length of the Mill Street elevation, was also built in the years since the building was surveyed for the nomination form. Its 12 top-hung casement windows light third floor rooms belonging to the second floor apartments. The balance of the fenestration consists of modern undivided double-hung sash. The building occupies a stone and brick foundation.

The simple detailing of this building, evident even after its recent renovation, reflect 19th century vernacular aesthetics and the economical approach brought to the design of utilitarian structures in the mid-19th century.

**Figure 38. View looking south-southwest at 13-19 Mill Street, 2016.**

# NATIONAL REGISTER ELIGIBILITY SUMMARY

A total of eleven resources, located within or adjacent to the project APE, were surveyed for this study (Table 1). Five of these (structures 1 thru 5 in Table 1) are already listed on the National Register as part of the Winooski Falls Mill Historic District (1978) or its boundary expansion in 1993 (Visser and Larson 1993). The remaining resources (structures 6 thru 11 in Table 1) would contribute to an expanded Winooski Falls Mill Historic District which would encompass not only mill structures, but the institutional, residential and commercial structures which were part of the context of the daily life of mill workers and owners. This approach informed the initial boundary increase of 1993.

## Eligibility as part of a potential district

The distinct neighborhood consisting of Chase, Barret, Mill and Grove streets, Chase Lane and Rumsey Lane, Colchester Court and Colchester Avenue up to its intersection with Calarco Court, and the north side of Calarco Court, is an identifiable entity whose development is closely related to the development and expansion of the mills along the Winooski River and to the City of Winooski, rather than to the City of Burlington, despite its legal incorporation into the latter community. The neighborhood's location on a wide peninsula, separated from the balance of Burlington by a steep hill, emphasizes its distinct nature and serves to orient it to the north, across the Winooski River to the City of Winooski.

The houses located throughout this neighborhood were chiefly constructed during the period c. 1825-1925, with few examples built during the second quarter of the 20$^{th}$ century, and none later than that period. Vernacular mechanic's cottages are prevalent among the neighborhood's housing stock, and together with tenement houses, represent the earliest examples of surviving dwellings. A variety of house types and forms were constructed in the later 19$^{th}$ and early 20$^{th}$ centuries, including dwellings for middle class and more affluent families; this variety is reflected in the eleven structures surveyed for this report. The structures within this potential district expansion thus reflect dwelling types popular throughout the most successful period of the mills' operation, and represent the dwellings of those who both worked, and managed, the mills. Additional research would be necessary to verify the relationship between the occupants of specific dwellings and particular industries, but their close proximity—both temporal and spatial—to the center of industrial production on the Winooski River, is strongly suggestive of this connection.

An expansion of the Winooski Falls Mill Historic District would also logically take in similar residential, commercial and institutional structures located in downtown Winooski constructed up to c. 1930, which marked the end of the period of prosperity of the mill industry in the region. Determination of the boundaries of such an expansion were, however, outside of the scope of work for the present survey.

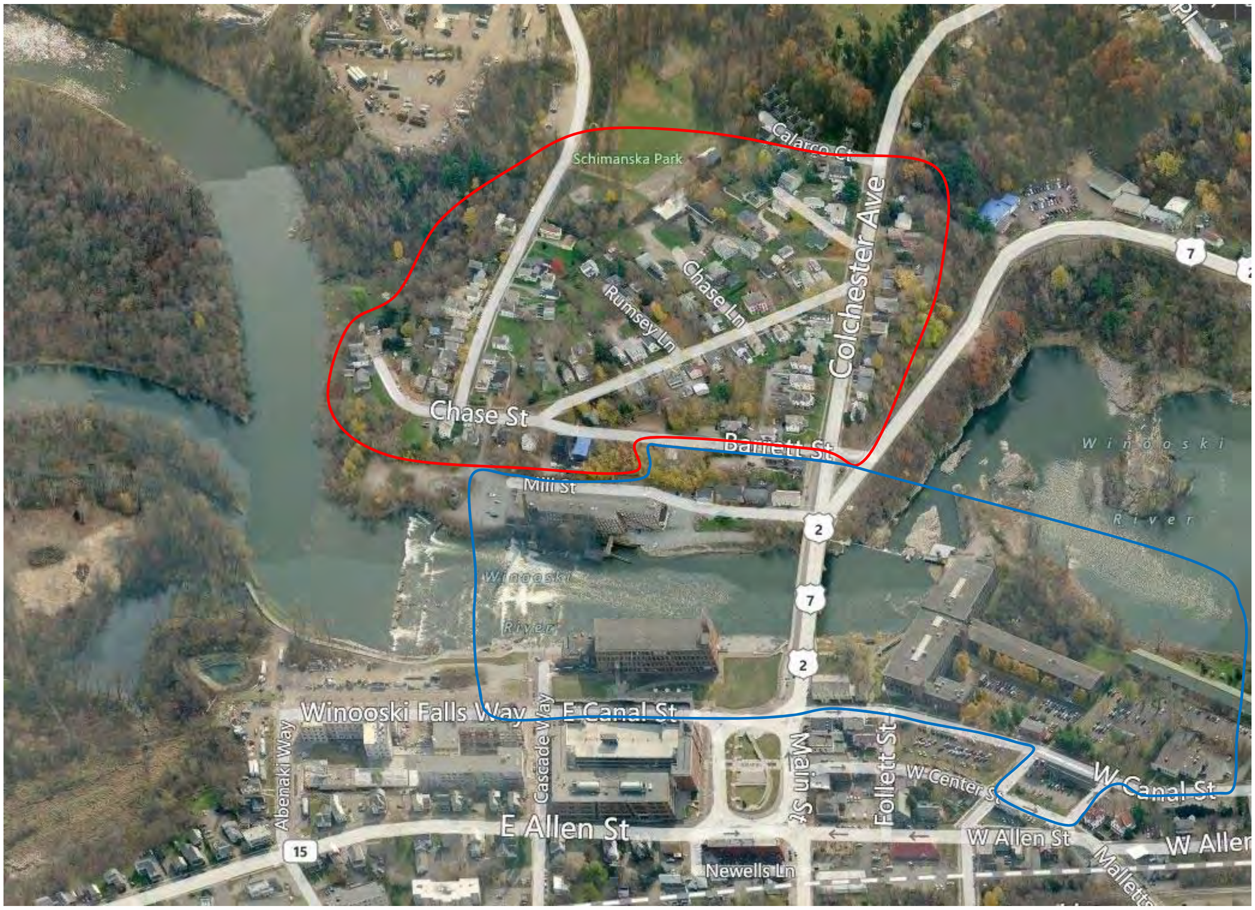



Figure 39. Aerial view looking south, showing the boundaries of a proposed expansion of the Winooski Falls Mill Historic District, in red. The southern edge of the already-listed Winooski Falls Mill Historic District is indicated with a blue outline.

Table 1. Summary of Resources Surveyed for the Riverside Avenue-Colchester Avenue Intersection Scoping Study

| Building Number (see Map 2 for locations) | Resource Address | Construction Date | Historic Use | Recommended National Register Listing |
|---|---|---|---|---|
| 1 | Winooski Bridge | 1928 | Vehicular and pedestrian bridge | Listed as part of the Winooski Falls Mill Historic District |
| 2 | 495-497 Colchester Avenue | c. 1841; 2016 | Blacksmith shop | Listed as part of the Winooski Falls Mill Historic District |
| 3 | 5-11 Mill Street | c. 1912 | Tenement housing | Listed as part of the Winooski Falls Mill Historic District |
| 4 | 13-19 Mill Street | 1853; 1874 | Tenement housing | Listed as part of the Winooski Falls Mill Historic District |
| 5 | 485 Colchester Avenue/ 8-10 Barrett Street | 1811; 1853; 1993 | Tenement housing; commercial | Listed as part of the Winooski Falls Mill Historic District |
| 6 | 460 Colchester Avenue | c. 1915 | Single family dwelling | Contributing to Proposed Winooski Falls Mill Historic District Boundary Expansion |
| 7 | 475 Colchester Avenue | c. 1875 | Single family dwelling | Contributing to Proposed Winooski Falls Mill Historic District Boundary Expansion |
| 8 | 11 Barrett Street | c. 1875 | Single family dwelling | Contributing to Proposed Winooski Falls Mill Historic District Boundary Expansion |
| 9 | 17-21 Barrett Street | c. 1905 | Duplex dwelling | Contributing to Proposed Winooski Falls Mill Historic District Boundary Expansion |
| 10 | 467 Colchester Avenue | c. 1920 | Flats (apartments) | Contributing to Proposed Winooski Falls Mill Historic District Boundary Expansion |
| 11 | 454-456 Colchester Avenue | c. 1875 | Tenement housing with commercial | Contributing to Proposed Winooski Falls Mill Historic District Boundary Expansion |

## REFERENCES


Beers, Frederick W.
1869 *Atlas of Chittenden County, Vermont*. F. W. Beers, A. D. Ellis & G. G. Soule, New York, NY.

Boyd, Hugh A. and Roger Brevoort
1978 *Winooski Falls Historic District National Register Nomination, Burlington, Vermont*. On file at University of Vermont.

Esri Inc.
2015 World Imagery. Esri, Inc., Redlands, CA. Accessed online at http://services.arcgisonline.com/ArcGIS/rest/services/World_Topo_Map/MapServer.

Meilbeck, E.
1877 *Birdseye View of Burlington and Winooski VT.* J. J. Stoner, Madison, WI.

Rann, William S.
1886 *History of Chittenden County, Vermont.* D. Mason & Co., Syracuse, NY.

Ratcliffe, N. M., R. S. Stanley, M. H. Gale, P. J. Thompson and G. J. Walsh
2011 *Bedrock Geologic Map of Vermont: U.S. Geological Survey Scientific Investigations Map 3184*, 3 Sheets, scale 1:100,000. Vermont Geological Survey, Waterbury, VT.

Sanborn Map Company
1889 *Burlington, Vermont,* Sheet 2, June 1889. Sanborn Map Company, New York, NY.
1894 *Burlington, Vermont*, Sheet 26, November 1894. Sanborn Map Company, New York, NY.
1906 *Burlington, Vermont*, Sheet 36, March 1906. Sanborn Map Company, New York, NY.
1912 *Burlington, Vermont,* Sheet 37, October 1912. Sanborn Map Company, New York, NY.
1919 *Burlington, Vermont*, Sheet 28, May 1919. Sanborn Map Company, New York, NY.
1926 *Burlington, Vermont,* Sheet 34, April 1926. Sanborn Map Company, New York, NY.
1942 *Burlington, Vermont*, Sheet 48, April 1942. Sanborn Map Company, New York, NY.

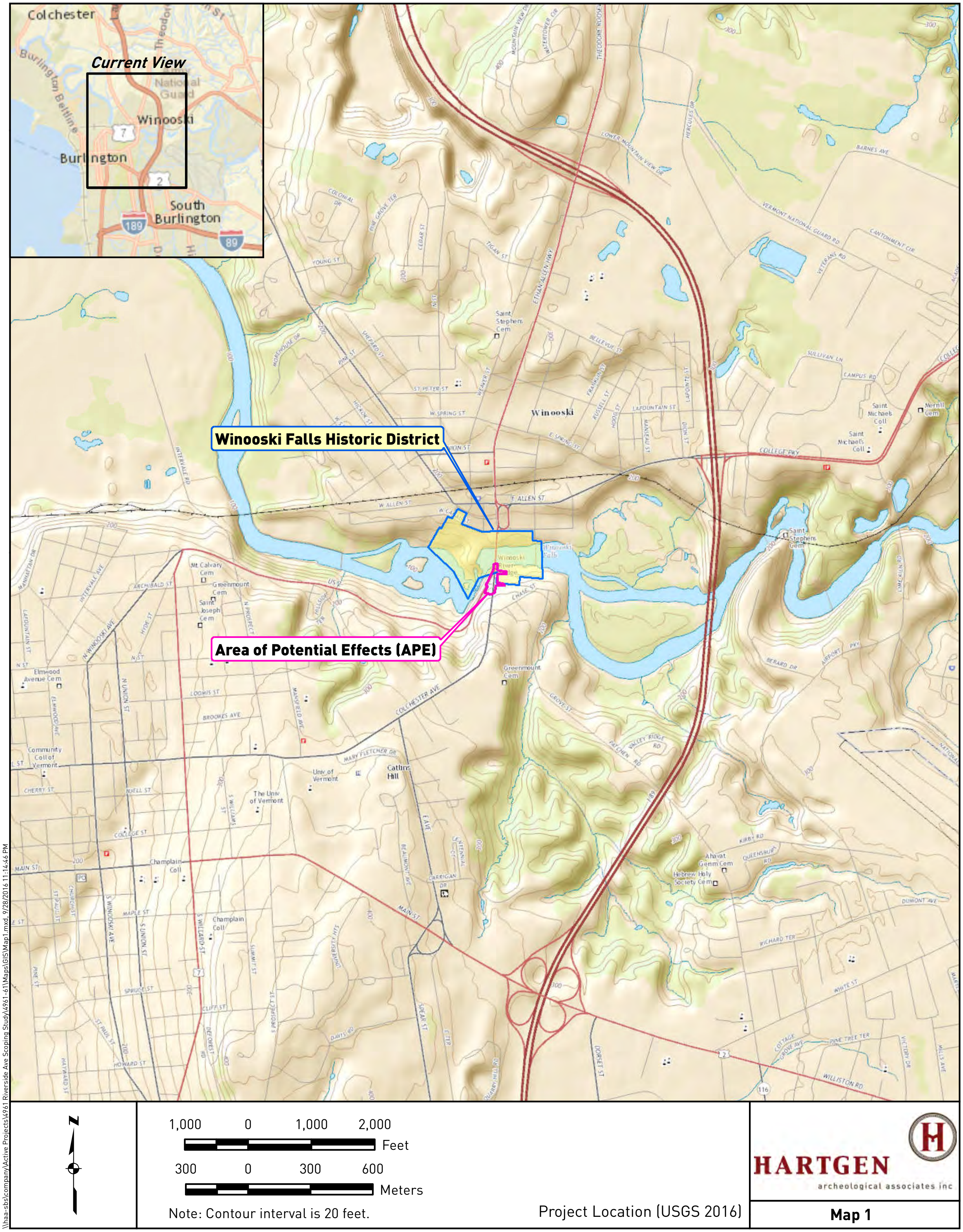
United States Geological Survey (USGS)
2015 *The National Map Topo Base Map - Large Scale*. USGSTopo (MapServer), The National Map Seamless Server, USGS, Sioux Falls, SD. Accessed online at http://services.nationalmap.gov/arcgis/rest/services/USGSTopoLarge/MapServer.

Visser, Thomas D. and Reid Larson
1993 *National Register Nomination Form, Winooski Falls Mill Historic District, Boundary Increase.* Accessed online at https://www.burlingtonvt.gov/docs/5032.pdf on 16 September 2016.

Walling, Henry Francis
1857 *Map of Chittenden County, Vermont: From Actual Surveys.* Baker, Tilden & Co., New York, NY.

Whitman, Chris
2013 *Burlington's Manufacturing Heritage along the Winooski River*
http://www.uvm.edu/~hp206/2013/ accessed 29 September 2016.

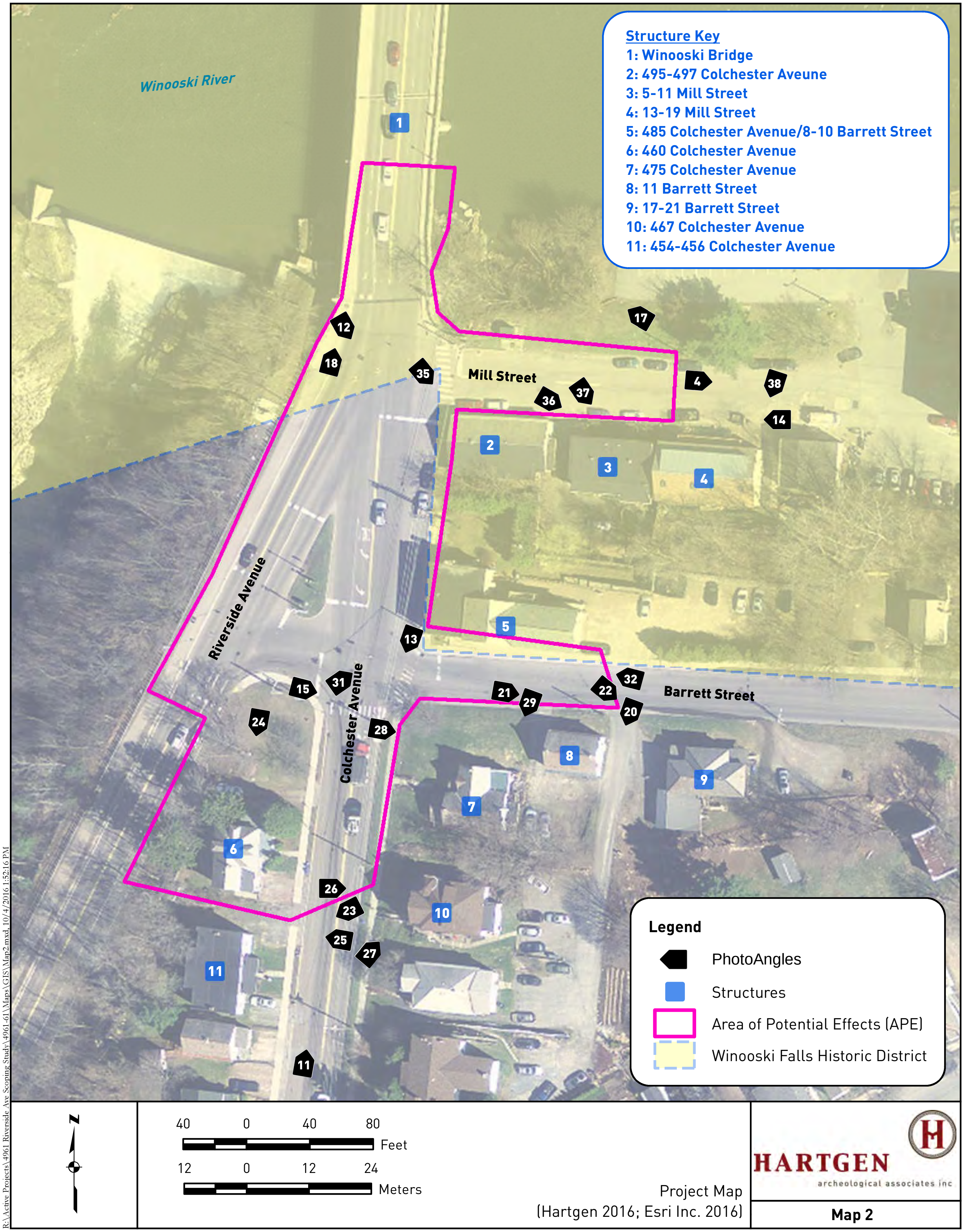
# Maps




Project Location (USGS 2016)

Map 1

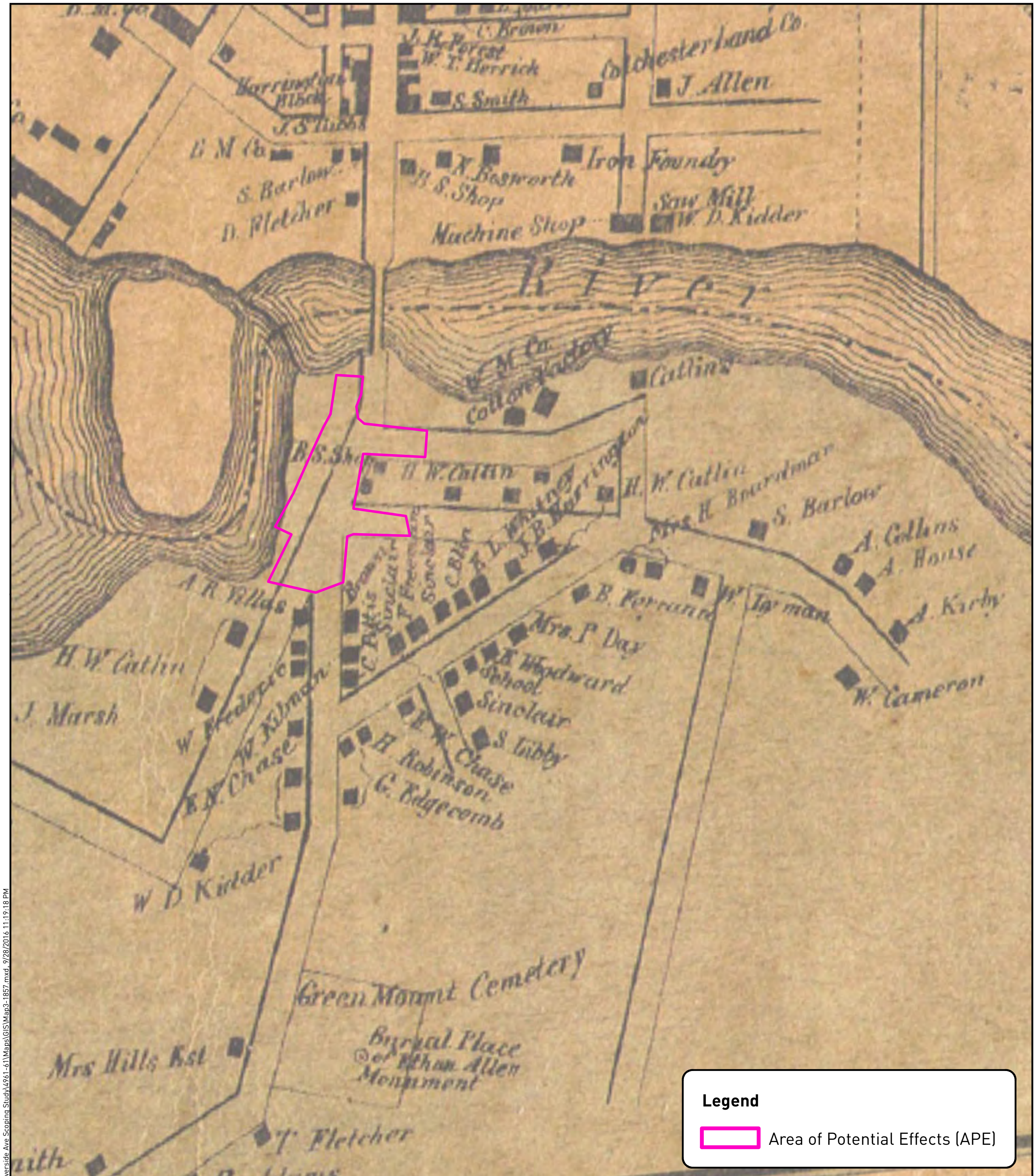
HARTGEN archeological associates inc




Project Map
(Hartgen 2016; Esri Inc. 2016)

Map 2

R:\Active Projects\4961 Riverside Ave Scoping Study\4961-61\Maps\GIS\Map2.mxd, 10/4/2016 1:52:16 PM




N

150 0 150 300 Feet

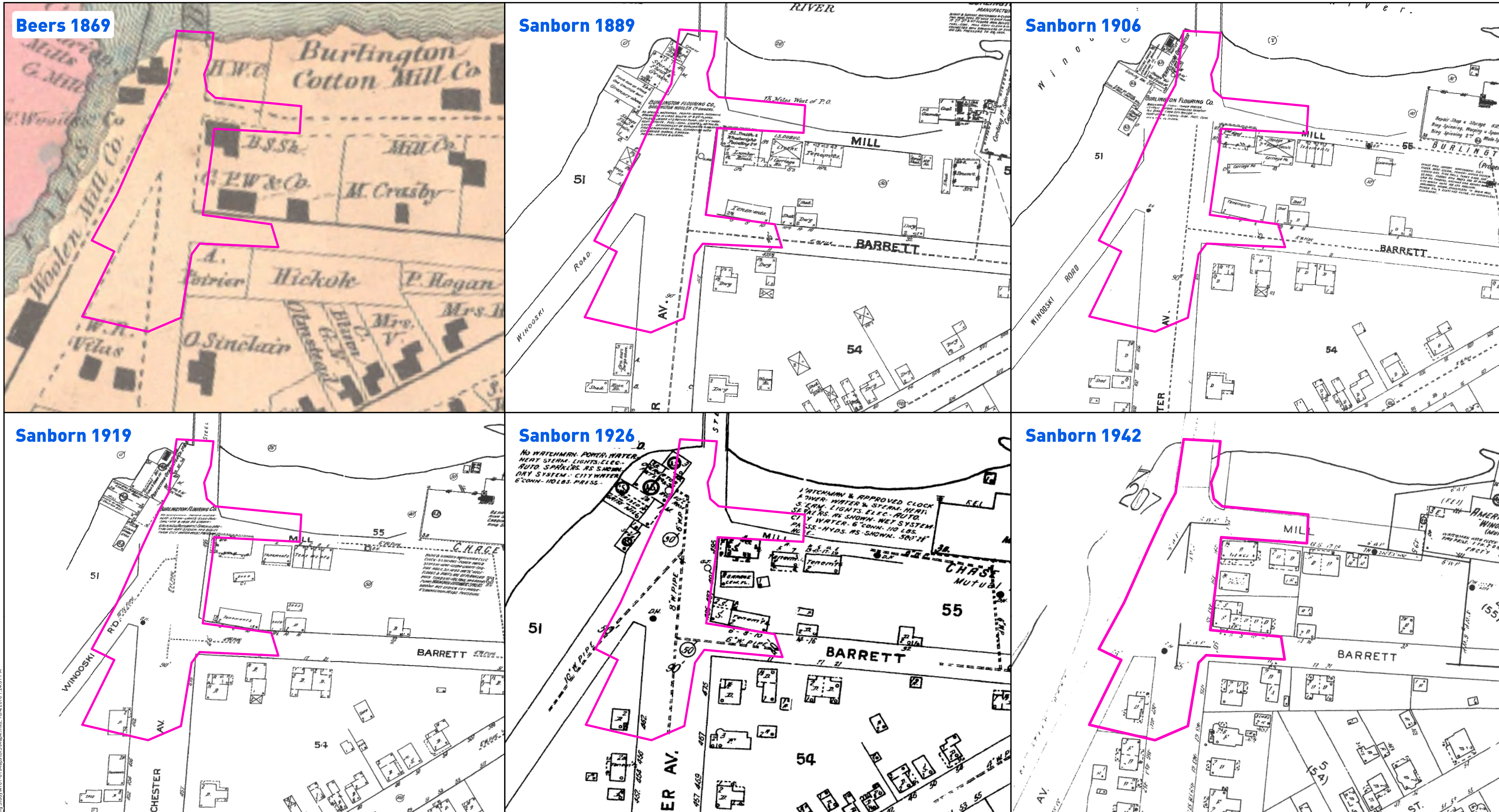
45 0 45 90 Meters

Walling 1857

HARTGEN archeological associates inc

**Map 3**

\\haa-sbs\company\Active Projects\4961 Riverside Ave Scoping Study\4961-61\Maps\GIS\Map3-1857.mxd, 9/28/2016 11:19:18 PM




75 0 75 150 Feet

22 0 22 44 Meters

**Legend**

Area of Potential Effects

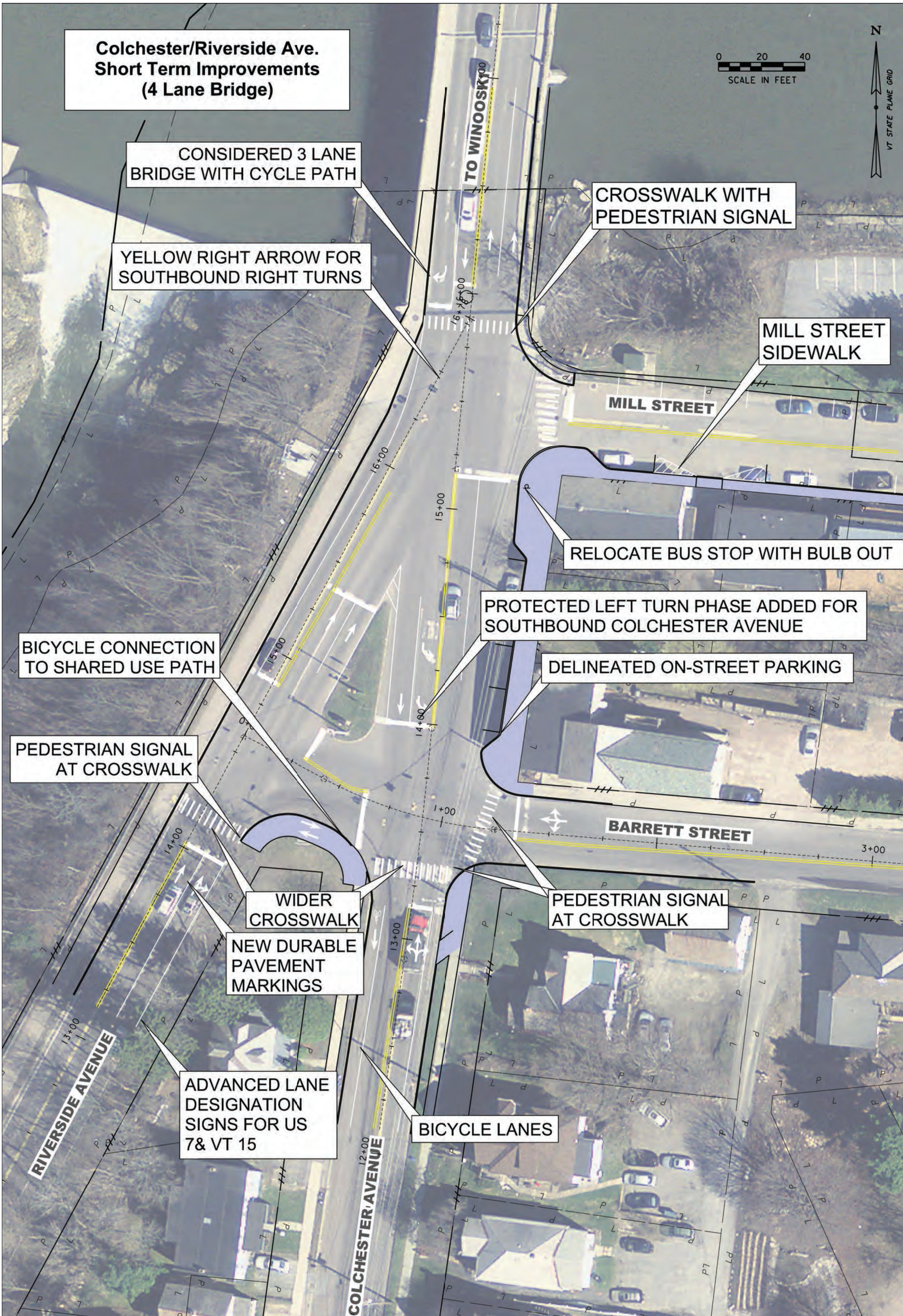
Historical Maps 1869-1942

HARTGEN archeological associates inc

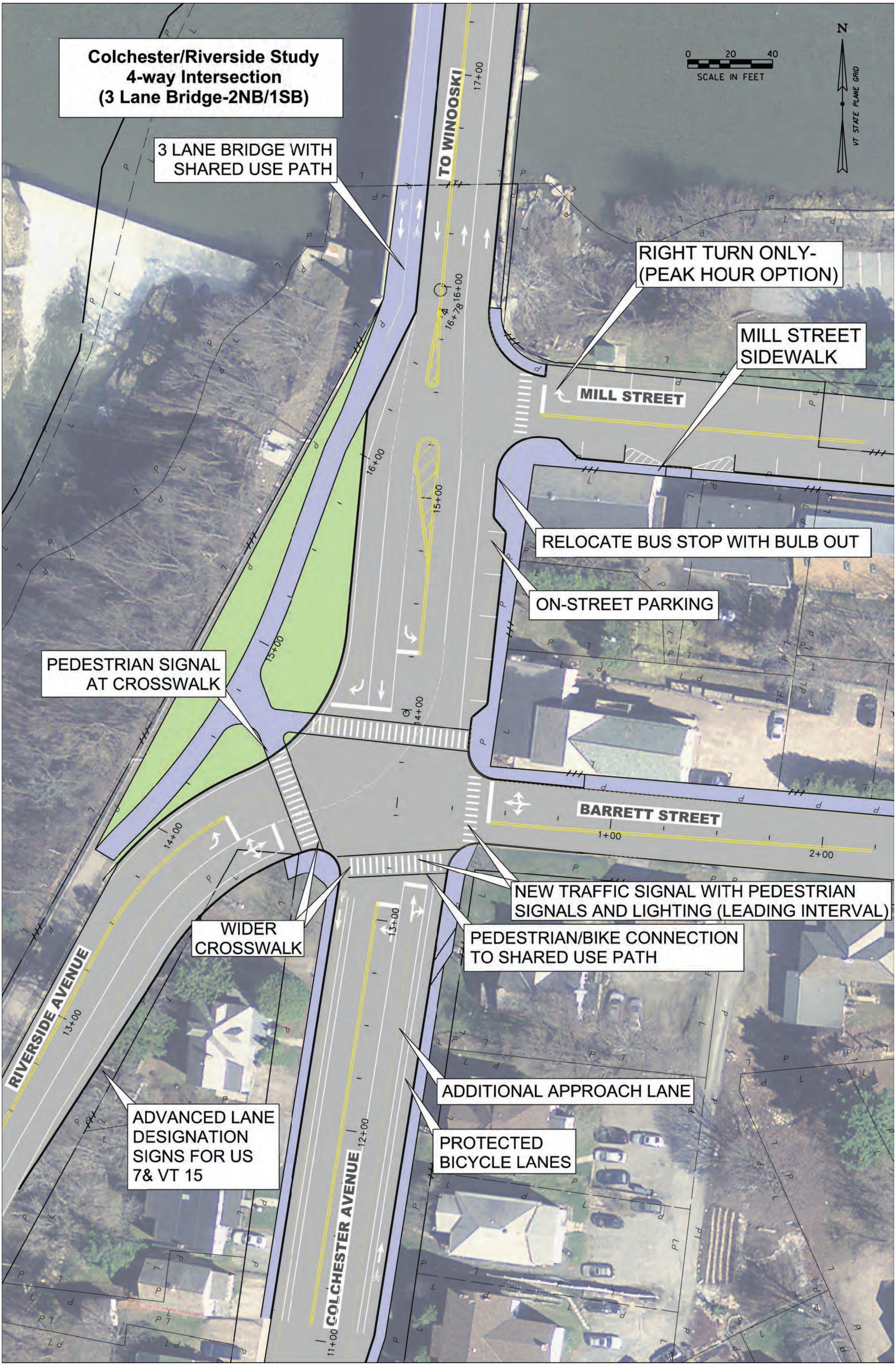
**Map 4**

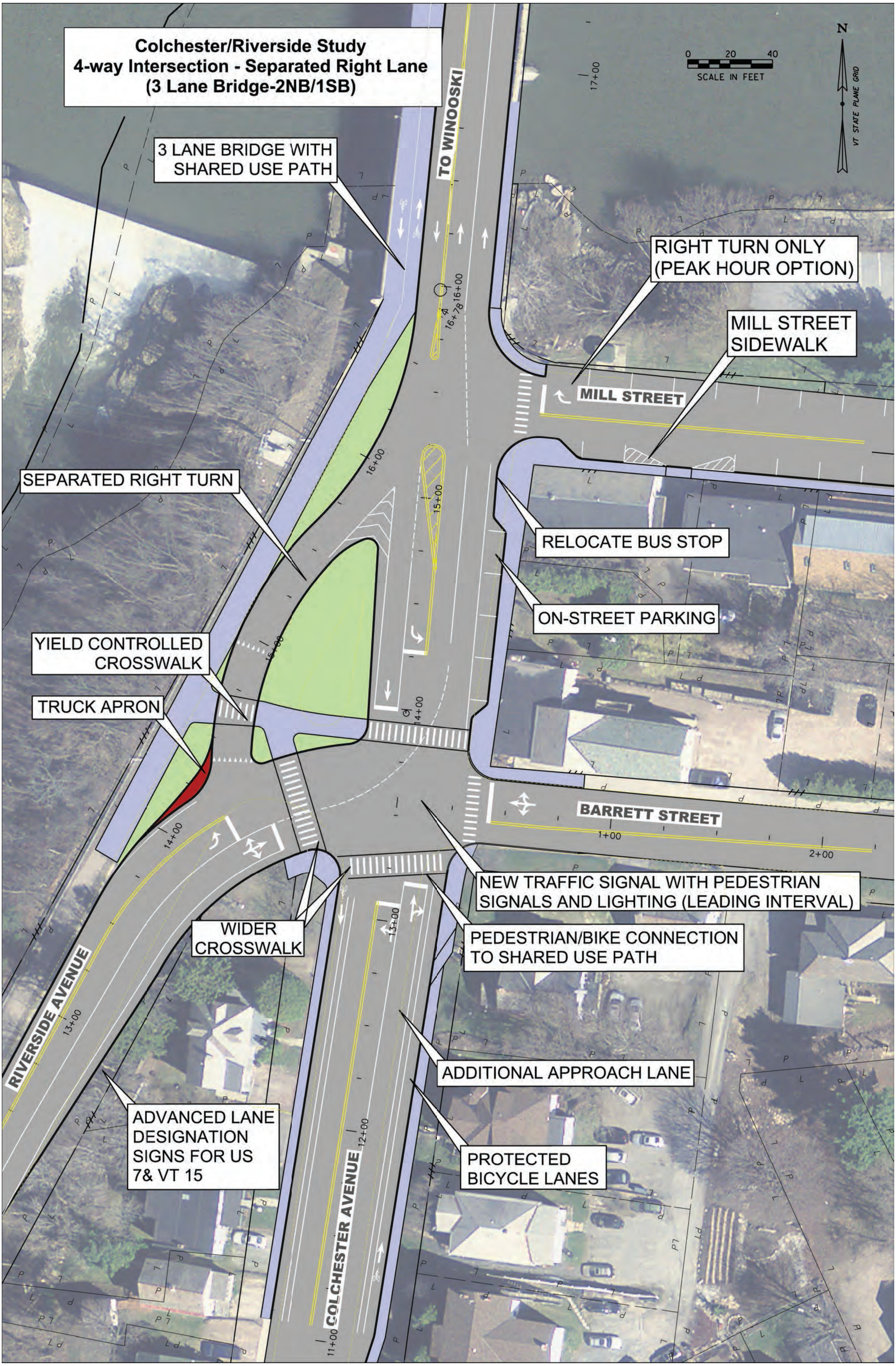
R:\Active Projects\4761 Riverside Ave Scoping Study\4761-61\Maps\GIS\Map4.mxd, 10/4/2016 1:24:01 PM

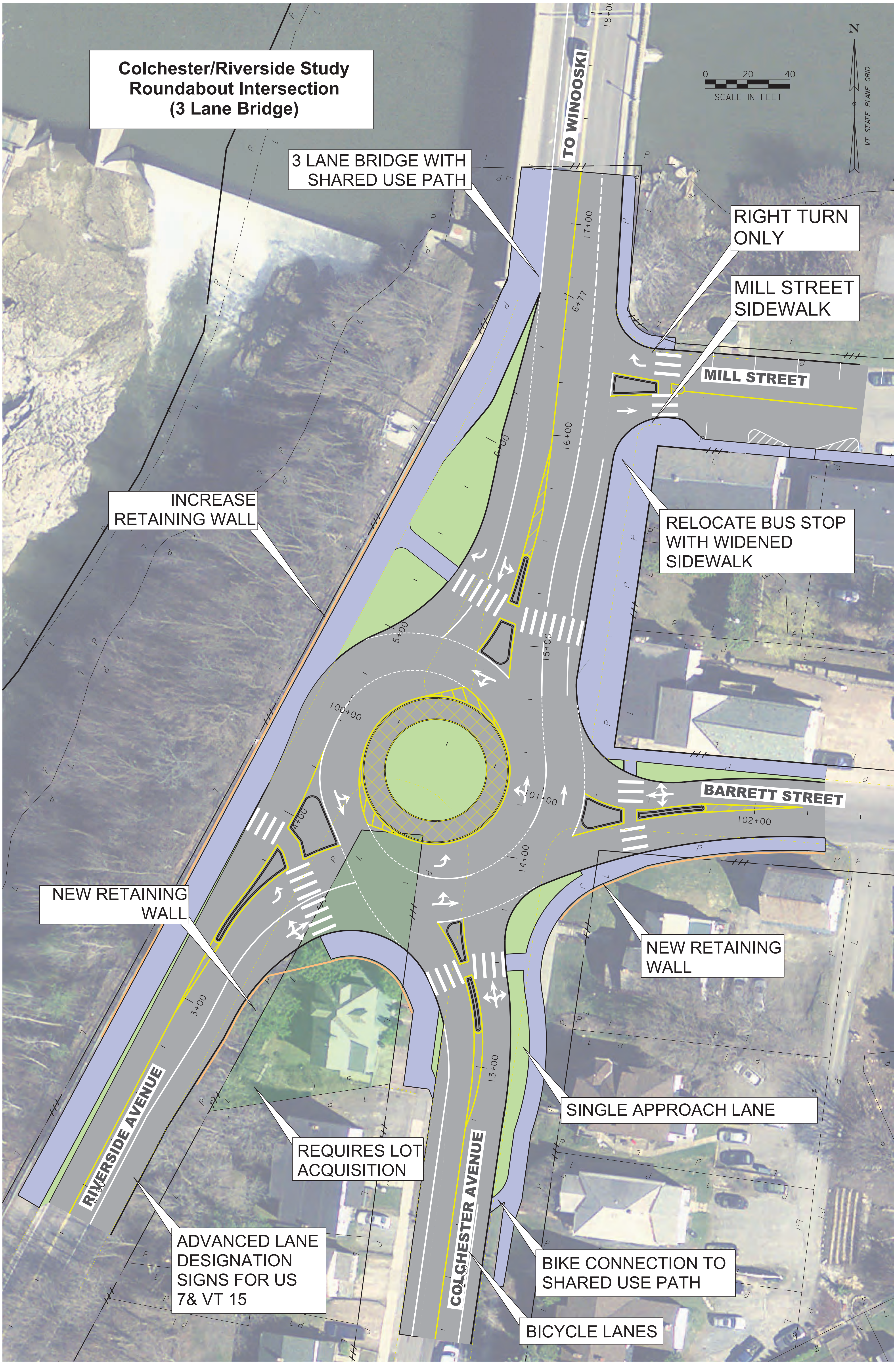
# Appendix 1
# Project Design Alternatives



Colchester/Riverside Ave.
Short Term Improvements
(4 Lane Bridge)
0 20 40
SCALE IN FEET
N
VT STATE PLANE GRID
TO WINOOSKI
CONSIDERED 3 LANE BRIDGE WITH CYCLE PATH
CROSSWALK WITH PEDESTRIAN SIGNAL
YELLOW RIGHT ARROW FOR SOUTHBOUND RIGHT TURNS
MILL STREET SIDEWALK
MILL STREET
RELOCATE BUS STOP WITH BULB OUT
PROTECTED LEFT TURN PHASE ADDED FOR SOUTHBOUND COLCHESTER AVENUE
BICYCLE CONNECTION TO SHARED USE PATH
DELINEATED ON-STREET PARKING
PEDESTRIAN SIGNAL AT CROSSWALK
BARRETT STREET
WIDER CROSSWALK
PEDESTRIAN SIGNAL AT CROSSWALK
NEW DURABLE PAVEMENT MARKINGS
ADVANCED LANE DESIGNATION SIGNS FOR US 7& VT 15
BICYCLE LANES
RIVERSIDE AVENUE
COLCHESTER AVENUE


Colchester/Riverside Study
4-way Intersection
(3 Lane Bridge-2NB/1SB)
SCALE IN FEET
3 LANE BRIDGE WITH SHARED USE PATH
TO WINOOSKI
RIGHT TURN ONLY- (PEAK HOUR OPTION)
MILL STREET SIDEWALK
MILL STREET
RELOCATE BUS STOP WITH BULB OUT
ON-STREET PARKING
PEDESTRIAN SIGNAL AT CROSSWALK
BARRETT STREET
NEW TRAFFIC SIGNAL WITH PEDESTRIAN SIGNALS AND LIGHTING (LEADING INTERVAL)
WIDER CROSSWALK
PEDESTRIAN/BIKE CONNECTION TO SHARED USE PATH
RIVERSIDE AVENUE
ADDITIONAL APPROACH LANE
ADVANCED LANE DESIGNATION SIGNS FOR US 7& VT 15
PROTECTED BICYCLE LANES
COLCHESTER AVENUE
VT STATE PLANE GRID


Colchester/Riverside Study
4-way Intersection - Separated Right Lane
(3 Lane Bridge-2NB/1SB)
0 20 40
SCALE IN FEET
N
VT STATE PLANE GRID
TO WINOOSKI
3 LANE BRIDGE WITH SHARED USE PATH
RIGHT TURN ONLY (PEAK HOUR OPTION)
MILL STREET SIDEWALK
MILL STREET
SEPARATED RIGHT TURN
RELOCATE BUS STOP
ON-STREET PARKING
YIELD CONTROLLED CROSSWALK
TRUCK APRON
BARRETT STREET
NEW TRAFFIC SIGNAL WITH PEDESTRIAN SIGNALS AND LIGHTING (LEADING INTERVAL)
WIDER CROSSWALK
PEDESTRIAN/BIKE CONNECTION TO SHARED USE PATH
RIVERSIDE AVENUE
ADDITIONAL APPROACH LANE
ADVANCED LANE DESIGNATION SIGNS FOR US 7& VT 15
PROTECTED BICYCLE LANES
COLCHESTER AVENUE



Colchester/Riverside Study
Roundabout Intersection
(3 Lane Bridge)
3 LANE BRIDGE WITH SHARED USE PATH
TO WINOOSKI
RIGHT TURN ONLY
MILL STREET SIDEWALK
MILL STREET
RELOCATE BUS STOP WITH WIDENED SIDEWALK
INCREASE RETAINING WALL
BARRETT STREET
NEW RETAINING WALL
NEW RETAINING WALL
SINGLE APPROACH LANE
REQUIRES LOT ACQUISITION
ADVANCED LANE DESIGNATION SIGNS FOR US 7& VT 15
BIKE CONNECTION TO SHARED USE PATH
BICYCLE LANES
RIVERSIDE AVENUE
COLCHESTER AVENUE
SCALE IN FEET
0
20
40
N
VT STATE PLANE GRID