RSG INC.
TRANSPORTATION

Colchester Avenue Corridor Plan

Burlington, Vermont

Final Report

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DATA ■ ANALYSIS ■ SOLUTIONS

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Prepared for:

The Chittenden County Metropolitan Planning Organization in partnership with the City of Burlington and the Campus Area Transportation Management Association

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TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

This document presents a transportation plan for Colchester Avenue located in Burlington, Vermont. The plan evaluates existing and future corridor conditions, articulates the vision and goals for the avenue, develops and compares design options and other recommendations, and offers a detailed implementation plan. It presents a comprehensive and coordinated list of bicycle, pedestrian, transit and roadway facility recommendations that taken together will achieve the corridor vision.

This plan was prepared collaboratively by staff from the City of Burlington Department of Public Works, Campus Area Transportation Management Association (CATMA), and the Chittenden County Metropolitan Planning Organization (CCMPO) with assistance from transportation planning and engineering consultants. The Colchester Avenue Task Force, which was established by resolution of the City Council, provided general oversight and policy direction throughout the planning process. Input from the general public was gathered at three public meetings. The first meeting focused on existing issues and short term recommendations, the second on the vision and goals and long-term design options, and a draft plan was presented for comment at the final meeting.

Vision and Goals

The Corridor's vision and goals presented below were built from the objectives developed by the Colchester Avenue Task Force in 2006 and the Burlington Transportation Plan adopted by the City in 2011.

Vision:

Colchester Avenue will evolve into a "Complete Streets" corridor that promotes safe, comfortable, and convenient travel for all users—including motorists, pedestrians, bicyclists, and public transportation riders.

Mobility of through traffic will be balanced with accessibility to neighborhoods and local businesses as well as the Institutions on the "Hill."

The corridor will develop into an attractive public space through streetscape and site design features. It will become more livable and desirable and will serve as a welcoming gateway to Burlington.

Goals:

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.*

Issues and Challenges

Colchester Avenue is a major arterial that connects Burlington with areas to the north and east, providing regional connectivity and accommodating a significant amount of through traffic. Colchester Avenue also provides access to the University of Vermont (UVM), Fletcher Allen Health Care (FAHC), area neighborhoods and residences and businesses in the corridor. The multiple functions and multimodal character of this corridor present a challenge of how to balance mobility, access and safety for all corridor users including pedestrians, bicyclists, vehicles, and buses. Significant issues include:

- **Safety:** The intersections of Colchester Avenue with Prospect Street, East Avenue and Riverside Avenue; and most of the roadway segment west of the Greenmount Cemetery are high crash locations.
- **Pedestrian Access:** Existing sidewalks are in poor condition and have inadequate drainage; and there is currently a significant gap in the sidewalk network between Greenmount Cemetery and Calarco Court. To accommodate the large number of pedestrians that cross Colchester Avenue, additional cross-walks and pedestrian signal upgrades are necessary throughout the corridor.
- **Bicycle Access:** Traveling by bicycle is difficult along Colchester Avenue. While new bike lanes between Prospect Street and East Avenue (to be provided as part of the re-paving project) are a significant improvement, the rest of the corridor lacks bicycle facilities.
- **Transit:** Numerous transit routes, operated by the Chittenden County Transportation Authority (CCTA) and CATMA, serve or pass through Colchester Avenue. Keeping in mind that each organization designed its transit service consistent with the needs of its passengers, some services should be consolidated where practical to eliminate redundancy and to reduce the number of buses traveling on the roadway. Consolidation of bus stops and pedestrian access improvements are also necessary.
- **Streetscape:** There are numerous opportunities for streetscape enhancement within the corridor. An intelligently designed plan for the streetscape would provide multiple benefits for a wide variety of users in the corridor in terms of functionality/safety, aesthetics, and the environment.
- **Traffic Congestion:** For an urban arterial like Colchester Avenue, signalized intersections, rather than road segments, are the primary cause of congestion. Congestion is an issue at the Prospect Street, East Avenue and Riverside Avenue-Barrett Street-Mill Street intersections.

Future Conditions

Over the last twenty-five years, traffic volumes on Colchester Avenue have remained stable at approximately 18,000 to 19,000 vehicles per day (vpd) on the western segment, between Prospect Street and East Avenue and 11,000-12,000 vpd on the eastern segment between East Avenue and Riverside Avenue. The plan concludes that traffic volumes are not expected to grow significantly (5%) over the next twenty years based on current trends, limited potential for land use changes, and other anticipated changes in the roadway network.

Little growth in traffic should not be confused with less overall travel demand. Additional travel in the corridor is being accommodated with more transit service, more walking and biking and through the transportation demand management programs provided for UVM, FAHC and the Red Cross by CATMA. Study area demographics also indicate growing travel demand for non-automobile modes of transportation, especially walking and transit. Thus, walking, biking and transit ridership are important and significant means of travel in the corridor and current trends suggest that use of these non-auto modes will increase. These trends underscore the need for Colchester Avenue to evolve into a complete street as articulated in the vision statement.

Recommendations

The plan presents a comprehensive and coordinated list of bicycle, pedestrian, transit and roadway facility recommendations for the short, medium and long term that taken together will achieve the Corridor's vision. The major recommendations are described below.

Long Term Roadway Design Recommendations

Consistent with complete street principles, all roadway design options include designated on-road bike lanes and sidewalks on each side of the street for the entire length of Colchester Avenue. Issues and recommendations for the western corridor section between Prospect Street and East Avenue, and the eastern corridor section between East Avenue and Riverside Avenue are described below.

Western Section: Two roadway designs were considered for the western section including a three-lane and a four-lane cross-section. Both roadway options were evaluated based on:

- Extensive analyses of traffic congestion and operations for the 2030 PM peak hour;
- Findings from the 2010-2011 complete street demonstration project when the City temporarily repaved the western section with a three-lane roadway configuration; and
- A review of other tradeoffs related to the Corridor's vision and goals.

The Corridor Plan recommends the *Three Lane Option* for the western corridor section as it supports and is more consistent with the corridor's vision and goals.

Eastern Section: The existing two lanes are sufficient for the eastern section due to lower traffic volumes so it was not necessary to consider additional travel lanes. Challenges along the eastern section include accommodating all modes of transportation by adding on-road designated bike lanes while strategically maintaining on-street parking to serve residents and businesses; preserving sections of the green strip; avoiding encroachment into the front yards of homes and businesses; enhancing landscaping; and creating a continuous sidewalk network. The two design options considered in the plan are:

- A wide curb lane, that allows shared use of the travel lane by bikes and cars with enough room for a continuous green strip and on-street parking; and
- Dedicated bike lanes, on-street parking at strategic locations adjacent to the sidewalk, intermittent green strips and continuous sidewalks.

The cross-section option that provides designated bike lanes is preferable because it provides continuity with the bike lanes on the western section and offers a higher level of visibility and safety for cyclists. However, the Plan also recognizes the challenges associated with reducing the

green strip and/or reducing on-street parking. The tradeoffs need to be addressed during the final design process with input from property owners, businesses and residents that will be directly affected.

Intersection Recommendations

The following recommendations are consistent with the roadway cross-section designs described above and can be implemented as stand-alone projects:

- **Pearl Street-Prospect Street-Colchester Avenue:** The South Prospect Street approach to Colchester Avenue would be relocated to the west to be aligned with North Prospect Street. The re-alignment would improve safety and traffic operations, create more greenspace adjacent to the UVM Green but it would also place the roadway and sidewalk closer to the UHC building at the corner of Pearl and South Prospect Streets.
- **University Place-Colchester Avenue:** In the long-term, and following further evaluation, it is recommended that this intersection be closed to general through traffic. The closure has been considered in the past and specific design elements should be verified with input from the City and UVM. In the short to mid-term, access could be restricted to right-in and right-out movements only. These changes would reduce potential vehicle-vehicle, vehicle-pedestrian and vehicle-cyclists conflicts, and would improve traffic operations by reducing the number of vehicles entering and exiting between two closely spaced signalized intersections.
- **Mansfield Avenue-Colchester Avenue Intersection:** The Colchester Avenue eastbound approach would have an exclusive left turn lane to accommodate vehicles turning into Mansfield Avenue. A single lane in the westbound direction would accommodate through and right-turning vehicles.
- **Mary Fletcher Drive (FAHC Access Road)-Colchester Avenue:** The Colchester Avenue westbound approach would have an exclusive left turn lane to accommodate vehicles turning into Mary Fletcher Drive. The Colchester Avenue eastbound approach would include a left turn lane for vehicles turning into the office driveway.
- **East Avenue-Trinity Drive-Colchester Avenue Intersection:** The lane designations for the Colchester Avenue approaches would remain unchanged (through-left and exclusive right) while allowing for the continuation of the bike lane. The East Avenue northbound approach would be re-aligned to the west to allow for a longer right turn lane while preserving the on-street parking located on the east side of the street. The Trinity Drive approach would also have to be shifted to the west to remain aligned with East Avenue.
- **Riverside Avenue-Barrett Street- Mill Street:** 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.

Pedestrian and Bicycle Facility Recommendations

The plan recommends dedicated bicycle lanes on each side of Colchester Avenue, rebuilding existing sidewalks to address drainage issues, and construction of a new sidewalk between Greenmount Cemetery and Calarco Court. Other specific recommendations include:

- **Pedestrian Crossings at Signalized Intersections:** All signalized intersections will include cross-walks and pedestrian signals with advanced pedestrian phasing. An advanced pedestrian phase allows pedestrians to begin crossing a street and establish the right-of-way in the cross-walk before motorists on the intersecting street are given a green light and can begin entering the intersection.
- **Trinity Campus Mid-Block Pedestrian Crossing:** A mid-block pedestrian crossing is recommended on Colchester Avenue in the vicinity of the Trinity Campus. Design details for this crossing will be determined during a more focused scoping/design phase. Possible crossing features include: textured, colored surface to emphasize its location; pedestrian activated in-pavement LED light system and LED-enhanced pedestrian signs; and a pedestrian refuge island. Guide rails in the green strip, similar in design to those provided along Main Street, could be provided to direct pedestrians to the mid-block crossing. The exact location of the crossing is to be determined.
- **Other recommendations include:**
    - Upgrade the existing multi-use path on the south side of Colchester Avenue and improve the connections at the ends of the path to the University Green in the west and East Avenue in the east
    - Install a cross-walk and pedestrian signals on the eastbound approach of Colchester Avenue to East Avenue
    - Upgrade the cross-walk at University Road
    - Install a cross-walk on Colchester Avenue at Chase Street
    - Traffic calming on Chase Street

General Transit Recommendations

Where practical, transit service should be consolidated to 1) reduce the number of buses and shuttles traveling in the corridor and the related effects to traffic flow, 2) increase overall efficiency and utilization of each bus, and 3) improve service and attract more passengers. The next step is a feasibility study to evaluate the organizational and funding challenges and opportunities. The plan recommends bus pull-offs for the western section of the corridor as well as consolidation of bus stops and locations for new shelters.

Operational and Maintenance Recommendations

The following recommendations are more general in nature and typically apply to the entire corridor.

- **Change speed limit to 25 miles per hour.** A 25 mph posted speed limit is reasonable to enhance safety for pedestrians crossing the road, cyclists traveling along the road, and will make it easier for cars exiting driveways and stop controlled side streets to enter the traffic stream.
- **Continue to review and optimize traffic signals.** Because the three lane option (western section) decreases the number of through lanes, it will be particularly important to maintain efficient and optimized traffic signal timing plans, and to ensure that all traffic signal components are functioning properly.
- **Transit Signal Priority.** Transit signal priority should be considered carefully and balanced with the other goals of the corridor. It could be used in off-peak periods to minimize impacts to pedestrians and side street traffic, or deployed throughout all hours of transit operation.
- **Prune trees and other brush on a regular basis.** The primary purpose of this recommendation is to maintain sight distances at intersections and driveways. Pruning trees and other vegetation also helps keep sidewalks open.
- **Encourage the City of South Burlington ambulance to access MCHV using Beaumont Drive.** Currently the South Burlington ambulance accesses the Medical Center Hospital of Vermont (MCHV) via Mary Fletcher Drive by using East Avenue and Colchester Avenue.
- **Clear snow banks from bus stops.** Access to bus service is restricted during the winter months due to snow banks. Removing snow is critical to maintain transit use but it will require more time and handwork and is probably not possible for City crews that are busy clearing roads and sidewalks. This issue may best be addressed by neighbors or volunteer groups.

Plan Implementation and Costs

The implementation plan provides descriptions of the recommendations, identifies a possible timeline for when a project or service should be implemented, presents order of magnitude cost estimates and potential funding sources, identifies the project leader and other partners that will participate or support the project leader, and recommends next steps.

Key elements of the implementation plan are:

- **Implementation of the complete street concept has already started.** Recent modifications to the western section of Colchester Avenue that reduced the number of vehicular travel lanes from four to three while providing on-road bicycle lanes are a first step towards a complete street. The three-lane/bike-lane design will be made permanent when the final course of pavement is completed in the fall of 2011. The next step for the western section is to reconstruct the sidewalks to address drainage issues and to rehabilitate the green strip. The recent re-paving of Colchester Avenue between Prospect/Pearl Streets and East Avenue created an opportunity to address many of the identified existing issues in the western corridor section such as improved signs, new cross-walks, and installation of a left-turn signal at Mary Fletcher Drive. In the long term the western section will need to be completely reconstructed to rehabilitate underground stormwater and other utilities.

- **Stand-alone Projects.** Reconstruction of the Prospect Street-Pearl Street and Riverside Avenue-Barrett Street-Mill Street intersections and the Trinity Mid-Block pedestrian crossing can proceed as stand-alone projects; although each location requires additional design, engineering and public outreach. By comparison, reconstruction of the East Avenue intersection should be pursued in coordination with site plan changes at the Trinity Campus, for which there is no current time frame.
- **Reconstruction of the eastern section of Colchester Avenue.** The eastern section requires additional outreach with businesses and residents. In order to accommodate on-road bike lanes its redesign will affect on-street parking and the green strip, and it may also encroach on some front yards. Regardless of the final design, it will also be necessary to relocate curbs, which will require reconstruction of underground stormwater infrastructure. As a result, reconstruction of the eastern section is identified as a long term project.

The estimated cost of all short, medium and long term recommendations for the Colchester Avenue corridor is approximately $11.5 million dollars, excluding right-of-way acquisition and major reconstruction of underground stormwater, water and wastewater infrastructure (Table E-1).

The costs can be organized into the following categories:

- **Rehabilitation:** These costs would have to be expended whether or not the corridor plan's vision is pursued. Examples include reconstructing sidewalks and curbs to address drainage issues, new signs, traffic signal optimization and repaving.
- **Functional:** This category includes recommendations that improve safety; add capacity for pedestrians, cyclists, buses and/or personal vehicles; or otherwise improve conditions beyond the existing system. Examples include reconstruction of the major intersections along Colchester Avenue, the bike lanes, new bus shelters, and the mid-block pedestrian crossing.
- **Enhancement:** This category includes recommendations that enhance community character and aesthetics. Examples include pedestrian scale decorative street lights, street furniture and trees.

Table E-1: Estimated Plan Costs

Time Frame	Project Category			Total Capital Cost [1]
	Rehabilitation	*Functional*	*Enhancement*	
One Year	$ -	$ 50,000	$ -	$ 50,000
1-5 Years	$ 1,200,000	$ 1,800,000	$ 400,000	$ 3,400,000
5-10 Years	$ 2,200,000	$ 2,600,000	$ 500,000	$ 5,300,000
More than 10 Years	$ 2,000,000	$ 300,000	$ 500,000	$ 2,800,000
Total	**$ 5,400,000**	**$ 4,750,000**	**$ 1,400,000**	**$ 11,550,000**

1. Does not include ROW acquisition or complete rehabilitation of underground utilities

The design recommendations presented in this plan were developed at a conceptual level and will require additional engineering, design and public input before they are ready for construction.

A project's funding source will affect the process requirements and timelines. Recommendations that have little or no footprint impact (like optimizing traffic signals, adding cross-walks, or

installing signs) and that are paid for with local or private funds can be implemented in a shorter time frame assuming the funds are available, and it is not necessary to acquire right-of-way.

Projects that use federal and state funds need to follow VTrans' project development process, which includes evaluation of alternatives, selection of a locally preferred alternative, and a public input process. Following approval of the locally preferred alternative, a project would then move through various design phases, providing the environmental documentation required by the National Environmental Policy Act (NEPA), acquiring other local and state permits, and right-of-way acquisition if necessary.

1. PLAN INTRODUCTION

This document presents a transportation plan for Colchester Avenue located in Burlington, Vermont. The plan envisions the evolution of Colchester Avenue into a "Complete Street" that promotes safe, comfortable, and convenient travel for all users, balances mobility for through traffic with access to the adjacent neighborhoods, and improves livability. The corridor plan evaluates existing and future conditions, articulates the vision and goals, develops and compares design options and other recommendations, and includes an implementation plan. It presents a comprehensive and coordinated list of bicycle, pedestrian, transit and roadway facility recommendations that taken together will achieve this vision.

The plan includes the following major sections:

- **Chapter 1 Introduction:** Provides background information, explains the purpose of the plan and provides a general description of the planning area. It also describes how the plan was developed and public outreach efforts.
- **Chapter 2 Vision and Goals:** Articulates the vision statement and goals.
- **Chapter 3 Existing Conditions:** Describes the land use context for the corridor and the characteristics and performance of the different components of the transportation system.
- **Chapter 4 Future Conditions:** Discusses factors affecting the amount and characteristics of travel within and through the corridor for a 2030 planning horizon.
- **Chapter 5 Design Options and Other Recommendations:** Evaluates and recommends roadway and intersection design options for the western and eastern segments of the corridor and includes other supporting recommendations.
- **Chapter 6 Implementation:** Presents timelines, order of magnitude cost estimates and potential funding sources; identifies the leader and other partners that will participate in or support moving a recommendation forward; and identifies next steps.

1.1 Study Background and Purpose

In 2004, the Burlington City Council passed a resolution that created the Colchester Avenue Task Force to address issues in the corridor such as: UVM's acquisition of the Trinity campus, institutional and background growth, and impacts on Ward 1 neighborhoods. The Task Force was facilitated by the Campus Area Transportation Management Association (CATMA) and its purpose was to identify short-term (two-year) and long-term (ten–year) objectives to address circulation, transit, bicycle facilities, safety, signage, and aesthetics. The Task Force published a list of objectives and recommendations in 2006.

The draft Burlington Transportation Plan completed in 2007 is organized around the following themes: 1) Strong and Healthy City; 2) Transportation Choices; and 3) Great Streets. Under the Great Streets theme, the Burlington Transportation Plan recommends implementation of a "Complete Street" design for Colchester Avenue. A complete street is designed to provide safe access for all users including pedestrians, cyclists, transit vehicles and riders, and people traveling

in motor vehicles. The complete street concept incorporates many of the neighborhood, street design, and traffic calming objectives recommended by the Colchester Avenue Task Force.

The Colchester Avenue Corridor Plan was initiated in 2009 and is also being directed by the Colchester Avenue Task Force. It incorporates and supplements the Task Force's previous recommendations, presents short and long term recommendations, develops concept plans for the entire corridor consistent with the complete street design principles and most importantly, provides a launching point from which the City can begin implementing the highest priority projects in partnership with the other stakeholders in the corridor.

1.2 Planning Area Overview

Colchester Avenue is a major arterial that connects the city with areas to the north and east, providing regional connectivity and accommodating a significant amount of through traffic. Colchester Avenue also provides access to the University of Vermont (UVM), Fletcher Allen Health Care-FAHC (including the Medical Center Hospital of Vermont [MCHV] and University Health Care [UHC] campuses), area neighborhoods and residences and businesses in the corridor (Figure 1). The multiple functions and multimodal character of this corridor present a challenge on how to balance mobility, access and safety for all corridor users including vehicles, buses, bicyclists and pedestrians. The corridor planning area is centered on Colchester Avenue between its intersections with Riverside Avenue near the Winooski River and Prospect Street to the west (Figure 2).

Figure 1: Colchester Avenue Regional Context

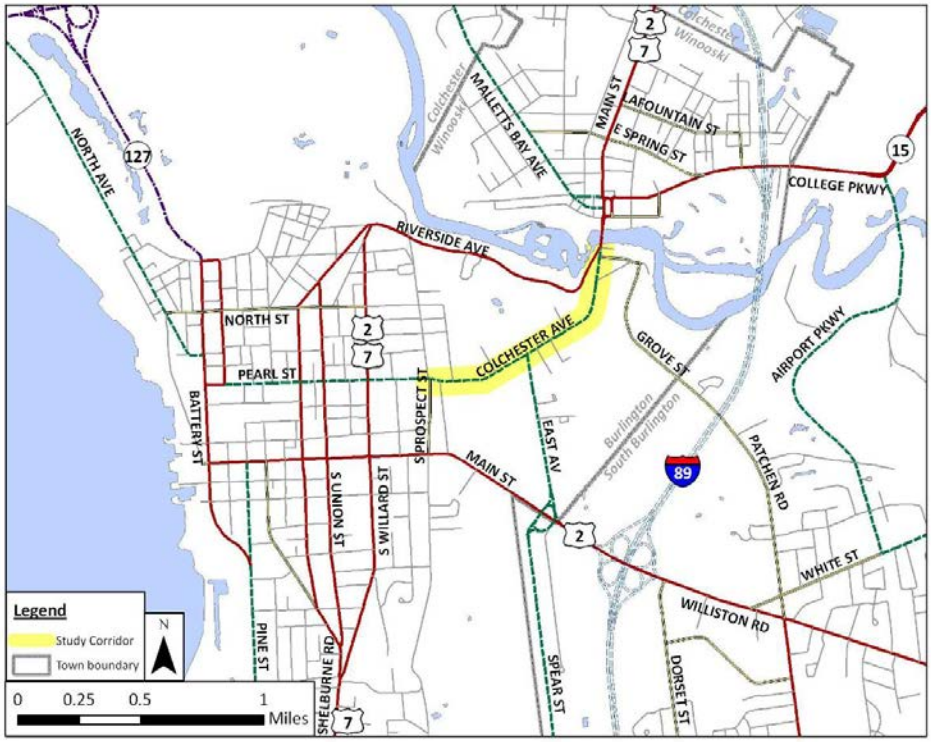
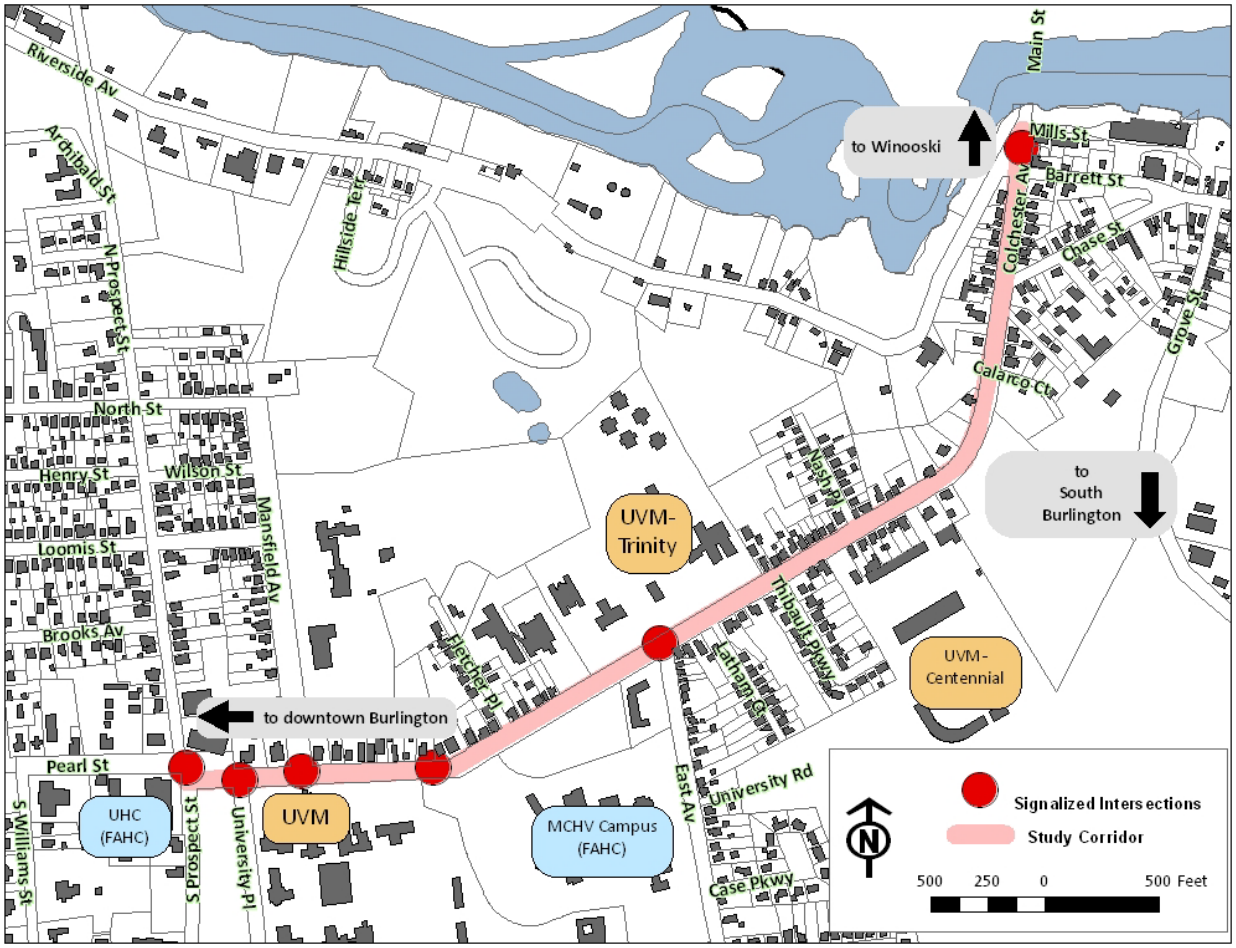


Figure 2: Corridor Planning Area



Prior to the complete streets demonstration project (fall of 2010) sections of the Colchester Avenue corridor were designed to accommodate a significant amount of through traffic. Arguably, this design served through traffic as well as adjacent neighborhoods, employees and students by providing a connection to other parts of the city and points beyond. However, it also created a barrier to local circulation and access, particularly for those traveling by foot or bike. There were also other negative impacts related to safety, noise and community character. This juxtaposition as a regional route and neighborhood/campus street creates multiple conflicts and opportunities.

1.3 Study Process and Public Outreach

This plan was prepared collaboratively by staff from the City of Burlington Department of Public Works, Campus Area Transportation Management Association (CATMA), Chittenden County Metropolitan Planning Organization (CCMPO) and transportation planning and engineering consultants Resource System Group, Inc. with support from LandWorks for landscape architecture and Third Sector Associates for public outreach. The Colchester Avenue Task Force provided general oversight and policy direction throughout the planning process (Table 1). A technical

committee also met several times with the planning team to provide expertise on specific modes and other technical support throughout the planning process (Table 2). Notes from task force and technical committee meetings are provided in Appendix A.

Table 1: Colchester Avenue Task Force

Name	Organization	Name	Organization
Ed Adrian	Burlington City Councilor, Ward 1	Nicole Losch	Burlington Department of Public Works
Meredith Birkett	Chittenden County Transit Authority (CCTA)	John Moore	CCTA
Bruce Bourgeois	Burlington Fire Department	Sue Palmer	American Red Cross
Dominic Brodeur	Burlington Police Department	Bob Penniman *(Committee Facilitator)*	CATMA
Sharon Bushor	Burlington City Councilor, Ward 1	Wayne Senville	Ward 1 Representative & Burlington Planning Commission[1]
Deac Decarreau	Winooski City Manager	Linda Seavey	University of Vermont
Munir Kastic	Burlington Electric Department	Chapin Spencer	Local Motion
Dave Keelty	Fletcher Allen Health Care (FAHC)	Sandrine Thibault	Burlington Department of Planning and Zoning

Table 2: Colchester Avenue Technical Committee

Name	Organization	Name	Organization
Eleni Churchill *(Committee Facilitator)*	CCMPO	Dominic Brodeur	Burlington Police Department
Bob Penniman	CATMA	Chapin Spencer	Local Motion
Munir Kastic	Burlington Electric Department	Steve Palmer	Winooski Public Works
Nicole Losch	Burlington Department of Public Works	Amy Bell	VTrans
Meredith Birkett	CCTA	Bruce Nyquist	VTrans
Steve Bourgeouis	Burlington Fire Department	Jason Charest	CCMPO

[1] Term ended in 2010.

1.3.1 Public Outreach

Three public meetings were conducted as the plan was developed**.** All meetings were held in the McClure conference room at Fletcher Allen Health Care which is located directly on Colchester Avenue. The following sections describe and summarize the results of each meeting. Detailed meeting notes are provided in Appendix A.

1.3.1.1 Initial Public Meeting

The purpose of the first public meeting, conducted on May 27, 2010, was to gather feedback from residents and other stakeholders on transportation issues along Colchester Avenue. Approximately 40 people participated (not including the consultants, City and CCMPO staff and others helping to run the meeting). The meeting consisted of an informal walking tour and a public workshop. During the workshop, participants were organized randomly into four "roaming" groups. Four stations were arranged that focused on 1) traffic congestion and safety, 2) bicycle and pedestrian, 3) transit and 4) community character issues; and all groups spent time discussing each topic.

Common issues that emerged include:

- Safety was identified as the biggest concern, particularly related to speed.
- Poor drainage along sidewalks.
- The frequency and size of the buses traveling along Colchester Avenue.
- Poor connectivity and safety for pedestrians and cyclists.

Meeting participants identified a list of short-term improvements that have been included in the implementation plan presented in Chapter 6 of this report.

1.3.1.2 Long Term Strategies Public Meeting

The purpose of this meeting, held on February 3, 2011, was to gather feedback from residents and other stakeholders on long-term street and intersection design concepts for Colchester Avenue. Approximately 40 persons participated. The meeting format consisted of break-out sessions in which small groups of participants discussed three design concepts. The three design concepts presented were: 1) a three-lane cross-section on the western segment between Prospect Street and East Avenue (two travel lanes, a two-way-left-turn-lane and bike lanes); 2) a four-lane cross-section on the western segment between Prospect Street and East Avenue (four travel lanes, left-turn lanes at intersections and bike lanes); and 3) a two-lane cross-section on the eastern segment between East Avenue and Riverside Avenue (two travel lanes with on-street parking and bike lanes). Comments gathered from this meeting were incorporated into the design concepts presented in Chapter 5 of this plan.

1.3.1.3 Draft Plan Public Meeting

The purpose of this meeting, held on September 7, 2011, was to gather comments from the general public on the Colchester Avenue Corridor Plan Draft Report (September 1, 2011). The consultants provided an overview of the plan's recommendations followed by questions and comments from the meeting participants. Members of the Task Force addressed the questions and comments with technical assistance from the consultants. There was general support for the recommendations in

the plan including the Three Lane Option for the western section. However, some meeting participants were not supportive of the Three Lane Option and were primarily concerned about the potential for more congestion. Written comments and responses, as well as meeting notes, are contained in Appendix A. This final report includes changes to address comments as summarized in Appendix A.

1.3.2 Colchester Avenue Complete Street Demonstration Project

In the fall of 2010, during a scheduled repaving of Colchester Avenue, the City took the opportunity to test (in the interim between the base and top courses of paving) a complete streets roadway cross section for the western section between Prospect Street and East Avenue. The vehicle travel lanes were reduced from four to three—one travel lane in each direction and a middle lane accommodating left turns—and shoulders were added on each side of the avenue. Results from the demonstration project informed the discussion of long term design concepts presented in Chapter 6 of this report. The demonstration project also included a significant amount of outreach including presentations to the Burlington DPW Commission and the Transportation, Energy and Utilities Committee of the Burlington City Council; a press conference and press release by the Mayor; two meetings with the Ward 1 Neighborhood Planning Assembly; interviews with DPW staff on local radio and public access television; and articles in the Burlington Business Association newsletter and North Ave News. Findings from the Complete Street Demonstration Project are presented in a memorandum contained in Appendix B.

1.3.3 Additional City Review

This final plan addresses and documents the public comments received during the comment period (September 1 to September 30, 2011). The final plan will be reviewed by appropriate City commissions and committees such as the Public Works Commission and the City Council's Transportation Energy and Utilities Committee. Other commissions and committees may comment as well. After review by City commissions and committees, the plan will be presented to the Burlington City Council for acceptance.

2. VISION AND GOALS

The vision and goals presented below build from the objectives developed by the Colchester Avenue Task Force in 2006 and the 2011 Burlington Transportation Plan. They are also based upon input gathered at the public meetings and the assessment of existing and future conditions which are summarized in Chapters 3 and 4. The vision and goals will be achieved through implementation of the recommendations contained in this report.

Vision:

Colchester Avenue will evolve into a "Complete Streets" corridor that promotes safe, comfortable, and convenient travel for all users—including motorists, pedestrians, bicyclists, and public transportation riders.

Mobility of through traffic will be balanced with accessibility to neighborhoods and local businesses as well as the Institutions on the "Hill."

The corridor will develop into an attractive public space through streetscape and site design features. It will become more livable and desirable and will serve as a welcoming gateway to Burlington.

Goals:

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.*

3. EXISTING CONDITIONS

This chapter provides an overview of the land use and demographics of residents and employees that affect travel demand through and within Colchester Avenue. The physical and operational characteristics of the roadway, pedestrian and bicycle facilities, transit system, and transportation demand management programs are described and evaluated. The discussion below is a summary of the Existing Conditions Report contained in Appendix C. Findings from the existing conditions analysis are combined below with comments from the Task Force and general public.

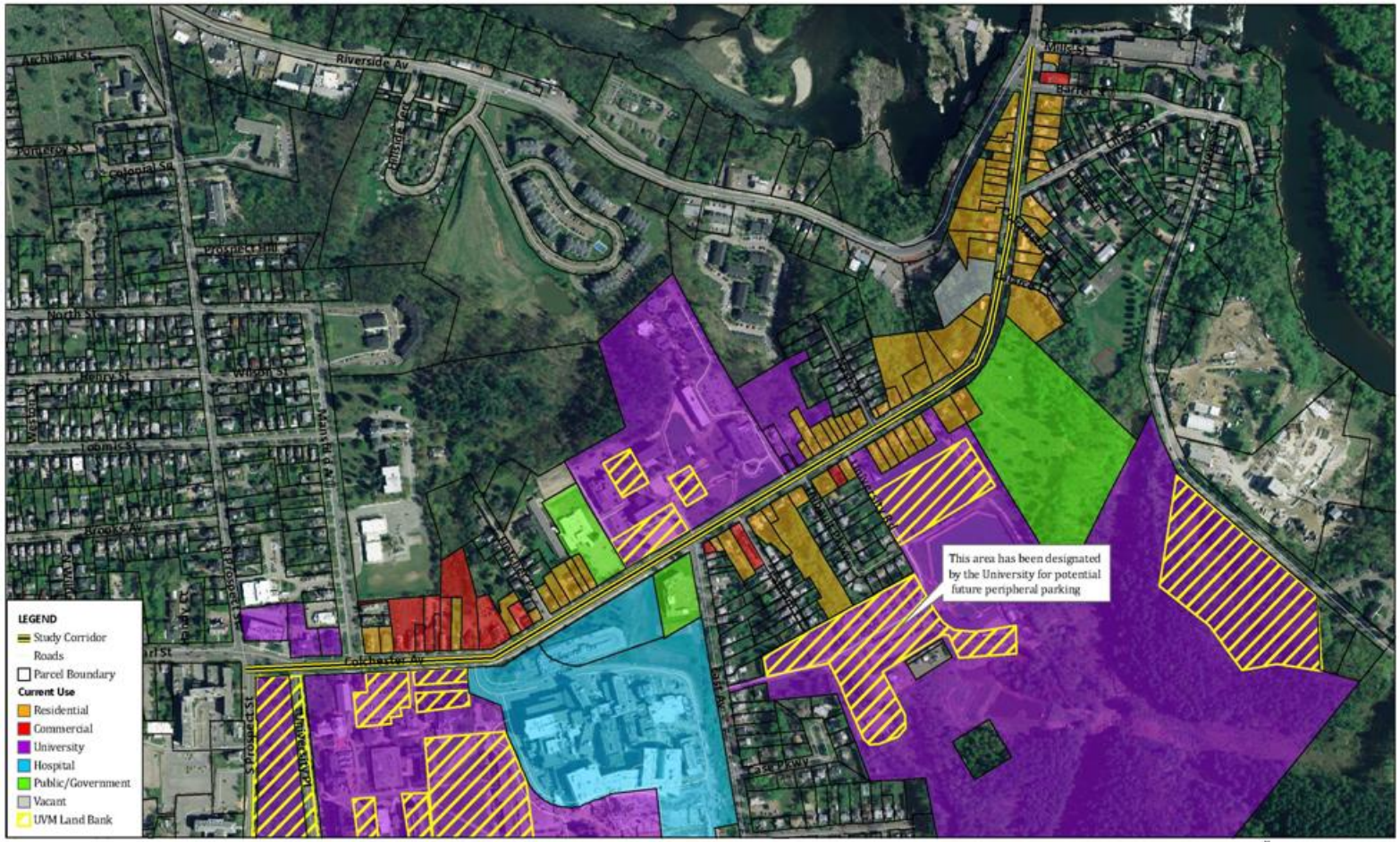
3.1 Corridor Land Use

Colchester Avenue is defined by a mix of land uses, which include residential, commercial, institutional (university and hospital), and government/public (Figure 3). Beginning at the eastern end of the corridor, the existing land use is primarily residential with a limited number of commercial retail businesses at the Colchester/Riverside Avenue intersection. As one travels from Winooski up the hill, the residential land use pattern continues, which is typically defined by a concentrated mix of single-family, duplexes and multi-family housing, primarily occupied by university students. Lot sizes range from around 3,500-6,000 square feet and there is no potential for infill. The Greenmount Cemetery is the only area along the corridor that can be defined as public greenspace.

Continuing west past the cemetery, residential uses carry on but are less densely concentrated, with lots as large as 1-acre, until the University of Vermont Trinity Campus. At this point, commercial retail, professional offices, and institutional buildings become more dominant, with a few residences interspersed or located on the second story. Between Mansfield Avenue and Fletcher Place, there are a series of medical and professional offices located within converted homes. In some cases, residential units are located on the second story and above. Parking for these facilities is located along the side or in the rear of the building. Infill development is limited within the non-university parcels, and, even if a few additional units were constructed (i.e. conversion of single-family to multi-family), there would be no significant impact to the character or function of the corridor.

The remainder of the corridor is institutional use, either owned by the hospital or university. This is the predominant and established use for more than half the study area and has the most influence on development and transportation patterns. The university has identified areas for possible future development, called Land Banks. These areas are highlighted on the Land Use map. While these areas are part of the university's long-range goals, development of these Land Banks could have a significant impact on the transportation system, namely parking and access.

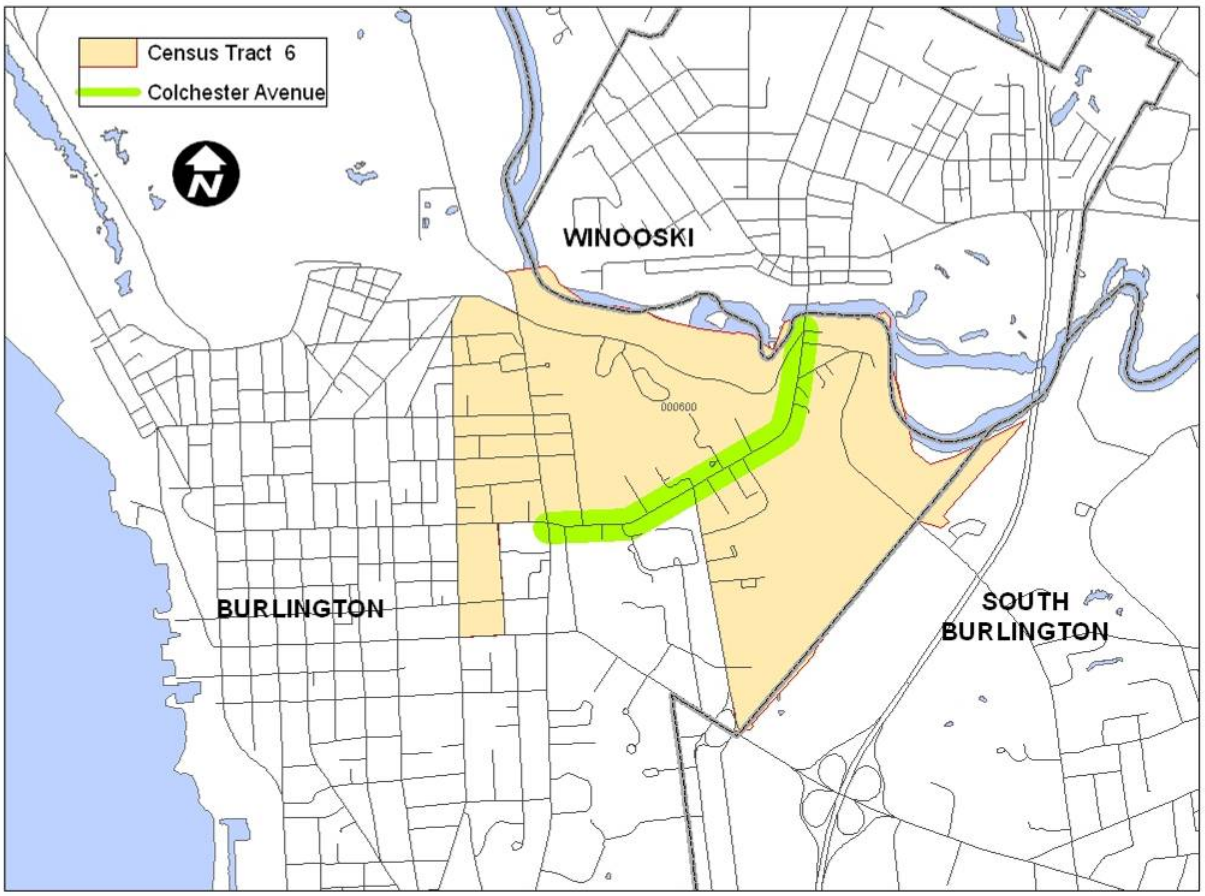
Figure 3: Existing Land Use



3.2 Corridor Demographics and Travel Characteristics

This section describes the social and economic characteristics for the residents and students that live within or near Colchester Avenue, and the more general characteristics of employees in the corridor. The primary sources of data are the 2000 US Census. Census data are available in a number of different geographies including Chittenden County and the City of Burlington. The City is further divided into census tracts. Census Tract 6 is shown in Figure 4 and is the geographic unit on which most of the data below are based. Although Census Tract 6 extends beyond Colchester Avenue to Riverside Avenue in the north and South Willard Street in the west, it is the unit of geography most associated with the study area.

Figure 4: Census Tract 6 Boundary and Colchester Avenue Study Area



While Burlington's total population did not change significantly between 1990 and 2008, the population (Table 3) and number of occupied housing units (Table 4) did increase within the study area (Census Tract 6). The increase may be due in large part to the construction of multi-family housing along Riverside Avenue, which is within Census Tract 6, but is not located directly along Colchester Avenue.

Table 3: Population Change in Burlington and in Census Tract 6[2]

Area	1990	2000	2008
Burlington	39,127	38,889	38,897
Census Tract 6	4,092	4,392	Not Available

Table 4: Occupied Housing Units in Burlington and Census Tract 6

Area	1990	2000
Burlington	14,680	15,885
Census Tract 6	1,463	1,827

The median age of study area residents was 25.5 in 2000 compared with 29.1 for the entire City and 34.2 for Chittenden County. The study area has a higher percentage of people within the 18-64 years old age cohort than the City as a whole and the County. This proportion is most likely driven by the number of students living off-campus in the study area.

It has been widely acknowledged that the percentage of the population over the age of 65 will increase significantly during the next twenty years as the baby boomer generation moves into its next age cohort. While the population in the Colchester Avenue study area will always be younger on average than almost everywhere else in Burlington, consideration should still be given to the transportation needs of older people living in the corridor. Past trends indicated that baby boomers were expected to bring their culture of "automobility" forward and their aging will not necessarily increase use of other modes of transportation. The 2009 National Household Travel Survey clearly shows a reversal in these trends and in past declines in the use of public transportation by older adults. Between 2001 and 2009, use of public transportation among this cohort increased by 40 percent. Walking is the second most popular means of getting around after travel by car, regardless of age and driving status. Among drivers, eight percent of all trips are taken on foot and nearly 20 percent of the trips by non-drivers are on foot[3]. Thus, improving pedestrian facilities and transit service are important components in this plan.

The total number of students enrolled at UVM and Trinity (until it closed in 2000) remained relatively flat over the last two decades. Although total enrollment has remained flat, the number of undergraduate students at UVM has increased between 2000 and 2009 (Table 5).

[2] The Census provides a population update for 2008 for the entire City but not the census tract.

[3] How the Travel Patterns of Older Adults Are Changing: Highlights from the 2009 National Household Travel Survey; Jana Lynott and Carlos Figueiredo; AARP Public Policy Institute; AARP Fact Sheer; April 2011; http://assets.aarp.org/rgcenter/ppi/liv-com/fs218-transportation.pdf

Table 5: Enrollment at UVM and Trinity[4]

Year	University of Vermont			Trinity	Totals
	Under Graduate	Graduate / Medical	Non-Degree/ Continuing Ed		
1991	7,922	1,487	1,610	719	11,738
1995	7,496	1,577	1,158	629	10,860
2000	7,406	1,500	1,212	0	10,118
2006	8,784	1,738	1,075	0	11,597
2009	9,829	1,335	430	0	11,594

The total number of people employed at the institutions increased between 1991 and 2009 by approximately 16% (Table 6). Most of the increase in employment has occurred at the MCHV campus of FAHC.

Table 6: Employment at Institutions in Study Area4

Year	FAHC[1]	UVM	Trinity	Totals
1991	3,415	3,101	238	6,754
1995	3,763	3,048	283	7,094
2000	3,542	3,332	0	6,874
2006	3,926	3,606	0	7,532
2009	4,546	3,313	0	7,859

1. Includes MCHV and UHC only.

Residents in zero-vehicle households depend on non-auto modes to meet daily transportation needs. Eleven percent of the households in the study area did not own a vehicle in 2000 (Table 7). This proportion of zero-vehicle households is less than proportions in the City and greater than the proportions in Chittenden County and may be driven to some extent by the high percentage of renters. According to the 2001 National Household Transportation Survey, almost 18% of rented households nationwide do not have a vehicle[5].

Table 7: Vehicle Ownership

Vehicles per Household	**Colchester Ave. Study Area (**Census Tract 6)		**City of Burlington**	**Chittenden County**
	Households	*Percent of Total*		
None	194	11%	15%	7%
1	781	43%	42%	33%
2	567	31%	33%	45%
3 or more	285	16%	10%	15%

Driving alone is the most common means of traveling to work for residents within the study area. Walking to work is also significant in the study area. A higher percentage of study area residents walk to work compared to the entire City and Chittenden County. The use of public transportation and carpooling was slightly less for residents in the study area, probably due to the higher percentage of people that walk to work (Table 8).

4 Source: Joint Institutional Parking Plans for the stated years published by CATMA.

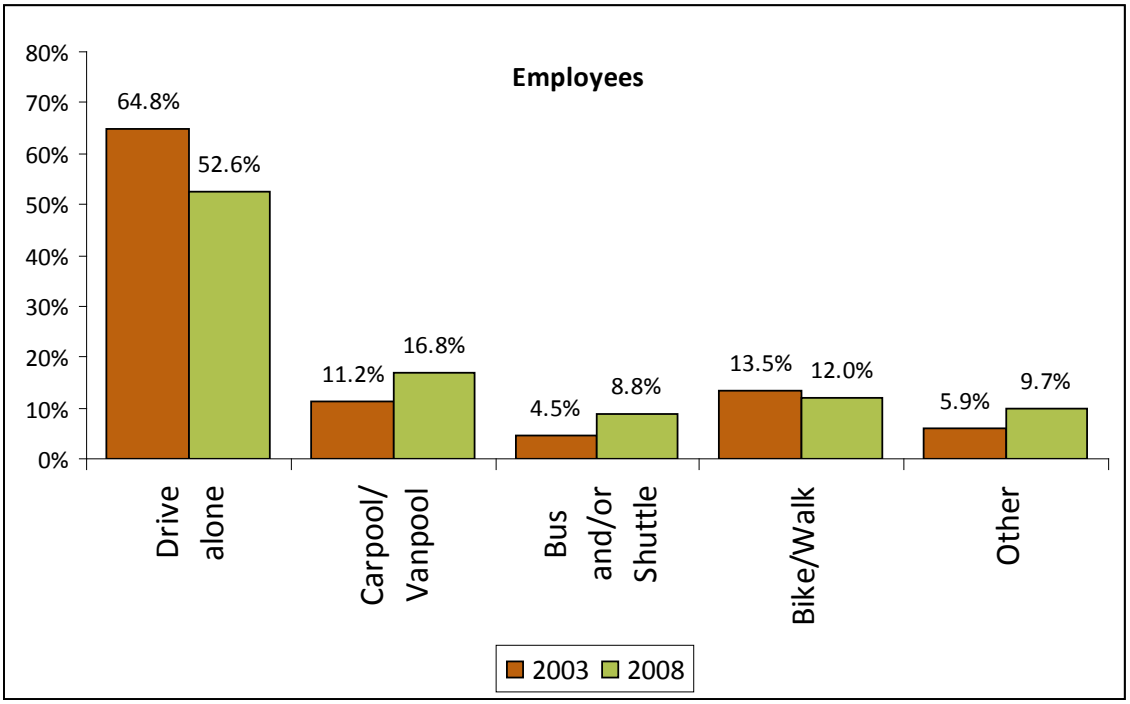
[5] Highlights of the 2001 National Household Travel Survey; Bureau of Transportation Statistics

Table 8: Means of Travel to Work for Corridor Residents

Travel Mode	Colchester Ave. Study Area (Census Tract 6)	City of Burlington	Chittenden County
Car, truck, or van -- drove alone	64%	62%	76%
Car, truck, or van -- carpooled	9%	12%	11%
Public transportation (including taxicab)	3%	4%	2%
Walked	20%	17%	7%
Other means	2%	2%	1%
Worked at home	2%	3%	4%

The largest employers in the study area are UVM and FAHC. The Campus Area Transportation Management Association (CATMA) conducts annual employee and student surveys of its members' constituents (additional information on CATMA is provided in Section 3.7). The results indicate that the drive alone mode share has declined since 2003. The surveys also indicate the dominance of walking as a mode of travel for students living on campus and those that live within ½ mile of campus. Transit is the second most used mode for students (Figure 5 through Figure 8).

Figure 5: Mode split for Hill Institution Employees[6]



[6] Source: 2008 Annual CATMA Employee Survey as presented in the *2009-2014 Joint Institution Parking Management Plan*

Figure 6: Mode split for Students Living on Campus[7]

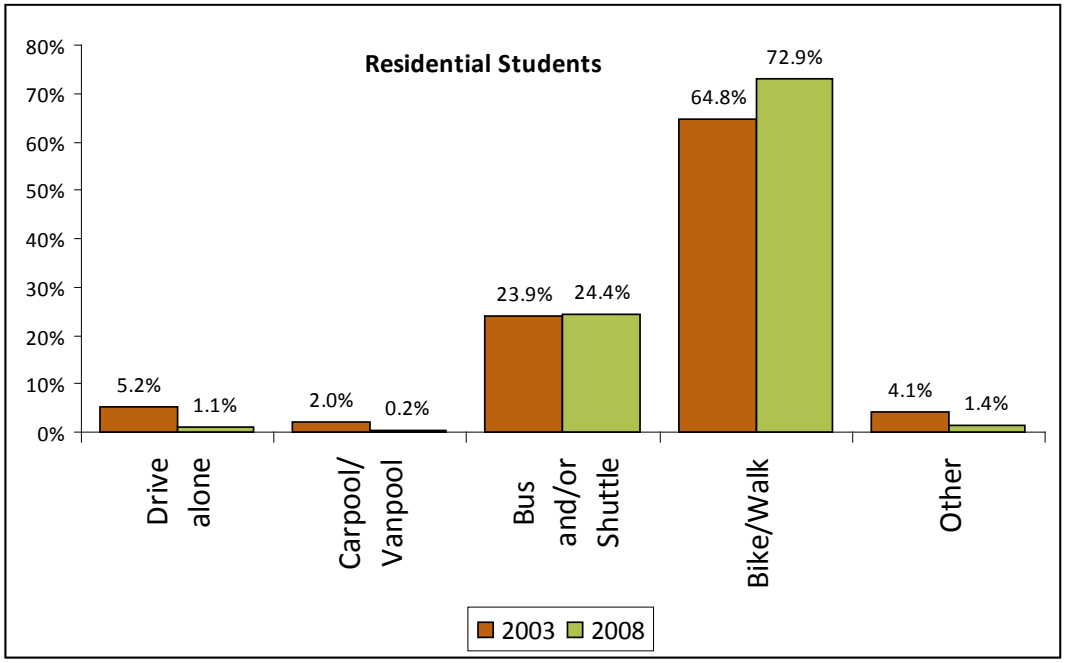
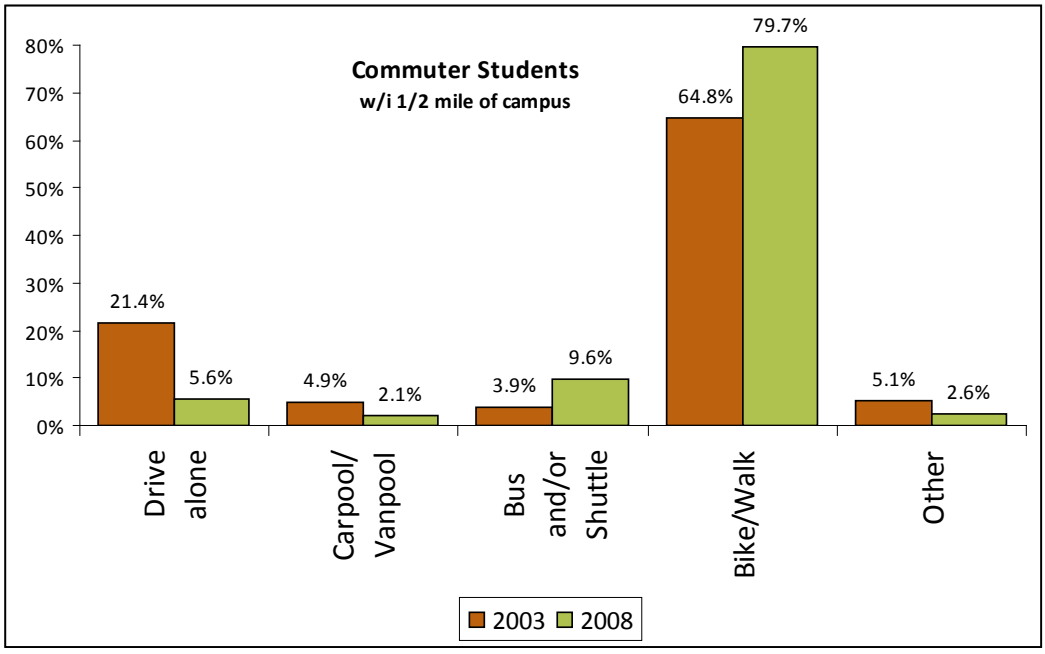


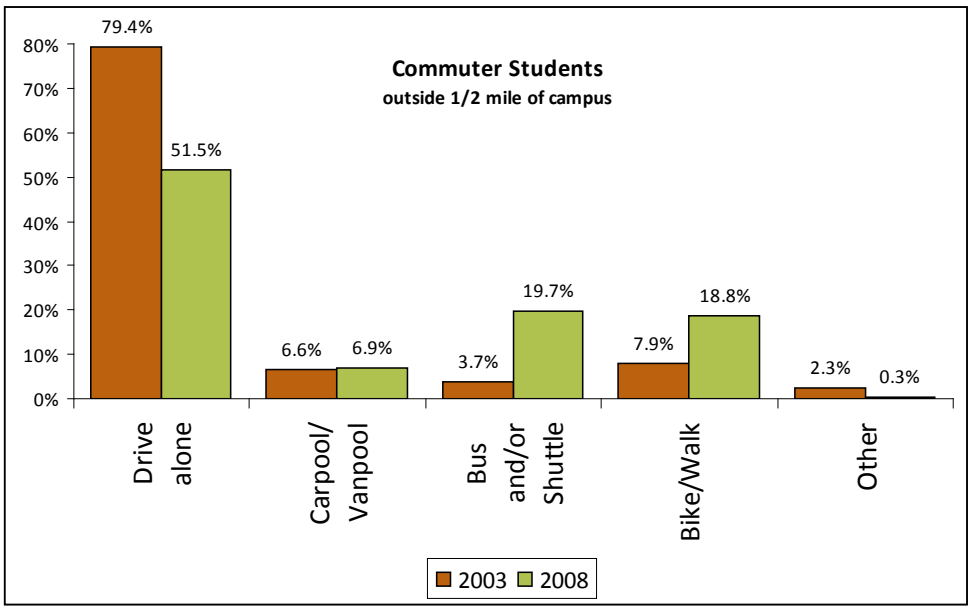
Figure 7: Mode split for Students that Live w/in a ½ mile of Campus[8]



[7] Ibid.

[8] Ibid.

Figure 8: Mode split for Students that Live more than a ½ mile from Campus[9]



3.3 General Roadway Characteristics

Colchester Avenue is owned and maintained by the City of Burlington and is designated as a minor arterial. The function of a minor arterial is to provide mobility for through traffic as well as access, primarily through connecting streets, to adjacent land uses. This classification is consistent with Colchester Avenue's actual role in the transportation network. It is a gateway into Burlington, connects the city with points to the north and east, and also provides access for local residents, businesses and the institutions. As a minor arterial, Colchester Avenue is eligible for the use of federal transportation funds for roadway reconstruction, safety as well as bicycle and pedestrian related projects.

Colchester Avenue is approximately one mile long and is controlled by traffic signals at all of its major intersections which include: Prospect-Pearl Street, Mansfield Avenue, Mary Fletcher Drive (FAHC access), East Avenue and Riverside-Barrett-Mill Streets. University Place and Chase Street are two stop controlled intersections that also feed through traffic to and from Colchester Avenue, and there are several lower volume residential streets connecting to Colchester Avenue that are controlled by stop signs.

Prior to the complete street demonstration project, the western section of Colchester Avenue between Prospect Street and East Avenue consisted of four vehicular travel lanes with green stri[s and sidewalks (Figure 9). The travel lanes were narrow (approximately ten feet), given the volume of traffic and number of buses that travel the corridor. During the complete street pilot project, the western segment was changed to include one travel lane in each direction, a center lane for left turns and shoulders on each side. The eastern segment of Colchester Avenue between East Avenue and the Winooski River consists of two travel lanes (Figure 10 and Figure 11). On-street parking is

[9] Ibid.

provided between East Avenue and the Greenmount Cemetery; and near Chase Street. Sidewalks are provided on each side of the eastern portion of Colchester Avenue with the exception of the segment directly adjacent to the Greenmount Cemetery. The posted speed limit is 30 miles per hour throughout the corridor.

Figure 9: Western Segment - Typical Cross-Section Prior to Complete Street Demonstration Project

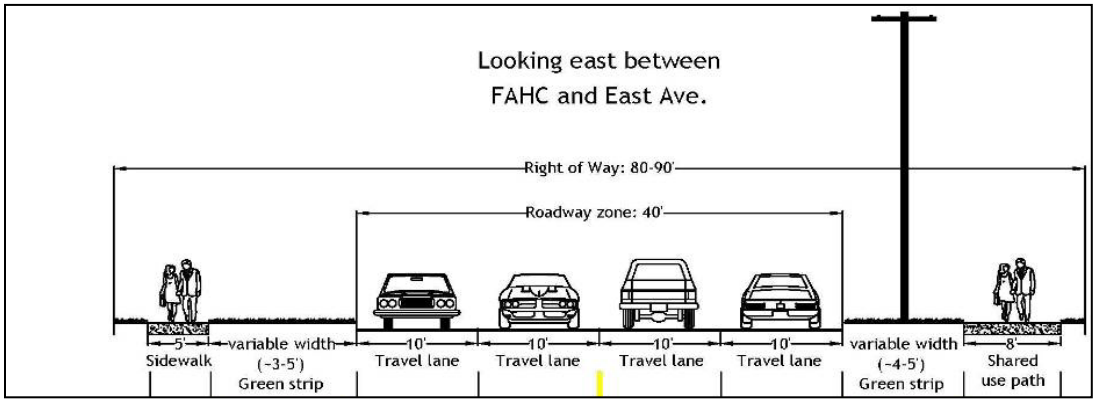


Figure 10: Eastern Segment - Typical Cross-Section west of Cemetery

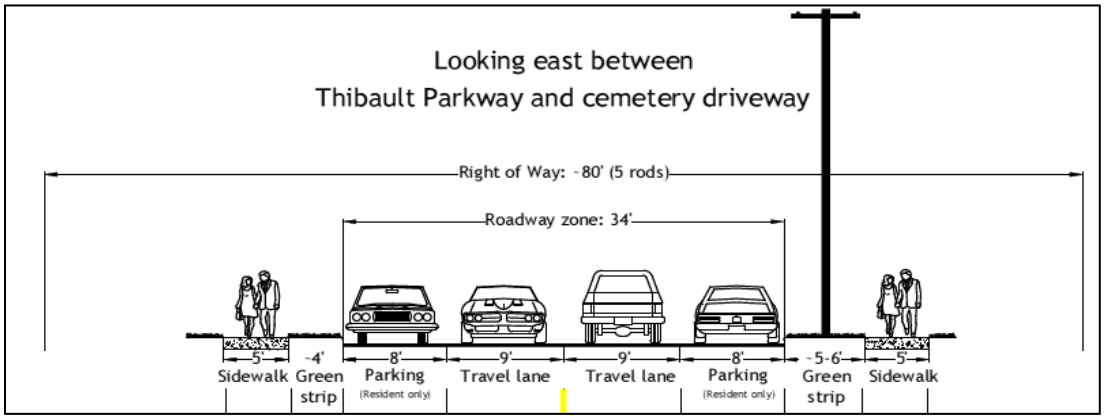
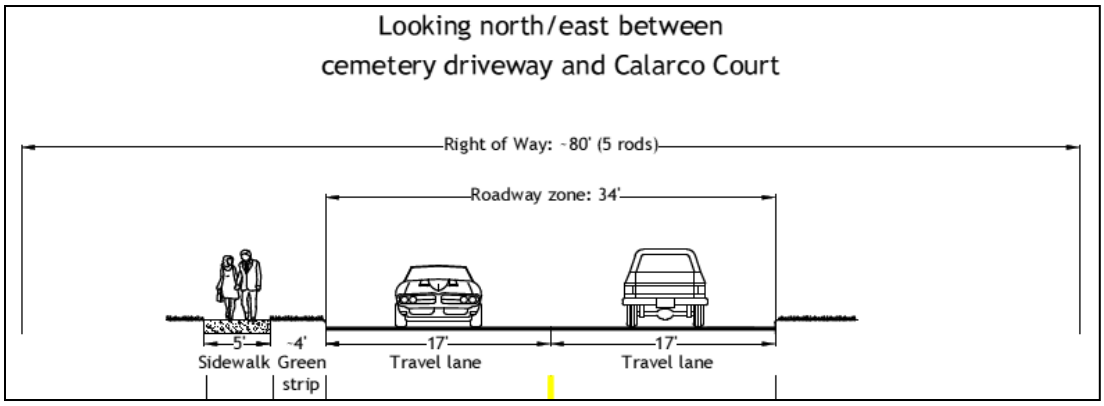


Figure 11: Eastern Segment - Typical Cross-Section Cemetery to Chase Street



3.3.1 Streetscape

Being a major transportation route to and from downtown Burlington, with access to both the University of Vermont and Fletcher Allen Health Care, the aesthetic character of Colchester Avenue is of great importance. As a gateway for vehicles entering the city from the north and east, the streetscape should set an appropriate tone that reflects the best qualities of the city. In addition to aesthetics, the design of the road, sidewalk, and associated streetscape components should support a safe environment for all transportation modes, including automobiles, buses, bicycles, and pedestrians. Ideally, there would be a continuity of streetscape details, including ornamental street lights, bus shelters, and curbing/paving details throughout Burlington's major transportation corridors. Given all these criteria, Colchester Avenue currently falls short of providing a multi-modal travel experience that is fully functional and equal to the aesthetic standards established elsewhere in Burlington.

Many of the aesthetic issues with the existing streetscape (Figure 12) also entail issues for safety and functionality. For example the current sidewalk network is in poor condition in many locations, thereby making a poor impression visually, resulting in poor drainage, and creating tripping hazards and challenges for people with disabilities. Likewise the street lighting, consisting of cobra heads on utility poles, presents a very utilitarian image and does not provide adequate lighting levels or qualities for safe pedestrian and vehicular movement. The maze of overhead utility wires and utility poles is a highly negative visual element in the corridor and presents challenges for street tree planting.

Figure 12: Existing Streetscaping

Despite the wide green strip, overhead utility lines along the south side of Colchester Avenue limit opportunities for street tree planting.

This generous tree belt with full-size street trees enhances the aesthetics of Colchester Avenue and contributes to the urban forest.

In terms of landscaping, the majority of Colchester Avenue does not have a green strip that is of adequate width to support street trees. Aside from enhancing/softening the visual environment, street trees have multiple benefits: support the urban forest, provide shade to pedestrians, and contribute to traffic-calming. The visual enhancement provided by street trees planted in a wide green strip (without overhead utilities) is readily apparent along the northern side of Colchester

Avenue between University Place and the Mary Fletcher Drive (FAHC entrance). Across the street, however, overhead utilities limit opportunities for street trees in an otherwise comparable green strip. In other areas, trees outside the city ROW contribute to Colchester Avenue's designation as an 'Urban Forest primary street tree corridor,'[10] yet gaps in these 'setback plantings' also exist.

In summary there are numerous opportunities for streetscape enhancement within the corridor. An intelligently designed plan for the streetscape would provide multiple benefits- in terms of functionality/safety, aesthetics, and the environment- for the wide range of users on Colchester Avenue's street and sidewalks.

3.4 Pedestrians

Travel for pedestrians is provided for by sidewalks along Colchester Avenue; and marked cross-walks over Colchester Avenue and the side streets at signalized intersections. With the exception of the segment between Greenmount Cemetery and Calarco Court, sidewalks are provided on both sides of Colchester Avenue. Many segments of the sidewalks are in poor condition and have inadequate drainage. Inadequate drainage was a critical issue raised during the public meetings because it restricts accessibility for pedestrians, particularly during the winter when standing water changes to ice or slush.

Pedestrian signals are provided for cross-walks at the signalized intersections at Prospect-Pearl, Mansfield Avenue, Mary Fletcher Drive and East Avenue; but are not provided with the signalized intersections at Riverside Avenue, Barrett Street and Mill Street. All of the pedestrian signals have advanced phasing which allows pedestrians to enter a cross-walk and establish right-of-way before traffic is allowed to move from the intersecting street[11]. Issues noted by the public include a desire for cross-walks and pedestrians signals on all approaches at the Mary Fletcher Drive and East Avenue intersections, and measures that discourage motorists from turning right when pedestrians are in a cross-walk. Many members of the public noted their observations that drivers turning right from Colchester Avenue to East Avenue do not comply with the "No Right Turn on Red" restriction when activated. During the public meetings, support was also expressed for exclusive pedestrian phasing, during which traffic on all roads entering an intersection is stopped while pedestrians cross.

There is a notable flow of pedestrians between UVM's main campus on the south side of Colchester Avenue and the Trinity campus on the north. The only designated cross-walks in this area are at the Mary Fletcher Drive and East Avenue intersections, neither of which are the most direct or convenient locations for this movement. Therefore, a substantial amount of jaywalking occurs in this section and pedestrians cross at random locations that may not always be visible to motorists when sight lines are blocked by cars in the other lanes. There is also a long stretch of roadway between Nash Place and Riverside Avenue that does not have any cross-walks; and a lack of pedestrian equipment at the Riverside, Barrett and Mill Street intersections that reduces accessibility for pedestrians traveling between Colchester Avenue and Winooski.

[10] The delineation of Urban Forest tree corridors is defined in the City of Burlington Open Space Protection Plan.

[11] By comparison, concurrent pedestrian phasing (which is common at signalized intersections) allows traffic turning from a side street to move at the same time pedestrians cross the intersecting street, creating the potential for conflicts between pedestrians and vehicles.

3.5 Biking

Traveling by bicycle is difficult along Colchester Avenue. Prior to the complete street demonstration project, only the most experienced and assertive cyclists would ride on-road along the western section of Colchester Avenue because it required taking over an entire lane under heavy traffic conditions. The one designated bicycle facility in the corridor is an 8 foot wide, concrete shared use path on the south side of Colchester Avenue from University Place to East Avenue. While the shared use path provides some connectivity beyond the corridor to a bike lane for northbound travel on Mansfield Avenue and one for southbound travel on East Avenue, it is not wide enough to accommodate bicycle travel in both directions and pedestrians at the same time. Reducing the travel lanes from four to three during the demonstration project allowed room for shoulders that were approximately 3 ½ feet wide; which are sufficient (but not ideal) for experienced cyclists to travel along the western segment. There are no designated bicycle facilities on the eastern segment of Colchester Avenue between East Avenue and the Winooski River. However, with only one vehicular travel lane in each direction, there is more room for cyclists and motorists to share the roadway, although the space is constrained in many locations due to on-street parking. A significant missing link in the east end of the corridor is a dedicated crossing of the Winooski River and lack of a well-defined connection to the on-road facilities and the multi-use path along Riverside Avenue. Previous planning efforts have evaluated a new bicycle and pedestrian bridge along the west side of the existing Winooski Bridge.

3.6 Transit

Numerous transit routes serve or pass through Colchester Avenue (Table 9). The services range from express commuter routes that run during the AM and PM peak hours, to regular fixed route service that runs throughout the day, to employee and student specific shuttles. During the morning rush hour there are ten different transit routes traveling along the corridor. Transit in the corridor is provided by several different operators including CCTA, CATMA, FAHC, UVM and Champlain College. The number of buses travelling on Colchester Avenue was identified as a concern during the public meetings because of their effect on traffic flow and safety, particularly along the western segment which had narrow lanes (prior to the complete street demonstration project). Keeping in mind that each organization designed its transit service consistent with the needs of its passengers, public meeting participants also suggested that some services should be consolidated where practical.

There are two bus shelters in the study area located near the Prospect Street intersection and at the Trinity Campus whereas all other official bus stops are at curb-side areas identified by signs (Figure 13 and Figure 14). All CCTA routes currently drop off and pick up passengers at the main entrance to MCHV which is located on Beaumont Avenue. This location is by far the most heavily used stop for CCTA routes in the corridor. For example, approximately 60% to 80% of the Essex Junction route and College Street Shuttle passengers (respectively) board or de-board at the MCHV stop. For the Essex Junction service, the MCHV stop requires a notable detour from Colchester Avenue that increases the travel time for all passengers on the route.

Table 9: Weekday transit service in the corridor during 2010

Operator	Route	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM
CCTA	#2-Essex Junction																		
	#11-College Street																		
	#56-Milton Commuter																		
	#76-Middlebury LINK																		
	#86-Montpelier LINK																		
	#96-St. Albans LINK																		
Champlain College	Spinner Place-Late Night/Weekend																		
FAHC	Champlain Mill																		
	Centennial	*No schedule information found.																	
	Fanny Allen																		
UVM-CATS	Redstone Express																		
	On Campus Daytime																		
	On Campus Evening																		
	Weekend Daytime	** Serves Colchester Aveune on the weekends.																	
	Weeknight Off-Campus																		
	Weekend Evening	** Serves Colchester Aveune on the weekends.																	
	Weekend Late Night	** Serves Colchester Aveune on the weekends.																	
	Patrick Gym Daytime																		

Public
Champlain only
FAHC only
UVM only

Figure 13: Bus stops in the corridor

Figure 14: Bus Shelters and Curb-side Stops

3.7 Transportation Demand Management

Transportation Demand Management (TDM) refers to programs that reduce single occupancy vehicle trips between home and work such as rideshare matching, cash incentives for participating in a car-pool, encouraging walking and biking, telecommuting and employer subsidized transit passes. The most effective TDM programs are managed by transportation management associations (TMA). TMAs are non-profit organizations established by private and public employers in a particular geographic area such as a downtown, mall, hospital, or industrial park. They provide an institutional framework for implementing TDM programs and are usually more cost effective than programs managed by individual employers.

The Campus Area Transportation Management Association (CATMA) is the TMA for the Hill Institutions in Burlington (Fletcher Allen Health Care, UVM, Champlain College and the Red Cross). CATMA is a nonprofit, employer-based organization formed in 1992 to enable its members to share resources as well as jointly plan, develop, and manage all transportation and parking programs, infrastructure, and associated facilities. CATMA's TDM programs include:

- Bike/Walks Bucks Reward
- Emergency Ride Home via Commute Smart Card
- Unlimited Access on CCTA transit network (All faculty/staff and students at UVM and Champlain College can use the entire CCTA route system at no charge by swiping their ID cards)
- RidesWork Carpooling (carpool matching service)
- CATMA Express Shuttle (15-minute shuttle between intercept parking at Gilbane/General Dynamics lot on Lakeside Avenue and Champlain College, UVM, and FAHC; free for CATMA members)

The TDM programs offered through CATMA are reinforced by parking polices at the institutions and have been successful at reducing the amount of single occupancy vehicle trips for employees

and students traveling to the UVM and FAHC campuses (Figure 5 through Figure 8). The TDM programs offered by CATMA are important in the Colchester Avenue corridor because they help reduce traffic, particularly during the peak hours, reduce the need for parking spaces, and encourage walking, biking and transit ridership.

3.8 Safety

Some crashes are expected to occur along almost all roadways. However, much of Colchester Avenue has been identified as a high crash location (HCL) by the Vermont Agency of Transportation (VTrans) based on data from 2003 through 2007. In general terms, an HCL is a location where the actual number of crashes is much higher than the average number of expected crashes for similar types of roadways and intersections.

There are five high crash locations in the corridor including three intersections and two sections of roadways:

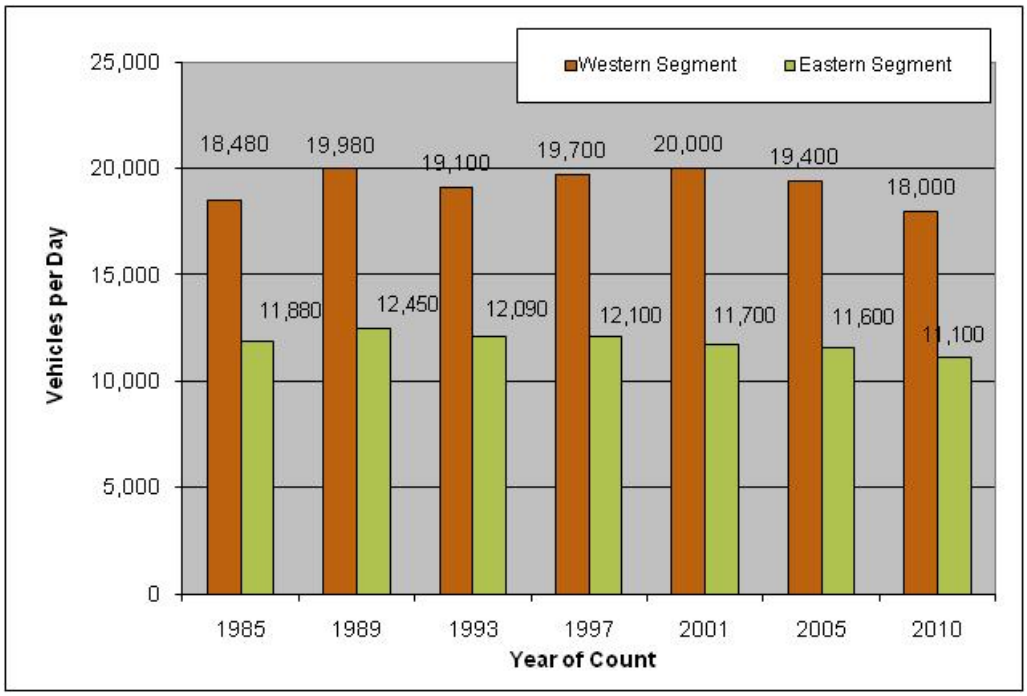
- The Prospect Street intersection had several head-on collisions and crashes between vehicles turning left and passing through. This crash pattern may be due to the offset configuration of North and South Prospect Streets.
- The East Avenue intersection had a large proportion of sideswipes, which may be attributed to the conversion of two through lanes on the Colchester Avenue eastbound approach to one through lane and one exclusive right turn lane.
- The Riverside Avenue-Barrett Street-Mill Street intersection is a very active area that can be confusing to drivers. There were many sideswipes and T-bone/broadside crashes.
- The section of Colchester Avenue between Mansfield Avenue and the East Avenue experienced many sideswipes, most of which involved driver inattention and/or failure to keep in the proper lane or yield right-of-way.
- The road section of Colchester Avenue between Latham Court and Greenmount Cemetery had the highest proportion of sideswipes. There does not appear to be a trend in contributing factors, but the presence of on-street parking on both sides of Colchester Avenue may have something to do with the crash pattern.

Out of the 448 total crashes that occurred on Colchester Avenue between South Prospect Street to Riverside Avenue from 2003 to 2007, 13 involved bicycles or pedestrians. There were a total of nine injuries and no fatalities. There do not appear to be any discernible patterns in the contributing factors or types of these bicycle crashes.

3.9 Traffic Volume and Congestion

Over the last twenty-five years, traffic volumes on Colchester Avenue have fluctuated between 18,000 to 20,000 vehicles per day (vpd) on the western segment and 11,000-12,000 vpd on the eastern segment (Figure 15). Approximately 70% of this traffic passes through the corridor, underscoring the role of Colchester Avenue as an arterial roadway.

Figure 15: Annual Average Traffic Volumes on Colchester Avenue[12]



Factors such as a shift from single occupancy vehicles to walking, biking and car-pooling and the use of park-and shuttle facilities outside of the corridor for Hill Institution employees have arguably contributed to the stabilization of traffic flow in the corridor. However, congestion may also be limiting the ability of Colchester Avenue to accommodate many more vehicles. In other words, Colchester Avenue may have reached its traffic capacity so drivers are choosing different routes or shifting to other modes of transportation.

Level of service (LOS) is the standard traffic engineering measure used to describe operating conditions (congestion) as perceived by motorists traveling on roadways and through intersections. LOS grades range from A through F. Operations under LOS A and B are characterized by minimal delay and vehicle queues (lines of cars waiting at a traffic signal) seldom form. Operations at LOS C and D are characterized by moderate delays, queues form more frequently, but interruptions in traffic flow (due to bad weather, construction activities or an accident for example) can quickly result in long delays and excessive queues. Traffic flow under LOS E conditions is more unstable as entering traffic volumes approach the capacity of the intersection. Operation at LOS F occurs when there is more traffic arriving than can pass through an intersection, resulting in continuously growing queues and delays. LOS can be calculated for the overall intersection and for specific approaches and lanes.

For an urban arterial like Colchester Avenue, signalized intersections, rather than road segments, are the primary cause of congestion. As part of the existing conditions assessment, LOS analyses were conducted for all of the signalized intersections along Colchester Avenue for the 2010 AM and PM weekday peak hours. The analysis is based on the turning lanes and traffic signal timings in

[12] 2010 AADT for the western segment is based on a count conducted by the CCMPO prior to the complete street demonstration project. All other AADTs are based on VTrans data.

place before the complete street demonstration project (4-lane cross section in the avenue's western segment) and is based on traffic volumes that account for traffic generated during the UVM academic year.

LOS analyses indicate that intersections at Prospect Street and East Avenue are the most congested in the corridor and are the bottlenecks that reduce the overall capacity of the corridor relative to traffic. They also indicate that intersections by the Winooski Bridge function relatively well. The Riverside-Barrett Street intersection operated at an overall LOS D but the Barrett Street westbound approach operated at LOS F during the PM peak hour. During the PM peak hour, vehicle queues on the northbound approach of Colchester Avenue to Barrett Street spill back uphill past Chase Street.

4. FUTURE CONDITIONS

The following factors will affect the amount and characteristics of travel within and through the Colchester Avenue Corridor:

- Through travel associated with forecasted growth in regional population and employment.
- Potential for redevelopment and infill of residential and commercial areas within the corridor but outside of the University of Vermont and Fletcher Allen Health Care campuses.
- Future plans at UVM and Fletcher Allen Health Care.
- Demographics of the corridor's population.

Each of these factors is discussed below.

4.1 Regional Population and Employment Growth

Approximately 70% of the traffic on Colchester Avenue is passing through on trips that begin and end outside of the corridor. Therefore, changes in through traffic over the next twenty years will be affected by growth and development outside of the corridor. Through traffic will also be affected by changes in the region's transportation system, such as adding capacity to existing roadways, expanding transit, providing intercept park-and-ride facilities, and building new roads. The Chittenden County Transportation Model (The Model) was used to forecast changes in traffic flows along Colchester Avenue for a 2030 planning horizon. The Model estimates the movement of people and vehicles within the region during a base year for the AM and PM peak hours and predicts future traffic volumes based on assumptions about land use and the transportation system. Additional information on the Model is available on the CCMPO web site at http://www.ccmpo.org/modeling/. For a detailed explanation of the Model refer to "CCMPO Model Documentation"[13].

The Model predicted a 12% increase in vehicle miles of travel (VMT) in Chittenden County between 2010 and 2030. However, traffic growth will vary for specific roadways. Projections developed using the Model suggest that traffic will not change significantly along Colchester Avenue over the next twenty years, and may even decrease slightly (Figure 16). This forecast is consistent with the historical traffic volumes along Colchester Avenue which have not changed significantly between 1985 and 2010.

The slow growth in traffic is not unique to Colchester Avenue. The Vermont Agency of Transportation (VTrans) collects traffic data on roadways throughout the state to develop forecasts for use in planning and design of highway facilities. When developing traffic forecasts for urban roadways like Colchester Avenue, VTrans recommends increasing traffic volumes a total of 1% for a twenty-year planning horizon[14].

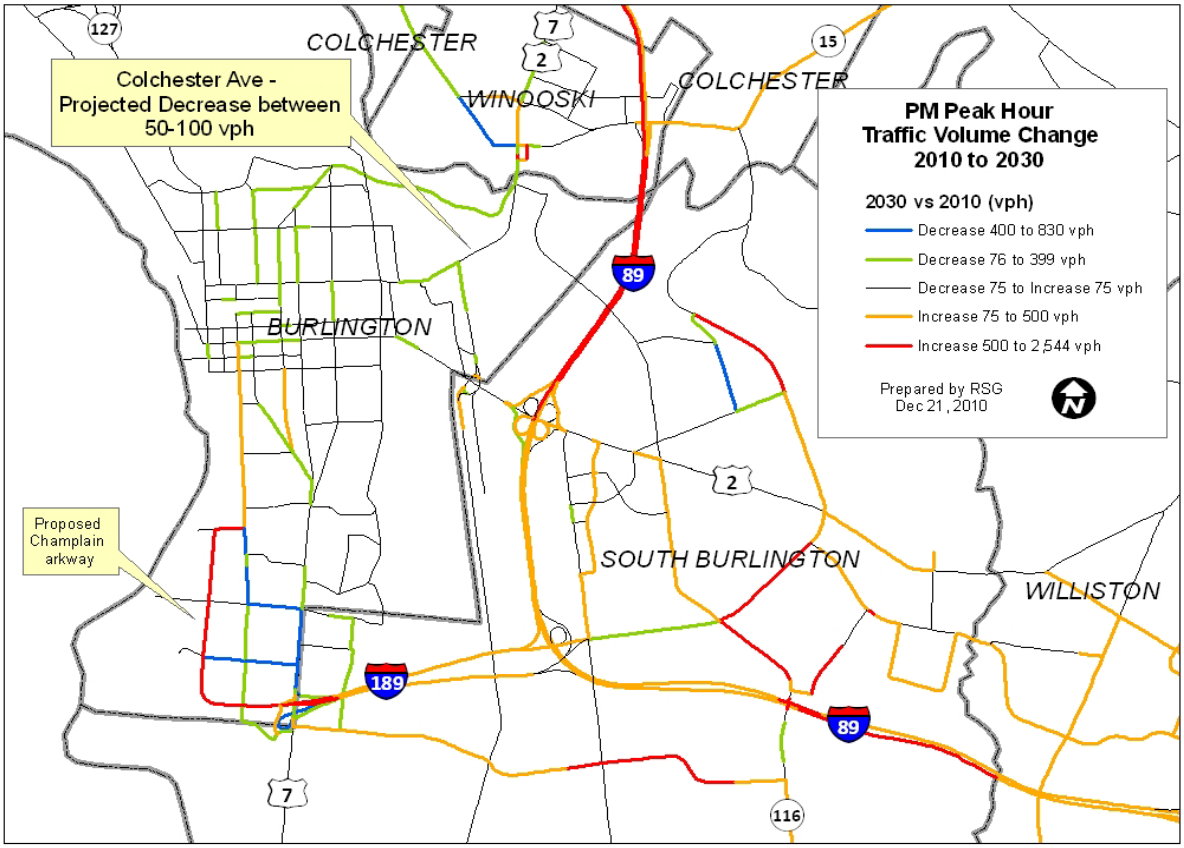
Little growth in traffic should not be confused with less overall travel demand. Additional travel in the corridor is being accommodated with more transit service, more walking and biking and through the transportation demand management programs provided for UVM, Fletcher Allen and

[13] Resource Systems Group, Inc., for the CCMPO, April 2006

[14] Page 72, Growth Factors for Urban Highways, "Continuous Traffic Counter Grouping Study and Regression Analysis Based on 2010 Data', Vermont Agency of Transportation, March 2011.

the Red Cross by CATMA. CATMA also serves Champlain College, the City of Burlington and the State of Vermont; which all have employees and/or students that travel along Colchester Avenue.

Figure 16: Estimated Change in PM Peak Hour Traffic Volume 2010 to 2030 (vph= vehicles per hour)



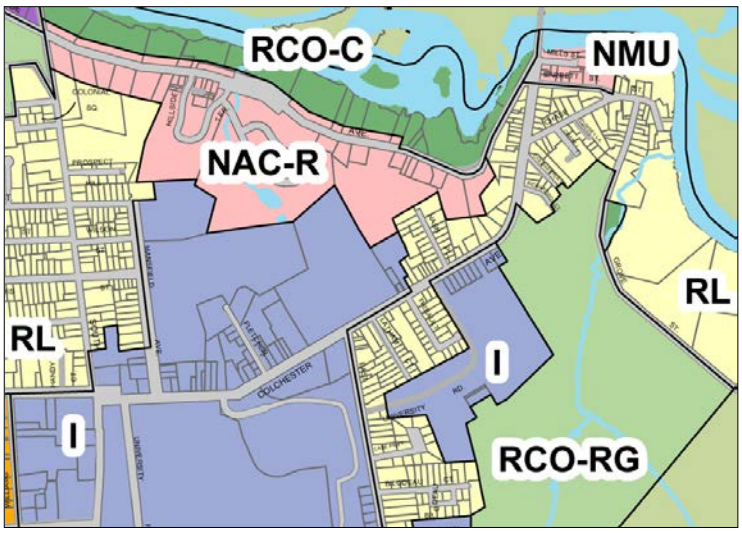
4.2 Development within the Corridor

The potential for new and infill development within the corridor depends on available land, City zoning regulations, and potential changes at UVM and Fletcher Allen Health Care.

4.2.1 Potential for development outside of the UVM and FAHC Campuses

Development potential within the corridor depends on available land and city land use regulations. The Burlington Zoning Ordinance (Ordinance) was adopted January 7, 2008 and most recently amended April 13, 2009. The Ordinance clearly defines the four planning districts along Colchester Avenue, which include: (NMU) Neighborhood Mixed Use, (RCO-RG) Recreation/Greenspace, (RL) Residential Low Density, and, (I) Institutional (Figure 17). The zoning districts will guide the density, design and types of development that may occur along the corridor as follows:

Figure 17: City-defined Zoning Districts along Colchester Avenue



NMU District: Permitted uses include neighborhood oriented goods and services within walking or biking distance to nearby residences. This district allows zero setbacks with maximum lot coverage of 80%. There is one vacant lot within this area. Its development potential is limited, with less than 3,000 sq. ft. available.

RCO-RG District: This district contains Greenmount Cemetery and is intended to "provide a diversity of passive and active recreational opportunities and other urban green spaces that provide for public use and enjoyment" as well as to protect the function and integrity of its current use. No development infill or redevelopment is likely.

RL District: This district encompasses a large portion of the study area and is "intended primarily for low-density residential development in the form of single detached dwellings and duplexes." There are a few single-family residences interspersed throughout the study area, but a majority of buildings are homes converted into either duplexes or multi-family units and generally house university students. There is the potential for some infill development, primarily in the form of additions to legal multi-family residences or conversion of homes to neighborhood commercial uses.

I District: This is the Institutional district discussed below.

4.2.2 University of Vermont Campus Master Plan

The institutional zoning district is "intended to support continued growth and flexibility within the city's major educational and health care institutions…" while respecting "the sensitive historic development patterns" of the surrounding neighborhood. While this zoning district will help guide the form and use of projects at UVM, the *2006 UVM Campus Master Plan and Design Guidelines* (UVM Master Plan) provides a more comprehensive assessment of UVM's future plans and how they relate to the Colchester Avenue Corridor. The UVM Campus Master Plan directly addresses growth of the campus through 2015, and looks forward to growth in the decades beyond. It is based upon operational assumptions, planning principles and other frameworks that will affect the physical characteristics and travel demand along Colchester Avenue.

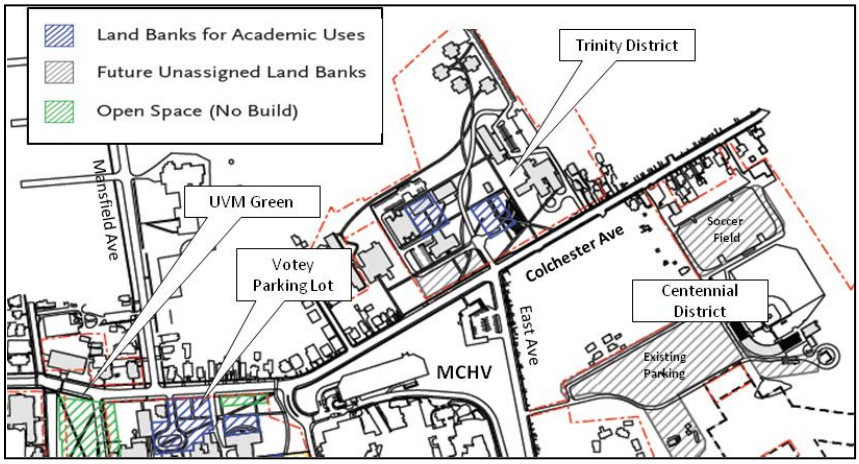
Two relevant operating assumptions in the UVM Campus Master Plan that could affect travel in the Colchester Avenue corridor are assumed changes in enrollment and employment. However, since 2006, UVM has realized the projected enrollment and employment changes identified in the UVM Campus Master Plan. If any changes do occur, only modest growth is expected through the next ten years.

The UVM Campus Master Plan includes broad guiding principles, philosophical planning principles and more specific planning principles which address a variety of topic areas. A commitment to create a pedestrian oriented campus is the overarching planning principle in the UVM Campus Master Plan that will affect the physical characteristics and travel along Colchester Avenue. Related to this principle, automobile access by the public and the University community will be focused primarily at the perimeter of the campus with multiple modes of access to and from visitor parking and the peripheral lots within the core campus. Parking on campus will be limited to requisite parking for accessibility, service, emergency and visitor needs. Parking needs will be met by periphery parking facilities (i.e., surface parking lots and/or garages) and all will be serviced by shuttles. Existing surface parking lots are the first options for new physical development for future new buildings and other facilities. Therefore, the future changes in enrollment and employment will not necessarily increase the amount of cars traveling along Colchester Avenue to and from UVM.

The UVM Campus Master Plan identifies land banks which are potential locations for future buildings (for which related site design will be determined in the future), circulation needs, informal recreational space, special event outdoor space needs, and open spaces/no-build zones. The land banks provide some indication of future changes at UVM. Land banks identified along the Colchester Avenue corridor include (Figure 18):

- Trinity District: Academic facilities within the campus and an undefined use directly adjacent Colchester Avenue;
- Centennial District: Undefined uses that would replace the existing soccer field and the existing surface parking lot along University Road; and
- Votey Parking Lot: Academic facilities that would replace the existing Votey parking lot generally between the Fleming Museum and Ira Allen Chapel.

Figure 18: UVM Campus Master Plan Land Banks along Colchester Avenue[15]



[15] As noted in the UVM Campus Master Plan, all land banks are fluid in nature and represent general areas for the location of future development and campus improvements. Land bank delineations are not intended to suggest literal footprints of proposed new buildings.

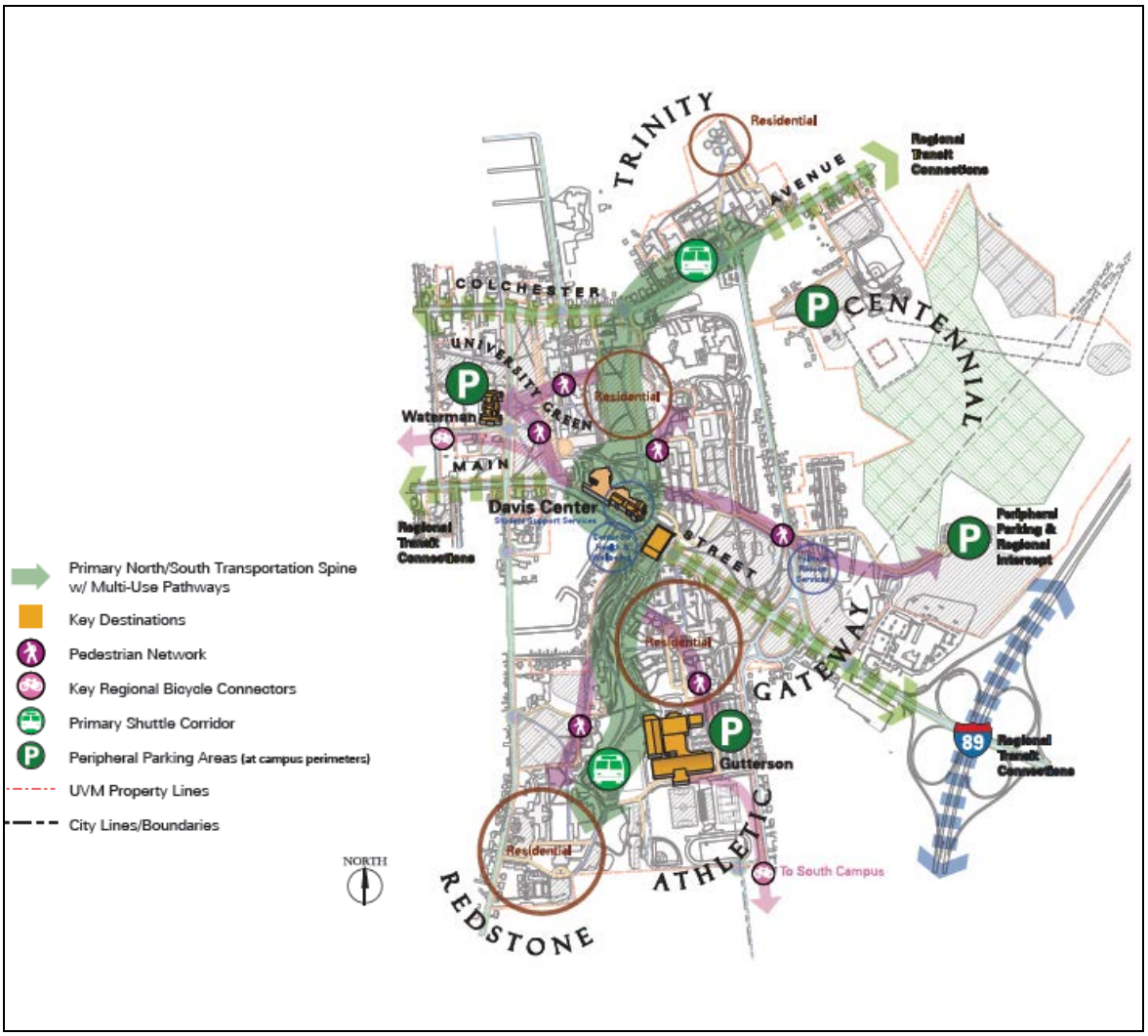
In the long-term, the Votey and Centennial parking lots could be replaced by buildings resulting in less traffic along Colchester Avenue. Additional buildings on the Trinity Campus, whether for academic or other uses, may result in more pedestrians traveling along and across Colchester Avenue.

In addition to the land banks, the UVM Campus Master Plan includes a Property Acquisition and Disposition Plan which notes that if the following properties (which are located north of Colchester Avenue) were to become available, UVM would consider acquiring them:

- Mansfield Avenue properties:
  - the Mater Christi School
  - Sisters of Mercy Convent
  - Red Cross
  - Planned Parenthood
- North Prospect Street properties:
  - Red Cross
  - fraternity house (northwest corner of the Colchester-Prospect intersection)

In the long term, acquisition and use of these properties, in combination with infill development on the Trinity Campus and at Centennial Field suggested by the land banks, would increase the amount of activity associated with UVM along and across Colchester Avenue. Vehicular traffic associated with UVM along Colchester Avenue would be diverted to other locations, and the amount of walking and bicycling are likely to increase. The UVM Campus Master Plan recognizes there is a need to create pedestrian and bicycle connections through to Trinity District to support the goal of realizing a pedestrian campus and the associated increases to the number of students, faculty, and staff walking and bicycling around campus. Through the UVM Campus Master Plan, the Green Mountain Walkway has been conceptualized as a north-south pedestrian corridor connecting the Redstone District through the campus core to the Trinity District (Figure 19). Additional pedestrian and bicycle traffic can also be anticipated at all of the intersections along Colchester Avenue with implementation of the UVM Campus Master Plan.

Figure 19: UVM's Green Mountain Walkway Concept



4.2.3 Fletcher Allen Health Care

Fletcher Allen Health Care has two campuses adjacent to the Colchester Avenue corridor. The Medical Center Campus accesses Colchester Avenue from Mary Fletcher Drive and is situated between the UVM campus, Colchester Avenue and East Avenue. The UHC campus is located at the corner of Pearl and South Prospect Streets. During the 2000s, the Medical Center campus underwent a major expansion to add an Ambulatory Care/Education facility and an associated parking garage. A radiation oncology expansion was recently completed. As noted in the 2009 Joint Institutions Parking Management Plan, the Fletcher Allen Health Care Conceptual Master Plan identifies an In-Patient Bed Replacement Project for some time beyond 2015. However, there will be no growth in beds or employees as a result of that project. Therefore, other than typical fluctuations in patient visits, there are no significant changes anticipated at Fletcher Allen Health Care that will affect travel along the Colchester Avenue corridor.

4.3 Demographics

Study area demographics, discussed in Section 3.2 , indicate growing travel demand for non-automobile modes of transportation, especially walking and transit:

- The population in the study area grew by about 7% between 1990 and 2000. A larger population increases density and contributes directly to more travel within the study area.
- Eleven percent of the households in the study area did not own a vehicle and were therefore dependent on non-auto modes of transportation to meet daily needs.
- Single occupancy vehicles provide for the highest percentage of work trips for residents. Walking to work is also significant in the study area.
- Walking and transit are the most common modes of transportation for students living in the corridor.
- It is reasonable to assume that the study area's population will continue to diversify, further increasing demand for transit and other non-automobile modes in the corridor.

4.4 Summary

Walking, biking and transit ridership are important and significant means of travel in the corridor and current trends suggest that use of these non-auto modes will increase. These trends underscore the need for Colchester Avenue to evolve into a complete street as articulated in the vision statement. The vision statement also calls for balancing mobility for through traffic with accessibility for neighborhoods, local businesses and the institutions. It is therefore prudent to plan for some increase in roadway traffic. Roadway design options, discussed in the next chapter, are therefore based on an assumed increase in traffic of 5% between 2010 and 2030 (Table 10).

Table 10: Traffic Growth Driving Factors

Considerations	Trends	Traffic Growth
Local / Corridor	•Historical traffic growth flat •Limited residential and commercial development potential in corridor •Growth leveling off at UVM and FAHC •Less on-campus parking •More walking, biking and transit use by corridor residents and employees	Small Increase
Regional	•Traffic diverted to other routes •More intercept and park-and-ride facilities •More transit service and use	Small Decrease
Statewide	Average urban roadway traffic growth: 1% total in 20 Years	Flat
Corridor Planning Assumption	5% in 20 Years	Small Increase

5. STREET DESIGN OPTIONS AND OTHER RECOMMENDATIONS

This chapter describes and evaluates roadway and intersection design options for the western and eastern segments of the corridor. Consistent with complete street principles, all roadway design options include designated on-road bike lanes and sidewalks on each side of the street for the entire length of Colchester Avenue. The designs for the western section include three-lane and four-lane options. Both western section options are evaluated based on an analysis of traffic congestion and operations for the 2030 PM peak hour, findings from the 2010-2011 complete streets demonstration project, and a summary of other tradeoffs related to the vision and goals. The eastern segment has one travel lane in each direction which is sufficient to accommodate existing and projected traffic volumes. Because the eastern section's width is constrained by adjacent buildings, its design options relate to on-street parking and green strip variations. Concept plans for each design option are provided in Appendix D. This section also describes transit and operations/maintenance recommendations that are related to both the eastern and western sections of the corridor.

5.1 Western Section Street Design Options

Two design options were considered for the western segment of Colchester Avenue between Prospect Street and East Avenue. Both options include sidewalks, green strips and designated bike lanes on each side of the roadway. They differ in their approach to accommodating motor vehicles.

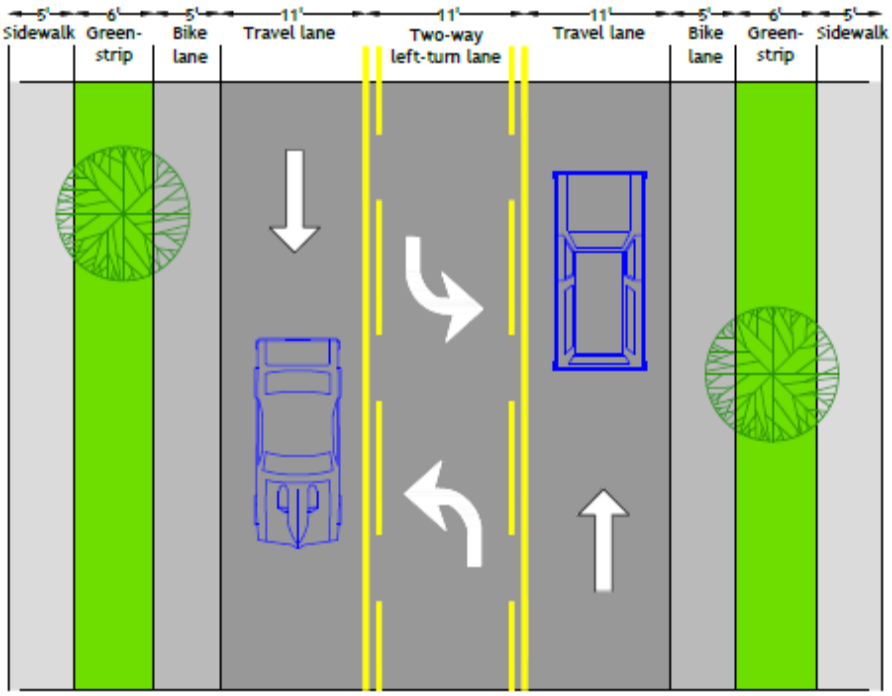
5.1.1 Three Lane Design Option

The Three Lane Option provides less capacity to move motor vehicles through the corridor while maintaining access to and from connecting streets and the institutions. Through traffic would be accommodated by one lane in each direction. Traffic turning into side streets and most driveways would be accommodated by exclusive turn lanes at intersections and a center two-way left turn lane between intersections. It accommodates cyclists with designated on-road bike lanes on each side of the street. The narrower roadway improves access for pedestrians by reducing crossing distance and eliminating potential conflict points.

- **General roadway cross-section**: The typical cross-section would include one travel lane in each direction, a center two-way left turn lane, on-road designated bike lanes (4 feet wide), green strips and sidewalks (Figure 20).
- **Pedestrian Crossing Controls**: This option would provide advanced pedestrian phasing at all signalized intersections. An advanced pedestrian phase allows pedestrians to begin crossing a street and establish the right-of-way in the cross-walk before motorists on the intersecting street are given a green light and can begin entering the intersection. Advanced pedestrian phasing, rather than exclusive pedestrian phasing, is recommended for the Three Lane Option because the roadway crossing distance is reduced and pedestrians have fewer lanes of traffic to cross. In addition, advanced pedestrian phasing maintains traffic performance even with reduced capacity due to the elimination of one travel lane by allowing some overlapping of vehicle and pedestrian movement phases. Cross-walks would be provided on all approaches to signalized intersections.

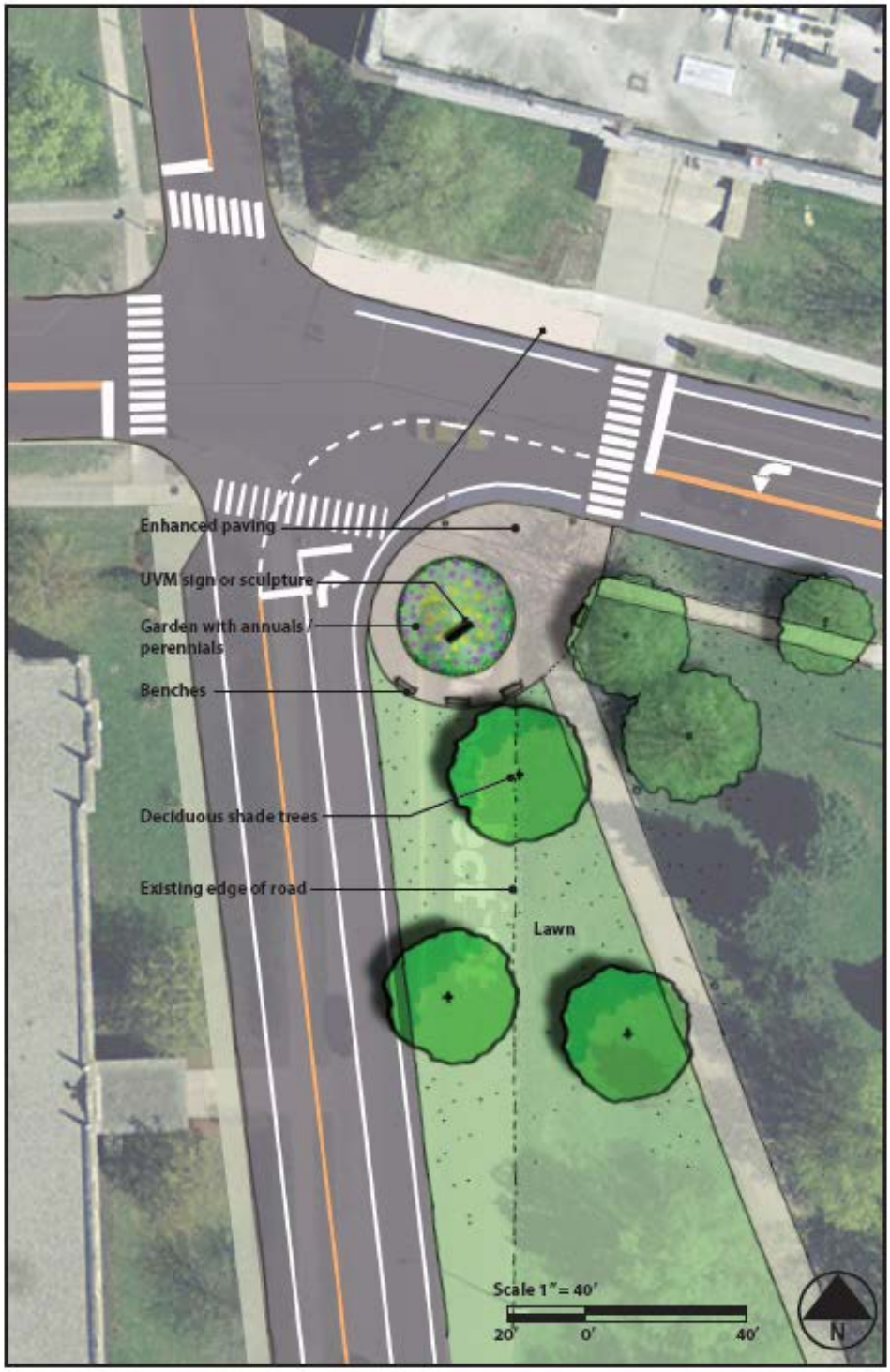
- **Bicycle Access**: Cyclists would be accommodated by the dedicated bike lanes to be provided on each side of the street throughout this section.
- **Transit Access**: Additional shelters are recommended along the corridor which would be accessed by CCTA buses with pull-offs (specific locations are recommended in Section 5.3). Pull-offs are recommended for the Three Lane Option because buses would otherwise block through traffic while picking up and dropping off passengers (which was observed during the complete streets demonstration project).

Figure 20: Typical Cross-Section - Three Lane Design Option



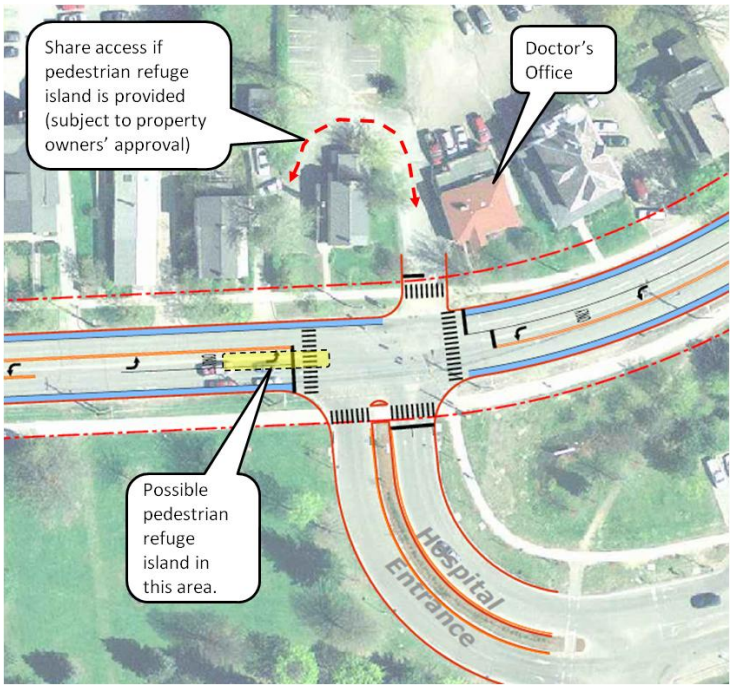
- **Intersection Designs:**
  - **Pearl Street-Prospect Street-Colchester Avenue:** The South Prospect Street approach to Colchester Avenue would be relocated to the west to be re-aligned with North Prospect Street. No other lane changes are currently suggested (Figure 21). Traffic analyses conducted for this plan indicated little benefit from adding an exclusive left-turn lane on the Pearl Street approach. The additional lane should be re-evaluated as part of the scoping and design process for this intersection. The re-alignment would improve safety and traffic operations, create more greenspace adjacent to the UVM Green but would also place the roadway and sidewalk closer to the UHC building at the corner of Pearl and South Prospect Streets.

Figure 21: Prospect Street Re-alignment



- **University Place-Colchester Avenue:** In the long-term, this intersection, following further evaluation, should be closed to general through traffic. Before closing the road to personal vehicle through traffic, the City and UVM must develop appropriate design and control features that allow access for emergency vehicles, regional transit and UVM shuttles; while also accommodating pedestrians, cyclists, and on-street parking changes. In the short to mid-term, access could be restricted to right-in and right-out movements only. These changes would reduce potential vehicle-vehicle, vehicle-pedestrian and vehicle-cyclists conflicts, and would improve traffic operations by reducing the number of vehicles entering and exiting between two closely spaced intersections.
- **Mansfield Avenue-Colchester Avenue Intersection:** The Colchester Avenue eastbound approach would have an exclusive left turn lane to accommodate vehicles turning into Mansfield Avenue. A single lane in the westbound direction would accommodate through and right-turning vehicles.
- **Mary Fletcher Drive (FAHC Access Road)-Colchester Avenue:** The Colchester Avenue westbound approach would have an exclusive left turn lane to accommodate vehicles turning into Mary Fletcher Drive. The Colchester Avenue eastbound approach would include a left turn lane for vehicles turning into the doctor's office. Since the eastbound left turn lane is not necessary to accommodate the low amount of traffic turning into the doctor's office it could be converted to a pedestrian refuge island (Figure 22). However, a pedestrian island at this location needs further evaluation as it might block access to properties west of the intersection and create potential issues with travel of emergency vehicles.

Figure 22: Mary Fletcher Drive Intersection with Three Lane Option



- **East Avenue-Trinity Drive-Colchester Avenue Intersection:** The lane designations for the Colchester Avenue eastbound approach would remain unchanged and would include an exclusive right-turn lane for vehicles turning into East Avenue and a shared through/left turn lane. The designated bike lane in the eastbound direction would be aligned between the left/through and right turn lanes. The East Avenue northbound approach would be re-aligned to the west to allow for a longer exclusive right turn lane while preserving the on-street parking located on the east side of the street. The Trinity Drive approach would also have to be shifted to

the west to remain aligned with East Avenue. The re-alignment of the Trinity Drive approach would be incorporated into future site planning for the campus, which is likely to include modifications to parking and internal circulation as well as new buildings located closer to the street (see land banks in Figure 18) identified for the Trinity District in the UVM Campus Master Plan).

- **Trinity Campus Mid-Block Pedestrian Crossing:** A mid-block pedestrian crossing is recommended on Colchester Avenue, between East Avenue and Mary Fletcher Drive (Figure 23) for a conceptual crossing location. Its purpose is to focus and provide safe access for pedestrians crossing between the Trinity Campus on the north side of Colchester Avenue and UVM, FAHC and other destinations on the south side. Design details for this crossing will be determined during a more focused scoping/design phase. Possible crossing features could include textured, colored surface to emphasize its location and a pedestrian refuge island in the center of the road but further analysis is needed to determine its effect on the eastbound vehicle traffic (through and right turning). Pedestrians currently cross at random and dispersed locations along this section of Colchester Avenue. To direct pedestrians to the mid-block crossing, architectural guide rails could be provided in the green strips on each side of the street. The guide rail could be similar in design to those provided along Main Street near the UVM Green and South Prospect Street which have granite posts, black steel rails and incorporate plantings (Figure 24).

  With the Three Lane Option, the mid-block crossing could be enhanced by a pedestrian activated in-pavement LED light system and LED-enhanced pedestrian signs (Figure 25). The system is used at crosswalks to alert motorists to the presence of a pedestrian crossing or preparing to cross the street. Amber lights are embedded in the pavement on both sides of the crosswalk and oriented to face oncoming traffic. When the pedestrian activates the system, either by using a push-button or through detection from an automated device, the in-pavement and sign LED lights begin to flash at a constant rate, warning the motorist that a pedestrian is in the vicinity of the crosswalk ahead.

Figure 23: Conceptual Location of Trinity Mid-block Pedestrian Crossing

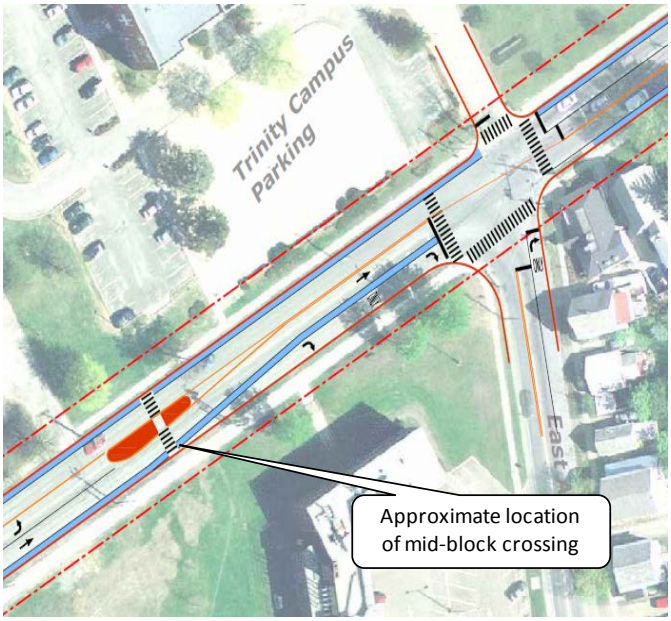


Figure 24: Perspective of Trinity Mid-block Pedestrian Crossing

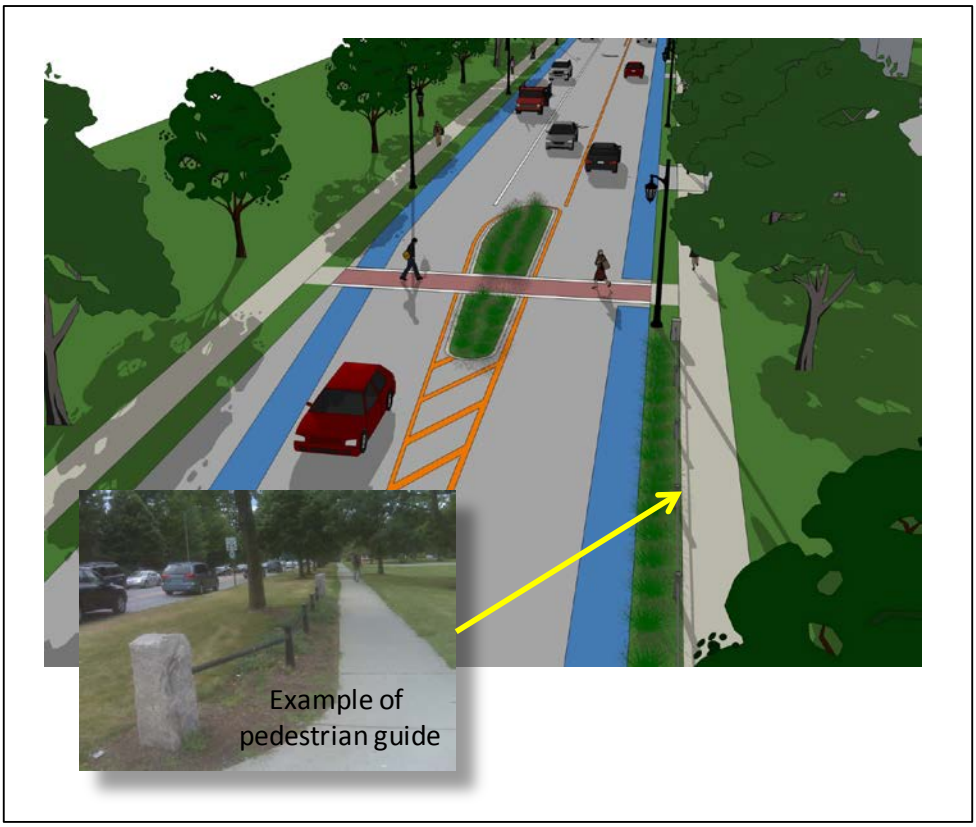


Figure 25: In-pavement LED Pedestrian Crossing System

According to a recent study by VTrans, in-pavement lights in combination with a LED-enhanced sign increased the number of motorists that stopped for pedestrians waiting to enter a cross-walk from 56% to 80%[16]. The in-pavement/enhanced sign system is less assertive than the HAWK beacon recommended for the Four Lane Option, which functions more like a traffic signal and clearly requires a motorist to stop when activated. The Colchester Avenue Task Force agreed that the in-pavement/enhanced sign system is appropriate for the Three Lane Option because the roadway crossing distance is smaller and there are fewer lanes of traffic creating conflict points between pedestrians and through traffic.

5.1.2 Four Lane Street Design Option

Prior to the complete street demonstration project, the western section of Colchester Avenue provided four, ten-foot wide travel lanes, no shoulders or bike lanes, with green strips and sidewalks. This option continues to accommodate motor vehicles with four through lanes and additional turn lanes at some intersections while also accommodating pedestrians, cyclists and transit vehicles. Key features of the Four Lane Option are discussed below:

- **Typical roadway cross-section features**: The width of the four travel lanes would be increased from ten to eleven feet. This option increases the pavement width (curb to curb) by 35% from 40 feet to approximately 54 feet (assuming one foot offsets to curb). On-road designated bike lanes (4 feet wide), green strips and sidewalks would also be provided (Figure 26).

- **Pedestrian Crossing Controls:** This option assumes that exclusive pedestrian phasing, which stops all traffic at an intersection while pedestrians walk across a street, would be provided at all signalized intersections. The Colchester Avenue Task Force decided that exclusive pedestrian phasing is necessary because the Four Lane Option creates a longer crossing distance and also creates more conflict points as pedestrians walk across more lanes of traffic. Cross-walks would be provided on all approaches to signalized intersections. A comparison between the amount of time it takes for a pedestrian to cross the street with three lanes versus four lanes of travel indicates that the crossing time would increase to 22 seconds for older people and 14 seconds for the average pedestrian (Figure 27).

- **Bicycle Access:** Cyclists would be accommodated by the dedicated bike lanes to be provided on each side of the street throughout this section.

[16] VTrans Materials and Research Section; "Evaluation of BlinkerSign® Flashing LED-Enhanced Signs and SmartStud™ In-Pavement Crosswalk Lighting Systems"; February 2011 Interim Report. Evaluated an installation in US 4 in Quechee, VT.

Figure 26: Typical Cross-Section for the Four Lane Option

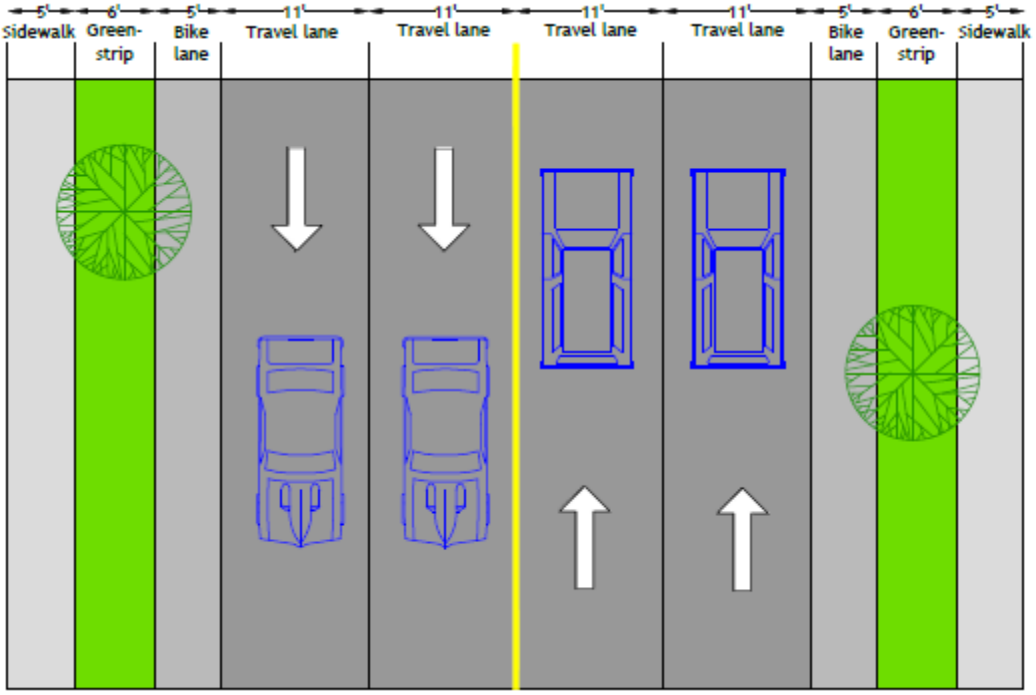
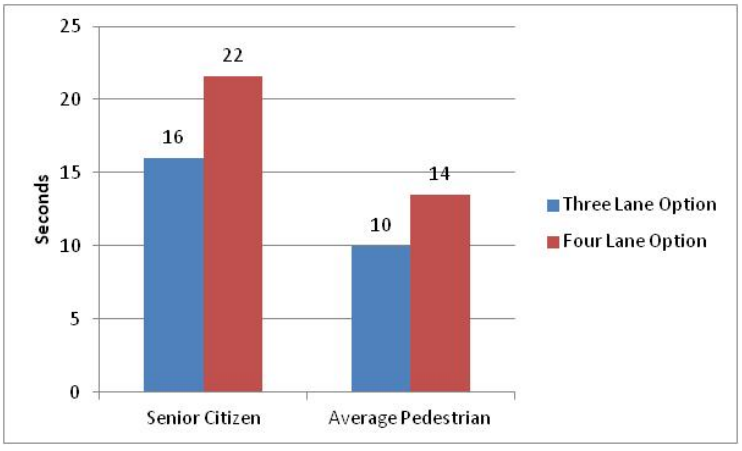


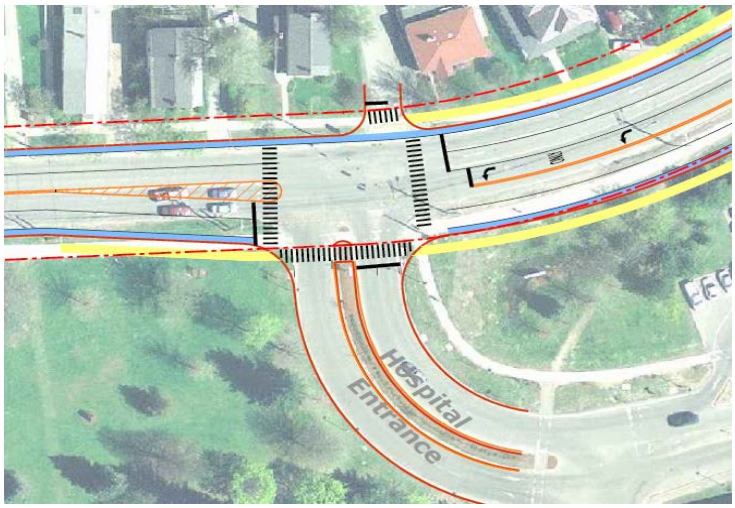
Figure 27: Comparison of Cross-walk Travel Time with Four Lanes[17]



[17] Based on walking speed of 4 feet/second for the average pedestrian per the Manual on Uniform Traffic Control Devices, and 2.5 feet/second per a study of older and younger pedestrian walking speeds, Road Engineering Journal, October 1997, http://www.usroads.com/journals/p/rej/9710/re971001.htm

- **Transit Access**: This design option does not include bus pull-offs. Buses would occupy the bike lane and a portion of the outside through lane while picking-up and dropping off passengers at bus shelters and the signed bus stops along Colchester Avenue. CCTA prefers, and currently uses this procedure. By occupying a portion of the travel lane, it is easier for a bus to re-enter the traffic stream. The Four Lane Option makes this possible because other vehicles can pass-by on the inside lane.
- **Intersection Designs:**
  - **Pearl Street-Prospect Street-Colchester Avenue:** The Pearl Street eastbound approach would be widened from one lane to two lanes. This change would allow two rows of vehicles to enter Colchester Avenue at the same time and would help reduce delays and queuing on that approach. The South Prospect Street approach to Colchester Avenue would be relocated to the west to be re-aligned with North Prospect Street (similar to Figure 21).
  - **University Place-Colchester Avenue:** (This intersection would be addressed in the same manner as the Three Lane Option.) In the long-term, this intersection should be further evaluated to be closed to general through traffic. In the short- to mid-term, access could be restricted to right-in and right-out movements only. These changes would reduce potential vehicle-vehicle, vehicle-pedestrian and vehicle-cyclists conflicts, and would improve traffic operations by reducing the number of vehicles entering and exiting between two closely spaced intersections.
  - **Mansfield Avenue-Colchester Avenue:** The intersection would have the same configuration that existed before the complete street demonstration project requiring that traffic turning into Mansfield Avenue share a through lane.
  - **Mary Fletcher Drive-Colchester Avenue:** In addition to the four through lanes, an exclusive left turn lane would be provided on the Colchester Avenue westbound approach to Mary Fletcher Drive (FAHC access). The intersection will require additional widening of the eastbound and westbound approaches on Colchester Avenue (Figure 28). Providing an exclusive pedestrian phase at this intersection is particularly important because the crossing distance is quite long and also the exclusive left turn lane creates an additional conflict point. A pedestrian refuge island on the Colchester Avenue eastbound approach could also be considered for this option.

Figure 28: Mary Fletcher Drive with Four Lane Option



  - **East Avenue-Trinity Drive-Colchester Avenue:** The Colchester Avenue westbound approach currently provides two lanes: an exclusive left turn lane for traffic turning into

East Avenue and a shared through/right-turn lane. The exclusive left turn lane would be re-designated as a shared through/left-turn lane to allow two rows of traffic to enter Colchester Avenue at the same time. The lane designations for the Colchester Avenue eastbound approach would remain unchanged and would include an exclusive right-turn lane for vehicles turning into East Avenue and a shared through/left turn lane. The East Avenue northbound approach would be re-aligned to the west to allow for an adequate exclusive right turn lane while preserving the on-street parking located on the west side of the street. The Trinity Drive approach would also have to be shifted to the west to remain aligned with East Avenue. The re-alignment of the Trinity Drive approach would be incorporated into future site planning for the campus, which is likely to include modifications to parking and internal circulation as well as new buildings located closer to the street (see land banks in Figure 18 identified for the Trinity District in the UVM Campus Master Plan).

- **Trinity Campus Mid-Block Pedestrian Crossing:** A mid-block pedestrian crossing is included on Colchester Avenue located west of East Avenue. Its purpose is to focus and provide safe access for pedestrians crossing between the Trinity Campus on the north side of Colchester Avenue and UVM, FAHC and other destinations on the south side. The mid-block crossing would have a textured, colored surface to emphasize its location and would include a pedestrian refuge island in the center of the road. Pedestrians currently cross at random and dispersed locations along this section of Colchester Avenue. To direct pedestrians to the mid-block crossing, architectural guide rails would be provided in the green strips on each side of the street. The guide rail would be similar in design to those provided along Main Street near the UVM Green and South Prospect Street which have granite posts, black steel rails and incorporate plantings.

With the Four Lane Option, the mid-block crossing could be controlled by a High intensity Activated Crosswalk (HAWK) pedestrian beacon (Figure 29) or a similar control device. A HAWK beacon is activated by pedestrians, stops traffic on the street using a series of amber and red balls similar to a typical traffic signal, and then permits drivers to proceed as soon as the pedestrians have passed. Unlike a traffic signal which always displays amber, green or red lights, a HAWK pedestrian beacon is dark when not activated.

Figure 29: HAWK Pedestrian Crossing

A pedestrian control beacon that requires cars to stop is recommended for the mid-block crossing for the Four Lane Option. This type of affirmative message was desired by the Colchester Avenue Task Force for the Four Lane Option because pedestrians have a long crossing distance and would be exposed to conflicts from four lanes of moving traffic.

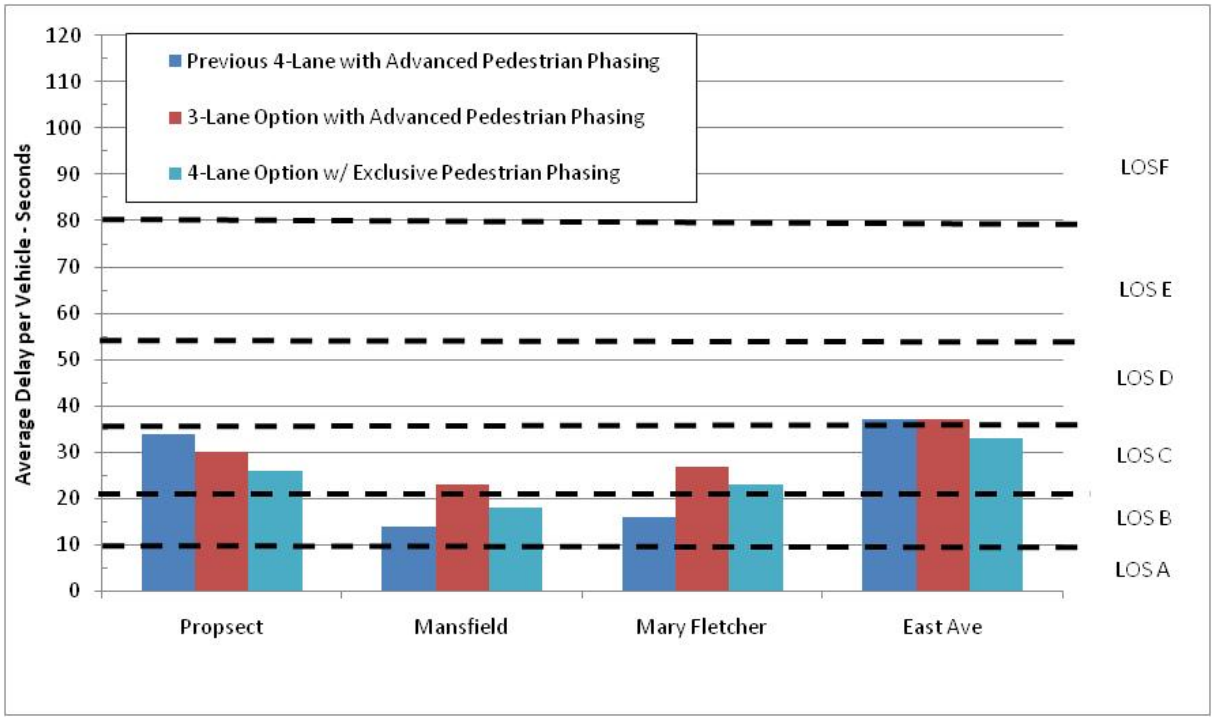
5.1.3 Comparison of Western Section Design Options

The Three Lane Option will provide better and safer access for pedestrians and cyclists by reducing crossing distances, eliminating potential conflict points caused by multiple lanes, and simplifying traffic flow adjacent to bike lanes by reducing weaving maneuvers. This option would also reduce the barrier created by the roadway in the neighborhood. The trade-off is the possibility that the Three Lane Option would increase vehicle congestion levels thus reducing access within the corridor, and to the destinations beyond the corridor, that rely on the regional access Colchester Avenue provides. The Four Lane Option would result in slightly less congestion for motorists passing through the corridor, but does so at the expense of access and safety for cyclists and pedestrians, would have a greater footprint impact and would require the acquisition of additional right-of-way. This section compares the Three Lane and Four Lane design options relative to traffic congestion and operations for the 2030 PM peak hour, summarizes findings from the 2010-2011 complete street demonstration project, compares the positives and negatives, and recommends the Third Lane Option for Colchester Avenue.

5.1.3.1 2030 PM Traffic Congestion and Operations

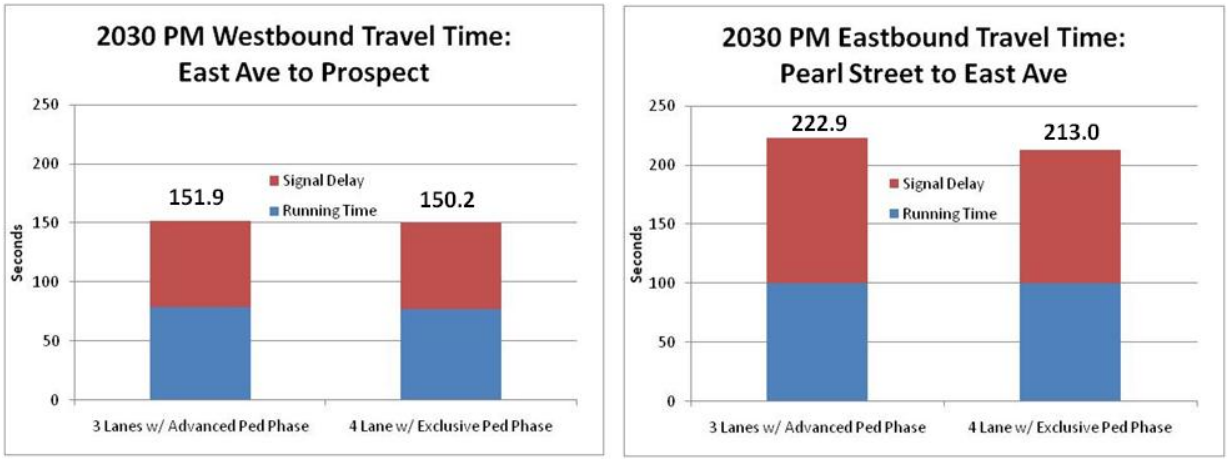
Overall, the major signalized intersections are projected to operate at LOS B through LOS D during the 2030 PM peak hour with both the Three Lane and Four Lane options (Figure 30). LOS D is considered acceptable in an urban setting. The Four Lane Option, which provides more lanes through the intersections but also includes exclusive pedestrian phases, would operate with slightly lower levels of delay compared to the Three Lane Option and the previous four lane design (pre-complete street test if left in place through 2030).

Figure 30: Overall Intersection LOS 2030 PM for Western Section



Travel time for a westbound vehicle on Colchester Avenue between Prospect Street and East Avenue would be very similar for the Three and Four Lane options during the 2030 PM peak hour. The Three Lane Option, compared to the Four Lane Option, would increase the travel time by about ten seconds for a vehicle traveling in the eastbound direction on Colchester Avenue between East Avenue and Prospect Street (Figure 31).

Figure 31: Western Section Travel Time Comparison



Because the Three Lane Option reduces the number of lanes passing through the intersections, it reduces their capacity to move cars while also reducing the available room to stack cars stopped at a traffic signal. As a result, the Three Lane Option is projected to create longer vehicle queues compared to the Four Lane Option (Figure 32) during the PM Peak hour. With the Three Lane Option, vehicle queues may fill the available space in both directions between Mansfield Avenue and Mary Fletcher Drive. Vehicle queues are also likely to increase on the East Avenue approach to Colchester Avenue. Vehicle queues would be long for the Pearl Street and South Prospect Street approaches for both the Three Lane and Four Lane options.

It is important to keep the traffic congestion evaluation in context. It focuses on the PM peak hour, which has the highest hourly volumes but represents a relatively small portion of the entire day and about 10% of the traffic volume that passes through the corridor over a 24 hour period (Figure 33). Delays, corridor travel time and vehicle queues are therefore less intense throughout the rest of the day.

Figure 32: Average Vehicle Queue Comparison 2030 PM Peak Hour

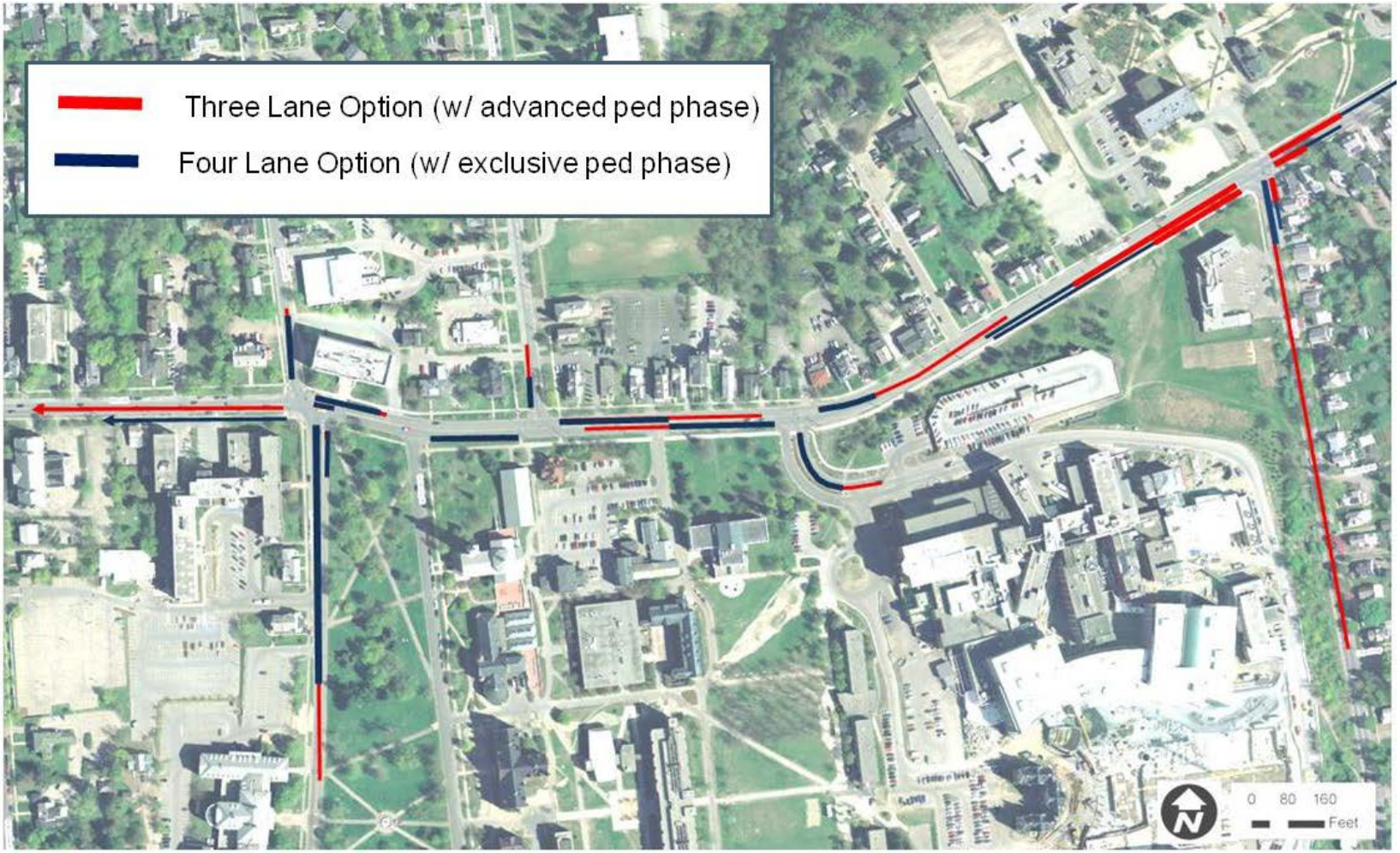
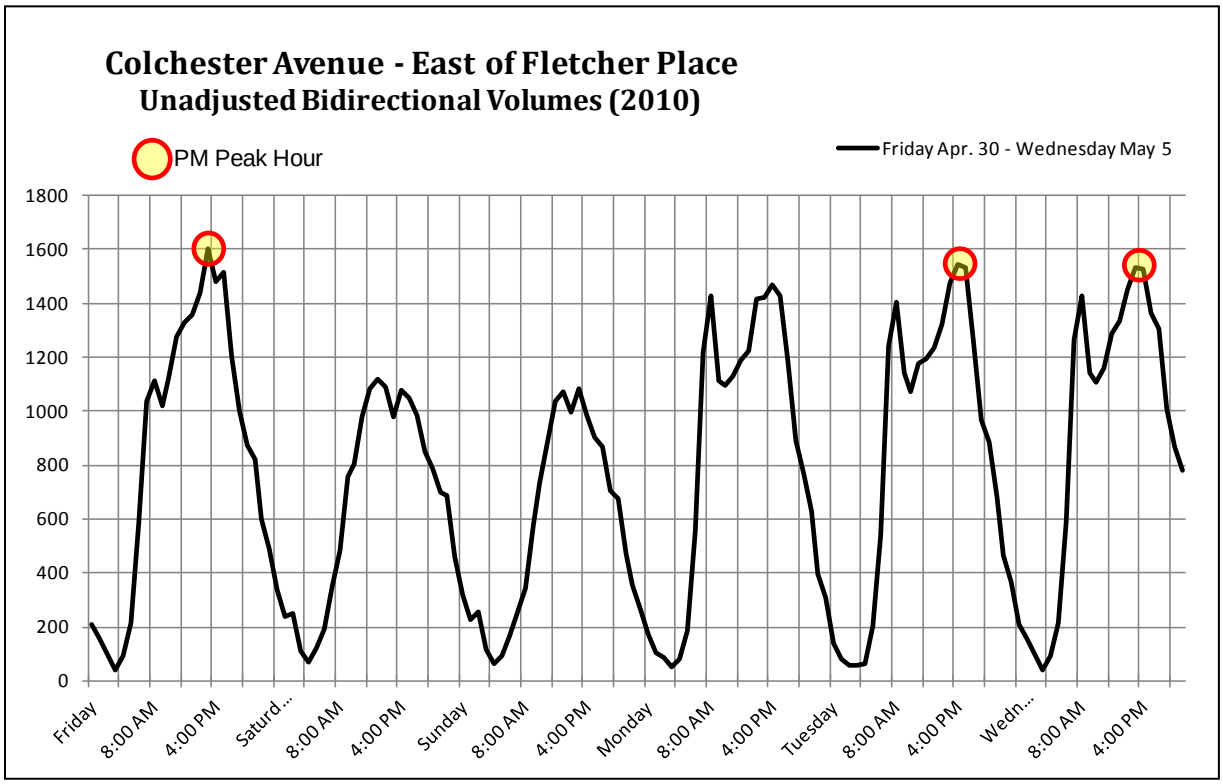


Figure 33: Hourly Traffic Variation on Colchester Avenue



5.1.3.2 Complete Street Pilot Project Findings

Findings from the 2010-2011 Complete Street Demonstration Project are presented in a memorandum contained in Appendix B. Traffic and safety data were collected before and during the demonstration project, the public was invited to offer comments by email and phone, and various stakeholders provided feedback through participation in the Colchester Avenue Task Force and Technical Committee. Key findings are summarized below:

- **Traffic Volume Diversion.** One possible outcome of reducing the number of travel lanes could have been a diversion of traffic from Colchester Avenue to other roads such as Riverside Avenue. Traffic volumes did decrease on Colchester Avenue at the start of the demonstration project but quickly returned to their previous levels. Similarly, traffic volumes on Riverside Avenue increased at the start of the demonstration project, but also returned to their previous levels.
- **Vehicle Queues.** During the AM peak hour, observed vehicle queues were similar before and during the demonstration project. During the PM peak hour, queues increased on the Colchester Avenue westbound approaches to Mansfield Avenue and Prospect Street, and along the Colchester Avenue eastbound approach to Mansfield Avenue. Vehicle queues at all other locations either decreased or remained the same.
- **Vehicle Speeds.** A slight, but insignificant, decrease in speeds occurred during the demonstration project.

- **Emergency Services and other Stakeholders.** The Burlington Fire Department had no issues related to access along Colchester Avenue but was concerned about delays caused by vehicle queues, particularly at the Pearl Street approach. The Police Department did not note any significant issues. CATMA (UVM, FAHC, Champlain College and Red Cross) were supportive. CCTA asked for some minor changes, such as relocating stop bars to preserve turning radii for buses, but was otherwise supportive. Local Motion, a local bicycle and pedestrian advocacy organization, was supportive but requested standard 4 foot wide designated bike lanes rather than the 3.5' shoulders provided in the demonstration project.
- **Comments from the General Public.** The vast majority of comments submitted by the general public through e-mail and phone calls were supportive of the demonstration project. The positive comments included: making it easier to walk and bike, the corridor feels safer and less stressful, the dedicated left-turn lanes are efficient, and wider lanes increase visibility. The negative comments included: confusing striping, more congestion and driver aggression, lack of gaps in the traffic stream makes left turns and exiting driveways more difficult, stopped buses cause back-ups, the eastbound bike lane ends before East Avenue, and add more pedestrian crossings to reduce jaywalking.
- **Additional Comments.** Small disturbances in traffic flow—such as buses discharging passengers or right turning vehicles—had noticeable effect on queuing since cars could not bypass slowed or stopped vehicles in the corridor. A substantial number of bicyclists were observed using the new on-road facilities.

5.1.3.3 Costs and Right-of-Way

Order of magnitude costs are $3.8 million and $4.8 million for the Three Lane and Four Lane Options respectively. These estimates do not include the cost to acquire new right-of-way and any major reconstruction of underground stormwater, water and wastewater infrastructure. New right-of-way would be required to accommodate the re-alignment of the South Prospect Street approach to Colchester Avenue, which is a recommended component of both the Three-Lane and Four Lane options. The Three Lane Option would not require acquisition of other right-of-way beyond the Prospect Street intersection. The Four Lane Option would require acquisition of right-of-way generally between the Mary Fletcher Drive and East Avenue intersections on the south side of Colchester Avenue. Most of the required right-of-way on the south side of Colchester Avenue is owned by UVM, Fletcher Allen Health Care or the State of Vermont and could potentially be transferred to the City without significant cost. If other right-of-way is required, the cost of the Four Lane Option could escalate and the timeline for implementation would increase significantly.

5.1.3.4 Tradeoff Summary and Recommendation

The Three Lane Option is recommended by the Colchester Avenue Task Force for the western section of Colchester Avenue. The Three Lane Option is more supportive of and consistent with the corridor plan's vision that Colchester Avenue will evolve into a complete street that promotes safe, comfortable and convenient travel for all users; and must balance mobility of through traffic with access to neighborhoods, local businesses and the institutions. The Three Lane Option may be perceived by motorists as more congested than the Four Lane Option because of longer vehicle queues which will intensify congestion during the busiest hour of the day. However, travel time, arguably the more important measure of mobility for through traffic, will not be significantly

different between the two options. The balance sought in the vision statement is achieved by accepting some increase in congestion for short durations with a roadway design that creates less of a barrier in the neighborhood, improves access and safety for pedestrians and cyclists, and continues to provide access to side streets, adjacent properties and the institutions. Tradeoffs for both options are summarized in Figure 34.

Figure 34: Comparison of Three and Four Lane Options

Issue	3-Lane w/ Advanced Pedestrian Phase	4-Lane w/ Exclusive Pedestrian Phases
Cost (No ROW cost)	Approximately $3.8 million	Approximately $4.7 million
Vehicle Congestion	•Longer vehicle queues during Peak Hours •Travel Time Similar to 4-Lane	•Smaller queues •Travel Time Similar to 3-Lane
Pedestrian Roadway Crossing and Congestion Tradeoff	•Advanced pedestrian phase is safe •Shorter Crossing Distances •Less vehicle/pedestrian conflict points	•Fully protected pedestrian crossing •Longer Crossing Distances
Bicycle Access	•New bike lane	•New bike lane
Vehicle Safety	•Traffic calming = less severe crashes •Less potential for sideswipes •Long queues means more rear ends •Less gaps to exit driveways	•Smaller queues less rear ends •Left turns in through lanes •Potential for sideswipes
Transit Operations	•Pull-offs recommended	•Pull-offs not essential
Emergency Vehicle Operations	•Long queues may cause delays during peak hours	•Less delay
Aesthetics, Community Character, Environment	•Less Pavement/stormwater •Balances arterial and neighborhood street •Roadway feels like less of an barrier	•More Pavement/Stormwater •Feels like an arterial •Creates obstacle •Front yard impacts •Existing Tree Impacts
Right-of-Way	•Pearl/Prospect	•Pearl/Prospect •New ROW required between Mary Fletcher and East Ave

Color Code: Positive Neutral Negative

5.1.4 Other Western Segment Recommendations

- Install no-right turn on red sign facing Mary Fletcher Drive. There are two exiting lanes from Mary Fletcher Drive. Vehicles that turn right-on-red from the right turn lane are not always aware of pedestrians crossing Mary Fletcher Drive. The recommendation will provide a protected crossing for pedestrians. During the summer of 2011, the City installed pedestrian activated "Yield to Pedestrian" signs oriented to the left and right turn movements from Colchester Avenue into Mary Fletcher Drive, which also protect pedestrians but do not address

the specific concern. A pedestrian activated no-right-on red sign should also be installed facing Mary Fletcher Drive.

- Upgrade the existing multi-use path and improve connections at the ends of the path. The existing shared use path is located on the south side of Colchester Avenue and extends from East Avenue to University Place. The path should be upgraded to meet recommended width standards (minimum of 10') and the western end at University Place should be modified to provide a better defined connection to the UVM Green. The eastern end at East Avenue should be modified to provide an easier connection to the southbound bike lane on East Avenue.
- Install a cross-walk and pedestrian signals on the eastbound approach of Colchester Avenue to East Avenue. Cross-walks are currently provided over the Colchester Avenue westbound approach, East Avenue, and Trinity Drive. Many pedestrians crossing Colchester Avenue at this location have destinations that also require crossing East Avenue (assuming they do not jaywalk). A cross-walk on the eastbound Colchester Avenue approach would provide a more direct connection, would eliminate the need to cross East Avenue and may help reduce jaywalking.

5.2 Eastern Section Design Options

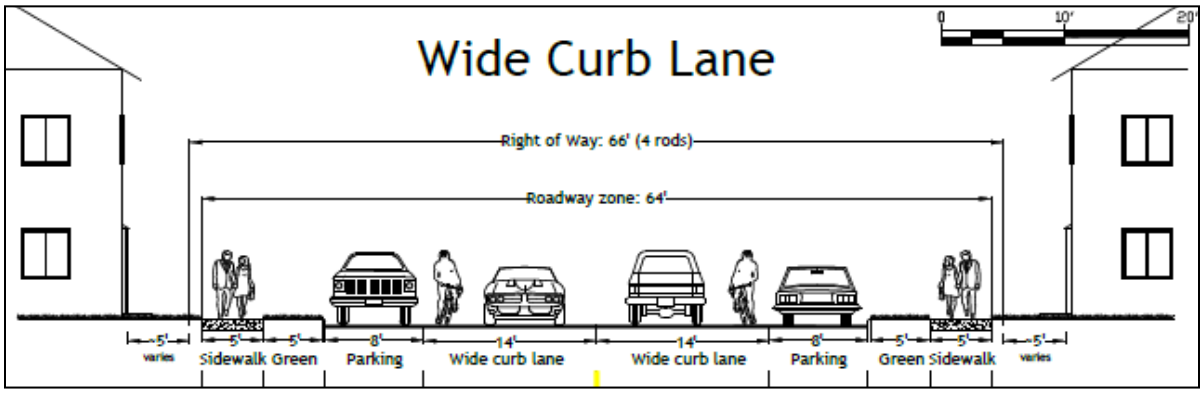
The eastern section of Colchester Avenue is located between East Avenue and the Riverside Avenue-Barrett Street-Mill Street intersection adjacent to the Winooski River. The existing roadway has one travel lane in each direction which is sufficient to accommodate existing and projected traffic volumes. Therefore, unlike the western section, it is not necessary to consider four and three lane options. Another notable difference is that land use adjacent to the eastern segment is less dominated by the institutions and is characterized by housing close to the sidewalks, residential side streets, and small businesses. Thus, challenges along the eastern section of Colchester Avenue include: maintaining intermittent green strip and on-street parking to serve residents and businesses, avoiding encroachment into the front yards of homes and businesses, while also making room for the designated on-road bike lanes, improving landscaping, and providing continuous sidewalks.

5.2.1 Roadway Cross-Sections Options

There is not enough room to provide on-road bike lanes, on-street parking, a green strip and sidewalks along much of the eastern segment without encroaching into front yards, and in some cases, actual buildings. The segment between East Avenue and the top of the hill is most constrained because on-street parking is located on both sides of the street (except in front of the Trinity Campus) and houses are particularly close to the sidewalk.

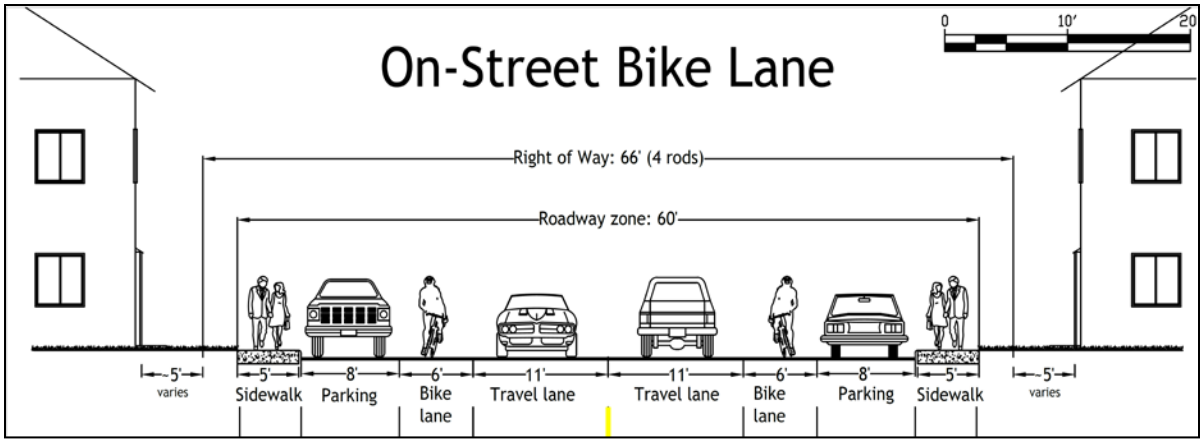
Two basic cross-sections were considered by the Task Force. A wide curb lane could be incorporated to accommodate on-road bicycle travel while also providing on-street parking, green strips and sidewalks (Figure 35). A wide curb lane allows motor vehicles to pass a bike without having to cross the center line. They are used in village or urban settings when there is not enough room for a designated bike lane and are typically marked using a "sharrow". The cross-section fits within the available right-of-way, but some properties would still be affected.

Figure 35: Cross-section with Wide Curb Lane and Green strip



The second cross-section option eliminates part of the green strip, provides on-street parking (at strategic locations) directly adjacent to the curb, and allows room for designated bike lanes on each side of the street (Figure 36 and Figure 37). This cross-section would fit within the available right-of-way and would push the outside edge of sidewalks two to four feet closer to adjacent properties. Smaller sections of green strips could be provided at specific locations to frame the start and end of parking locations and to maintain sight lines at street intersections and some driveways. Because this option would eliminate portions of the continuous green strip, snow removal and storage would require additional operation and management and some additional operational costs.

Figure 36: Cross-section with Bike Lane, On-Street Parking and <u>No</u> Green strip



Between Greenmount Cemetery and Colarco Court, on-street parking would not be provided (consistent with current conditions) and a green strip and bike lane on both sides of the road is possible. Between Colarco Court and Riverside Avenue, the westbound/uphill side could include a sidewalk, curb-side on-street parking and a bike lane; and the eastbound/downhill side would include a sidewalk, green strip and bike lane, but no on-street parking.

Both cross-section options will require the relocation of overhead utilities and associated poles. Both options will also require relocating catch basins and other drainage infrastructure because the curbs will be relocated; which will add substantial time and cost to the project.

In general, the Task Force prefers the cross-section option that provides designated on-street bike lanes because it provides continuity with the bike lanes on the western section and offers a higher level of visibility and safety for cyclists. However, the Task Force also recognizes the challenges associated with reducing the green strip and reducing on-street parking. The tradeoff of between on-street parking and the green strip needs to be addressed during the final design process with input from property owners, businesses and residents that will be directly affected.

Figure 37: Eastern Section Existing and Proposed Cross-Section from East Avenue to approximately Greenmount Cemetery[18]

Existing

With Bike Lane , On-Street Parking, and Intermittent Greenstrip.

5.2.2 University Road/Centennial Field Cross-Walk and Kampus Kitchen

University Road provides access to Centennial Field and is close to the Kampus Kitchen convenience store. A colored cross-walk is located across Colchester Avenue at University Road. People attending events at Centennial Field utilize the cross-walk when walking from parking at the Trinity Campus. Events often occur in the evenings when there is less light. Pedestrian activated in-pavement LED lights and LED pedestrian signs could be installed at this cross-walk to enhance access and safety for pedestrians. As part of the longer term design of this section of Colchester Avenue, the sidewalk and parking adjacent to Kampus Kitchen should be redesigned to improve access for pedestrians, bikes and motor vehicles, while maintaining access for delivery trucks and improving the overall aesthetics of this area.

5.2.3 Chase Street Intersection

Chase Street is used as a cut-through route for traffic between Colchester Avenue and Grove Street (eventually to South Burlington). It intersects Colchester Avenue at an angle that encourages faster speeds for traffic entering from the eastbound/downhill direction. The “throat” of the intersection

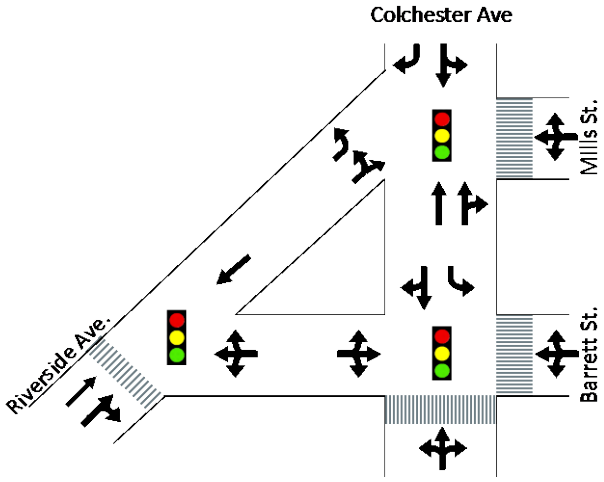
[18] Overhead utilities are not shown in the visualization of proposed cross-section. Cost estimates presented in Chapter 6 do not include underground overhead utilities.

should be reduced to encourage slower speeds. Additional traffic calming measures should be considered along the length of the street such as speed tables, curb-extensions, and medians to encourage slower speeds and discourage through traffic. Tradeoffs need to be carefully evaluated with input from residents when developing a traffic calming plan for a specific street. The City's Traffic Calming and Neighborhood Enhancement Program[19] defines the process for identifying the issues, developing a plan, seeking input from residents and then seeking assistance from the Department of Public Works to implement the recommendations. The effort is spearheaded by a working group of neighbors who must then seek support from 60% of the street's other residents before the City will implement the recommendations. A cross-walk over Colchester Avenue should be provided from Chase Street to the opposite side of the road. Currently, there is a gap in the sidewalk network along the Greenmount Cemetery. In the short-term, the cross-walk would provide access to the sidewalk on the west side of Colchester Avenue. In the long-term, even after the sidewalk along the cemetery is complete, the cross-walk would provide access to the proposed bus shelter (See section 5.3).

5.2.4 Riverside Avenue-Barrett Street-Mill Street Intersection

This location consists of three closely spaced signalized intersections that form a triangle at the eastern end of the Colchester Avenue (Figure 38). The area is identified as a high crash location. The configuration creates multiple conflict points and is inefficient. Long vehicle queues are common on the Colchester Avenue eastbound (towards Winooski) approach to Barrett Street which can spill back a significant distance up the hill. There is not enough room on the short section of Barrett Street between Riverside Avenue and Colchester Avenue to store vehicles that back-up while waiting at the traffic signals at each end. The complex of intersections requires pedestrians to cross several streets but lacks pedestrian signals. The multiple conflict points and associated turning vehicles also reduce access and safety for cyclists.

Figure 38: Riverside Ave-Barrett St-Mill St Existing Configuration



To address the safety, congestion, pedestrian and bicycle issues, the complex of intersections should be simplified by eliminating two legs of the triangle, and consolidating all of the major movements into one signalized intersection between Colchester Avenue, Riverside Avenue and Barrett Street (Figure 39). 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.

[19] http://www.dpw.ci.burlington.vt.us/transportation/neighborhoods/

Figure 39: Riverside Ave-Barrett St.-Mill St. Proposed Consolidation and Lane Configuration

Relative to traffic congestion, consolidating the intersections will reduce delays for all traffic on Colchester Avenue, Riverside Avenue and Barrett Street while also providing an exclusive pedestrian phase (Table 11 and Table 12). The proposed design provides two lanes on the Colchester Avenue eastbound approach to Barrett Street thus significantly reducing the vehicle queue that currently spills back up the hill from this intersection. The average wait time during the peak hour for vehicles exiting from Mill Street is projected to increase from 40 seconds with the current traffic signal to 46 seconds assuming the traffic signal is eliminated as part of consolidating the intersections. Vehicles will spill back from the traffic signal at Colchester- Riverside-Barrett and will block access to and from Mill Street for about half the time during the PM peak hour. Blocking will primarily affect cars turning left from Mill Street, about 30 vehicles during the PM peak hour.

Table 11: 2030 PM LOS for Colchester Avenue-Riverside-Barrett-Mill Intersections with Current Configuration

Performance Measure	Colchester - Barrett	Riverside-Barrett	Colchester-Riverside-Mill
Average Intersection LOS	E	D	B
Average Intersection Delay	58	46	12
Worst Approach LOS	F [1]	E [2]	D [3]
Worst Approach Delay	237	63	40

1. Worst approach is Barrett Street
2. Worst approach is the Colchester Avenue northbound (towards Winooski) approach
3. Worst approach is Mill Street

Table 12: 2030 PM LOS for Proposed Colchester Avenue-Riverside-Barrett-Mill Intersections with Exclusive Pedestrian Phasing

Performance Measure	Colchester - Barrett-Riverside[1]	Colchester-Mill[2]
Average Intersection LOS Average Intersection Delay	D 45	Not Applicable
Worst Approach LOS Worst Approach Delay	E [3] 65	E [4] 46

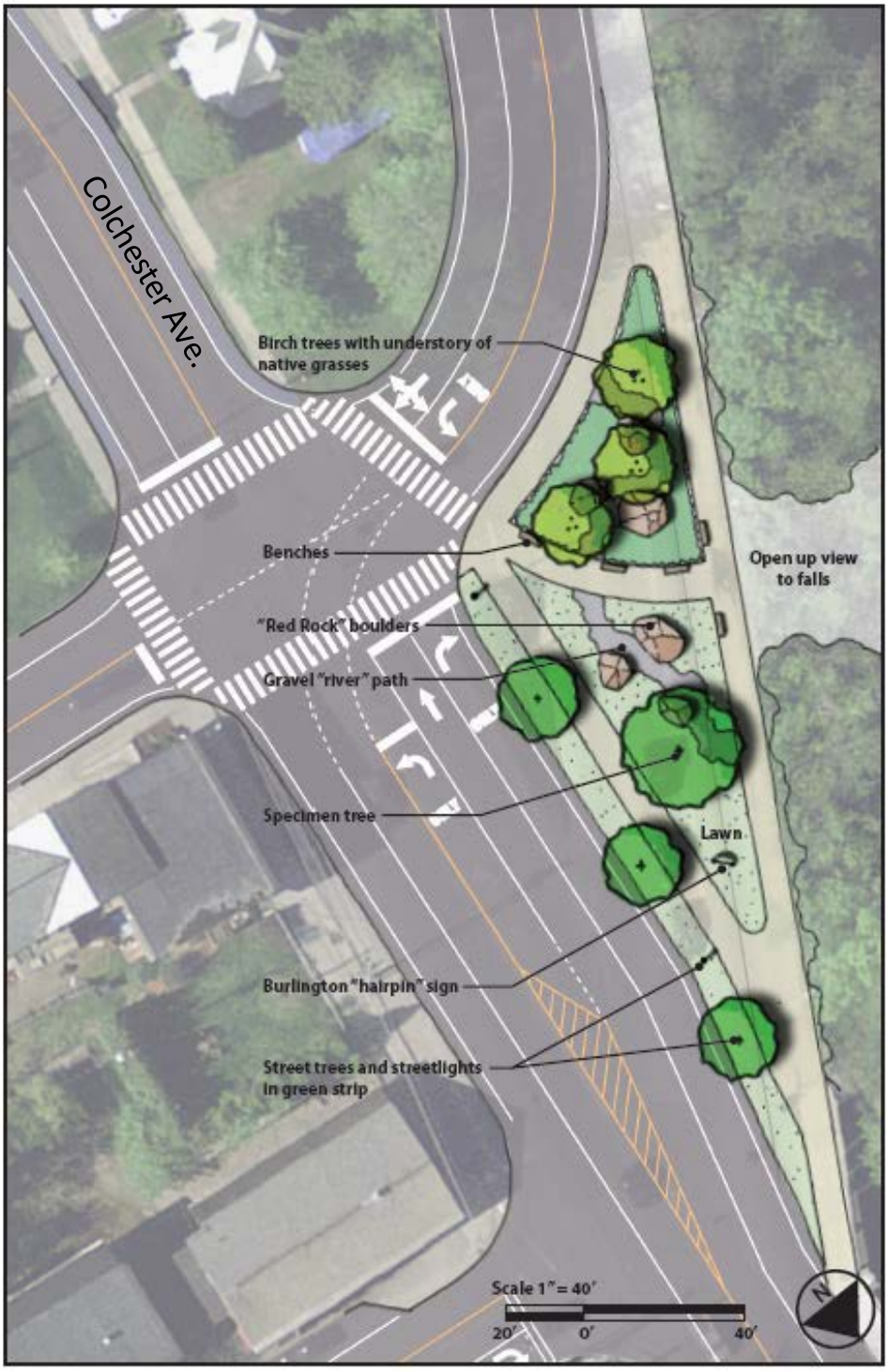
1. Traffic signal
2. Stop-controlled
3. Worst approach is Riverside Avenue
4. Worst approach is Mill Street

Consolidating the intersection would create an opportunity to enhance this gateway location .The leg of Riverside Avenue that currently intersects with Mill Street would be eliminated and could be replaced by landscaping and other design features that take advantage of its proximity to the Winooski River and location at the end of the Riverside Avenue multi-use path and linear greenway (Figure 40).

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. Issues to be addressed include:

- Grading of the Riverside Avenue approach to Colchester Avenue. There is a difference in elevation between Riverside Avenue and Colchester Avenue that will require raising the grade of Riverside Avenue some distance west of the intersection. Retaining walls may also be necessary in some locations.
- Loading zone. There is a curb-side loading zone on the east side of Colchester Avenue between Barrett and Mill Streets that serves existing businesses. The loading zone may have to be redesigned or eliminated to accommodate the two through lanes. It may be possible to maintain a loading zone in that area by reducing the sidewalk and/or lane widths, or by relocating the loading zone to Barrett and/or Mill Streets. This issue will need to be addressed during design and by working with the business owners.
- Connection to a future bicycle/pedestrian crossing of the Winooski River. There has been a long standing desire to find a suitable location for an improved bicycle and pedestrian crossing of the Winooski River. The final design for the intersection, including the plan for the landscaped gateway area, should be coordinated with the latest plans for the crossing.

Figure 40: Colchester Ave-Riverside Ave.-Barrett St.-Mill St. Gateway Enhancement Concept



5.3 General Transit Recommendations

- Consolidate transit services. Transit in the corridor is provided by several different operators including CCTA, CATMA, FAHC, UVM and Champlain College. Where practical, transit service should be consolidated to 1) reduce the number of buses and shuttles traveling in the corridor and the related effects to traffic flow, 2) increase overall efficiency and utilization of each bus, and 3) improve service and attract more passengers. Consolidating transit services will be challenging because each of the operating agencies have designed their routes and schedules to meet the specific needs of their passengers which range from the general public with multiple origins and destinations, employees shuttled between intercept parking facilities and their place of work, and students traveling between off and on-campus housing and classes. Funding is another challenge that would need to be addressed.
- Potential bus stop locations. Bus stop locations are important because transit riders are one of the users that should be served by a complete street and they connect pedestrians and cyclists to the transit system. The location and access to bus stops will also affect traffic operations when buses stop to drop-off and pick-up passengers and when they re-enter the traffic stream. To maintain access to bus service while also minimizing the effect on traffic flows, bus stops have been consolidated to some extent and recommended locations for the western Colchester Avenue segment are shown in Figure 41 and for the eastern segment in Figure 42.

  New shelters are recommended at the busiest pick-up locations based on CCTA boarding and alighting data. Along the western section, pull-offs are recommended for four new shelter locations because buses will be stopped for longer periods of time while picking up passengers (it takes longer to pick-up passengers because they are paying a fare and need to find a seat). A pull-off is also recommended for the existing bus stop and shelter on the Pearl Street approach to the Prospect Street-Colchester Avenue intersection to help minimize impacts to existing traffic flow issues at that location. Pull-offs are not recommended at stops along the western section where most passengers are being dropped off because this type of stop takes less time. There are no pull-offs recommended for the eastern section because there are less boardings and less traffic. New shelters and pull-offs are recommended at the Mary Fletcher Drive intersection and assume that the CCTA Essex Route will remain on Colchester Avenue rather than diverting to the main MCHV entrance on Beaumont Avenue.

Figure 41: Proposed Bus Stops and Pull-offs Western Section

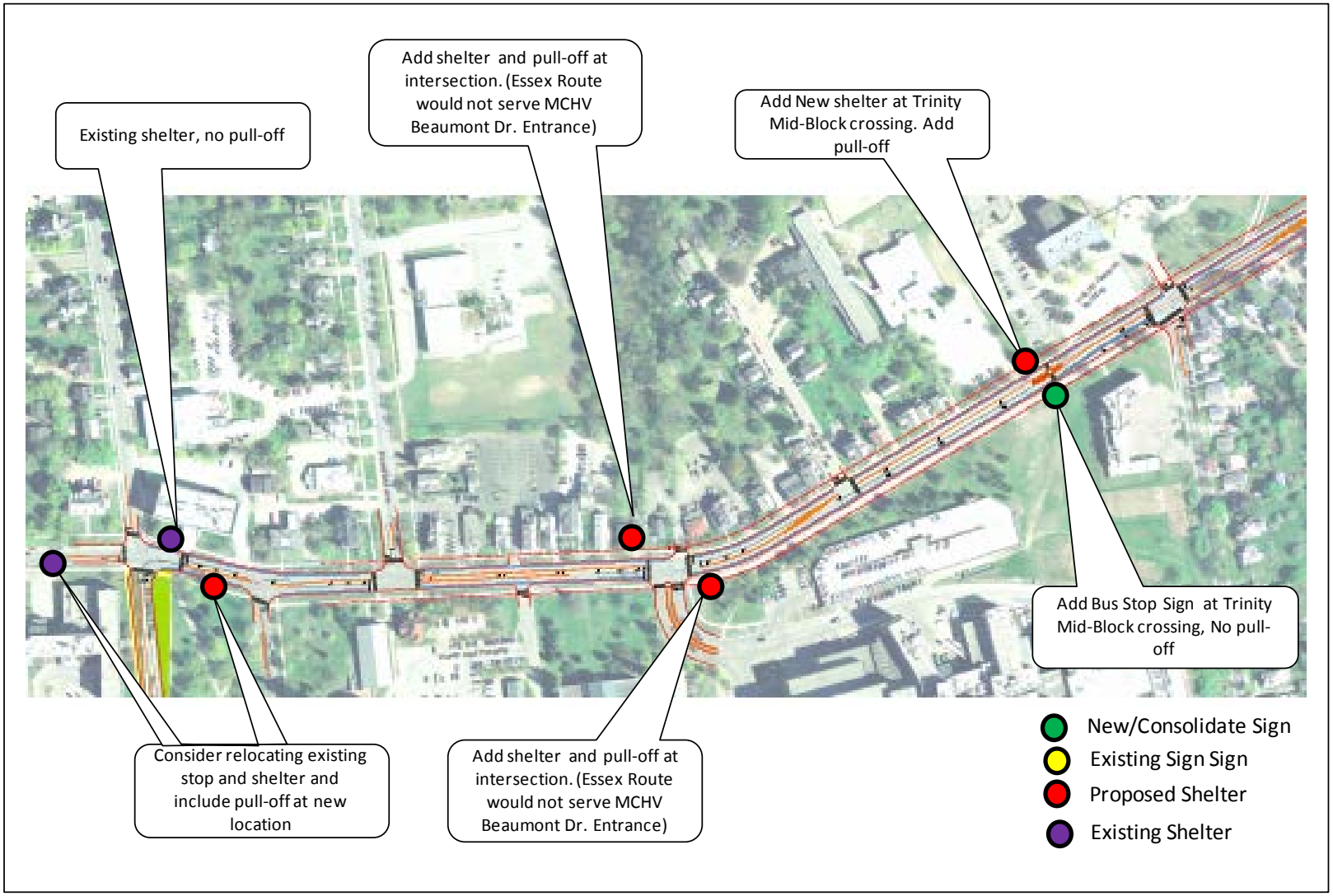
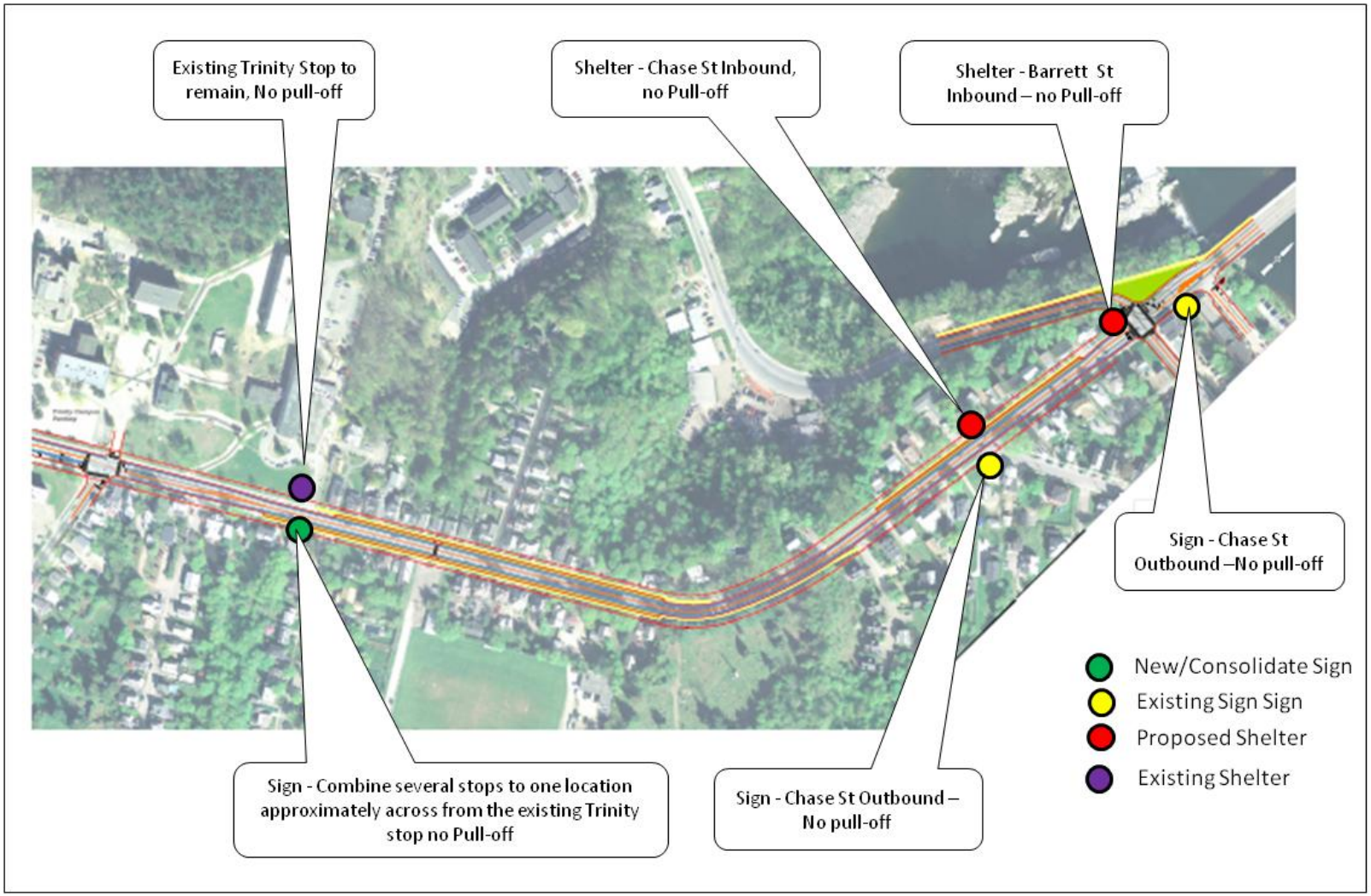


Figure 42: Proposed Bus Stops Eastern Section



5.4 Operations and Maintenance Recommendations

The following recommendations are more general in nature and typically apply to the entire corridor.

- Change speed limit to 25 miles per hour. The existing speed limit is posted at 30 miles per hour. Data collected before and during the complete street demonstration project indicate that the 85th percentile speed of cars traveling on Colchester Avenue ranges between 32 and 34 mph, depending on direction. The 85th percentile speed reflects the speed motorists perceive as safe and reasonable for roadway conditions. It is a key factor when traffic engineers recommend a posted speed limit. It does not however account for the perceptions of pedestrians, cyclists and other roadway users. A 25 mph posted speed limit is reasonable to enhance safety for pedestrians crossing the road, cyclists traveling along the road, and will make it easier for cars exiting driveways and stop-sign controlled side streets to enter the traffic stream.
- Continue to review and optimize traffic signals. Traffic flow on urban arterials is affected most by the operation of traffic signals. This dynamic is evident along the section of Colchester Avenue between East Avenue and Prospect Street which is controlled and greatly affected by its closely spaced traffic signals. The value of traffic signal operations was demonstrated by adjustments made during the complete street demonstration project which helped reduce queues and delay. Because the three lane option decreases the number of through lanes, it will be even more important to maintain efficient and optimized traffic signal timing plans, and to ensure that all traffic signal components are functioning properly.
    - Transit Signal Priority. Transit signal priority reduces delays for buses traveling along a roadway by ensuring that they receive a green light as they approach a traffic signal. The system uses transmitters on buses and receivers on traffic signals. This technology would help reduce travel time for buses, as well as all vehicles traveling through Colchester Avenue. The tradeoff is longer wait times for vehicles exiting or entering side streets, and potentially longer waits for pedestrians. Transit signal priority should be considered carefully and balanced with the other goals of the corridor. It could be used in off-peak periods to minimize impacts to pedestrians and side street traffic, or deployed throughout all hours of transit operation.
- Prune trees and other brush on a regular basis. The primary purpose of this recommendation is to maintain sight distances at intersections and driveways. Pruning trees and other vegetation also helps keep sidewalks open.
- Encourage the City of South Burlington ambulance to access MCHV using Beaumont Drive. The South Burlington ambulance currently accesses MCHV via Mary Fletcher Drive by using East Avenue and Colchester Avenue.
- Clear snow banks from bus stops. Access to bus service is restricted during the winter months due to snow banks. Removing snow will require more time and handwork and is probably not possible for City maintenance crews that are busy clearing roads and sidewalks. This issue may best be addressed by neighbors or volunteer groups.

6. IMPLEMENTATION PLAN

This section provides an overview of corridor recommendations and implementation steps common for transportation projects as well as typical funding sources. The implementation plan summarized in Section 6.3 includes: a recommendation description, timeline for when a project or service should be implemented, an order of magnitude cost estimate, potential funding sources, the project leader, other partners that will participate or support the project leader, and recommended next steps.

6.1 Plan Costs

The estimated cost of all short, medium and long term recommendations is approximately $11.5 million dollars (Table 13), excluding right-of-way acquisition and major reconstruction of underground stormwater, water and wastewater infrastructure. The costs can be organized into the following categories:

- **Rehabilitation:** These costs would have to be expended whether or not the complete street vision is pursued. Examples include reconstructing sidewalks and curbs to address drainage issues, new signs, traffic signal optimization and repaving.
- **Functional:** This category includes recommendations that improve safety; add capacity for pedestrians, cyclists, buses and/or personal vehicles; or otherwise improve conditions beyond the existing system. Examples include reconstruction of the major intersections along Colchester Avenue, the bike lanes, new bus shelters, and the mid-block pedestrian crossing.
- **Enhancement:** This category includes recommendations that enhance community character and aesthetics. Examples include pedestrian scale decorative street lights, street trees and street furniture.

Table 13: Estimated Plan Costs

Time Frame	Project Category			Total Capital Cost [1]
	Rehabilitation	*Functional*	*Enhancement*	
One Year	$ -	$ 50,000	$ -	$ 50,000
1-5 Years	$ 1,200,000	$ 1,800,000	$ 400,000	$ 3,400,000
5-10 Years	$ 2,200,000	$ 2,600,000	$ 500,000	$ 5,300,000
More than 10 Years	$ 2,000,000	$ 300,000	$ 500,000	$ 2,800,000
Total	**$ 5,400,000**	**$ 4,750,000**	**$ 1,400,000**	**$ 11,550,000**

1. Does not include ROW acquisition or complete rehabilitation of underground utilities

6.2 Implementation Overview and Funding Sources

The design recommendations presented in this plan were developed at a conceptual level and will require additional engineering, design and public input before they are ready for construction. A project's funding source will affect the process requirements and timelines. Recommendations that have little or no footprint impact (like optimizing traffic signals, adding cross-walks, or installing signs) and that are paid for with local or private funds can be implemented in a short time frame

assuming the funds are available, and it is not necessary to acquire right-of-way. Projects that use federal and state funds need to follow the VTrans project development process, which includes development of a purpose and need statement, evaluation of alternatives, selection of a locally preferred alternative, and a public input process. Following approval of the locally preferred alternative, a project would then move through various design phases, providing the environmental documentation required by the National Environmental Policy Act (NEPA), acquiring other local and state permits, and right-of-way acquisition if necessary.

6.2.1 Federal and State Transportation Funds

Federal transportation funds are provided through several standard programs and typically require a non-federal match. The match is most often covered with state funds (approved by the Legislature) and local funds (in municipal capital budgets approved by the voters). Non-federal match could also be provided from private sector partners. All projects or services in Chittenden County that use federal funds must be included on the CCMPO's Transportation Improvement Program (TIP).[20] Federal/state programs that may fund some portion of the recommendations include the following:

- ***Surface Transportation Program/VTrans Capital Program*** – Projects on the Federal-aid highway system can be funded through the Surface Transportation Program. STP funds have the most flexible uses of any federal transportation funds and may be used for highway, transit, park and ride lot, and non-motorized facility construction and improvements. STP funds are distributed to a variety of transportation programs. The non-federal match is 20%. For projects that are completely on the state system, the state covers the 20% match. When local roads or bridges are involved (Colchester Avenue is a local road), a non-federal match of 10%–20% may be required depending on the classification of the highways involved and other factors. Projects using STP funds must be on the CCMPO TIP and included in a state's Transportation Capital Program approved by the Legislature.
- ***Transportation Enhancement Program*** – Transportation enhancements include several types of projects, such as bicycle and pedestrian facilities; landscaping and other scenic beautification projects; and rehabilitation of historic transportation buildings, structures, and facilities.[21] This competitive grant program provides a maximum of 80% federal funds with the non-federal match often funded by the applicant.
- ***Bicycle and Pedestrian Program*** – This competitive grant program is similar to the transportation enhancement program and could be used to fund specific bicycle and pedestrian facility improvements identified for implementation in the short- and medium-term.
- ***Safety Program*** - The goal of the Highway Safety Improvement Program (HSIP) is to enhance safety on all Vermont roads. It specifically addresses safety issues at high crash or high crash potential locations in the state. The HSIP is eligible for federal funding which may include a variety of sources including 164 Penalty and 148 Safety Funds. Identified High Crash Locations

[20] The TIP identifies federally funded, multimodal transportation projects and operations in the CCMPO region. It authorizes the implementing agency (e.g., Vermont Agency of Transportation, CCTA) to obligate federal funds for listed projects and operations over the next four federal fiscal years. See http://www.ccmpo.org/TIP/ for additional information.

[21] Visit the VTrans transportation enhancement website for a complete listing of eligible activities. http://www.aot.state.vt.us/progdev/Sections/LTF/Enhancements%20Program/EnhancementsHomePage.htm

(HCLs/roadway sections and intersections) are eligible for HSIP funds depending on priority level and funding availability.

- ***Congestion Mitigation and Air Quality*** – VTrans uses its CMAQ funds to support public transit, medical transportation as well as other programs. These funds have a three year time limit for specific projects and could be applied toward capital or operational costs for initiating transit recommendations in the plan.

6.2.2 Local Funds

Local funds can be used to match federal or state funded projects or to pay for the complete cost of a project. Projects funded by municipalities are included in its capital program. Property taxes are the primary source of local funds, but other sources, such as impact fees, can be used to help pay for transportation projects.

- ***Traffic Impact Fees*** – Burlington has established impact fees that are used to fund a list of projects identified in its capital improvement plans. Through impact fees, new developments pay a "fair-share" of the costs related to updating and improving infrastructure based on the amount of "impact" the development would have on that infrastructure.
- ***Municipal Bonds*** – Some municipalities choose to use municipal bonds to fund large infrastructure projects, such as reconstruction of Colchester Avenue. Local governments have several options available to raise revenue for paying back a bond. The most common options include property taxes, special assessment tax districts, impact fees and local options sales taxes. Careful review of the advantages of each method, including reliable estimates on how these options affect local tax rates, is necessary before selecting an appropriate funding mechanism.

6.2.3 Private Funds and Other Contributions

Developers, institutions such as the University of Vermont and Fletcher Allen Health Care, or any entity that is seeking to develop or redevelop land, are charged impact fees and often pay for and implement additional modifications to the transportation system. Private participation in transportation projects also occurs through public-private partnerships outside of the development review process. The contribution could be financial or may include donation of land to support a specific project. The Institutions have a history of contributing towards the costs of transportation projects such as the reconstruction of Main Street and the South End Transit Center.

6.3 Implementation Table

The implementation table (Table 14) includes the following components:

- **Category:** Describes the general type of project.
- **Location:** Identifies the specific or general location of a recommendation.
- **Description:** Brief description of the recommendation. Refer to the discussion above for additional information.
- **Timeline:** Provides an approximate time frame when a recommendation could be constructed or put into service. The timing considers the effort necessary for engineering, public outreach,

right-of-way acquisition, environmental documentation and other permitting, and construction requirements.

- **Order of Magnitude Cost Estimates**: Cost estimates for recommendations from other studies and plans have been used when available. Cost estimates for other projects are based on unit costs applied to approximate quantities of construction items, plus percentage allowances for right-of-way acquisition (15%–20% depending on location), traffic control during construction (10%–40%), storm water management and drainage (maximum of 30%), engineering design and permitting (25%), and a 25% contingency. Detailed cost estimates are provided in Appendix E.
- **Potential Funding Sources**: Identifies if the recommendation can utilize the local, state or private funds described above, or some combination thereof.
- **Project Lead:** The project lead will champion the effort to implement the project. In most cases, the municipality will lead the effort to keep a project on the front burner and moving forward. Specific departments within the municipality, often planning or public works, will play the leading role.
- **Partners:** Identifies other agencies, institutions, and public or private sector organizations that will support implementation of a project. These organizations may provide oversight and review functions (e.g., VTrans), technical assistance and programming of funds (e.g., CCMPO, VTrans), financial and implementation assistance (e.g., CATMA, private developers), or assistance with public outreach and support (e.g., Local Motion).
- **Next Steps**: These are the first steps or actions that should be initiated by the project leaders to move a specific recommendation forward.

The recommendations are generally organized into the following geographic sections: Corridor-wide; Western Section- Prospect Street to East Avenue; Eastern Section - East Avenue to Riverside.

Table 14: Colchester Avenue Corridor Recommendations

Recommendation Description			Time Frame				Funding		Project Lead	Potential Partners	Next Steps & Comments	Comments
Category	*Location*	*Description*	*1 Year*	*5 Years*	*10 Years*	*More Than 10 Years*	*Cost*	*Potential Sources*				
Operations and Maintenance	Corridor-wide	Prune trees on a regular basis to maintain adequate sight lines	X	→	→	→	Minor	Annual City Budget	Parks and Recreation	None	P&R to review site conditions and prune trees as necessary	
Operations and Maintenance	Corridor-wide	City of South Burlington Ambulance should use Beaumont to access the hospital	X				Not Applicable	Not Applicable	CATMA, FAHC	City of South Burlington	CATMA and FAHC to continue working with South Burlington	
Operations and Maintenance	Corridor-wide	Clear snow banks from bus stops	X	→	→	→	Minor	Not Applicable	DPW	City, DPW, UVM, Ward 1 NPA	Review and revise policy as necessary	Investigate possibility for college students to provide community service – UVM Shovel Brigade
Operations and Maintenance	Corridor-wide	Change speed limit to 25 mph	X				1,000	Not Applicable	DPW	Not Applicable	Public Works Commission vote to approve speed limit change	Recommended city-wide in Burlington Transportation Plan
Traffic Signals and Intersections	Corridor-wide	Continue to review and optimize traffic signals	X	→	→	→	$5,000 annual	Annual City Budget	DPW	CCMPO		
Transit	Corridor-wide	Coordinate and consolidate where feasible transit and shuttle operations through the corridor	X	X			$20,000	CCMPO	CATMA	CCTA, DPW, CCMPO	Develop a consolidated transit operations plan	
Transit	Corridor-wide	Provide new bus shelters, and eliminate other bus stops		X			$220,000	Federal, State	CCTA	DPW, CATMA		Plan proposes 5 new bus shelters
Transit Signal Priority	Corridor-wide	Install equipment that changes traffic signals in real time to provide green lights for buses		X			$70,000	Federal, State	CCTA	City, CATMA	Evaluate effects on traffic and pedestrian access	Cost assumes equipment required for seven existing traffic signals

Recommendation Description			Time Frame				Funding		Project Lead	Potential Partners	Next Steps & Comments	Comments
Category	*Location*	*Description*	*1 Year*	*5 Years*	*10 Years*	*More Than 10 Years*	*Cost*	*Potential Sources*				
Roadway	Prospect to East Avenue	Make the complete street demonstration project roadway layout permanent	X				$10,000	Not Applicable	DPW	Public Works Commission & TEUC	Make final decision	Incorporate minor modification requested by stakeholders (See Appendix B)
Sidewalks, Bike and Pedestrian Facilities	Prospect Street to East Avenue	Reconstruct existing sidewalks and curbs and fix surface related drainage problems, maintain 3 lane cross-section, restore green strip and include new lighting.		X			$1.6 Million	Federal, State, City Sidewalk Capital Program	DPW & BED	Institutions		Curbs remain in same location. Does not include rehabilitation of drainage and other underground utilities.
Roadway	Prospect Street to East Avenue	Full implementation of the three Lane Option. Includes upgrading underground stormwater and other utilities.				X	$2.8 million	Federal, State, City, Institutions	DPW	CCMPO, VTrans, Institutions	Conduct Scoping Study to refine design and prepare for final design	Does not include intersections
Sidewalks, Bike and Ped Facilities	Trinity to FAHC	Provide mid-block pedestrian crossing		X			$110,000	Institutions, Federal, State, City	DPW	UVM, FAHC	Conduct Scoping Study to identify location and refine design	
Traffic Signals and Intersections	Prospect Street Intersection	Reconstruct to align South and North Prospect Street approaches		X			$980,000	Federal, State, City	DPW	CCMPO, VTrans, Institutions	Conduct Scoping Study to refine design and prepare for final design	
Traffic Signals and Intersections	University Place Intersection	**Phase I** - Limit access to right-in / right-out	X				$1,000	City	DPW	UVM	Public Works Commission approval	Requires ordinance to restrict movement
Traffic Signals and Intersections	University Place Intersection	**Phase II** – Following results of further evaluation, close University Place to through traffic.		X			$50,000	UVM	UVM	DPW, UVM	Conduct study to evaluate the road closure	

Recommendation Description			Time Frame				Funding		Project Lead	Potential Partners	Next Steps & Comments	Comments
Category	*Location*	*Description*	*1 Year*	*5 Years*	*10 Years*	*More Than 10 Years*	*Cost*	*Potential Sources*				
Traffic Signals and Intersections	Mary Fletcher Drive	**Phase I:** Prohibit Right-turns-on-red for traffic exiting Mary Fletcher Drive. Install static "No Right Turn on Red" sign.	X				$1,000	City	DPW	FAHC	Install static sign	
Traffic Signals and Intersections	Mary Fletcher Drive	**Phase II:** Install pedestrian actuated "No Right Turn on Red" sign for traffic exiting Mary Fletcher Drive		X			$10,000	City	DPW	FAHC	Purchase and install equipment	
Sidewalks, Bike and Ped Facilities	Multi-use Path: at East Avenue	Improve connection between multi-use path on Colchester Ave and bike lane on East Avenue	X				$10,000	City	DPW	None	Prepare design and construct	
Sidewalks, Bike and Ped Facilities	Multi-use Path: at University Place	Improve connection from the multi-use path to Mansfield and across University Place to the UVM Green		X			$10,000	City, UVM	DPW	UVM	Prepare design and construct	Coordinate with UVM multi-use path planning
Traffic Signals and Intersections	East Avenue Intersection	Install cross-walk and pedestrian signal equipment on the eastbound approach of Colchester Avenue to East Avenue		X			$10,000	City	DPW	UVM	Purchase and install equipment	
Traffic Signals and Intersections	East Avenue Intersection	Re-align East Ave to the west approach and lengthen right-turn lane			X		$660,000	Federal, State, City, Private	DPW	CCMPO, VTrans, UVM	Incorporate into site planning for Trinity Campus	Includes new traffic signal equipment. Assumes donated ROW
Sidewalks, Bike and Ped Facilities	Greenmount Cemetery to Colarco Ct.	Construct Sidewalk		X			$110,000	Federal, State and City	DPW	None	Design in 2011	
Roadway	East Avenue	Long term full			X		$3.2 million	Federal,	DPW	CCMPO, VTrans	Determine the	Requires relocating

Recommendation Description			Time Frame				Funding		Project Lead	Potential Partners	Next Steps & Comments	Comments
Category	*Location*	*Description*	*1 Year*	*5 Years*	*10 Years*	*More Than 10 Years*	*Cost*	*Potential Sources*				
	to Riverside	reconstruction with bike lane, on-street parking, green strip bulbouts, street trees, lighting, etc. and underground stormwater and other utilities.						State, City			number of required on-street parking spaces. Conduct Scoping Study to refine design and prepare for final design.	overhead and underground utilities. Cost does not include Riverside-Barrett-Mill St intersection.
Lines/Signs	University Road	Upgrade cross-walk		X			$60,000	Federal, State, City	DPW		Include in DPW capital program	
Sidewalks, Bike and Ped Facilities	Kampus Kitchen	Enhance access by improvements to parking and sidewalk		X			$50,000	City, Private	DPW		Prepare design alternatives. Need to work with business owner.	Use bulbouts and on-street parking.
Roadway	Chase Street	Narrow Chase Entrance to slow traffic; Install traffic calming devices		X			$20,000	City	Residents`	DPW	Residents should form working committee	
Traffic Signals and Intersections	Riverside-Barrett-Mill St.	Reconstruct to create one signalized intersection at Riverside-Barrett			X		$1.4 million	Federal, State, City	DPW	CCMPO, VTrans	Conduct Scoping Study to refine design and prepare for final design	

7. SUMMARY

This document presents a transportation plan for Colchester Avenue located in Burlington, Vermont. The plan envisions the evolution of Colchester Avenue into a "Complete Street" that promotes safe, comfortable, and convenient travel for all users, balances mobility for through traffic with access to the adjacent neighborhoods, and improves livability. The corridor plan evaluates existing and future conditions, articulates the vision and goals, develops and compares design options and other recommendations, and includes an implementation plan. It presents a comprehensive and coordinated list of bicycle, pedestrian, transit and roadway facility recommendations that taken together will achieve the corridor vision.