Exit 17 Growth Center Transportation Study

Colchester, VT

October 2006
Final Report

Chittenden County Metropolitan Planning Organization

Communities working together to meet Chittenden County's transportation needs

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TABLE OF CONTENTS

EXECUTIVE SUMMARY 1
EXISTING TRANSPORTATION SYSTEM CHARACTERISTICS AND PERFORMANCE 1
FUTURE CONDITIONS 2
ALTERNATIVES ANALYSIS 3
PHASING PLAN 4
RECOMMENDATION 6
INTRODUCTION 1
STUDY AREA OVERVIEW 2
SUMMARY OF PREVIOUS TRANSPORTATION STUDIES AND PLANS 3
PART I: EXISTING CONDITIONS 6
TRANSPORTATION SYSTEM CHARACTERISTICS 6
TRAVEL DEMAND 16
EXISTING SYSTEM PERFORMANCE 24
NATURAL AND CULTURAL RESOURCES 32
EXISTING CONDITIONS SUMMARY 35
PART II: FUTURE CONDITIONS 38
EXISTING LAND USE CHARACTERISTICS 38
FUTURE LAND USE SCENARIOS 39
2025 TRAFFIC VOLUMES 44
EFFECT OF THE CIRCUMFERENTIAL HIGHWAY AND MILTON INTERCHANGE 50
LEVEL OF SERVICE RESULTS 50
FUTURE CONDITIONS SUMMARY 55
PART III: ALTERNATIVES ANALYSIS 64
EXIT 17 RAMPS/CHIMNEY CORNERS 66
ISOLATED INTERSECTION ALTERNATIVES 83
ROADWAY CROSS-SECTIONS 89
ALTERNATIVES ANALYSIS SUMMARY 90
PART IV: PHASING PLAN AND FUNDING OPTIONS 92
PHASING PLAN 92
FUNDING OPTIONS 95
RECOMMENDATION 96
SUMMARY 97

APPENDICES

Appendix A: Volumes

Appendix B: Level of Service Worksheets

Appendix C: Crash Data

Appendix D: Concept Plans

Appendix E: Phasing Schematics

TABLES

Table E- 1: Phasing Plan E-5

Table 1: Roadway Design Standards 7

Table 2. VTrans Access Management Categories 10

Table 3: Roadway Characteristics by Section 12

Table 4: Study Intersection Characteristics 13

Table 5: Population Growth in Proximity to Study Area 20

Table 6: 2000 Census Journey to Work Data for Milton, VT 21

Table 7: 2000 Census Journey to Work Data for Grand Isle County, VT 22

Table 8: Intersection Traffic Count Dates 24

Table 9: LOS Criteria for Intersections 26

Table 10: LOS Results for 2005 and 2025 AM Peak Hours 28

Table 11: Queuing Analysis Results for AM and PM 2005 and 2025 Peak Hours 29

Table 12: Description of General Land Use Categories 38

Table 13: Land Use Scenario Options 43

Table 14: Development Potential by Scenario Option- Entire Study Area 43

Table 15: Phase 1 Land Use Scenario by TAZ 44

Table 16: Phase 2 Land Use Scenario by TAZ 44

Table 17: Background Traffic Growth Rate 45

Table 18: ITE Residential Average Trip Generation Rates – Peak Hour of Adjacent Street Traffic 45

Table 19: ITE Office and Specialty Retail Average Trip Generation Rates - Peak Hour of Adjacent Street Traffic 46

Table 20: Total Study Area Trip Generation for Phase 1 and Phase 2 Land Use 46

Table 21: Phase 1 Land Use AM Peak Hour Trip Generation 47
Table 22: Phase 1 Land Use PM Peak Hour Trip Generation 47
Table 23: Phase 2 Land Use AM Peak Hour Trip Generation 47
Table 24: Phase 2 Land Use PM Peak Hour Trip Generation 48
Table 25: ITE Multi-Use Internal Capture Rates – PM Peak Hour 49
Table 26: Origin-Destination of Trips Generated by Phase 1 and Phase 2 Land Use Scenarios 49
Table 27: Effect of Land Use Scenarios and Circ/Milton Exit on Traffic Volumes 50
Table 28: AM Peak Hour LOS Results 53
Table 29: PM Peak Hour LOS Results 54
Table 30: Effect of Circ. Highway with and without Milton Interchange – 2025 PM Phase 2 Land Use ..55
Table 31: Differences between Roundabouts and Rotaries 70
Table 32: Advantages and Disadvantages of Traffic Signals and Roundabouts 70
Table 33: 2025 Projected Vehicles Queues on US 2 Between Northbound Ramps and US 7 71
Table 34: LOS Criteria for Intersections 79
Table 35: 2025 PM Peak Hour I-89 Exit 17 Interchange Level of Service 81
Table 36: I-89 Exit 17 Interchange Evaluation Matrix 82
Table 37: 2025 PM Peak LOS for US 2-Jasper Mine Road Alternatives 83
Table 38: US 2-Jasper Mine Road Alternatives Evaluation Matrix 84
Table 39: US 7-Arbor Gardens 2025 PM Peak Hour Conditions 85
Table 40: US 7-Brentwood Drive 2025 PM Peak Hour Conditions 86
Table 41: US 7-Brentwood Drive Alternatives Evaluation Matrix 87
Table 42: Road Section Cost Estimates 89
Table 43: Exit 17 Phasing Plan 93
Table 44: Costs and Alternatives 94

FIGURES

Figure 1: Study Area 2
Figure 2: Conceptual Roadway Functional Hierarchy 6
Figure 3: Road Functional Class 8

Figure 4: Study Area Access Management Categories 11

Figure 5: Jasper Mine Road-US 2 Jughandle 13

Figure 6: Bicycle and Pedestrian Facilities in the Study Area 15

Figure 7: AADT in Study Area 17

Figure 8: Bi-Directional Traffic Volumes on US 2 – West of Jasper Mine Road (ATR #S6D019 on 9/30/2004) 18

Figure 9: Bi-Directional Traffic Volumes on US 7/US 2 south of Chimney Corners (ATR #S6D103 on 10/26/2004) 19

Figure 10: Seasonal Traffic Variations for CTC D040 and D092 in Colchester 20

Figure 11: Bi-Directional Truck Volumes on US 2 – West of Jasper Mine Road (ATR #S6D019 on 9/30/2004) 23

Figure 12: Bi-Directional Truck Volumes on US 7/US 2 south of Chimney Corners (ATR #S6D103 on 10/26/2004) 23

Figure 13: 2005 AM Peak Hour Volumes 25

Figure 14: 2005 PM Peak Hour Volumes 25

Figure 15: Crash Locations, High Crash Intersections, and High Crash Segments from 1999-2003 30

Figure 16: Wetlands In or Near the Study Area 33

Figure 17: Steep Slopes 34

Figure 18: Endangered Species and Deer Wintering Areas 35

Figure 19: Zoning and Existing Land Use 39

Figure 20: Exit 17 Transportation Analysis Zones 40

Figure 21: Buildable Area 41

Figure 22: Parcels Constrained by Off-Site Wastewater Availability 42

Figure 23: 2025 AM – Background Traffic 57

Figure 24: 2025 AM –Phase 1 Traffic Assignment 57

Figure 25: 2025 AM –Phase 2 Traffic Assignment 58

Figure 26: 2025 AM –Background Plus Phase 1 Traffic 58

Figure 27: 2025 AM –Background Plus Phase 2 Traffic 59

Figure 28: 2025 PM – Background Traffic 59

Figure 29: 2025 PM –Phase 1 Traffic Assignment 60

Figure 30: 2025 PM –Phase 2 Traffic Assignment 60

Figure 31: 2025 PM –Background Plus Phase 1 Traffic....61

Figure 32: 2025 PM –Background Plus Phase 2 Traffic....61

Figure 33: 2025 PM –Background Plus Phase 1 Traffic with Circ and West Milton Road Exit....62

Figure 34: 2025 PM –Background Plus Phase 2 Traffic with Circ and West Milton Road Exit....62

Figure 35: 2025 PM –Background Plus Phase 2 Traffic with Circ, without West Milton Road Exit....63

Figure 36: Growth Center Traffic Analysis Zones and Conceptual Local Street Networks....64

Figure 37: 2025 PM Peak Design Hour Analysis Volumes....65

Figure 38: 2025 AM Peak Design Hour Analysis Volumes....66

Figure 39: Existing Lane Geometry....67

Figure 40: Exit 17/Chimney Corners Alternative 1 - Traffic Signals with Additional Lanes....68

Figure 41: Example of 4-Lane Arterial with Roundabouts (left), Typical Roundabout Design Elements (right)....69

Figure 42 : Exit 17/Chimney Corners Alternative 2A – All Roundabouts....72

Figure 43: Exit 17/Chimney Corners Alternative 2B – Roundabouts and Traffic Signal at Northbound Ramps....72

Figure 44: Exit 17/Chimney Corners Alternative 2C – Roundabouts and Traffic Signal at Chimney Corners....73

Figure 45: Exit 17/Chimney Corners Alternative 3 –Northbound Off-Ramp Fly-Over....74

Figure 46: Exit 17/Chimney Corners Alternative 4 - Single Point Urban Interchange....76

Figure 47: Exit 17/Chimney Corners Alternative 5 - Tight Diamond Interchange....78

Figure 48: US2-Jasper Mine Road Signalized Intersection....84

Figure 49: US2-Jasper Mine Road Roundabout Intersection....85

Figure 50: US7-Arbor Gardens Concept Plan....86

Figure 51: US7-Brentwood Drive Signalized Intersection Alternative....88

Figure 52: US7-Brentwood Drive Roundabout Intersection Alternative....88

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EXECUTIVE SUMMARY

The purpose of this study is to identify transportation system improvements for the Exit 17 Growth Center in Colchester, VT assuming that a wastewater system is implemented that allows the area to reach its development potential as envisioned by the Town. The study was prepare by Resource Systems Group, Inc. for the Town, and was financed by the Chittenden County Metropolitan Planning Organization (CCMPO). The study was directed by a steering committee that consisted of professional staff from the Town, CCMPO, and the Vermont Agency of Transportation (VTrans).

The study area is consistent with the boundaries of the Exit 17 Growth Center designated by the Town of Colchester. It includes the following intersections, and the connecting road segments along US 7 and US 2:

- US 2 with US 7 (Chimney Corners);
- US 2 with Exit 17 Ramps;
- US 2 with Jasper Mine Road;
- US 7 with Brentwood Drive, and the VTrans District Garage and Park-and-ride Lot; and
- US 7 with Arbor Gardens Residential Complex

This study describes the characteristics of the existing transportation system in the Exit 17 Growth Center and evaluates its performance relative to congestion, safety, access management, and bicycle and pedestrian access. Traffic projections are developed for a twenty-year planning horizon that account for regional background growth, trips generated for two land use scenarios, and the effect of the proposed Circumferential Highway and a new I-89 exit at West Milton Road. Several highway and intersection design alternatives are developed to accommodate the twenty-year traffic forecasts, the alternatives are evaluated and recommended, and a phasing plan is presented.

EXISTING TRANSPORTATION SYSTEM CHARACTERISTICS AND PERFORMANCE

US 7and US 2 are classified as urban arterials and US 7 is designated as part of the Vermont Truck Network. These designations suggest that US 2 and US 7 need to provide a high level of mobility for through traffic and an efficient connection to the interstate. All of the roadways are owned by the State of Vermont and maintained and operated by VTrans.

There are no sidewalks along US 2 or US 7. There are some limited sidewalks within the Arbor Gardens Apartment Complex and the park-and-ride facility and the existing shoulders are wide enough to accommodate on-road bicycle travel. Current plans for new facilities will form the spine of a network that will serve travel around the Exit 17 Growth Center as the surrounding land is developed.

The study area contains a recently reconstructed park-and ride facility. Past data suggest that only about 30% of the parking spaces are utilized. The Chittenden County Transportation Authority

(CCTA) recently began providing an inter-regional commuter route connecting Chittenden County with St. Albans with a stop at the Exit 17 park-and-ride facility.

Traffic counts and US Census journey-to-work data all indicate that the overall traffic pattern in the study area is significantly affected by commuters from Grand Isle County and Milton. These travel patterns are characterized by a distinctive southbound flow of traffic towards the center of Chittenden County during the AM peak hour and a northbound flow in the PM peak hour. Much of this traffic is utilizing the I-89 Exit 17 interchange.

In 2005, excessive congestion is limited to the minor street approach of Jasper Mine Road to US 2 during the AM and PM peak hours while all other intersections operate with acceptable levels of delay.

The following intersections satisfy the criteria for designation as a high crash location based on 1999-2003 crash data:

- The US 7 road segment from the Arbor Garden Apartments to 0.1 mile south of the US 7–US 2 intersection; and
- The US 7-US 2 intersection.

FUTURE CONDITIONS

Future traffic projections were developed that account for a 42% increase between 2005 and 2025 in regional traffic plus traffic to be generated by development in the Exit 17 Growth Center. Accounting for the constraints of an off-site waste water system recently studied by the Town, zoning regulations, and natural resources, the Exit 17 Growth Center can accommodate approximately 1,200 new dwelling units and an additional 462,000 square feet of commercial uses[1]. This development will generate approximately 2,100 vehicles per hour during the PM peak hour and 1,450 in the AM peak hour.

A highway capacity analysis was conducted based on these traffic projections that assumed no modifications to the existing lane configurations or traffic control at the study intersections and road segments. The analysis indicates:

- Assuming the Circumferential Highway and the I-89 exit at West Milton Road are not constructed, congestion will be severe at Exit 17 and the other study intersections.
- If the Circumferential Highway is constructed, but not the West Milton Road exit, modifications will still be necessary at all of the study intersections to address congestion issues.

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[1] This estimate does not represent the full development, or buildout, of the growth center. Additional development could occur in the growth center if additional wastewater capacity is provided beyond what was designed in the Decentralized Wastewater Study.

- If both the Circumferential Highway and West Milton Road interchange are constructed, modifications to the existing roadways and intersections would still be necessary, but these changes would be relatively minor (such as adding a traffic signal or a new turn lane).

ALTERNATIVES ANALYSIS

Several design alternatives were evaluated for the I-89 Exit 17-US 2 interchange, the US 2-US 7 (Chimney Corners) intersection, the three other study intersections, and the connecting road segments along US 2, US 7, and US 2/7.

The alternatives were designed to accommodate traffic generated by regional growth and the 1,200 dwelling units and 462,000 square feet of commercial space possible in the Exit 17 Growth Center. The traffic projections assumed that the entire Circumferential Highway is constructed, but did not assume completion of the I-89 interchange with West Milton Road. Given the complexities involved in constructing interstate interchanges, the steering committee decided not to assume that the West Milton Road exit will be completed.

The traffic projections also assume that a network of local streets, sidewalks and paths for pedestrians, and bicycle facilities would connect all areas of the Growth Center. This local network would accommodate travel within the Growth Center and help reduce the amount of traffic added by development to US 7 and US 2 by 10-20%.

The total cost of the roadway and intersection projects on US 2 and US 7 ranges between $18 and $22 million, depending on which alternative is constructed at the Exit 17/Chimney Corners area. All of the designs include sidewalks, cross-walks, and shoulders wide enough to accommodate on-road bicycle travel.

The local street network recommended to accommodate internal circulation is estimated to cost approximately $4 million for the roadways and an additional $3 million for two new bridges over I-89.

Findings and recommendations are summarized below for each specific section of the study area.

I-89 Exit 17 Ramps and Chimney Corners Findings:

- The following alternatives were evaluated: Do Nothing, Traffic Signal improvements with additional lanes, Roundabouts, Traffic Signal/Roundabout Mix, Northbound off-ramp Fly-Over, Single-Point Urban Interchange (SPUI), and Tight-Diamond Interchange.
- The Traffic Signal Alternative, SPUI, Tight Diamond, and Fly-Over alternatives would cost between $11.3 to $12.6 million. These costs are three to four million dollars more than the Roundabout Alternatives ($8.0 million). This cost difference is caused by the need to widen the US 2 bridge over I-89 from three to five to seven travel lanes. The roundabout alternative also requires widening the bridge, but only four lanes are necessary.
- Widening the bridge contributes almost 90% of the total cost of the Alternative 1-Traffic Signals and approximately 85% for the Roundabout alternatives.

- None of the operational and safety advantages make either the traffic signal or the roundabout alternative the obvious choice and none of the disadvantages suggest that either alternative should be eliminated. Rather, this analysis has shown that the traffic signal and roundabout alternatives are feasible, effective, and should be considered in more detail through the scoping process.

US 2-Jasper Mine Road and US 7-Brentwood Drive Intersection Findings:

- These intersections are similar because they both provide gateways at the edge of the Exit 17 Growth Center. Traffic signals with additional lanes ($150,000) and double lane roundabouts ($250,000) were evaluated.
- Relative to congestion, each alternative performs equally well. Although the roundabouts would cost more to construct, they enhance safety, and at these particular locations have the advantage of enhancing the gateways into the Growth Center.

US 7-Arbor Garden Intersection Findings:

- Because the projected traffic volume entering and exiting the intersection is low, only a left turn lane on US 7 is recommended. Traffic signals or roundabouts are not necessary. The cost of the lane is included in the roadway widening summarized below.

Road Segment Cross-section Recommendations:

- Two through lanes should be provided in each direction on:
    - US 7 between US 2 and Brentwood Drive. This segment will also include a median to allow for the turn lanes at US 7, Arbor Gardens, and Brentwood Park ($4.8 million).
    - US 2 between the Exit 17 southbound ramps to Jasper Mine Road. The cross-section would transition to a two lane rural road segment west of the Jasper Mine Road intersection ($3.8 million).
    - US 2/7 south of US 2 to a future, intersection with a new local roadway ($1.7 million).
- The four lane cross-section with medians will provide a consistent, logical flow of traffic between the intersections and will eliminate the need to create confusing merge and diverge transition areas. The cross-section also includes sidewalks, green strips, and shoulders to accommodate shared use by cyclists through the Growth Center.

PHASING PLAN

The phasing plan organized the study area into the following major project areas based on proximity and operational relationships:

- US 2 intersections with I-89 northbound on/off ramps and US 2/US 7;
- US 2 intersection with southbound on/off ramps and the US 2 bridge over I-89;
- US 2 intersection with Jasper Mine Road, including sections of US 2 east and west of the intersection;
- US 7 intersection with Brentwood Drive and the section of US 7 to Chimney Corners; and
- US 2/7 road section south of Chimney Corners.

A phasing plan was developed for the all-traffic signal and all-roundabout alternatives that began by assuming constant regional growth and even distribution of development in the Growth Center over time. Using this approach, it was possible to identify the traffic volumes for each major project area where volume exceeded capacity triggering the need for an improvement. These "trigger volumes" are presented for each major project area and can be used by the Town, CCMPO, and VTrans to monitor the need for action.

Table E1 presents the phasing plan. It identifies the specific location or locations within each project area that should be monitored to track the need for improvements. The US 2-Northbound Off Ramp/Chimney Corners project area is unique because it has two trigger locations. Depending on how much and where development occurs in the Growth Center, either intersection may reach its trigger volume first. Regardless of which intersection reaches its trigger volume first, both intersections should be reconstructed at the same time.

Table E- 1: Phasing Plan

Project Area	Trigger Location	Critical Time Period	Existing 2005 Traffic Volume (1)	Traffic Volume Trigger (1)	Approximate Year (2)
Chimney Corners and US 2/Northbound Ramps	Peak Hour Traffic Through: US 2-I-89 NB Ramps, or	PM	2160	2527	2010
	US 2/US 7 Intersection	PM	1955	2413	2015
US 7/Brentwood Drive and US 7 to Chimney Corners	Two traffic volume on US 7	PM	1301	1610	2015
US 2/Jasper Mine Road	Peak Hour Traffic Through: US 2/Jasper Mine Road	AM	1320	2077	2015
US 2-Southbound Ramps, Bridge Widening, and US 2 widening to Jasper Mine Road	Peak Hour Traffic Volume Through: US 2/Southbound Ramps	AM	2096	3435	2020
US 2/7 South of Chimney Corners	Two traffic volume on US 2/7	PM	1203	1505	2025

(1) Vehicles per hour

(2) Assumes constant growth in background traffic and that development occurs at a constant rate and is evenly distributed in the Exit 17 Growth Center

Traffic volume triggers provide a simple way to monitor the need for action at a particular location. However, a decision on what if any modifications are necessary at that time should be verified with updated traffic counts and detailed traffic engineering and capacity analyses.

RECOMMENDATION

The recommendations in this study will most likely be financed with federal and state transportation funds which require completion of a project definition study. A project definition study develops a purpose and need statement, evaluates alternatives, and selects a preferred alternative.

A project definition study should be conducted that focuses on the Exit 17 interchange and the Chimney Corners intersection with the following purpose:

> *The purpose of this transportation project is to preserve the operation of the Exit 17 interchange so that it continues to provide a safe and efficient connection between the interstate and arterial highway systems while also accommodating travel demand anticipated as the surrounding Growth Center develops.*

The project definition study should include the all-traffic signal, all-roundabout, traffic signal/roundabout mix alternatives. The redesign of the interchange into different configurations (single point urban interchange, tight diamond interchange, or northbound off-ramp fly-over) should not be considered further.

Reconstruction of the US 2 bridge over I-89 is a critical element. The project definition study will finalize how the bridge should be re-constructed. Widening of the bridge will be triggered by the need to reconstruct the US 2-Southbound on/off ramp intersection which could occur within fifteen years.

The project definition study should include the northbound and southbound ramp intersections and Chimney Corners but construction should occur in two major phases. The first phase will reconstruct the Chimney Corners and the US 2/northbound ramps. The second phase will reconstruct the US 2/southbound ramps and the bridge. Initiating the project definition study now will provide enough time to plan for widening the bridge while allowing other improvements to be implemented before the bridge is reconstructed.

Project definition studies should also be conducted for the other major project areas. However, the need for projects on these sections will depend on the location and pace of development in the Growth Center. The Town and CCMPO should use the traffic volume triggers presented in this study to determine if and when a project definition study, and a project, should be initiated.

The local street network will be an important part of the Growth Center's transportation system and is necessary to accommodate 20% of the travel demand generated by development. These streets will be incorporated into the site plans of development projects within the Growth Center and will therefore be built and paid for by the developers.

New bridges over I-89 should be considered as long-term needs dependent on how much development occurs on each side of the interstate. The bridges may serve vehicular travel but could also be dedicated to pedestrians and cyclists. In short-term, right-of-way or easements should be secured to locations where bridges may cross the interstate.

INTRODUCTION

The purpose of this study is to identify transportation system improvements for the Exit 17 Growth Center in Colchester, VT. The recommendations are intended to assist the Town, Chittenden County Metropolitan Planning Organization (CCMPO), and Vermont Agency of Transportation (VTrans) with planning for improvements that support local development while maintaining mobility through the interchange.

The area surrounding Exit 17 was designated as a growth center by the Town of Colchester in its 1996 Municipal Plan. An Exit 17 Growth Center Plan was completed in 2000 that identified the type and intensity of land uses desired by the Town and recommended specific use and design standards for inclusion in the zoning regulations. The recommendations from the 2000 study are now included in the most recent version of Colchester's zoning regulations.

The primary constraint to developing the Exit 17 Growth Center is the lack of a wastewater disposal system. Different options have been investigated by the Town. There are two options that are technically and politically feasible and would require about the same amount of money to implement.

This study describes the characteristics of the existing transportation system in the Exit 17 Growth Center and evaluates its performance relative to congestion, safety, access management, and bicycle and pedestrian access. Traffic projections are developed for a twenty-year planning horizon that account for regional background growth, trips generated for two land use scenarios based on the two wastewater system options, and the effect of the proposed Circumferential Highway and a new I-89 exit at West Milton Road. Several design alternatives are presented and evaluated to accommodate the twenty-year traffic forecasts, and a phasing plan is presented.

This report contains the following major sections:

- Introduction and study area overview,
- Existing conditions,
- Future conditions,
- Alternatives Analysis, and
- Phasing and Implementation Plan.

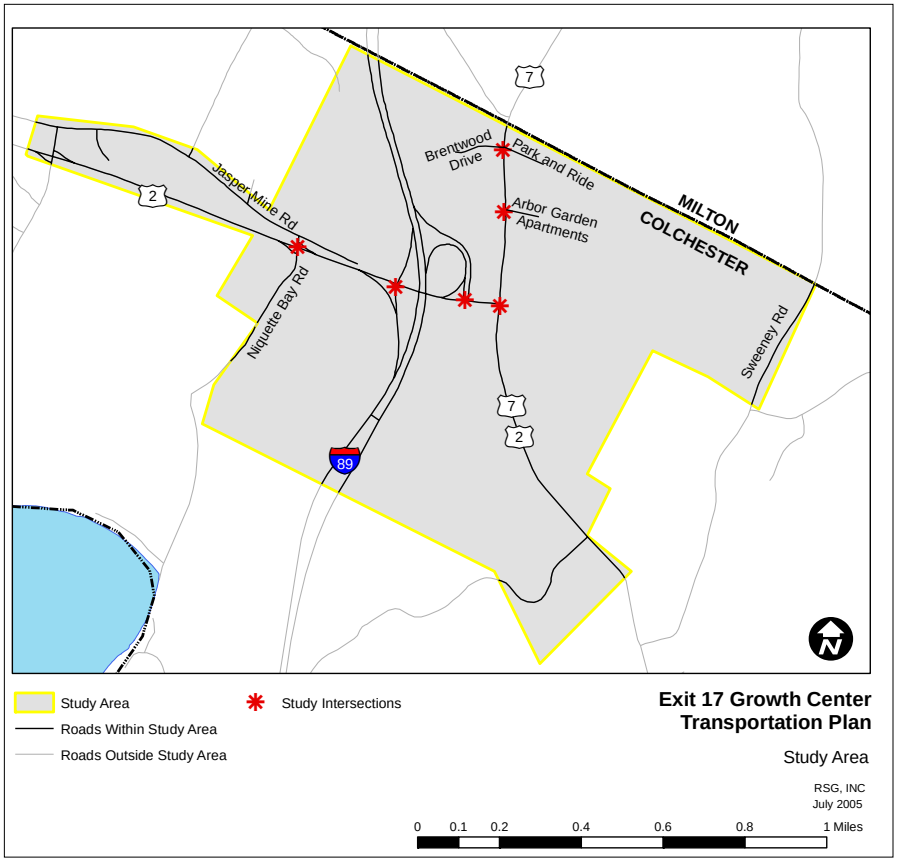
This study was conducted for the Town of Colchester and the Chittenden County Metropolitan Planning Organization (CCMPO). It was funded by the CCMPO through its planning assistance program. The study was conducted by Resource Systems Group, Inc. (RSG) under the direction of a steering committee that met several times throughout the study. The steering committee included Colchester's public works director and town planner, CCMPO's senior transportation planner, VTrans planning coordinator assigned to Chittenden County, and VTrans District 8 Transportation Administrator.

STUDY AREA OVERVIEW

The study area is high-lighted in gray in Figure 1. All of US 2 and US 7 within this area are included and the following major intersections:

- US 2 with US 7 (Chimney Corners)
- US 2 with Exit 17 Ramps
- US 2 with Jasper Mine Road
- US 7 with Brentwood Drive, and the VTrans District Garage and Park-and-ride Lot
- US 7 with Arbor Gardens Residential Complex

Figure 1: Study Area



The Exit 17 area in Colchester is a crossroads for 3 important highways in Vermont: I-89, US 7, and US 2. Few business and residences are present in the study area; therefore the primary function of the study area roadways is to provide mobility. In general, I-89 functions as the central artery in the

study area. It collects and disperses traffic from US 2 traveling to and from Grand Isle County and from US 7 traveling to and from northern Colchester and Milton.

Most of the land in the study area is currently open. A few large and mostly vacant parcels contain the majority of land within the study area. The existing land use within the study area is predominantly small scale commercial.

Residential uses exist mostly on the edge of the study area. All of the study area is located within the General Development 4 (GD4) zoning district. The purpose of this zoning district is to encourage a mix of residential and non-residential uses. Commercial uses should be smaller scale (less than 20,000 square feet) and are intended to serve adjacent uses in the Growth Center and pass-by traffic rather than serve as a major regional attraction.

SUMMARY OF PREVIOUS TRANSPORTATION STUDIES AND PLANS

This section summarizes the policies and recommendations included in a US 7 Corridor Study and the Chittenden County Metropolitan Transportation Plan relative to the Exit 17 Growth Center..

Winooski to Georgia Route 7 Corridor Study Final Report; Prepared by Oman Analytics with Kathleen Ryan-Landscape Architect for the CCMPO; October 2001.

The corridor plan is centered along US 7 from the US 7-Exit 18 interchange in Georgia to the US 7-VT 15 intersection in downtown Winooski. The study area includes the Exit 17 Growth Center.

The corridor plan provides the following list of transportation principles and priorities that should be considered as recommendations are developed in this study:

- The corridor should be served by a hierarchical roadway system with the interstate providing for through traffic, Route 7 providing a distribution/collection function, and local back roads preserved for local traffic;
- Provide a safe highway and transport environment for highway users and abutters;
- Provide meaningful alternative means of transportation;
- Transportation service and facilities should support, further, and enhance community land use and development strategies. They should support a balance between growth and economic development on the one hand and environmental protection and community preservation on the other;
- Transportation facilities, particularly roadways, play a major role in defining community character. They should be designed to complement the areas in which they are located; and
- Provide for sound and effective long-term fiscal management of necessary improvements within the corridor.

The corridor plan consists of a network plan detailing the overall large-scale network of transportation facilities, a modal plan detailing the development of alternatives to the single/low

occupancy auto, a land use/development strategy, and a number of location specific improvements. The following recommendations are specific to the Exit 17 Growth Center:

- Network Plan: Considers modern roundabouts at the two ramps and at Chimney Corners and installation of traffic signals. Suggests that the roundabouts perform better but final recommendations would depend on more detailed design;
- Modal Plan: Includes express bus service between Burlington and Milton with stops at the Exit 17 Park-and-ride Lot (this service currently exists); supports expansion of the Exit 17 park-and-ride lot (which has since been completed); and envisions significant sidewalk and/or bicycle improvements in conjunction with "main street" style or growth center developments at the Exit 17 Growth Center (as well as all growth centers in the corridor);
- Land Use Recommendations: Recognizes the desire of the Town of Colchester to encourage mixed-use development in the Exit 17 Growth Center; and
- Miscellaneous Supporting Improvements: Includes numerous modifications to intersections throughout the corridor but does not include any additional recommendations specific to the Exit 17 Growth Center area.

2025 Chittenden County Metropolitan Transportation Plan – Adopted January 19, 2005

The Metropolitan Transportation Plan (MTP) identifies existing and future transportation needs in the County and recommends policies, services, and projects to address those needs. The MTP divides the County into nine primary transportation corridors through which people and freight move. The Exit 17 study area is located near the center of the MTP's Northern Corridor which follows US 7/US 2 from Winooski to the Chittenden County borders with Franklin County and Grand Isle County. The following recommendations are located within the Exit 17 study area or may have some influence on the study area even if located beyond its borders:

Travel Demand Management/Intelligent Transportation Systems/Transportation System Management

- Establishment of a Transportation Management Associations in Milton and around Exit 17;
- Modifications to the Exit 17 ramp intersections with US 2
- Application of access management techniques along US 2/7

Public Transportation

- US 7 corridor bus service connecting Milton Village, through Colchester, to Burlington

Bicycle/Pedestrian Improvements

- Shared use bike path connecting the Colchester bike path to the Milton Town Core
- On-road bicycle facilities to be implemented wherever feasible in conjunction with road rehabilitation/reconstruction projects

Roadway – Interstate improvements/expansion

- New I-89 Exit with West Milton Road
- Complete Circumferential Highway Segments I and J (Completion of all un-built sections of the Circumferential Highway is included in the MTP as recommendations within other corridors)
- Reconstruct I-89 Exit 17

Roadways – Arterial improvement/expansion

- No recommendations that affect Exit 17 are included.

PART I: EXISTING CONDITIONS

This section of the report:

- Describes transportation system characteristics including: roadways, pedestrian and bicycle facilities, park-and-ride facilities, and transit service;
- Analyzes travel demand characteristics;
- Analyzes congestion for the 2005 AM and PM peak hours;
- Analyzes safety and access management; and
- Screens for potential natural and cultural recourses constraints.

TRANSPORTATION SYSTEM CHARACTERISTICS

Highway System Context

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

Functional Class

The Federal Highway Administration's roadway functional classification system is organized as a hierarchy of facilities, based on the degree to which the roadway serves mobility and access to adjacent land uses. As shown in Figure 2, freeways and interstate highways, at the top of the hierarchy, are devoted exclusively to vehicle mobility, with no direct access to adjacent land. Arterials and Collectors provide both mobility and access to adjacent land uses. The local road system is devoted exclusively to providing local access, with limited capacity and relatively slow speeds.

Figure 2: Conceptual Roadway Functional Hierarchy

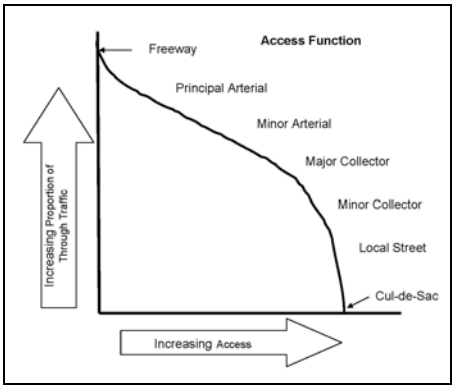


Figure 3 on the following page shows the functional classification for the roadways in

the study area. I-89 is classified as an urban interstate. The combined US 2/US 7 section of highway is classified as an urban principal arterial. After US 2 and US 7 diverge they are considered minor arterials in the study area. All other roads in the study area are classified as urban local.

As indicated in Figure 2, mobility for through traffic is the primary function of principal and minor arterials. Given the rural nature of the Exit 17 study area, it may be surprising that the roads and highways are classified as urban. However, the study area is entirely within the census designated urban area which includes all of Chittenden, Franklin, and Grand Isle counties.

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

Table 1 summarizes the major roadway design guidelines as published in the *Vermont State Standards*[1] for principal and minor arterials in urban and rural areas. The guidelines for principal and minor arterials in urban and village areas are identical. The *Vermont State Standards* provide a significant amount of flexibility in selecting lane and shoulder widths for arterials that pass through built-up urban and village areas. Lane and shoulder width guidelines for arterials passing through rural areas are more rigid. The recommended shoulder widths range from 5 to 8 feet. The flexibility allowed for urban arterials provides an opportunity to change the characteristics of the roadways through the Exit 17 area as the surrounding land is developed.

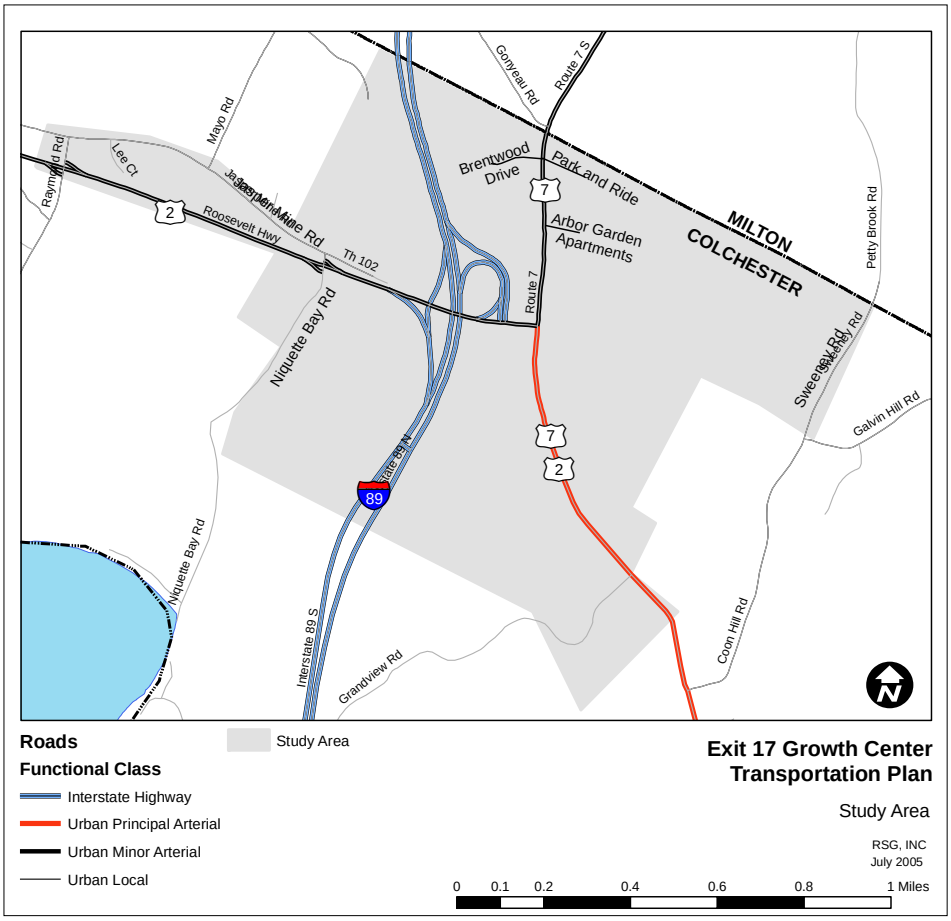
Table 1: Roadway Design Standards

Design Feature	Urban/Village Principal and Minor Arterials	Rural Principal Arterial	Rural Minor Arterial
Design Speeds	30-55 mph, occasionally 25 mph	35-55 mph	35-55 mph
Lane Widths	10-12 feet	11 ft with speed < 50 mph 12 ft with speed > 50 mph	11 ft with speed < 50 mph 12 ft with speed < 50 mph
Shoulder Widths	Varies from 2 to 8 ft depending on surrounding area	8 ft	5 ft
Minimum Shoulder Widths to Accommodate Bicycle Travel	With curbs: 3-6 ft based on speeds from 25-55 mph	3 ft < 50 mph; 4 ft at 50 mph; 5 ft at 55 mph	3 ft < 50 mph; 4 ft >50 mph

Source: *Vermont State Standards*

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

Figure 3: Road Functional Class



National Highway System and VT Truck Route

The NHS consists of Interstate and Defense Highways and principal arterial roads essential for interstate and regional commerce, travel, national defense, intermodal transfer facilities, international commerce, and border crossings. NHS routes were designated in the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA). In the study area I-89 is the only roadway segment that is part of the NHS.

Title 23 V.S.A. Section 1432 as amended by the 2000 Vermont Legislature, establishes the Vermont Truck Network where trucks with overall lengths less than 72 feet (including 53-foot tractor-trailer combinations) may travel without permits. The Truck Network is defined as all of the NHS routes, plus VT 22A between its intersections with US 7 and US 4, VT 105 in its entirety, and VT 104 from I-89 Exit 19 to VT 105. The roads that are not part of the NHS were added to the truck network based on the volume of truck traffic and/or through the legislative decision making process.

Inclusion on the truck network does not affect design standards which are governed by functional class, AADT, and truck traffic.

Within the study area, US 7 is designated as part of the Vermont Truck Network. Because of this designation, recommendations related to the re-design of Chimney Corners that may results from this study should accommodate trucks with overall lengths of 72 feet. This requirement will affect turning radii and should be considered in selecting appropriate lane widths.

Roadway Jurisdiction

The entire public highway network in Vermont is owned either by the state or a municipality. VTrans has established a roadway classification system to identify the levels of jurisdiction over each section of road across the state. These classifications identify whether, for example, VTrans or the Town is responsible for pot hole patching on a particular section of road. Roads owned by municipalities are categorized as class 1, 2, 3, or 4 town highways. A class 1 town highway has a VT or US route number and is an important part of the state system. In general, municipalities own and are responsible for all maintenance and construction costs associated with class 1-4 town highways although some funds are provided by the state to support projects on local roads.

US 7, US 2, and I-89 in the study area are owned and maintained by the State of Vermont. Jasper Mine Road is a class 2 town highway that provides an alternate route between Milton and Colchester via Mayo Road and West Milton Road to the north. All other roadways in the study area are class 3 town highways.

VTrans Access Management Categories

In the study area I-89, US 2, and US 7 are owned by VTrans which is responsible for issuing access permits. VTrans has established an Access Management Program that assigns all segments of the State's Highway System into one of six access management categories. The standards provide the basis for access permitting on state highways and are used in the planning and development of VTrans roadway construction projects. Existing highways are not required to meet the design standards. However, the standards are applied to all new access permits and construction projects.

The access management categories, which are summarized in Table 2**,** specify whether or not direct access to adjacent property is permitted, the type of driveway design factors to be considered, and type of turning movement allowed (Traffic Operations).

The following access management categories exist in the study area and are also shown in Figure 5:

- Category 1: The entire interstate falls within this classification. Access is allowed only through grade separated interchanges;
- Category 2: US 2 from Chimney Corners to a point west of the southbound ramps and US 7 to points north and south of its intersection with US 2 are designated within this category. Direct access to abutting land is not permitted without approval from the Vermont

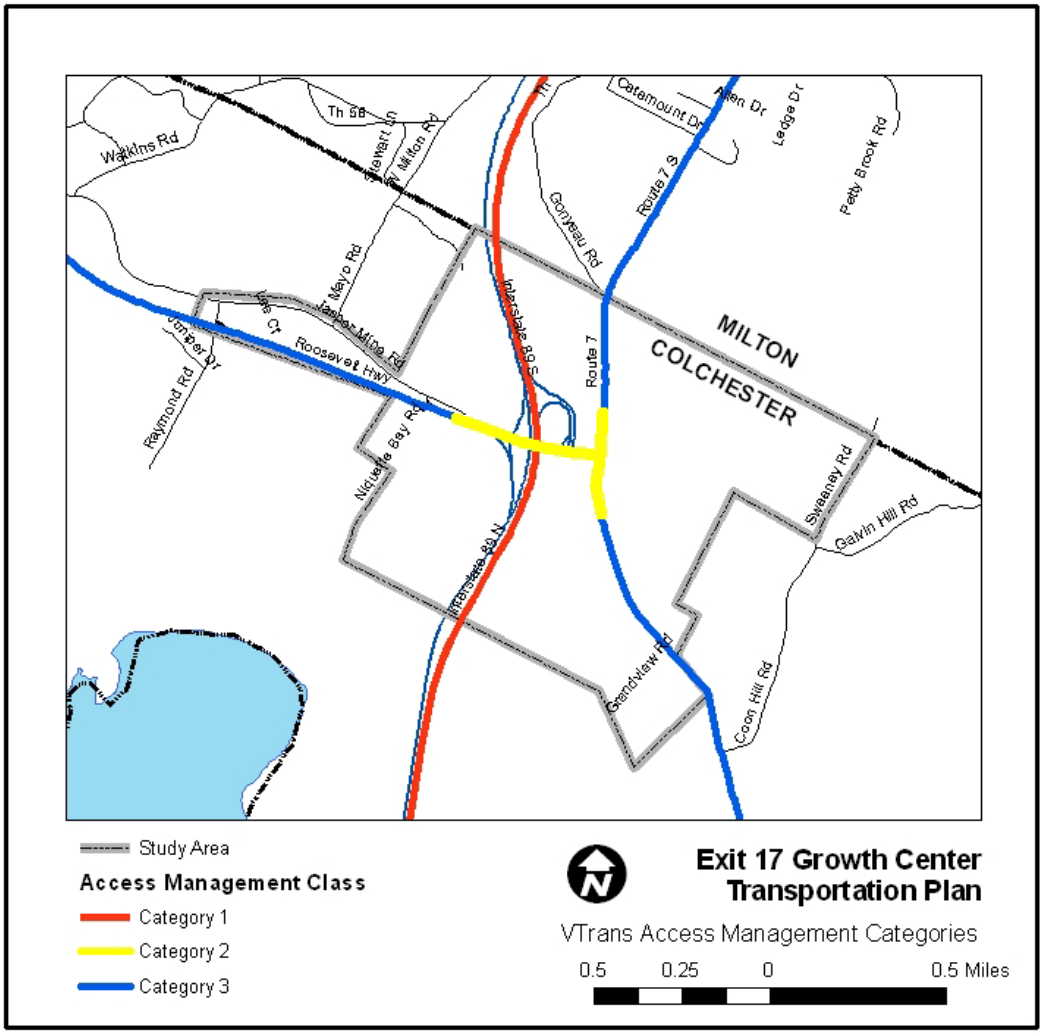
Transportation Board. This designation protects the operation of the interchange and the nearby intersection with Chimney Corners from the effect of poorly placed driveways

- Category 3: The balance of US 2 and US 7 in the study area fall within this category. Direct access may be denied by VTrans if safe and reasonable alternative locations are possible on a side street. VTrans may also restrict certain movements (left in/left out for example) and can limit the number of driveways to one per parcel.

Table 2. VTrans Access Management Categories

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

Figure 4: Study Area Access Management Categories



Roadway Characteristics

Characteristics of the two primary roadways in the study area, US 2 and US 7, are shown in Table 3. All roadway sections of US 2 and US 7 in the study area have a speed limit of 50 miles per hour, except US 2 west of Jasper Mine Road which has a speed limit of 55 miles per hour.

Travel lanes are generally between 12 to 11.5 feet in the study area. All roadway segments have 1 travel lane in each direction. However, additional turning lanes are present in the vicinity of intersections (refer to Table 4: Study Intersection Characteristics). Shoulder widths meet or exceed

the minimum widths recommended in the *Vermont State Standards* (See Table 1: Roadway Design Standards) with the following exceptions: along US 2 as it passes its intersections with the I-89 ramps; and along the east side of US 7 between Chimney Corners and Arbor Garden Apartments.

Table 3: Roadway Characteristics by Section

Highway	Section Limits	Posted Speed	Lanes			Shoulder	
			Width		Notes		
US 2	West of Jasper Mine Road	55 MPH	WB 12 ft.	EB 12 ft.	1 Lane Each Direction	WB 11 ft.	EB 11 ft.
US 2	Jasper Mine Road to I-89 SB On/Off Ramps	50 MPH	WB 12 ft.	EB 12 ft.	1 Lane Each Direction	WB 9.5 ft.	EB 5 ft.
US 2	I-89 SB On/Off Ramps to I-89 NB On/Off Ramps	50 MPH	WB 12 ft.	EB 12 ft.	1 Lane Each Direction	WB 2.5 ft.	EB 3 ft.
US 2	I-89 NB On/Off Ramps to US 7 - US 2 Intersection	50 MPH	WB 12 ft.	EB 12 ft.	1 Lane Each Direction	WB 2 ft.	EB 2 ft.
US 7 / US 2	South of US 7 - US 2 Intersection	50 MPH	NB 11.5 ft.	SB 11.5 ft.	1 Lane Each Direction	NB 5 ft.	SB 7.5 ft.
US 7	US 7 - US 2 Intersection to Arbor Garden Apartmetns	50 MPH	NB 11.5 ft.	SB 11.5 ft.	1 Lane Each Direction	NB 2.3 ft.	SB 6.3 ft.
US 7	Arbor Garden Apartments to Park and Ride	50 MPH	NB 11.5 ft.	SB 11.5 ft.	1 Lane Each Direction	NB 5.7 ft.	SB 6.1 ft.
US 7	North of Park and Ride	50 MPH	NB 11.5 ft.	SB 11.5 ft.	1 Lane Each Direction	NB 5 ft.	SB 6.5 ft.

Intersection geometries and control types are summarized in Table 4. The US 2-Jasper Mine Road, US 7-Arbor Garden Apartments, and US 7-Park-and-Ride intersections are all stop controlled on the minor approach. The US 2-Southbound I-89 On/Off Ramps, US 2-Northbound I-89 On/Off Ramps, and the US 2-US 7 intersections are all signalized and part of one coordinated system. The master controller is located at the US 2-Southbound I-89 On/Off Ramps intersection. No pedestrian facilities, such as cross walks or pedestrian signals, are present at any of the study intersections.

Slip lanes for right turn vehicles are present at the intersections of Jasper Mine Road and the I-89 Southbound and Northbound On/Off ramps with US 2. Left turns are prohibited at the US 2-Jasper Mine Road intersection. The intersection functions like a jug handle - vehicles must make right turns onto either Niquette Bay Road or Jasper Mine Road and proceed straight through the intersection to facilitate a left turn from US 2 (See Figure 5).

Figure 5: Jasper Mine Road-US 2 Jughandle

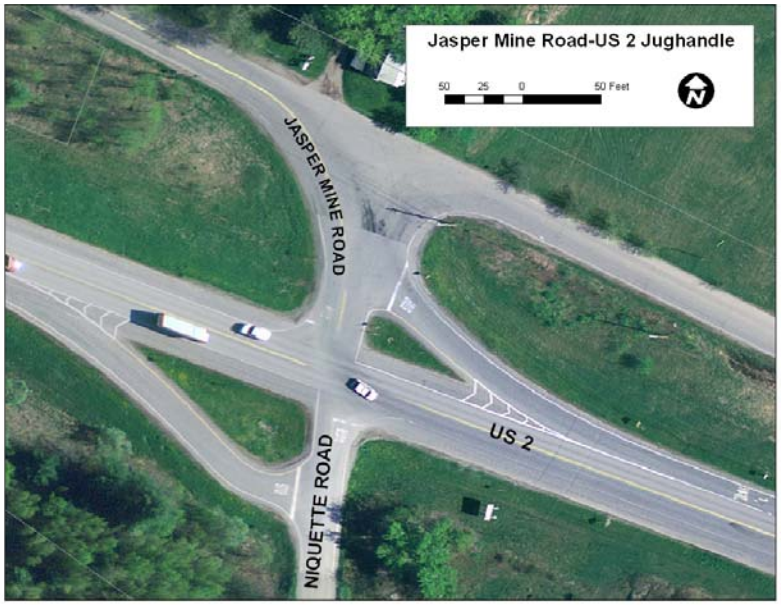


Table 4: Study Intersection Characteristics

Lane Configuration	Control Type	Pedestrian Facilities	Notes
US 2 - Jasper Mine Road US 2 EB- One Lane Approach US 2 WB- One Lane Approach Jasper Mine Road SB - One Lane Approach Niquette Bay Road NB - One Lane Approach	Minor Stop	None	Slip lanes on US 2 EB and WB for vehciles turning right onto Jasper Mine Road and Niquette Bay Road are provided. No left turns from US 2 EB and WB onto Jasper Mine Road and Niquette Bay Road are permitted - vehicles must turn on to Jasper Mine Road or Niquette Bay Road first.
US 2 - I89 Southbound On/Off Ramps US 2 EB- One Lane Approach US 2 WB- Two Lane Approach (Through and Left) I-89 Southbound Off Ramp SB - Two Lane Aprroach (Left and Right)	Signal	None	A Slip lane on US 2 EB for vehciles turning right onto SB I-89 is provided.
US 2 - I89 Northbound On/Off Ramps US 2 EB- One Lane Approach US 2 WB - One Lane Approach I-89 Northbound Off Ramp SB - One Lane Aprroach	Signal	None	A Slip lane is provided for vehciles turning onto US 2 WB from the I-89 NB off ramp.
US 7- US 2 US 2 EB - Two Lane Appraoch (Left and Right) US 7 SB - Two Lane Approach (Right and Through) US 7/US 2 NB - Two Lane Approach (Left and Through)	Signal	None	None
US 7 - Arbor Garden Aparments Arbor Garden Apartments WB- One Lane Appraoch US 7 SB- One Lane Approach US 7 NB - One Lane Approach	Minor Stop	None	None
US 7 - Park and Ride Brentwood Drive - Two Lane Appraoch (Right and Left, Through) Park and Ride - Two Lane Appraoch (Right and Left, Through) US 7 SB - Two Lane Appraoch (Right and Left, Through) US 7 NB - Two Lane Appraoch (Right and Left, Through)	Minor Stop	None	None

Pedestrian and Bicycle Facilities

There are no sidewalks along US 2 or US 7. There are some limited sidewalks within the Arbor Gardens Residential Complex and the park-and-ride facility. US 7/US2 and US 2 are designated segments of the Lake Champlain Bikeway.

The following shoulder widths are suggested in the *Vermont State Standards* to accommodate on-road bicycle travel based on the functional class, traffic volumes, and speeds in the study area:

- Three feet on US 2 and on US 7 north of the US 2-US 7 intersection; and
- Four feet on US 2/US 7 south of the US 2-US 7 intersection.

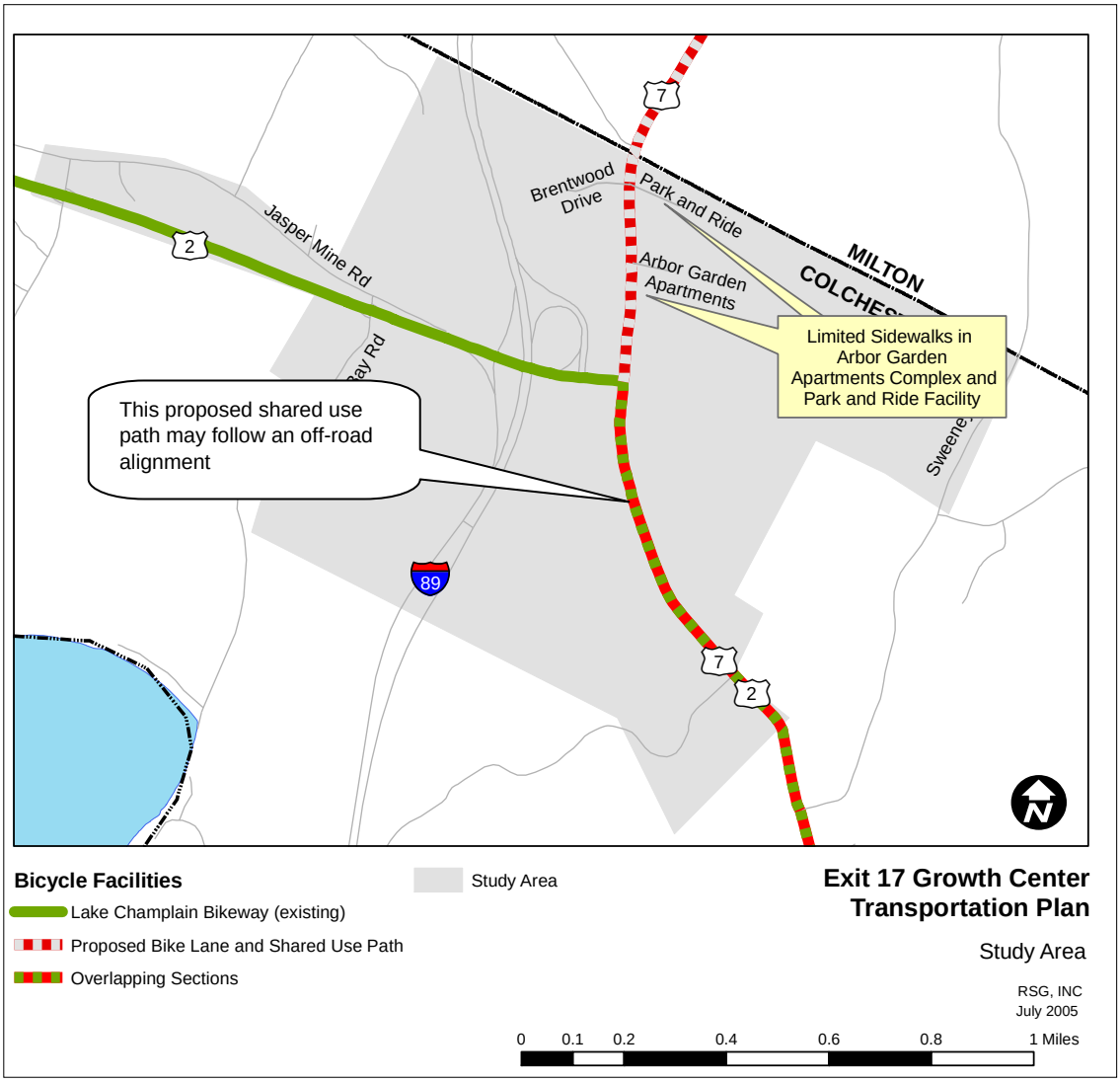
The existing conditions meet these minimum width suggestions with the following exceptions:

- Westbound US 2 between the northbound and southbound I-89 on/off ramps on the overpass (2.5 feet versus 3 feet recommended);
- Eastbound and westbound US 2 between the northbound I-89 on/off ramps and the US 7-US 2 intersection (2 feet versus 3 feet recommended); and
- Northbound US 7 between the US 7-US 2 intersection and the Arbor Garden Apartment Complex (2.3 feet versus 3 feet recommended).

In 2003 the CCMPO issued a Regional Bicycle and Pedestrian Plan with a purpose of providing guidance for the implementation of interconnected bicycle and pedestrian networks for transportation. The CCMPO plan proposes the construction of a shared use path paralleling the entire length of US 7 in Colchester and a bike lane covering the entire length of US 7 in Colchester. These bicycle facilities would extend northward along US 7 to the Milton Town Center.

Figure 6 illustrates current and proposed bicycle and pedestrian facilities in the study area. The existing and proposed bicycle facilities create the spine of a network that could be expanded around the Exit 17 Growth Center as the surrounding land is developed.

Figure 6: Bicycle and Pedestrian Facilities in the Study Area



Park-and-Ride

Suburban and rural park-and-ride lots are primarily intended as a meeting location for car and vanpooling. As a secondary function they have the potential for providing low frequency shuttle or transit service.

A park-and-ride facility is present in the study area approximately ¾ of a mile north of the US 2 and US 7 intersection and is also the site of the new VTrans District 5 Maintenance Facility. This park-and-ride facility, with a capacity of 108 vehicles (5 are designated handicap spaces), was opened in

October, 2003 to replace a smaller facility which provided 32 parking spaces. The new park-and-ride lot is paved, has striped parking spaces, lighting, a shelter, and a bike rack[1].

Two capacity/utilization studies were conducted at the Colchester park-and-ride facility. The first was conducted by VTrans[1], which observed that 20 cars were using the park-and-ride facility in both the AM and PM hours, corresponding to a 19% utilization of total parking capacity. The second study was conducted by the CCMPO[2], which observed 28, 34, 21 vehicles utilizing the park-and-ride facility during an unspecified time of day in May, June, and July of 2004 respectively. These vehicle counts would correspond to utilizations between 19% and 31% of total capacity. A study of the older, smaller Colchester park-and-ride facility conducted by the CCMPO in 2000 states that peak utilization was 28 parked vehicles.

These surveys suggest that (1) the use of the park-ride-facility has remained stable in the last five years and (2) there is adequate capacity at the new park-and-ride facility for the foreseeable future. Use may have increase now that a commuter transit service is provided at this lot.

Transit Service

The Chittenden County Transportation Authority (CCTA) recently began providing an inter-regional commuter route connecting Chittenden County with St. Albans. The service is called the St. Albans Link Express and consists of two round-trips in the morning and afternoon peak hours. The service stops at the Exit 17 Park and Ride lot. Its other stops are Main/Allen street in Winooski, Fletcher Allen/MCHV and Cherry Street in Burlington, Georgia Park and Ride lot at Exit 18, Highgate Commons shopping center on US 7 south of Exit 20 in Saint Albans Town, and the Collins-Perley recreational center in St. Albans near Exit 19.

TRAVEL DEMAND

Traffic Volumes

Average Annual Daily Traffic (AADT) volumes for roads in the study area are presented in Figure 7. AADT volumes were estimated from traffic counts conducted at the study intersections (discussed in detail on page 24).

As seen in Figure 7, I-89 is the most heavily traveled road in the study area. There is a significant increase in AADT on I-89 from north to south of Exit 17. This observation demonstrates that the predominant travel demand in the study area occurs between Milton and Grand Isle County and points south.

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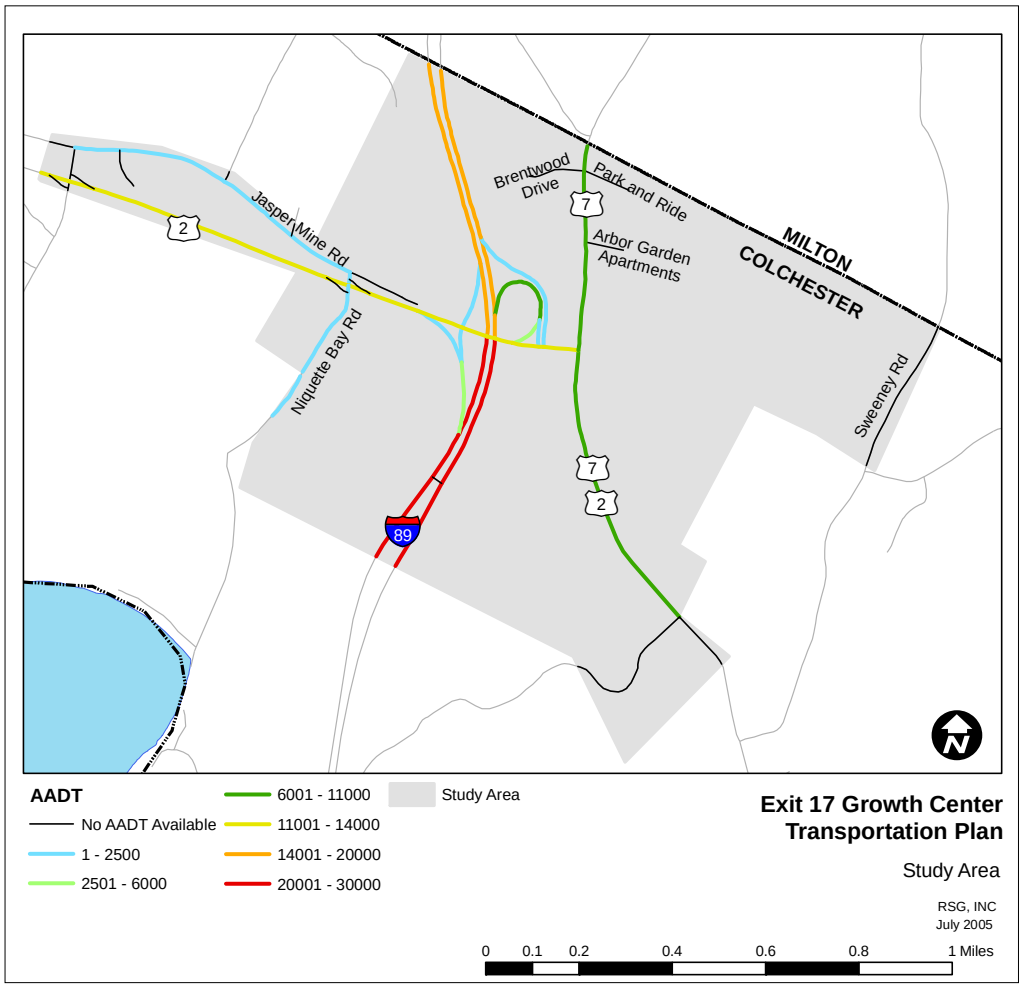
[1] VTrans, "Park-and-ride Study", February 15, 2004.

[2] CCMPO, "Park-and-ride Count Data" 2004 and 2000.

US 2 is more heavily traveled than US 7 in the study area. US 2 is one of two routes connecting Grand Isle County with mainland Vermont and also connects Vermont with Northern New York. Therefore the travel demand on US 2 is drawn from much of Grand Isle County and through traffic to/from Northern New York. US 7, by comparison, predominantly serves travel demand from Milton and several of the smaller surrounding towns and is unlikely to be used for long distance north-south movements given its location relative to I-89.

Figure 7: AADT in Study Area



Hourly traffic variations are captured through the use of automatic traffic recorders (ATRs) placed by VTrans. Recently, in the fall of 2004, two ATR counters were deployed in the study area.

One counter was located on US 2 0.9 miles west of Jasper Mine Road (ATR # S6D019). This location allowed the analysis of the hourly variation of traffic entering and exiting Grand Isle County. The bi-directional traffic flow at this location is graphed in Figure 8. The solid black line represents the flow of traffic eastbound (exiting Grand Isle County) and the dotted line represents the flow of traffic westbound (entering Grand Isle County). The eastbound traffic flow peaks in the morning, while the westbound traffic peaks in the afternoon. These data demonstrate that Grand Isle County, and to a lesser extent New York State, act like a large residential traffic generator that loads onto the Chittenden County roadway system from US 2. Given the increase in AADT south of Exit 17 on I-89, a large proportion of traffic generated from Grand Isle County is accessing I-89 to travel to final destinations.

Data are also available from a counter located on US 7/US 2 1.1 miles south of the US 2-US 7 intersection (ATR # S6D103). In Figure 9 the southbound traffic flow along US 7/US 2 is represented by the solid black line, while the northbound traffic flow along US 7/US 2 is represent by the black dotted line. Comparing Figure 9 to Figure 8, which are both plotted on the same scale, it is obvious that US 2 is more heavily traveled than US 7/US 2. This is likely due to the fact that US 7/US 2 is a parallel secondary route to I-89. Commuters to and from the Lake Champlain Islands, Milton, and smaller surrounding towns are more likely to choose I-89 over US 7/US 2. Additional evidence that commuters are less likely to utilize US 7/ US 2, is that the peaks in directional AM and PM traffic flows are considerable less prominent in Figure 9 than Figure 8.

Figure 8: Bi-Directional Traffic Volumes on US 2 – West of Jasper Mine Road (ATR #S6D019 on 9/30/2004)

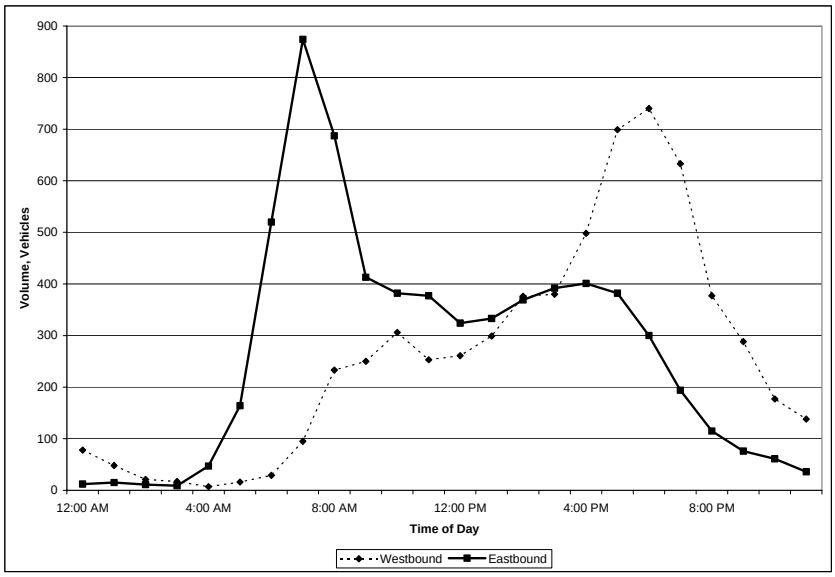
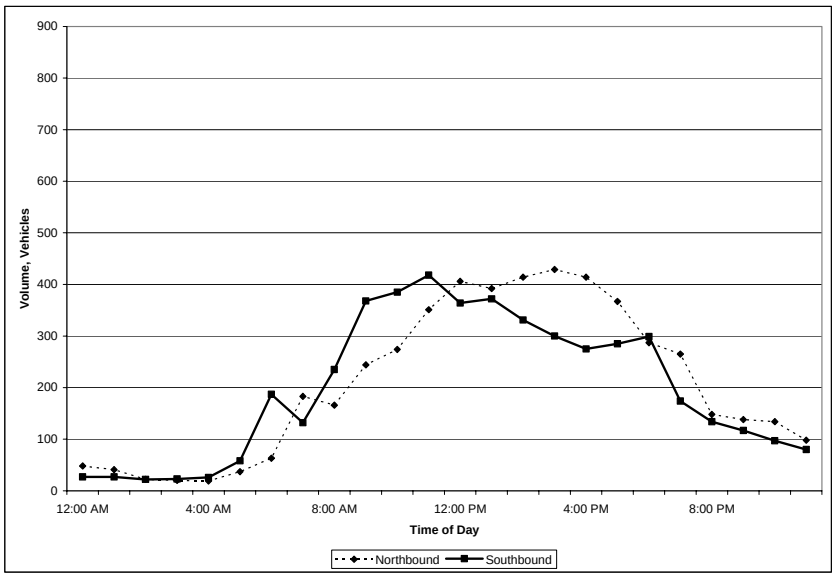
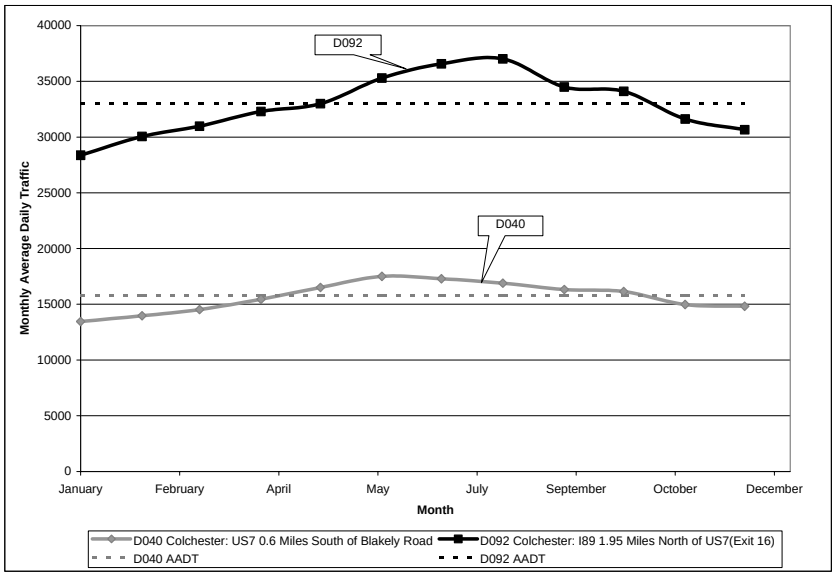


Figure 9: Bi-Directional Traffic Volumes on US 7/US 2 south of Chimney Corners (ATR #S6D103 on 10/26/2004)



While ATRs provide detailed traffic information, they are usually in place for only several weeks. To capture seasonal variations in traffic, data from continuous traffic counters (CTCs) is used. Figure 10 graphs the monthly average daily traffic for CTC-092 (solid black line) located south of exit 17 on I-89 and CTC-040 (solid gray line) located just south of the junction of US 2/US 7 with VT 2A. The average annual daily traffic (AADT) for both locations is also included on the graph for comparison purposes. Figure 10 demonstrates that traffic volumes are highest during the warmer months of May to September. These volumes are most likely driven by the summer homes and general recreation opportunities on Lake Champlain.

Figure 10: Seasonal Traffic Variations for CTC D040 and D092 in Colchester



Population Growth

Data from the 1990 and 2000 censuses, as well as 2004 population estimates, are presented in Table 5. From 1990 to 2000 the populations of Milton, Colchester, Franklin County, and Chittenden County grew at rates between 1.0% to 1.4% per year. These rates are slightly higher than the growth rate of 0.8% for the State of Vermont during the same period. However, Grand Isle County grew over 3 times faster than the State of Vermont and almost two times faster than either Chittenden or Franklin Counties for the same period. These data suggest that traffic volumes on US 2 will grow at a faster pace than traffic volumes on US 7 in the study area.

Table 5: Population Growth in Proximity to Study Area

	Census Year		Estimate	Annual % Increase	
	1990	2000	2004	1990 - 2000	2000 - 2004
Milton	9,982	11,016	11,633	1.0%	1.4%
Colchester	14,731	16,986	17,177	1.4%	0.3%
Grand Isle County	5,318	6,901	7,643	2.6%	2.6%
Franklin County	39,980	45,417	47,556	1.3%	1.2%
Chittenden County	131,761	146,571	149,286	1.1%	0.5%
Vermont	562,758	608,827	621,394	0.8%	0.5%

US Census Journey-to-Work Data

Table 6 shows the journey to work data for Milton from the 2000 census. The top table (Commuting from Milton) shows the place of work for people that live in Milton. The bottom part of the table (Commuting to Milton) shows where people who work in Milton live.

Examining the top table (Commuting from Milton), it is observed that only 20% of Milton residents work in Milton. The vast majority of Milton residents commute to other locations in Chittenden County to work. The increase in AADT on I-89 south of Exit 17, as illustrated in Figure 7, is caused in part by Milton residents traveling on I-89 to places of employment in the rest of Chittenden County. It is also evident that Milton residents prefer to use I-89 over US 7/ US 2 since the bi-directional traffic flows at on US 7/2 south of Chimney Corners (Figure 9) lack prominent AM and PM peaks.

As indicated in the bottom table (Commuting to Milton) it is observed that 43% of the people who work in Milton are residents of Milton. Roughly equal number of commuters travel south from Franklin County and destinations north (28%) and north from Chittenden County (23%).

Examining the raw numbers from both the top and bottom tables reveals that approximately 4,000 people from Milton commute south, while only 600 people who work in Milton commute from the south. These data are consistent with the traffic flows documented in Section 0.

Table 6: 2000 Census Journey to Work Data for Milton, VT

Commuting From Milton

Destination	Raw Count	Percent
Milton	1045	20%
Chittenden County excluding Milton	3901	74%
Franklin County and Destinations North	202	4%
Destinations South and East of Chittenden County	91	2%
Grand Isle County and Destinations West	10	<1%

Commuting to Milton

Origin	Raw Count	Percent
Milton	1045	43%
Chittenden County excluding Milton	549	23%
Franklin County and Destinations North	689	28%
Destinations South and East of Chittenden County	88	4%
Grand Isle County and Destinations West	52	2%

Table 7 presents the same type of journey to work data for all of Grand Isle County. About one-third (32%) of Grand Isle County residents work and live in Grand Isle County. Almost half (48%) of Grand Isle County residents commute to Chittenden County (excluding Milton), 11% commute to Franklin County, and 2% commute to destinations south and east of Chittenden County. These three destination categories most likely utilize I-89 and comprise 61% of the working population on Grand Isle. Half (50%)of the commuters will likely travel southbound on I-89, while 11% will likely travel northbound on I-89. By adding the 2% of the Grand Isle County working population that commutes to Milton and destinations east, it is determined that 63% of the working population of Grand Isle County utilizes US 2 to commute to work. The heavy daily commuting traffic on US 2 is supported by the prominent AM and PM peaks in bi-directional traffic flow on US 2 as seen in Figure 8.

The bottom table (Commuting to Grand Isle County) indicates that 82% of the people who work in Grand Isle County are residents of Grand Isle County. This high percentage is due to the fact there is little commercial or industrial development on Grand Isle that would attract commuters from else where.

Table 7: 2000 Census Journey to Work Data for Grand Isle County, VT

Commuting From Grand Isle County

Destination	Raw Count	Percent
Chittenden County excluding Milton	1640	48%
Grand Isle	1103	32%
Franklin County and Locations North	393	11%
New York State and Locations West	157	5%
Milton and Locations East	73	2%
Destinations South and East of Chittenden County	54	2%

Commuting to Grand Isle County

Destination	Raw Count	Percent
Chittenden County excluding Milton	152	11%
Grand Isle	1103	82%
Franklin County and Locations North	49	4%
New York State and Locations West	28	2%
Milton and Locations East	10	<1%
Destinations South and East of Chittenden County	2	<1%

Truck Traffic

Figure 11 and Figure 12 display the hourly truck volumes on US 2 west of Jasper Mine Road and on US 7/US 2 south of Chimney Corners respectively. Truck traffic peaks during the mid-day on US 2. There is no distinguishable peak in truck traffic on US 7/US 2 south of Chimney Corners. Truck traffic is considerably higher on US 2 than US 2/US 7. This difference is most likely due to the fact

that I-89 carries the bulk of north-south truck traffic while US 2 is the only significant east-west connection in the study area.

Figure 11: Bi-Directional Truck Volumes on US 2 – West of Jasper Mine Road (ATR #S6D019 on 9/30/2004)

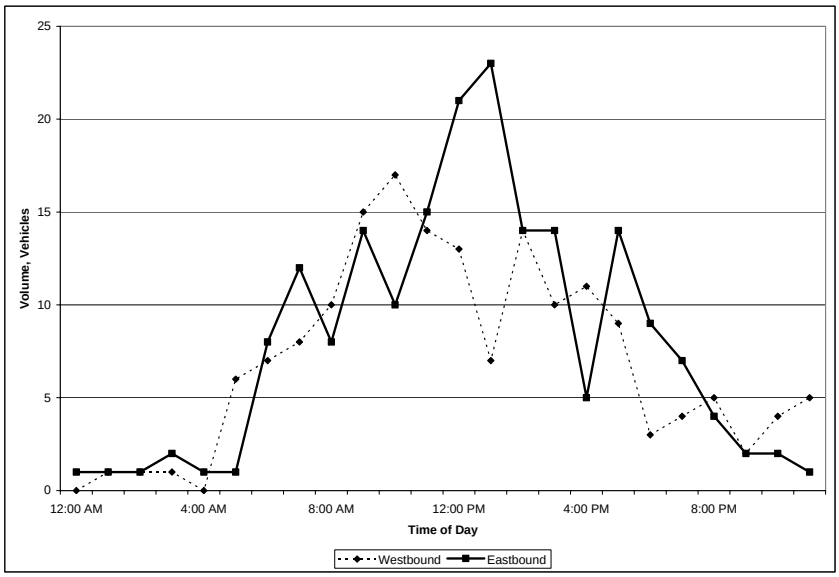
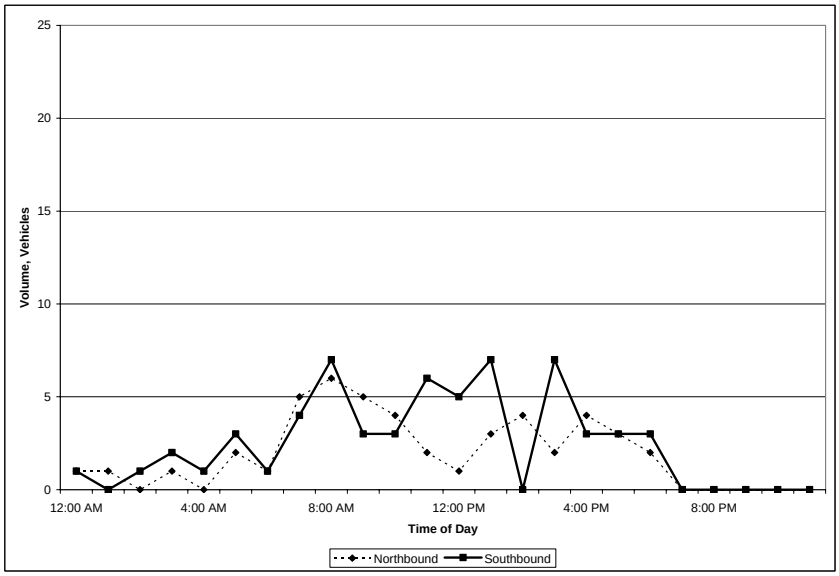


Figure 12: Bi-Directional Truck Volumes on US 7/US 2 south of Chimney Corners (ATR #S6D103 on 10/26/2004)



EXISTING SYSTEM PERFORMANCE

Congestion Analysis

This section describes the development of 2005 ad 2025 AM and PM design hour volumes, explains the methodology used to assess congestion, and presents delay, level of service and queuing results for the study intersections.

Development of 2005 AM and PM Peak Hour DHV Volumes

Turning movement counts for the study intersections were conducted on the dates shown in Table 8. The majority of intersections experienced the AM peak hour of traffic from 7:00 AM to 8:00 AM and the PM peak hour from 4:30 PM to 5:30 PM.

Table 8: Intersection Traffic Count Dates

Intersection	TM Count Date
US7 - Jasper Mine Road	5/19/2005
US2-I89 SB Ramps On/Off	6/16/2004
US2-I89 NB Ramps On/Off	6/16/2004
US2-US7	6/2/2005
US7 - Arbor Gardens Apartment Complex Driveway	5/19/2005
US7 - Park and Ride	5/19/2005

The raw traffic counts have been modified to represent the design hour volume (DHV)[1] in 2005 using two adjustment factors:

- The design hour adjustment factor is based on VTrans Continuous Traffic Counter (CTC) D040, located on US 7 in Colchester. This counter collects traffic volumes 365 days per year, 24 hours per day. These data describe the daily fluctuations in traffic volumes and are used to adjust a ground count conducted on a specific date to the design hour. The counts conducted on 6/16/2004 were increased by 3% and the other counts were decreased by 1% to reflect design hour conditions.
- An annual adjustment factor, which represents general background traffic growth, is based on the growth rate for urban areas in the 2004 VTrans Redbook. The base year annual adjustment factor increased the raw 2004 volumes by 1% to represent 2005 conditions.

Figure 14 presents the 2005 design hour volumes for the AM and PM peak hour.

Raw turning movement count data and adjustments are provided in Appendix A.

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

Figure 13: 2005 AM Peak Hour Volumes

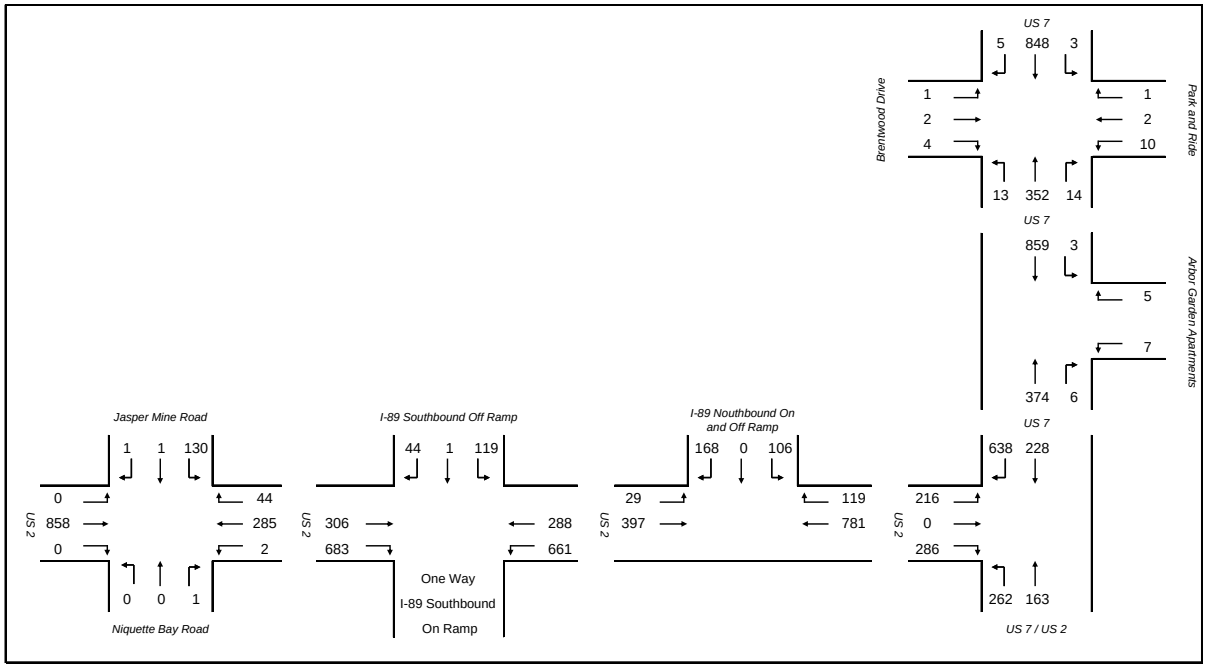
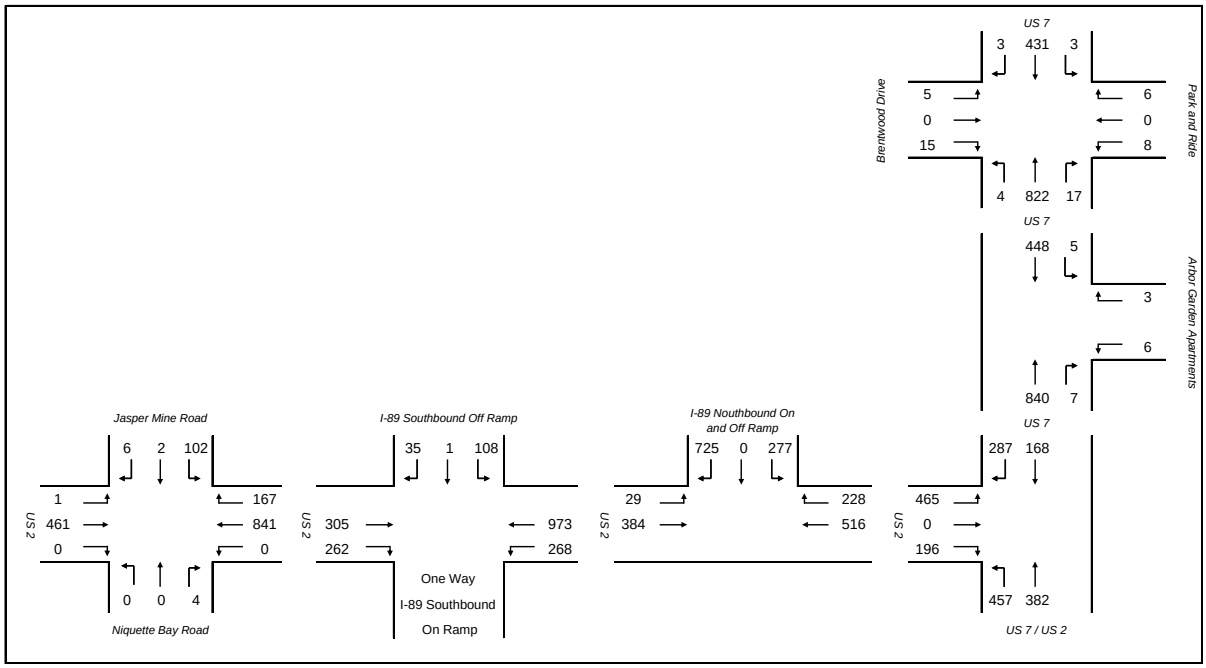


Figure 14: 2005 PM Peak Hour Volumes



LOS Methodology

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

Table 9 shows the various level-of-service grades, qualitative descriptions, and quantitative definitions for unsignalized and signalized intersections.

Table 9: LOS Criteria for Intersections

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

The VTrans policy on LOS states that, principal and minor arterials in urban or village areas will generally be designed for a level of service C or better. However, in heavily developed urban areas, reduced level of service criteria such as E or F may be appropriate as judged on a case by case basis. For the purpose of this study, the assumed performance target is LOS D or better.

LOS Results

Synchro (v6), a traffic analysis software package from Trafficware, was used to quantify delay, level of service, and vehicle queues at the study intersections. The software uses procedures that are consistent with those specified in the 2000 Highway Capacity Manual.

The LOS results for the 2005 AM and PM peak hours are shown in Table 10. The results utilize the existing traffic signal timings which were provided by VTrans. Both signalized and unsignalized intersections are reported in each table.

The LOS and delays are reported for each approach and for the overall intersection where traffic signals exist. At stop-controlled intersections, overall LOS and delay are not provided. Through traffic on the major street is seldom delayed and typically has much higher traffic volumes. As a result, the overall intersection LOS at unsignalized intersection is less meaningful. Detailed LOS worksheets are provided in Appendix B.

The congestion analysis indicates that in 2005, poor level of service (LOS F) is limited to the minor street approach of Jasper Mine Road to US 2 during the AM and PM peak hours while all other intersections operate at LOS D or better.

Table 10: LOS Results for 2005 and 2025 AM Peak Hours

	2005 - AM		*2005 PM*	
US7 - Jasper Mine Road Unsignalized	LOS	Delay	LOS	Delay
Northbound: Niquette Bay Road	C	15	B	11
Southbound: Jasper Mine Road	F	78	F	106
US2-I89 SB Ramps On/Off Signalized	LOS	Delay	LOS	Delay
Overall	**B**	**14**	**B**	**10**
Eastbound: US 2	B	20	B	10
Westbound: US 2	A	10	A	8
Southbound: I89 SB Off Ramp	C	25	C	29
US2-I89 NB Ramps On/Off Signalized	LOS	Delay	LOS	Delay
Overall	**A**	**8**	**C**	**21**
Eastbound: US 2	A	5	C	25
Westbound: US 2	A	8	C	21
Southbound: I89 NB On/Off Ramps	C	23	B	15
US2-US7 Signalized	LOS	Delay	LOS	Delay
Overall	**C**	**22**	**B**	**18**
Eastbound: US 2	C	31	C	21
Northbound: US 2/ US 7	B	10	B	15
Southbound: US 7	C	23	B	20
US7 - Arbor Gardens Apartment Complex Driveway Unsignalized	LOS	Delay	LOS	Delay
Westbound: Arbor Garden Apartments	C	19	D	26
Southbound: US 7	A	<1	A	<1
US7 - Park and Ride - Unsignalized	LOS	Delay	LOS	Delay
Eastbound: Brentwood Drive	C	21	C	16
Westbound: Park and Ride	D	30	D	25
Northbound: US 7	A	<1	A	<1
Southbound: US 7	A	<1	A	<1

Queuing Analysis

Vehicle queues at critical turning lanes (a lane where the possibility exists for vehicles to spill back and block adjacent lanes) were estimated using Synchro. Estimated queue lengths for each critical lane approach are presented in Table 11 for the AM and PM peak hours in 2005. As with the estimated delays, the estimated queues below should be anticipated for only peak periods, rather than average conditions. The queuing analysis for the 2005 AM and PM peak hour scenarios utilize the current signal timings acquired from VTrans.

As shown in Table 11, none of the projected queues exceed available storage under existing conditions.

Table 11: Queuing Analysis Results for AM and PM 2005 and 2025 Peak Hours

	Available Storage Space, ft.	50th Percentile Queue Length by Scenario, ft	
		2005 AM	2005 PM
US 2 - I-89 SB On/Off Ramps			
Westbound: US 2, Left	570	106	31
US 2 - I-89 NB On/Off Ramps			
Eastbound: US 2, Left and Through	899	55	144
US 7 - US 2			
Eastbound: US 2, Left	183	62	151
Eastbound: US 2, Right	183	0	15
Northbound: US 7, Left	300	53	124
Southbound: US 7, Right	278	0	5

Safety Analysis

Crash data were obtained from VTrans from 1999 through 2003 for the US 2, US 7, and US 7/US 2 roadway segments within the study area. VTrans identifies High Crash Locations (HCL) based on the number of crashes that involve injuries, fatalities, or those that exceed $1,000 in property damage. Figure 15 shows the locations of crashes that meet these requirements from 1999-2003 in the study area.

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

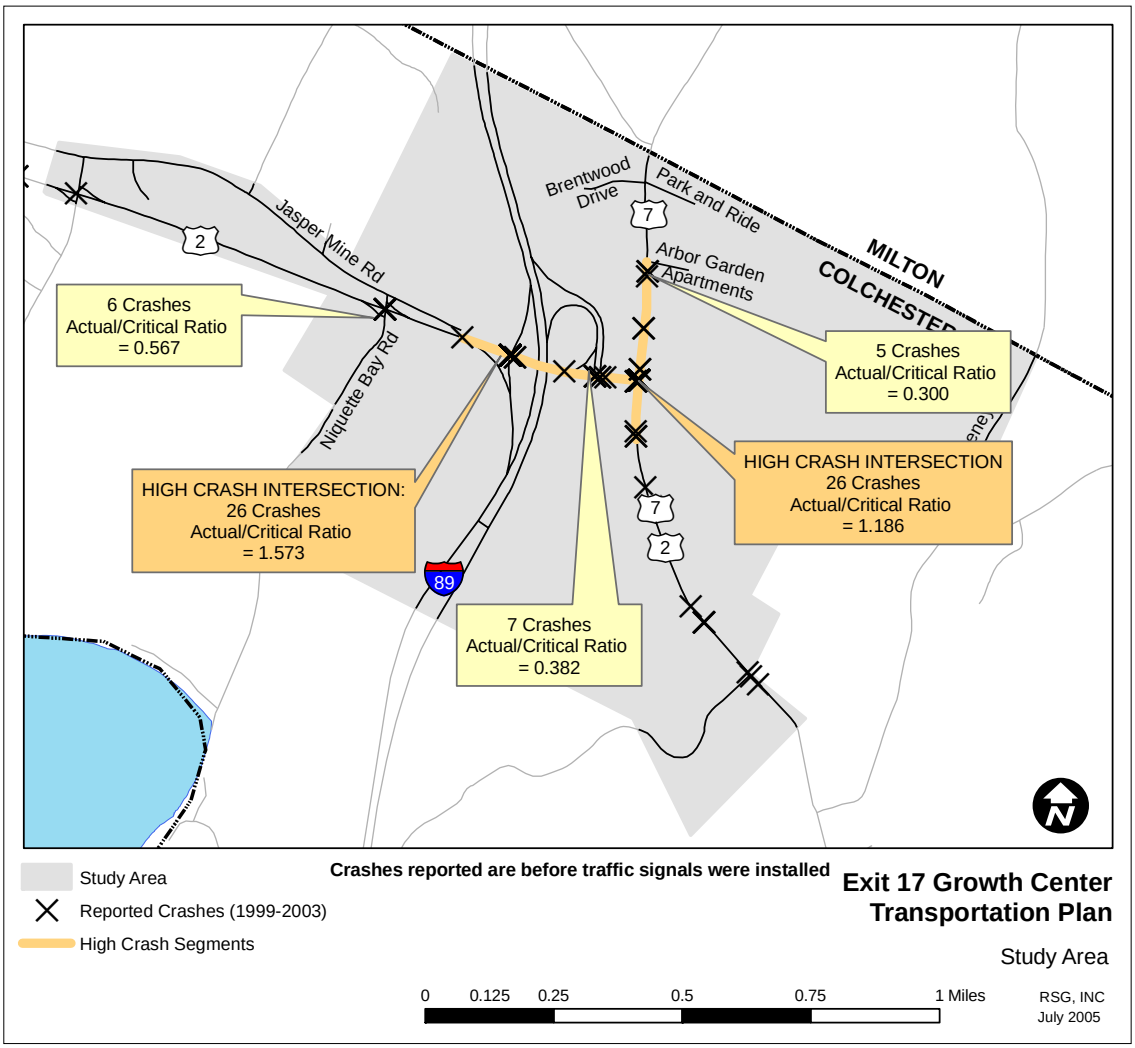
The following locations satisfy the HCL criteria based on 1999-2003 crash data:

- The US 7 road segment from the Arbor Garden Apartments to 0.1 mile south of the US 7–US 2 intersection; and
- The US 7-US 2 intersection.

An analysis of the 1999-2003 crash data also indicate that high crash locations exist at: the US 2 road segment from the I-89 Southbound Ramps to the US 7–US 2 intersection; and at the US 2-Southbound Ramps intersection. However, the HCL analysis for these locations is no longer valid because VTrans installed traffic signals at each ramp in 2003. Whether or not the traffic signals have addressed the safety issues at these locations can not be verified at this time because crash data are not yet available beyond 2003.

Crash data are contained in Appendix C.

Figure 15: Crash Locations, High Crash Intersections, and High Crash Segments from 1999-2003



Access Management Assessment

There are only three commercial driveways with direct access to US 7 and no commercial driveways accessing US 2 in the study area. There is adequate separation between driveways, adequate corner clearance between the roadway intersections and driveways, and with one minor exception, the existing driveways and intersections have been designed in accordance with VTrans standards.

There are examples of good access management practices in the study area such as: shared access between the Arbor Garden Apartments complex and the landscape business; the driveway serving the park-and-ride is aligned with the opposite street intersection (Brentwood Drive), and driveways to both gas stations north and south of the Chimney Corners intersection have adequate corner clearance.

Following is a list of access management issues that are common along many roadways. Each issue is described followed by observations related to the study area.

- ***Issue: Poor definition and/or continuous curb cuts.*** Driveways should be designed with clearly defined borders that safely channel traffic between the street and parking area. Wide open curb cuts cause confusion by mixing entering and exiting traffic, creating additional conflict points, and often obscure sidewalks (where they exist).

  Study Area Condition: The gas station located on US 7/US 2 south of Chimney Corners has two driveways that are somewhat wider than desirable. VTrans guidelines suggest access widths between 30-40 feet for two-way driveways that serve multi-unit vehicles. The existing driveways are each 55-60 feet wide. All other existing commercial driveways satisfy the access width guidelines and are well defined.

- ***Issue: Lack of adequate spacing between driveways.*** Adequate spacing between driveways provides the distance necessary for drivers to react to vehicles entering and exiting a driveway. Although there are no national standards that provide minimum driveway spacing distances, VTrans uses the lower limit of the AASHTO stopping sight distance[1]. Given the posted speed limit of 50 miles per hour through most of the study area, the resulting driveway spacing is 425 feet.

  Study Area Condition: The distances between the gas station driveway, the Arbor Gardens Apartment Complex driveway, and the park-and-ride entrance all exceed the minimum spacing distance.

- ***Issue: Poor alignment with driveways or intersections on opposite sides of the road***. Driveways on opposite sides of a road should be aligned to reduce the number of potential conflict points. If driveways on opposite sides of road can not be aligned, they should be

[1] "Vermont Agency of Transportation Access Management Program Guidelines"; Utilities and Permits Unit, Technical Services Division; July 17, 2000.

separated by the same distance recommended for driveways on the same side of the road (425 feet for the 50 mph posted in the study area).

Study Area Condition: There are no issues in the study area. An example of good access management practice is the alignment of the relatively recent driveway serving the park-and-ride lot and VTrans District Garage with Brentwood Drive.

- ***Issue: Inadequate corner clearance***. Corner clearance is the distance between the edge of a street intersection and a driveway. Insufficient corner clearance causes conflicts between vehicles within a functional area of an intersection and vehicles entering and exiting a driveway. The functional area of an intersection includes the approaches where vehicles may be changing lanes, merging, accelerating or decelerating, or forming queues as they wait at traffic signals or to exit from a stop-controlled side street. Recommended corner clearance varies based upon the movements allowed at a driveway (for example: right-out/right-in versus all movements allowed); and whether or not a driveway is located downstream or up-stream from an intersection. The largest recommended corner clearance is 230 feet.

  Study Area Condition: The corner clearances between Chimney Corners and the access points to the gas stations located to the north and south of 330 and 475 feet respectively exceed the guideline. There are no other commercial driveways near any of the other intersections.

- **Multiple access points for a single parcel**. VTrans limits the number of access points for new projects along state highways to one per parcel. It is desirable to limit access points because each one creates potential conflict points

  Study Area Condition: The gas station located on US 7/US 2 south of Chimney Corners is served by two two-way driveways. Access to all other existing development is limited to one driveway.

NATURAL AND CULTURAL RESOURCES

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

- Wetlands;
- Steep Slopes; and
- Endangered Species and Deer Wintering Areas.

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

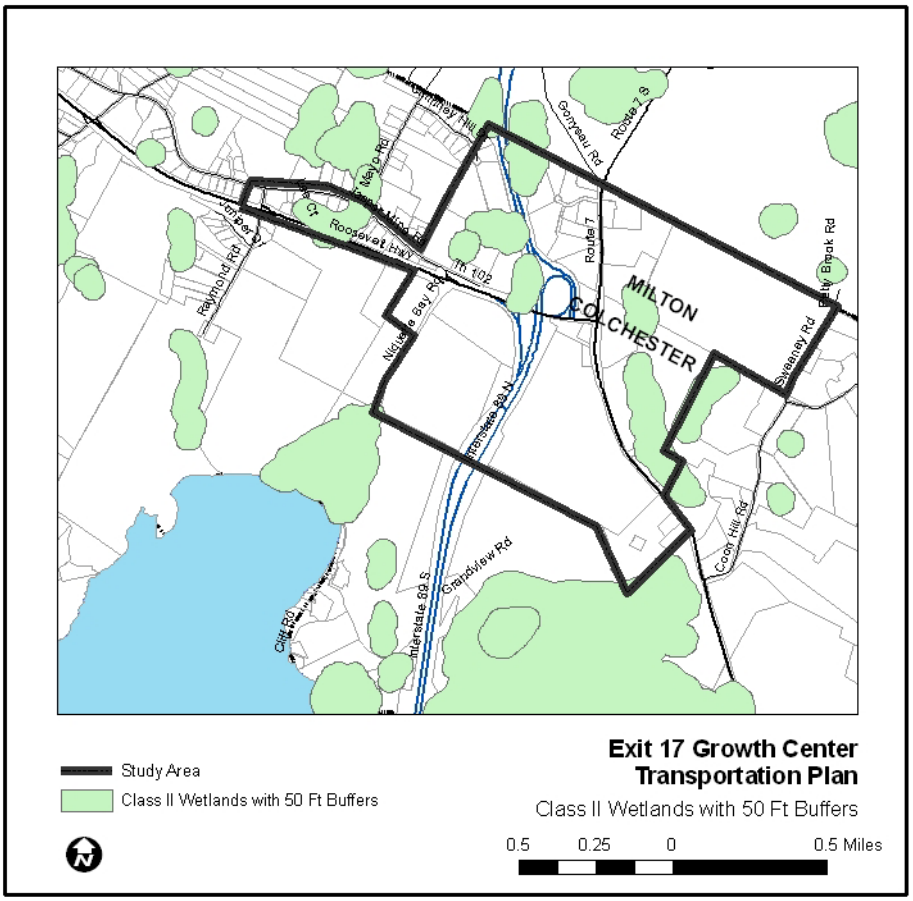
Wetlands

Figure 16 shows the extent of identified Class II wetlands adjacent to the study corridor. The wetland boundaries are based on the Vermont Significant Wetlands Inventory developed by the Vermont Agency of Natural Resources. All Class II wetlands, including a 50-foot protective buffer, are

protected under the Vermont Wetland Rules. Any intrusion into the identified wetland or its buffer requires a Conditional Use Determination from the Water Quality Division of the Department of Environmental Conservation.

The Class II wetlands in the study area are clustered near the southbound off-ramp and east of US 7/2. The first cluster may affect the design options at the Exit 17 interchange. The cluster east of US 7 could affect the location of new local roadways.

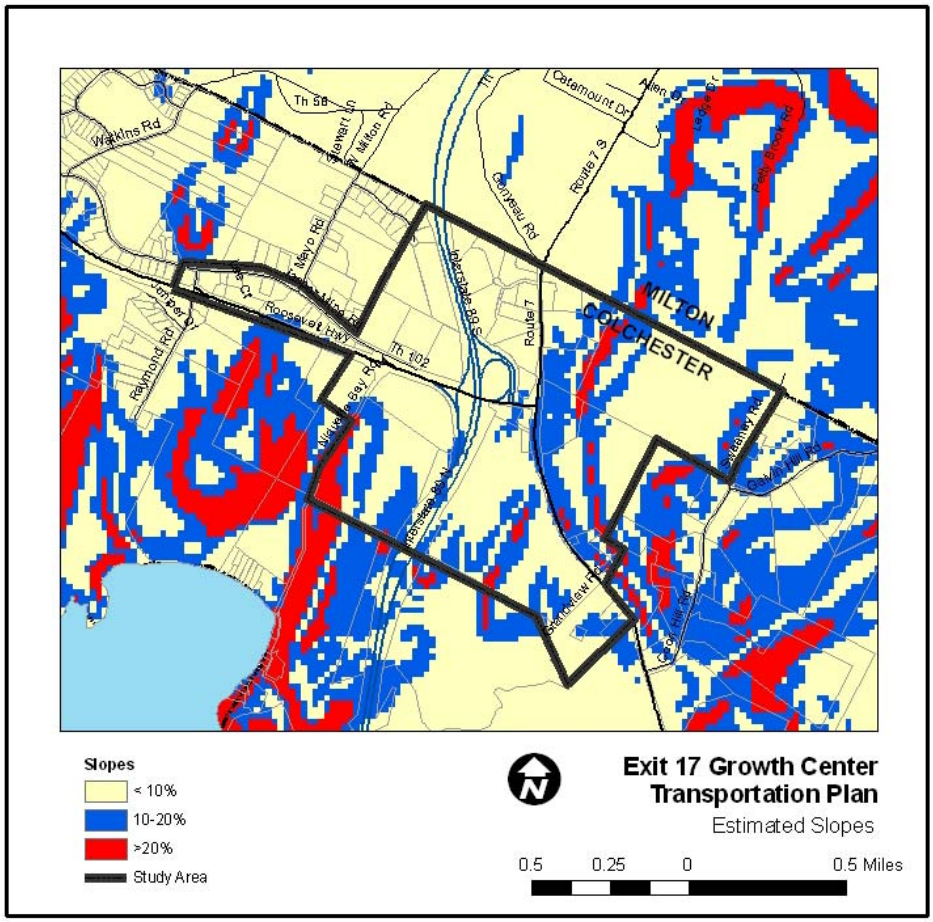
Figure 16: Wetlands In or Near the Study Area



Steep Slopes

Figure 17 shows a composite image of estimated slopes in and near the study area. Most of the study area has slopes less than 10%. The steeper slopes in the study area are located parallel to and just east of US 7 in a ravine that runs in a north-south direction. This ravine cause somewhat of a barrier to providing access to the large parcels east of US 7.

Figure 17: Steep Slopes

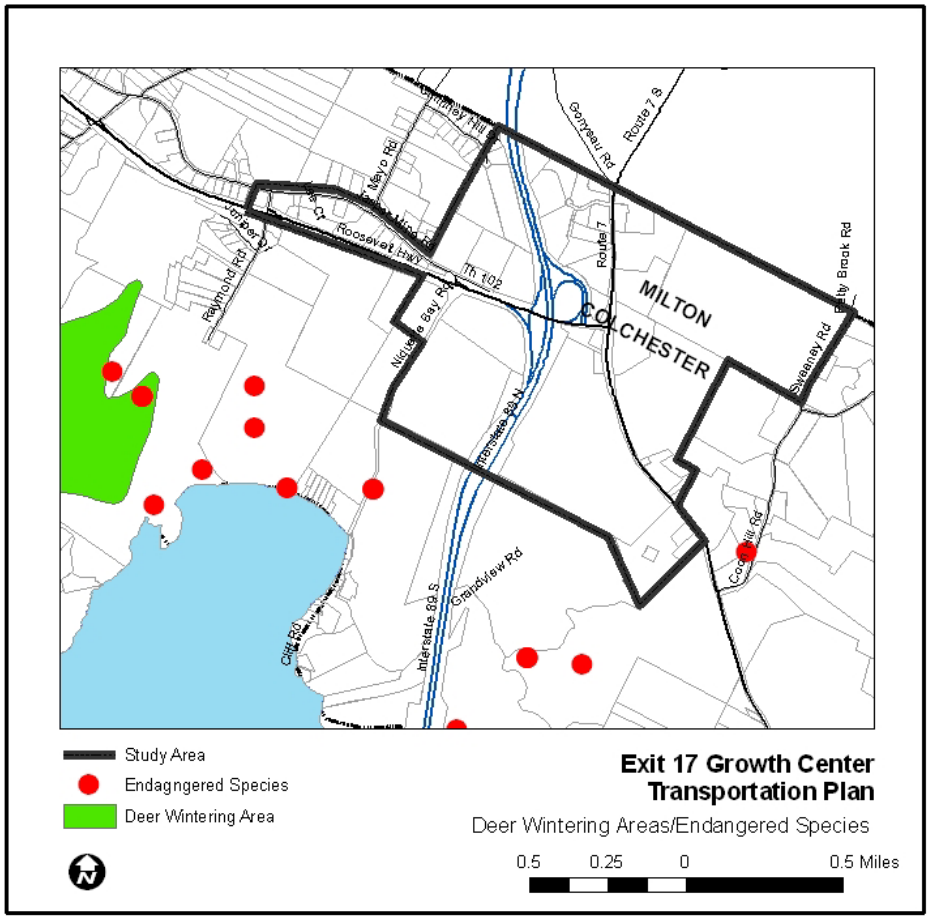


Rare, Threatened and Endangered Species and Deer Wintering Areas

Figure 18 shows the location of rare, threatened, or endangered species as defined by the Vermont Department of Fish and Wildlife as well as identified deer wintering areas based on boundaries established by the Vermont Agency of Natural Resources. Deer wintering areas generally begin at the edge of mature coniferous tree cover. Any disturbances on either identified endangered species grounds or deer wintering areas may require special permitting and/or mitigation.

As the graphic shows, there are no identified threatened species or deer wintering areas within the study area.

Figure 18: Endangered Species and Deer Wintering Areas



EXISTING CONDITIONS SUMMARY

Previous Transportation Plans and Studies

The Georgia-Winooski US 7 Corridor Study and the CCMPO Metropolitan Transportation Plan (MTP) identify several projects and services for the Exit 17 Growth Center. The most significant projects include:

- Establishing a transportation management association that includes Milton and the Exit 17 Growth Center;
- Reconstruction of the Exit 17 interchange and new interchange at West Milton Road;
- Expanding commuter transit service to Milton with a stop at the Exit 17 park-and-ride lot;
- Completion of the Circumferential Highway; and

- Shared use bike path connecting the Colchester bike path to the Milton Town Core

Transportation System Characteristics

- US 7 and US 2 are classified as urban arterials. The *Vermont State Standards* provide a significant amount of flexibility in selecting lane and shoulder widths for arterials that pass through built-up urban and village areas. The flexibility allowed for urban arterials provides an opportunity to change the characteristics of the roadways through the Exit 17 area as the surrounding land is developed.
- US 7 is designated as part of the Vermont Truck Network. Because of this designation, recommendations related to the re-design of Chimney Corners that may result from this study should accommodate trucks with overall lengths of 72 feet. This requirement will affect turning radii and should be considered in selecting appropriate lane widths.
- Existing lane widths satisfy the minimums recommended in the *Vermont State Standards*. With the exception of US 2 near the I-89 interchange and the northbound side of US 7 between Chimney Corners and Arbor Garden Apartments, the existing shoulder widths also satisfy the *Vermont State Standards*.
- There are no sidewalks along US 2 or US 7. There are some limited sidewalks within the Arbor Gardens Apartment Complex and the park-and-ride facility.
- The existing shoulders and proposed bicycle facilities create the spine of a network that could be expanded around the Exit 17 Growth Center as the surrounding land is developed.

Travel Demand

- AADT, hourly traffic variations, and journey to work data all indicate that the overall traffic pattern in the study area is significantly affected by commuters from Grand Isle County and Milton. These travel patterns are characterized by a distinctive southbound flow of traffic towards the center of Chittenden County during the AM peak hour and an northbound flow in the PM peak hour. Much of this traffic is utilizing the I-89 Exit 17 interchange.
- The Colchester park-and-ride lot was expanded recently from 32 to 108 total spaces. Past and current surveys indicate that (1) the use of the park-ride-facility has remained stable in the last five years (approximately 30 parked cars during peak periods); and (2) there is adequate capacity at the new park-and-ride facility for the foreseeable future.

Congestion, Safety, and Access Management

- In 2005, poor level of service (LOS F) is limited to the minor street approach of Jasper Mine Road to US 2 during the AM and PM peak hours while all other intersections operate at LOS D or better.

- The following locations satisfy the High Crash Location criteria based on 1999-2003 crash data:
    - The US 7 road segment from the Arbor Garden Apartments to 0.1 mile south of the US 7–US 2 intersection; and
    - The US 7-US 2 intersection.
- An analysis of the 1999-2003 crash data also indicate that high crash locations exist at: the US 2 road segment from the I-89 Southbound Ramps to the US 7–US 2 intersection; and the US 2-Southbound Ramps intersection. However, the HCL analysis for these locations is no longer valid because VTrans installed traffic signals at each ramp in 2003.
- There are only three commercial driveways with direct access to US 7 and no commercial driveways accessing US 2 in the study area. There is adequate separation between driveways, adequate corner clearance between the roadway intersections and driveways, and with one minor exception, the existing driveways and intersections have been designed in accordance with VTrans standards.
- The study area includes good examples of access management practices: shared access between the Arbor Garden Apartments complex and the landscape business; the driveway serving the park-and-ride is aligned with Brentwood Drive on the opposite side of the road; and the driveways for the stations on US 7 north and south of Chimney Corners have adequate corner clearance. In addition, the designation of US 2 near the Exit 17 ramps and US 7 on its approaches to Chimney Corners as a limited access highway will protect the operation of the interchange from poor location of commercial driveways.

Natural Resources

- Existing Class II wetlands may affect design options for the interchange and the location of new local roads east of US 7.
- Most of the study area has slopes of less than 10%. Steep slopes located east of US 7 may affect the location of new local roads.
- There are no deer wintering areas or endangered species located within the study area.

PART II: FUTURE CONDITIONS

This part of the report develops two land use scenarios for the Ext 17 Growth Center, quantifies the amount of traffic that would be generated, forecasts traffic volumes for 2025, and projects levels of congestion at the study intersections assuming no modifications are made. It also evaluates the effect of constructing the complete Circumferential Highway and a new interchange between I-89 and West Milton Road in Milton.

EXISTING LAND USE CHARACTERISTICS

Figure 19 on the following page shows the zoning districts located within the study area. The existing land use is also shown in Figure 19 within the study area and for the surrounding area in Colchester and Milton. The existing land use has been identified using the E911 site location dataset. The data have been organized into the general categories described in Table 12

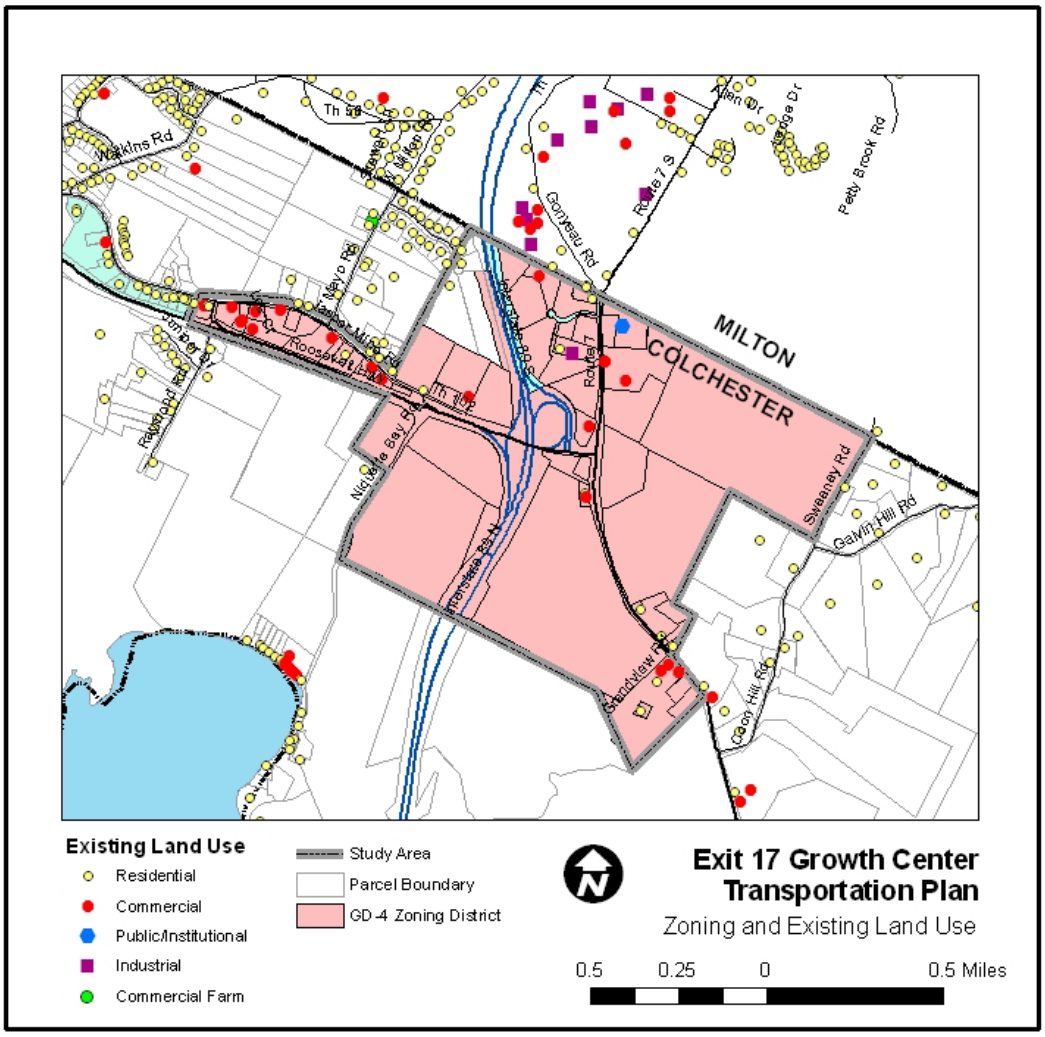
Table 12: Description of General Land Use Categories

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

All of the study area is located within the General Development 4 (GD4) zoning district. The purpose of this zoning district is to encourage of mix of residential and non-residential uses. Commercial uses should be smaller scale (less than 20,000 square feet) and are intended to serve adjacent uses in the Growth Center and pass-by traffic rather than serve as a major regional attraction.

Most of the land in the study area is currently open. A few large and mostly vacant parcels contain the majority of land within the study area. The existing land use within the study area is predominantly small scale commercial. Residential uses exist mostly on the edge of the study area.

Figure 19: Zoning and Existing Land Use



FUTURE LAND USE SCENARIOS

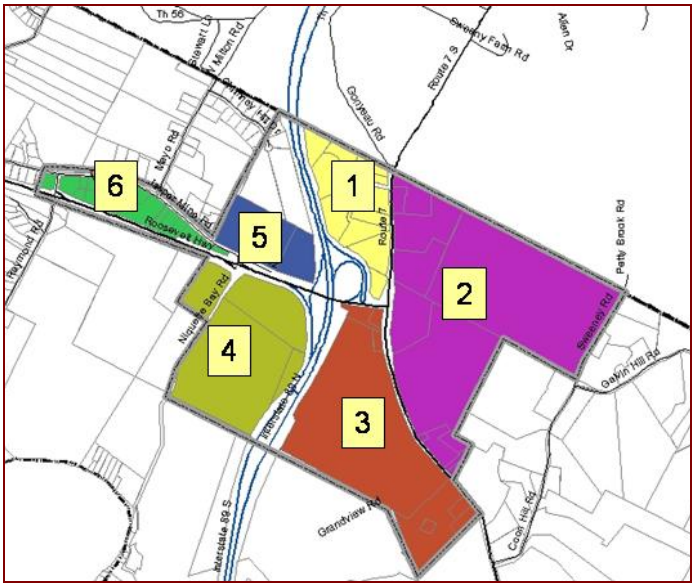
For the purpose of this study, the Exit 17 Growth Center has been divided into the six transportation analysis zones (TAZs) shown in Figure 20. Two land use scenarios are developed which identify the number of new housing units and square footage of commercial uses that could occur in each TAZ if off-site wastewater facilities are provided. The two land use scenarios correspond to the Phase 1 and Phase 2 off-site wastewater capacity options as designed and recommended in the 2003 Decentralized Wastewater Study (DWW).

The methodology used to determine development potential is consistent with the build-out analysis used in the DWW, modified to account for recent zoning updates and the technical needs of a transportation study. The development potential methodology is as follows:

- Estimate the amount of buildable land;
- Apply local zoning parameters to determine the total development potential of the study area assuming no constraints to water and waste-water exist;
- Adjust the full development potential to account for the Phase 1 and Phase 2 wastewater capacity as proposed in the DWW; and
- Determine net-new development potential.

Additional information on each step is provided below.

Figure 20: Exit 17 Transportation Analysis Zones

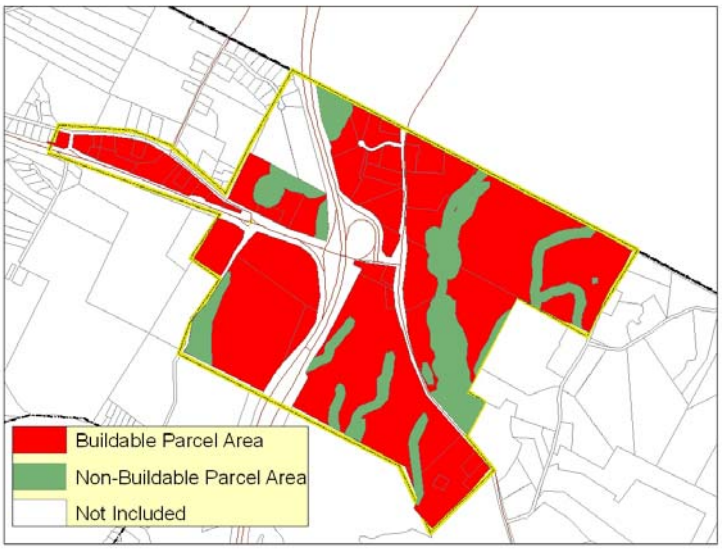


Determine Buildable Land

Figure 21 identifies the buildable area within the Exit 17 Growth Center. The natural and physical constraints that are protected from development are: wetlands plus a fifty-foot buffer; streams plus an eighty-five foot buffer; and slopes greater than 25%. The wetland boundaries are based on GIS data of the Vermont Significant Wetlands Inventory developed by the Vermont Agency of Natural Resource (available from the VT Center for Geographic Information). The streams, plus the 85 foot buffers, were digitized from recent high resolution orthophotos. The steep slopes were identified from GIS data available from the Vermont Center for Geographic Information. Various GIS spatial

analyses and data management techniques were used to quantify the buildable area within each parcel located within the study area.

Figure 21: Buildable Area



Zoning Assumptions

The key zoning assumptions are:

- The minimum lot size for one residential unit is 10,000 square feet (0.23 acres);
- The minimum lot size for a commercial building is 20,000 square feet (0.46 acres);
- Half of the land within the study area is developed as a planned unit development (PUD) which allows 20,000 square feet of commercial space per 50 residential units;
- In the balance of land that is not part of a PUD, 75% is developed as residential and 25% commercial;
- There is a maximum of one commercial building per parcel outside of a PUD; and
- 25% of a parcel's buildable area is utilized for roads, sidewalks, etc and is therefore not available for development.

The DWW considered five different scenarios that varied the amount of land assumed to be developed as residential, commercial, and PUD. However, the final recommendations for Phase 1 and Phase 2 were based on, for the most part, the assumptions listed above. The only differences result from revisions to zoning since 2003 that have increased the minimum lot size for residential to 10,000 square feet and changed all zoning in the study area to GD4.

Determine Land Use Based on Wastewater Capacity and Local Development Plans

The land use buildout estimates developed in the DWW study were refined based on interviews with several owners of large parcels within the study area. Figure 22 identifies the parcels in the study area that (1) depend on off-site wastewater to achieve their development potential; (2) parcels that already have permits and therefore have satisfied their wastewater needs; and (3) parcels whose owners have indicated that they have enough on-site capacity to meet their development plans.

Figure 22: Parcels Constrained by Off-Site Wastewater Availability

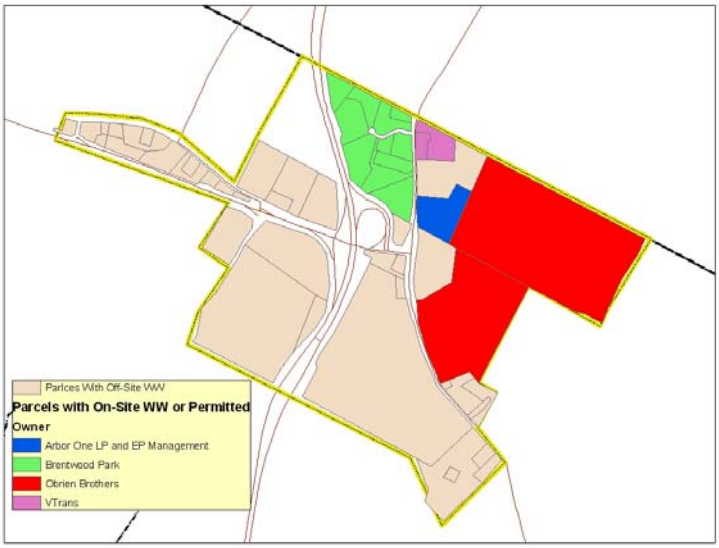


Table 13 describes three possible land use scenarios. The buildout scenario assumes there are no wastewater constraints in the study area and that all parcels are developed to their fullest potential accounting for the physical constraints and zoning assumptions described above.

The Phase 1 scenario assumes that there is 120,500 gallons per day of off-site wastewater available to the parcels identified in Figure 22. Phase 1 also assumes that the O'Brien parcels (red parcels in Figure 22), would reach 50% of their full development potential. The O'Brien parcels are not assumed to be constrained by the availability of off-site wastewater based on interviews conducted as part of the 2003 DWW study.

The Phase 2 scenario assumes that off-site wastewater is almost doubled to 225,000 gallons per day and that the O'Brien Parcels are developed to 100% of their potential. Both Phase 1 and Phase 2 assume that Brentwood Park is 100% built-out and include the Arbor Garden Apartment project.

Table 13: Land Use Scenario Options

Scenario Option	Assumptions
Build-Out	- Total development potential assuming no wastewater constraints
Phase 1	- Assumes 120,000 gpd limit for parcels requiring off-site waste water - Assumes 100% buildout of Brentwood Park - Includes Arbor Garden Apartment Project - Assumes 50% Build-out of Obrien Parcels (172 res units/38,400 sf com)
Phase 2	- Assumes 225,000 gpd limit for parcels requiring off-site wast water - Assumes 100% buildout of Brentwood Park -Includes Arbor Garden Project - Assumes 100% Build-out of O'Brien Parcels (344 res units/76,800 sf com)

Calculate Total and Net New Development Potential

Table 3 presents the total development and net-new development potential for the entire study area under each of the three land use scenario options. For parcels constrained by the availability of off-site wastewater (Phase 1 or Phase 2), the residential and commercial development potential are based upon the daily usage figures provided in the 2003 DWW (224 gpd/dwelling unit and 360 gpd/20,000 sf of commercial). Wastewater capacity was distributed to residential and commercial uses in proportion to the amount of flow generated by each use under the full build-out scenario.

The net-new development potential is equal to the full potential less existing land use. The existing number of residential units was counted from orthophotos. The existing square footage for commercial uses was measured from orthophotos.

Table 14: Development Potential by Scenario Option- Entire Study Area

	Total Dev. Potential		Existing Land Use		New Dev. Potential	
Scenario Option	*Residential (Units)*	*Commercial (Square Feet)*	*Residential (Units)*	*Commercial (Square Feet)*	*Residential (Units)*	*Commercial (Square Feet)*
Full Build-Out	1,342	718,813			1,294	560,803
Phase 1	765	433,396	48	158,010	717	275,386
Phase 2	1,223	620,224			1,175	462,214

Table 15 and Table 16 present the final land use for Phase 1 and Phase 2 respectively within each transportation analysis zone. The tables identify how much of the estimated land use within each TAZ is attribute to parcels that depend on off-site wastewater, and how much falls within parcels that have permits or will accommodate wastewater on-site. The existing land use is also presented for each TAZ.

Table 15: Phase 1 Land Use Scenario by TAZ

	Phase 1 Land Use Scenario									
	Off-Site WW (120,500 gpd)		On-Site WW or Permitted		Total Dev. Potential		Existing Land Use		Net New Dev. Pot.	
TAZ	Res Units	Com SF	Res Units	Com SF	Res Units	Com SF	Res Units	Com SF	Res Units	Com SF
1	6	7,031	55	106,635	61	113,667	2	39,000	59	74,667
2	52	44,634	194	58,383	246	103,017	40	23,600	206	79,417
3	187	41,195	0	0	187	41,195	3	17,375	184	23,820
4	172	58,881	0	0	172	58,881	0	0	172	58,881
5	41	41,833	0	0	41	41,833	1	18,850	40	22,983
6	60	74,804	0	0	60	74,804	2	59,185	58	15,619
Total	516	268,379	249	165,018	765	433,396	48	158,010	717	275,386

Table 16: Phase 2 Land Use Scenario by TAZ

	Phase 2 Land Use Scenario									
	Off-Site WW (225,000 gpd)		On-Site WW or Permitted		Total Dev. Potential		Existing Land Use		Net New Dev. Pot.	
TAZ	Res Units	Com SF	Res Units	Com SF	Res Units	Com SF	Res Units	Com SF	Res Units	Com SF
1	9	10,921	55	106,635	64	117,556	2	39,000	62	78,556
2	80	69,323	366	96,765	446	166,088	40	23,600	406	142,488
3	290	63,981	0	0	290	63,981	3	17,375	287	46,606
4	267	91,449	0	0	267	91,449	0	0	267	91,449
5	63	64,972	0	0	63	64,972	1	18,850	62	46,122
6	93	116,179	0	0	93	116,179	2	59,185	91	56,994
Total	802	416,824	421	203,401	1,223	620,224	48	158,010	1,175	462,214

2025 TRAFFIC VOLUMES

The 2025 traffic volumes consist of background growth, which would occur even if no new development is built in the Exit 17 Growth Center, plus traffic generated by the households and commercial uses developed for the Phase 1 and Phase 2 land use scenarios. This section provides justification for a background growth and describes the trip generation estimates for the two land use scenarios.

Background Growth

To determine an appropriate background growth rate for the study area, historical traffic data were analyzed for the three VTrans count location identified in Table 17. All three locations have historical count data, approximately every two years, from the early 1980s through 2002. The twenty-year growth factors and average annual growth rates for each location were determined using linear regression. A weighted average was developed for the entire study area based on the 2002 AADT of each location.

The resulting twenty-year growth factor of 1.42 is higher than the statewide average for rural primary and secondary highways of 1.30 as published in the VTrans Red Book. The higher rate in this study area is justified because (1) it is based on reliable historical count data in the study area, and (2) the population of Grand Isle County, Colchester, and Milton are growing at faster rates that the statewide average (See *Table 5: Population Growth in Proximity to Study Area* on page 20).

Table 17: Background Traffic Growth Rate

Station ID	Location	20 Year Growth Factor	Average Annual Growth	2002 AADT
D018	US 2 Just west of Jasper Mine Road	1.46	1.9%	12,100
D103	US 2/7 Just south of Coon Hill Road	1.47	1.9%	10,800
D298	US 7 Just north of Colchester/Milton town line	1.32	1.4%	10,200
	Weighted Average Growth Rate	1.42	1.77%	

Land Use Scenario Trip Generation

To quantify the number of trips generated by the Phase 1 and Phase 2 land use scenarios, standard Institute of Transportation Engineers (ITE) trip generation rates published in *Trip Generation 7th Edition* were applied to either the square footage or number of units of each land use type.

ITE provides trip generation rates for many different types of residential developments. The most common types are shown in Table 18. Although the study area will likely be developed with a mix of housing types, this study assumes that all of the residential units will be developed as detached single family houses. This assumption provides a high estimate of residential trip generation, but is reasonable given the overall uncertainty related a future land use projection.

Table 18: ITE Residential Average Trip Generation Rates – Peak Hour of Adjacent Street Traffic

ITE Land Use Code	Description	AM Trips/Unit	PM Trips/Unit	
210	Detached Single Family	0.75	1.01	<-- Use for Exit 17 Study
220	Apartment	0.51	0.62	
230	Condo/Townhouse	0.44	0.52	

The land use scenarios describe all non-residential uses as commercial. For the purpose of trip generation, the commercial uses have been categorized as general office (ITE land use code 710) and specialty retail (ITE land use code 814). As defined by ITE:

- General offices house multiple tenants including professional services, insurance companies, investment brokers, etc. They may also include additional tenant services such as banks, a restaurant or cafeteria, or small retail facilities; and
- Specialty retail centers are smaller shopping centers that contain a variety of retail shops that specialize in quality apparel, hard goods, and services such as real estate office, dance studios, florists, and small restaurants.

A key assumption of this analysis is that the 60% of the commercial use is general office and 40% is specialty retail. The steering committee agreed that this assumption is reasonable for planning purposes.

Table 19 presents the trip generation rates for each of these uses. ITE does not provide a trip generation rate for specialty retail for the AM peak hour of adjacent street traffic (sometime between 7:00 AM to 9:00 AM). The morning peak hour of generation for specialty retail centers occurs closer to noon. As noted in *Trip Generation 7th Edition*, specialty retail centers have similar characteristics to shopping centers, but are smaller and generate less traffic per square foot. Therefore, the trip generation rate for the AM peak hour of adjacent street traffic shown in Table 19 is based upon the ratio of AM to PM peak hour of adjacent street traffic rates of shopping centers applied to the PM rate for specialty retail.

Table 19: ITE Office and Specialty Retail Average Trip Generation Rates - Peak Hour of Adjacent Street Traffic

ITE Land Use Code	Description	AM Trips/1000 Square Ft.	PM Trips/1000 Square Ft.
710	General Office	1.55	1.49
814	Specialty Retail	0.74	2.71

Table 20 summarizes the total trip generation estimate for the Phase 1 and Phase 2 land use scenarios. The following observations can be made regarding these results:

- PM peak hour trip generation is 45% higher than AM peak hour trip generation;
- The residential land use accounts for 60% of the AM peak hour trip generation and more than 55% of the PM peak hour trip generation;
- During the AM peak hour, office uses generate about three times as much traffic as retail uses. Retail uses generate the least amount of traffic; and
- During the PM peak hour, retail uses generate slightly more traffic than the office uses.

Table 20: Total Study Area Trip Generation for Phase 1 and Phase 2 Land Use

Phase 1 Land Use Trip Generation

	AM Peak Hour		PM Peak Hour	
Land Use	Veh/Hour	Share of Total	Veh/Hour	Share of Total
Residential	538	61%	725	57%
Office	256	29%	246	19%
Retail	82	9%	299	24%
Total	876		1269	

Phase 2 Land Use Trip Generation

	AM Peak Hour		PM Peak Hour	
Land Use	Veh/Hour	Share of Total	Veh/Hour	Share of Total
Residential	881	61%	1187	56%
Office	430	30%	413	20%
Retail	138	9%	501	24%
Total	1449		2101	

Table 21 through Table 24 present the land use and trip generation by TAZ for each time period and land use scenario.

Table 21: Phase 1 Land Use AM Peak Hour Trip Generation

Exit 17 TAZ	Net New Land Use			Entering and Exiting Trip Generation Rate by Land Use and Veh/Hour							Total-In	Total-Out
	Residential	Office	Retail	Type:	Res-In	Res-Out	Office-In	Office-Out	Retail-In	Retail-Out		
	Dwlg Units	Square Ft	Square Ft	Rate:	0.19	0.56	1.36	0.19	0.45	0.29	Veh/Hour	Veh/Hour
1	59	44,800	29,867	Vehicles per Hour	11	33	61	8	14	9	86	50
2	206	47,650	31,767		39	116	65	9	14	9	118	134
3	184	14,292	9,528		34	103	19	3	4	3	58	109
4	172	35,328	23,552		32	97	48	7	11	7	91	110
5	40	13,790	9,193		7	22	19	3	4	3	30	27
6	58	9,371	6,247		11	33	13	2	3	2	26	36
Totals	717	165,232	110,155		135	404	225	31	50	32	410	466

Table 22: Phase 1 Land Use PM Peak Hour Trip Generation

Exit 17 TAZ	Net New Land Use			Entering and Exiting Trip Generation Rate by Land Use and Veh/Hour							Total-In	Total-Out
	Residential	Office	Retail	Type:	Res-In	Res-Out	Office-In	Office-Out	Retail-In	Retail-Out		
	Dwlg Units	Square Ft	Square Ft	Rate:	0.64	0.37	0.25	1.24	1.19	1.52	Veh/Hour	Veh/Hour
1	59	44,800	29,867	Vehicles per Hour	37	22	11	55	36	45	84	123
2	206	47,650	31,767		131	77	12	59	38	48	181	184
3	184	14,292	9,528		117	69	4	18	11	14	132	101
4	172	35,328	23,552		109	64	9	44	28	36	146	144
5	40	13,790	9,193		25	15	3	17	11	14	40	46
6	58	9,371	6,247		37	22	2	12	7	9	47	43
Totals	717	165,232	110,155		456	268	42	204	131	167	630	640

Table 23: Phase 2 Land Use AM Peak Hour Trip Generation

Exit 17 TAZ	Net New Land Use			Entering and Exiting Trip Generation Rate by Land Use and Veh/Hour							Total-In	Total-Out
	Residential	Office	Retail	Type:	Res-In	Res-Out	Office-In	Office-Out	Retail-In	Retail-Out		
	Dwlg Units	Square Ft	Square Ft	Rate:	0.19	0.56	1.36	0.19	0.45	0.29	Veh/Hour	Veh/Hour
1	62	47,134	31,422	Vehicles per Hour	12	35	64	9	14	9	90	53
2	406	85,493	56,995		76	228	117	16	26	17	219	261
3	287	27,963	18,642		54	161	38	5	8	5	100	172
4	267	54,869	36,580		50	150	75	10	17	11	142	171
5	62	27,673	18,449		12	35	38	5	8	5	58	45
6	91	34,196	22,798		17	51	47	6	10	7	74	64
Totals	1,175	277,329	184,886		220	661	378	52	84	54	683	766

Table 24: Phase 2 Land Use PM Peak Hour Trip Generation

Exit 17 TAZ	Net New Land Use			Entering and Exiting Trip Generation Rate by Land Use and Veh/Hour								
	Residential	Office	Retail	Type:	Res-In	Res-Out	Office-In	Office-Out	Retail-In	Retail-Out	Total-In	Total-Out
	Dwlg Units	Square Ft	Square Ft	Rate:	0.64	0.37	0.25	1.24	1.19	1.52	Veh/Hour	Veh/Hour
1	62	47,134	31,422	Vehicles per Hour	39	23	12	58	37	48	89	129
2	406	85,493	56,995		258	152	22	106	68	86	348	344
3	287	27,963	18,642		183	107	7	35	22	28	212	170
4	267	54,869	36,580		170	100	14	68	44	56	227	223
5	62	27,673	18,449		39	23	7	34	22	28	68	85
6	91	34,196	22,798		58	34	9	42	27	35	94	111
Totals	1,175	277,329	184,886		748	439	70	343	220	281	1038	1063

Trip Assignment

The assignment of vehicle trips from the transportation analysis zones to the adjacent street network accounts for the following origin-destination pairs:

- Internal TAZ Trips – these trips occur between the land uses within a TAZ and are therefore not added to the adjacent street network;
- TAZ-TAZ Trips – these trips occur between Exit 17 TAZs, are added to the adjacent street network, and are assumed to follow the shortest path between any two TAZs. These trips do not leave the study area;
- External Trips – these trips are between TAZs and points beyond the study area via US 2 to the west, I-89 and US 7 to the north, and I-89 and US 2/7 to the south. External trips are equal to total trip generation less Internal-TAZ and TAZ-TAZ trips.

To quantify the amount of Internal-TAZ and TAZ-TAZ trips, the methodology used to estimate the internal capture rate of multi-use developments described in ITE's Trip *Generation Handbook* was utilized. The concepts were applied by assuming that one TAZ is a large multi-use development. The ITE's methodology was then used to estimate how many trips would occur between the residential, office, and retail used in a TAZ. The Internal-TAZ trips were then subtracted from the total trip generation of each TAZ.

It is logical to assume that some of the trips entering and exiting a TAZ would be made between the other TAZs in the study area. To estimate the TAZ-TAZ trips, it was assumed that the entire Exit 17 study area was one large multi-use development. ITE's multi-use development methodology was then used to estimate how many of the trips entering and exiting a TAZ would be made between the residential, office, and retail uses contained in the other TAZs.

The methodology applies the internal capture rates shown in Table 25 to the entering and exiting traffic volumes between the three land uses. As indicated in the table, the percent reductions vary based on land use type and whether or not the trip is entering or exiting. A balancing rule is used to ensure the reduction does not exceed the amount of traffic entering or exiting between two land

uses. ITE does not provide internal capture rates for the AM peak hour. This study assumes that the PM internal capture rates apply in the AM as well. As indicated below, the overall internal capture rate for the AM peak hour will be less than the PM peak hour because the share of trips by use and the exiting/entering proportions are different.

Table 25: ITE Multi-Use Internal Capture Rates – PM Peak Hour

	To Retail		To Office		To Residential	
From Retail	Exit from Ret to Ret	20%	Exit From Retail to Office	3%	Exit from Ret to Res	12%
	Enter to Ret from Ret	20%	Enter to Office from Retail	31%	Enter to Res from	31%
From Office	Exit from Office to Ret	23%	Exit From Office to Office	1%	Exit from Office to Res	2%
	Enter to Ret from Office	2%	Enter to Office from Office	6%	Enter to Res from Office	2%
From Residential	Exit from Res to Ret	53%	Exit From Res to Office	0%	Exit from Res to Res	0%
	Enter to Ret from Res	9%	Enter to Office from Res	0%	Enter to Res from Res	0%

Table 26 summarizes the three trip types for the entire study area. During the PM peak hour, the effect of internal trip making reduces the amount of traffic added to the adjacent street network by almost ten percent. Eleven percent of generated trips will be made between TAZs. This result suggest that connecting these TAZs with a local roadway, pedestrian, and bicycle network could help mitigate the effects of development on the existing roadways in the study area.

The effect of internal trip making does not appear to be as significant during the AM peak hour. However, additional research is necessary to develop internal capture rates for the AM peak hour. This lack of data is not that important for this study because the critical time period, even with the reduction due to internal trip making, continues to be the PM peak hour.

Table 26: Origin-Destination of Trips Generated by Phase 1 and Phase 2 Land Use Scenarios

Phase 1

Origin-Destination	AM Peak Hour		PM Peak Hour	
	Veh/Hour	Share of Total	Veh/Hour	Share of Total
Internal TAZ	29	3%	112	9%
TAZ-TAZ	35	4%	144	11%
External	812	93%	1014	80%
Total	876		1269	

Phase 2

Origin-Destination	AM Peak Hour		PM Peak Hour	
	Veh/Hour	Share of Total	Veh/Hour	Share of Total
Internal TAZ	49	3%	188	9%
TAZ-TAZ	59	4%	241	11%
External	1340	93%	1671	80%
Total	1449		2101	

The TAZ-TAZ trips were assigned to the roadway network by following the shortest path between two TAZs. The External trips were assigned between TAZs and US 2, I-89, US 7, and US 7/2 in proportion to the entering and exiting traffic at each of these locations.

EFFECT OF THE CIRCUMFERENTIAL HIGHWAY AND MILTON INTERCHANGE

The complete Circumferential Highway and a new I-89 interchange at West Milton Road have the potential to significantly change traffic volumes around the Exit 17 study area. The CCMPO's Regional Transportation Model has been used to assess the effect of these two projects during the 2025 PM peak hour for the Phase 1 and Phase 2 scenarios.

As shown in Table 27, the Circumferential Highway has its greatest effect at the northbound off-ramp and the US 2-US 7 intersection. The Circumferential Highway would offset much of the traffic generated by the Phase 1 land use at these two intersections but does not have a significant effect on the other study intersections.

If the Circumferential Highway and the West Milton Road interchange are both constructed, Table 27 demonstrates that these two projects would off-set all most all of the traffic generated by Phase 1, and most of the traffic generated by Phase 2 land use scenarios.

Table 27: Effect of Land Use Scenarios and Circ/Milton Exit on Traffic Volumes

	Impact on 2025 PM Peak Hour Traffic Volumes			
Study Intersection	Phase 1 Land Use Scenario	Phase 2 Land Use Scenario	Full Circ - No Milton Interchange	Circ and Milton Exit
US 2 - Jasper Mine Road	25%	42%	-1%	-6%
US2-I89 SB Ramps On/Off	23%	38%	-4%	-20%
US2-I89 NB Ramps On/Off	19%	32%	-13%	-38%
US2-US7	27%	44%	-24%	-53%
US7 - Arbor Gardens	22%	35%	0%	-52%
US7 - Park and Ride	20%	28%	0%	-52%

Intersection turning movement volumes are provided in Figure 23 through Figure 34 at the end of this section.

LEVEL OF SERVICE RESULTS

Table 28 presents the AM peak hour LOS results for 2005 and the 2025 Phase 1 and Phase 2 scenarios without the Circumferential Highway or the West Milton Road interchange. Table 29 presents the PM peak hour LOS results for 2005 and the 2025 Phase 1 and Phase 2 scenarios with an without the Circumferential Highway and the West Milton Road exit. Table 30 presents LOS in 2025 with Phase 2 land use assuming (1) the Circumferential Highway is constructed but the West Milton Road exit is not, and (1) both the Circumferential Highway and the West Milton Road exit are built.

Traffic signal timings have been optimized, but no additional modifications have been assumed to the study intersections with the following exception. A westbound approach to the US 7-US 2 intersection has been added as one of three entrances serving TAZ 2. This TAZ is assumed to connect to US 7 at US 2, through the existing entrance to Arbor Gardens Apartment, and a new location south of the US 7-US 2 intersection.

The following observations can be made with regard to the LOS results:

- Without the Circumferential Highway and the West Milton Road interchange:
  - During the PM peak hour, poor level of service is projected at every study intersection under the Phase 1 and Phase 2 land use scenarios, and
  - During the AM peak hour, with, traffic generated by Phase 1, the projected overall LOS at the US 2-US 7 intersection is acceptable, although southbound US 7 is projected to operate at LOS E. Under Phase 2, poor overall intersection LOS occurs at the US 2-US 7 intersection.
- With the Circumferential Highway and the West Milton Road interchange, and assuming Phase 1 land use:
  - Acceptable LOS is projected at all of the study intersections, in the AM and PM peak hours, with the exception of traffic exiting from Jasper Mine Road and from Arbor Gardens Apartments.
- If just the Circumferential Highway is built (no West Milton Road exit), all of the study intersections are projected to operate at LOS F with traffic generated by the Phase 2 land use scenario.
- If Phase 2 is assumed with the Circumferential Highway and the West Milton Road interchange, poor LOS is projected at the two I89-US 2 ramp intersections.

These observations suggest that:

- Additional modifications to the study intersections and road segments will be necessary to accommodate projected land use if the Circumferential Highway and West Milton Road interchange are not built;
- If only the Circumferential Highway is constructed, modifications will still be necessary at all of the study intersections.
- By reducing traffic that currently passes through the study area, the Circumferential Highway and West Milton Road interchange free up highway capacity that could be used to accommodate almost all of the Phase 1 traffic volumes. Some modifications to the existing roadways and intersections would still be necessary, but these changes would be relatively minor (such as adding a traffic signal or new turn lane); and

- With the level of development assumed in Phase 2, and accounting for the traffic reduction resulting from the Circumferential Highway and West Milton Road interchange, modifications to the I89-US 2 ramps would still be necessary to maintain acceptable levels of service at the ramps.

Although not apparent in the tables below, an important aspect of these findings is that almost 10% of the traffic generated by the Phase 1 and Phase 2 land use scenarios has not been added to the adjacent roadway network. This additional traffic is internal to the TAZs. However, for this assumption to be valid, the TAZs would need to be developed in a manner that allows connections between the different land uses with well designed and interconnected networks of streets, sidewalks and paths for pedestrians, and bicycle facilities. Another 10% of the traffic generated by the Phase 1 and Phase 2 land use scenarios could be re-routed if additional connections were provided between TAZs.

Table 28: AM Peak Hour LOS Results

	2005		2025 Background Growth Only		2025 Phase 1		2025 Phase 2	
US 2- Jasper Mine Road Unsignalized	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Northbound: Niquette Bay Road	C	15	C	21	F	>100	F	>100
Southbound: Jasper Mine Road	F	78	F	>100	F	>100	F	>100
US2-I89 SB Ramps On/Off Signalized	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Overall	**B**	**14**	**F**	**>100**	**F**	**>100**	**F**	**>100**
Eastbound: US 2	B	20	F	>100	F	>100	F	>100
Westbound: US 2	A	10	F	>100	F	>100	F	>100
Southbound: I89 SB Off Ramp	C	25	E	57	E	63	E	68
US2-I89 NB Ramps On/Off Signalized	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Overall	**A**	**8**	**B**	**15**	**F**	**>100**	**F**	**>100**
Eastbound: US 2	A	5	B	10	F	>100	F	>100
Westbound: US 2	A	8	B	12	F	>100	F	>100
Southbound: I89 NB On/Off Ramps	C	23	E	58	E	61	E	63
US2-US7 Signalized	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Overall	**C**	**22**	**C**	**27**	**D**	**48**	**F**	**>100**
Eastbound: US 2	C	31	D	48	C	34	D	36
Westbound: US 2					D	39	D	53
Northbound: US 2/ US 7	B	10	A	10	D	44	F	>100
Southbound: US 7	C	23	C	23	E	61	F	>100
US7 - Arbor Gardens Apartment Complex Driveway Unsignalized	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Westbound: Arbor Garden Apartments	C	19	E	36	F	>100	F	>100
Southbound: US 7	A	<1	A	<1	A	1	A	3
US7 - Park and Ride - Unsignalized	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Eastbound: Brentwood Drive	C	21	E	35	E	48	F	59
Westbound: Park and Ride	D	30	F	78	F	>100	F	>100
Northbound: US 7	A	<1	A	12	B	13	B	14
Southbound: US 7	A	<1	A	9	A	9	A	9

Table 29: PM Peak Hour LOS Results

	2005		*2025 Background Growth Only*		*2025 Phase 1*		*2025 Phase 2*		*2025 Phase 1 w/Circ and Milton Exit*		*2025 Phase 2 w/Circ and Milton Exit*	
US7 - Jasper Mine Road Unsignalized	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Northbound: Niquette Bay Road	B	11	B	13	F	>100	F	>100	F	>100	F	>100
Southbound: Jasper Mine Road	F	106	F	>100	F	>100	F	>100	F	>100	F	>100
US2-I89 SB Ramps On/Off Signalized	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Overall	**B**	**10**	**C**	**28**	**F**	**>100**	**F**	**>100**	**C**	**27**	**F**	**86**
Eastbound: US 2	B	10	C	21	F	>100	F	>100	C	22	F	82
Westbound: US 2	A	8	C	28	F	>100	F	>100	C	23	F	87
Southbound: I89 SB Off Ramp	C	29	D	55	D	53	F	87	E	62	F	91
US2-I89 NB Ramps On/Off Signalized	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Overall	**C**	**21**	**C**	**25**	**F**	**>100**	**F**	**>100**	**A**	**9**	**F**	**82**
Eastbound: US 2	C	25	C	26	F	>100	F	>100	A	8	F	>100
Westbound: US 2	C	21	B	11	F	>100	F	>100	A	3	A	10
Southbound: I89 NB On/Off Ramps	B	15	E	59	F	>100	F	>100	D	54	D	53
US2-US7 Signalized	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Overall	**B**	**18**	**D**	**43**	**F**	**>100**	**F**	**>100**	**C**	**32**	**D**	**43**
Eastbound: US 2	C	21	C	34	F	>100	F	>100	C	27	C	33
Westbound: New Road					F	>100	D	49	D	40	D	51
Northbound: US 2/ US 7	B	15	D	39	F	>100	F	>100	C	28	D	37
Southbound: US 7	B	20	E	61	F	>100	F	>100	D	53	E	76
US7 - Arbor Gardens Apartment Complex Driveway Unsignalized	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
WB: Arbor Garden Apartments	D	26	F	78	F	>100	F	>100	F	69	F	>100
Southbound: US 7	A	<1	A	<1	E	35	F	>100	A	1	A	2
US7 - Park and Ride - Unsignalized	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Eastbound: Brentwood Drive	C	16	D	28	F	>100	F	>100	C	16	C	19
Westbound: Park and Ride	D	25	F	58	F	>100	F	>100	D	27	D	34
Northbound: US 7	A	<1	A	9	A	9	A	10	A	8	A	8
Southbound: US 7	A	<1	B	11	B	12	B	13	A	10	A	10

Table 30: Effect of Circ. Highway with and without Milton Interchange – 2025 PM Phase 2 Land Use

	2025 PM Phase 2 Land Use		2025 PM Phase 2 Land Use w/Circ No Milton Exit		2025 PM Phase 2 Land Use w/Circ and Milton Exit	
US7 - Jasper Mine Rd. Unsignalized	LOS	Delay	LOS	Delay	LOS	Delay
NB: Niquette Bay Road	F	>100	F	>100	F	>100
SB: Jasper Mine Road	F	>100	F	>100	F	>100
US2-I89 SB Ramps Signalized	LOS	Delay	LOS	Delay	LOS	Delay
****	**F**	**>100**	**F**	**>100**	**F**	**86**
EB: US 2	F	>100	C	30	F	82
WB: US 2	F	>100	F	>100	F	87
SB: I89 SB Off Ramp	F	87	C	34	F	91
US2-I89 NB Ramps Signalized	LOS	Delay	LOS	Delay	LOS	Delay
****	**F**	**>100**	**F**	**>100**	**F**	**82**
EB: US 2	F	>100	F	>100	F	>100
WB: US 2	F	>100	F	>100	A	10
SB: I89 NB On/Off Ramps	F	>100	C	26	D	53
US2-US7 Signalized	LOS	Delay	LOS	Delay	LOS	Delay
Overall	**F**	**>100**	**F**	**>100**	**D**	**43**
EB: US 2	F	>100	F	>100	C	33
WB: New Road	D	49	D	37	D	51
NB: US 2/ US 7	F	>100	F	>100	D	37
SB: US 7	F	>100	C	26	E	76
US7 - Arbor Gardens Unsignalized	LOS	Delay	LOS	Delay	LOS	Delay
WB: Arbor Garden	F	>100	F	>100	F	>100
SB: US 7	F	>100	A	5	A	2
US7 - Park and Ride - Unsignalized	LOS	Delay	LOS	Delay	LOS	Delay
EB: Brentwood Drive	F	>100	F	>100	C	19
WB: Park and Ride	F	>100	F	>100	D	34
NB: US 7	A	10	A	10	A	8
SB: US 7	B	13	B	13	A	10

FUTURE CONDITIONS SUMMARY

- Under current zoning regulations, the full development potential of the study area allows 1,290 new residential units and 560,000 square feet of additional commercial uses above the existing amount of development. However, the amount of development possible in the study area will be limited by the capacity of off-site wastewater facilities.

- Assuming the Phase 1 recommendation of the DWW is implemented, the study area has the potential to accommodate approximately 720 new homes and an additional 275,000 square feet of commercial development. If the Phase 2 recommendation is implemented, the study area's development potential is approximately 1,200 new homes and an additional 462,000 square feet of commercial development.
- The Phase 1 and Phase 2 land use scenarios could create almost 1,300 and 2,100 PM peak hour and 880 and 1,450 AM peak hour trips respectively. Observations specific to the trip generation are:
    - PM peak hour trip generation is 45% higher than AM peak hour trip generation;
    - The residential land use accounts for 60% of the AM peak hour trip generation and more than 55% of the PM peak hour trip generation;
    - During the AM peak hour, office uses generate about three times as much traffic as retail uses. Retail uses generate the least amount of traffic during the AM peak hour; and
    - During the PM peak hour, retail uses generate slightly more traffic than the office uses.
- During the PM peak hour, the effect of internal trip making reduces the amount of traffic added to the adjacent street network by almost ten percent. An additional eleven percent of generated trips will be made between TAZs. This result suggest that connecting the Exit 17 TAZs with a local roadway, pedestrian, and bicycle network could help reduce the effects of development on the existing roadways in the study area.
- Additional modifications to the study roads in intersections will be necessary to accommodate projected land use if the Circumferential Highway and West Milton Road interchange are not built.
- If the Circumferential Highway is constructed, but not the West Milton Road exit, modifications will still be necessary at all of the study intersections to accommodate traffic generated by the Phase 2 land use scenario.
- By reducing traffic that currently passes through the study area, the Circumferential Highway and West Milton Road interchange free-up highway capacity that could be used to accommodate almost all of the Phase 1 traffic volumes. Some modifications to the existing roadways and intersections would still be necessary, but these changes would be relatively minor (such as adding a traffic signal or new turn lane).
- With the level of development assumed in Phase 2, and accounting for the traffic reduction resulting from the Circumferential Highway and West Milton Road interchange, modifications to the I89-US 2 ramps would still be necessary to maintain acceptable levels of service at the ramps.

Figure 23: 2025 AM – Background Traffic

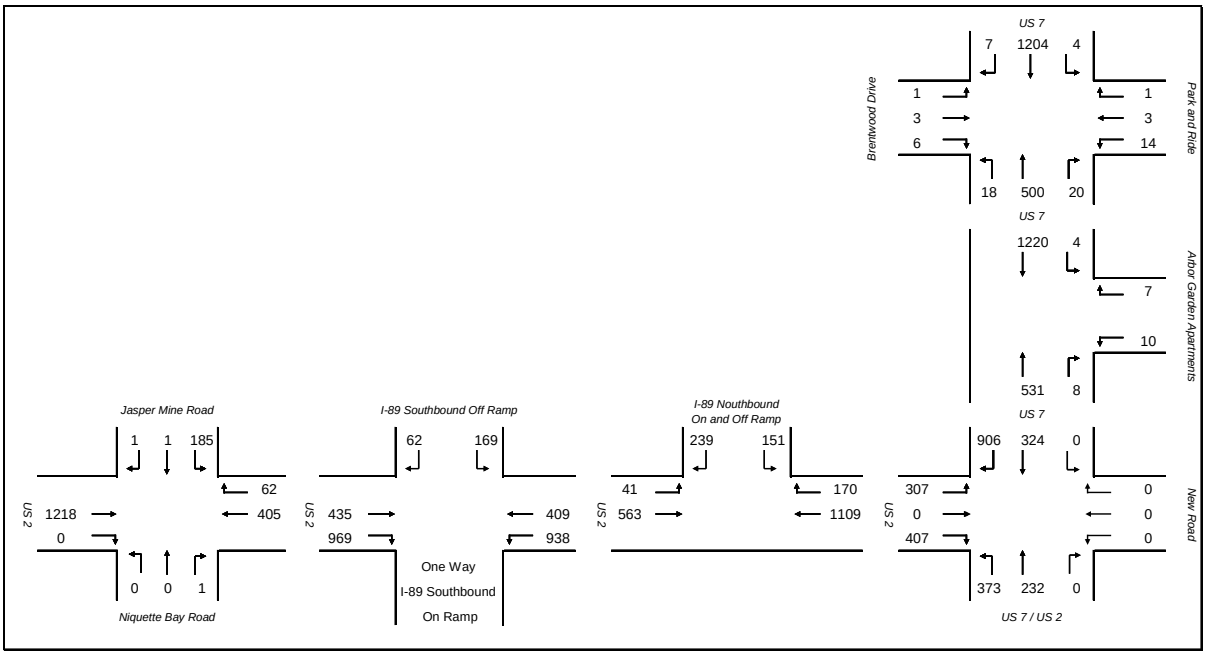


Figure 24: 2025 AM –Phase 1 Traffic Assignment

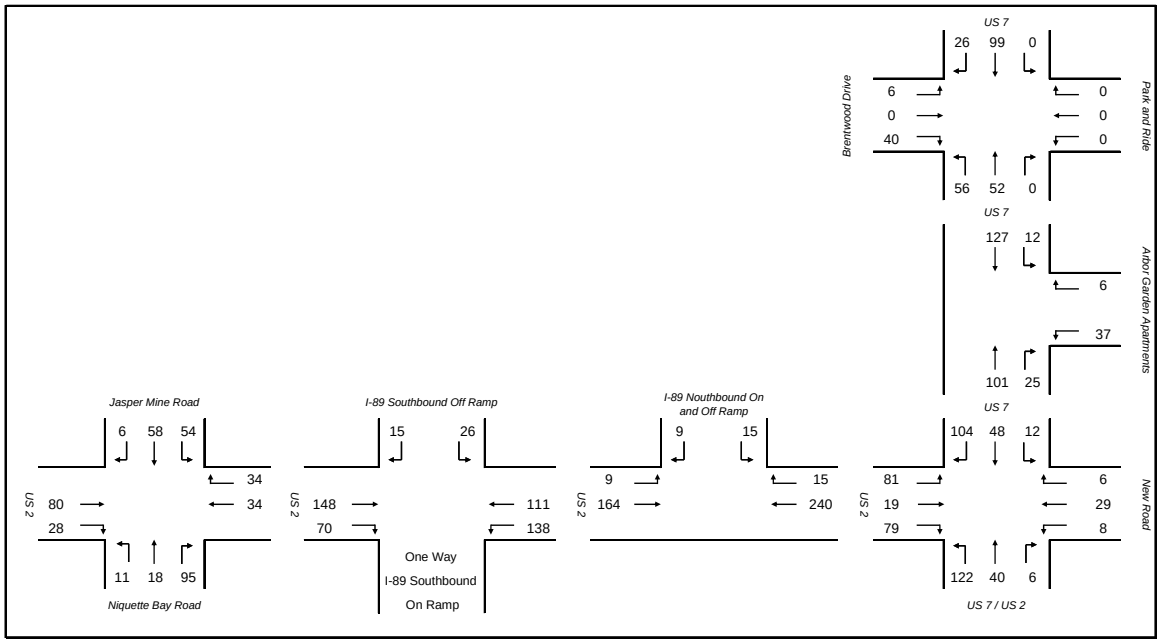


Figure 25: 2025 AM –Phase 2 Traffic Assignment

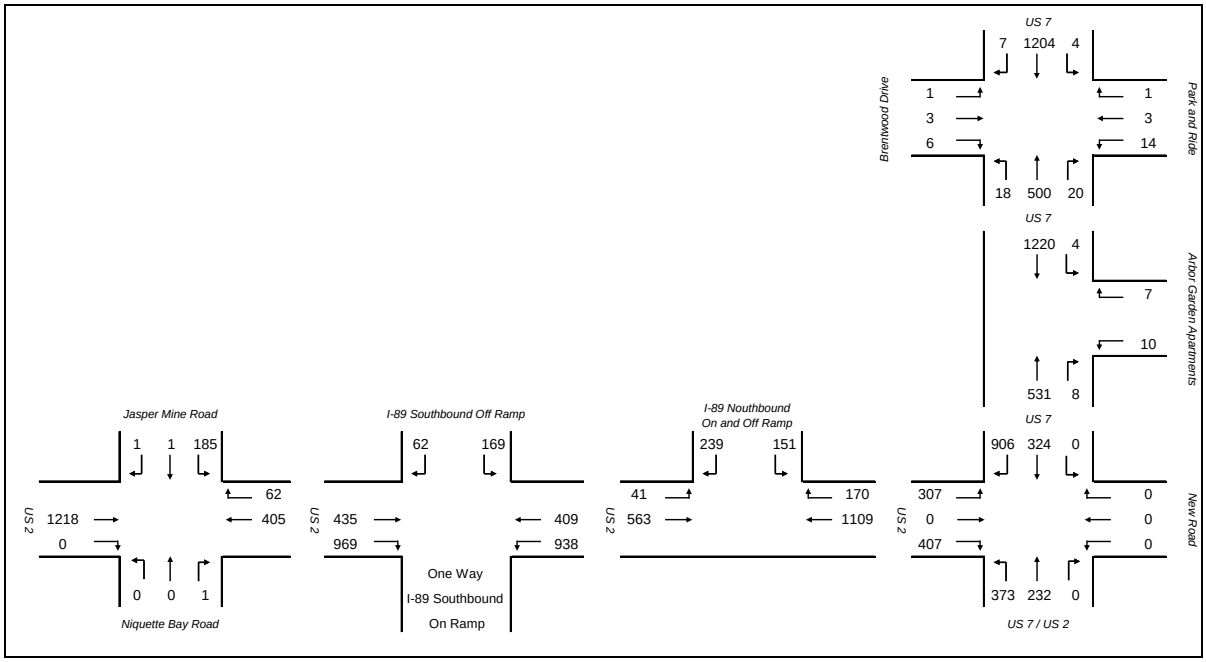


Figure 26: 2025 AM –Background Plus Phase 1 Traffic

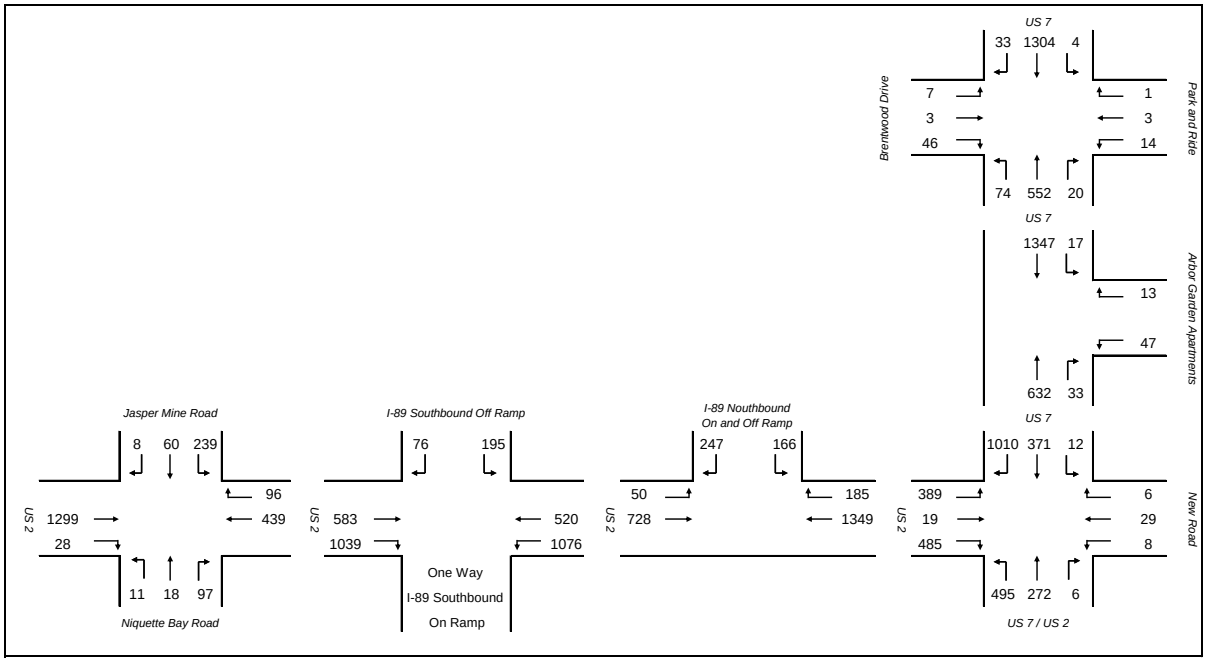


Figure 27: 2025 AM –Background Plus Phase 2 Traffic

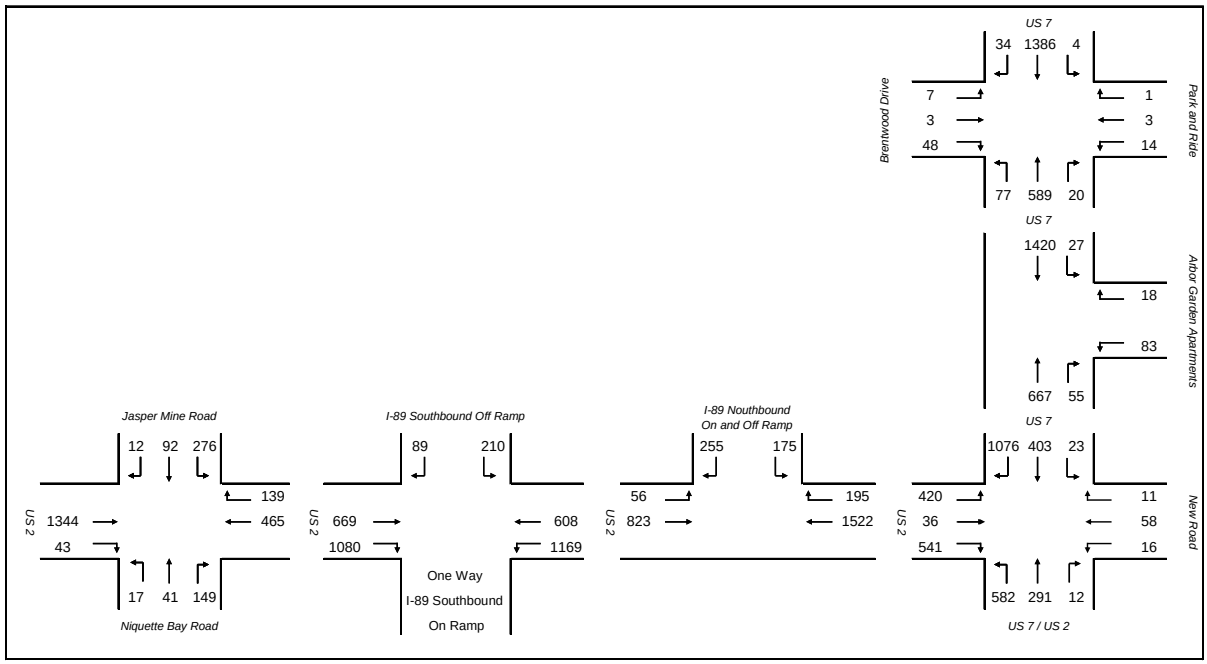


Figure 28: 2025 PM – Background Traffic

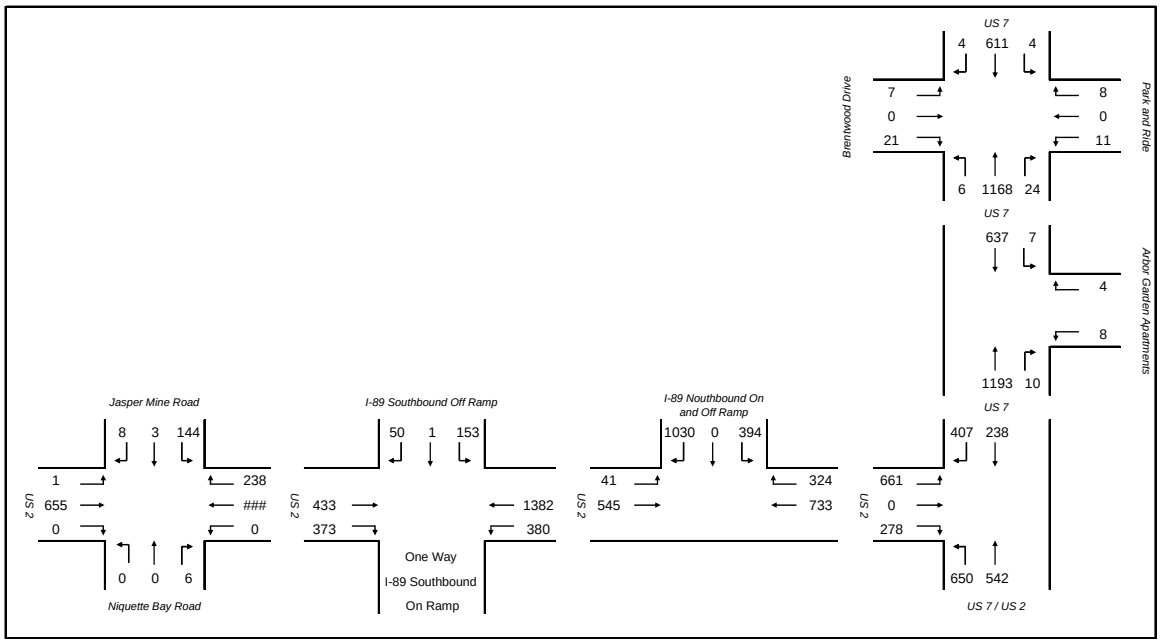


Figure 29: 2025 PM –Phase 1 Traffic Assignment

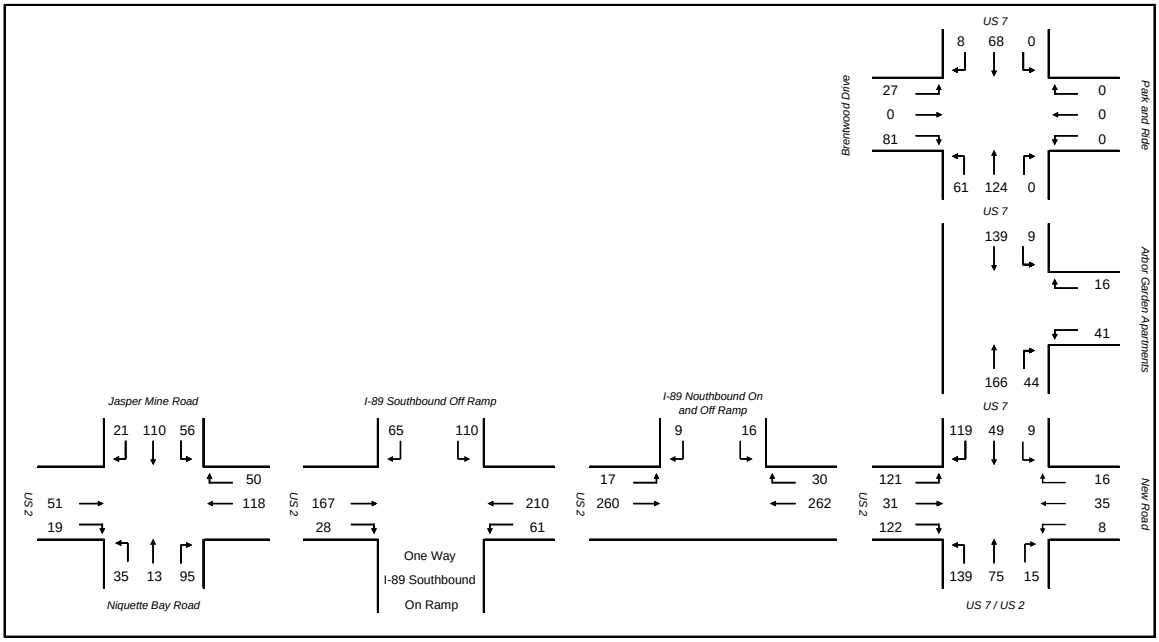


Figure 30: 2025 PM –Phase 2 Traffic Assignment

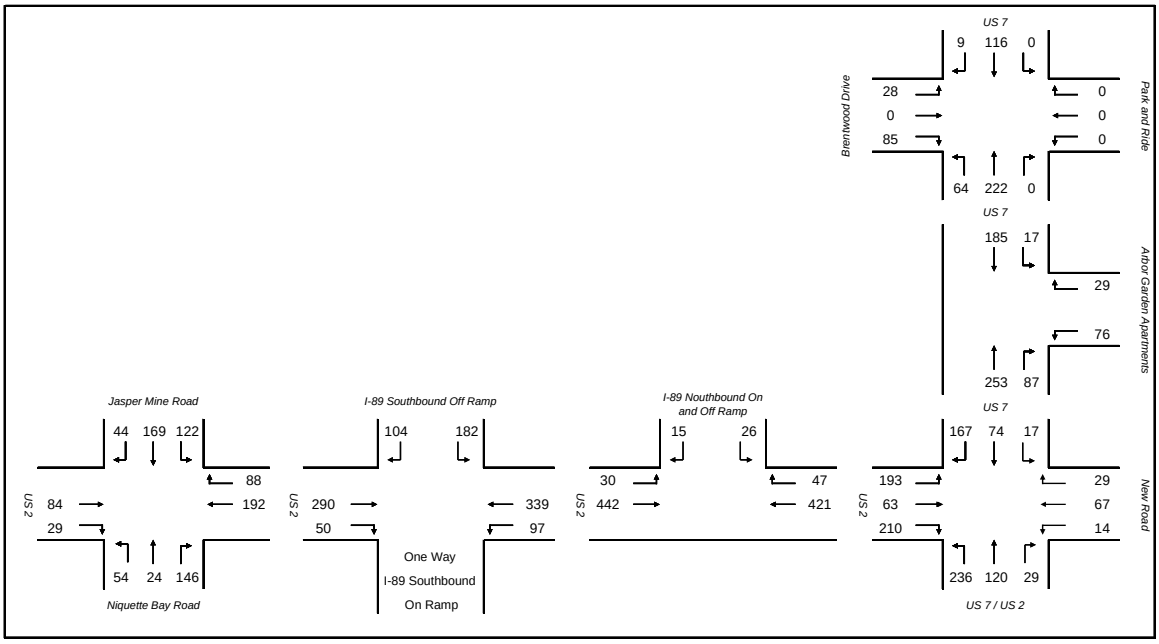


Figure 31: 2025 PM –Background Plus Phase 1 Traffic

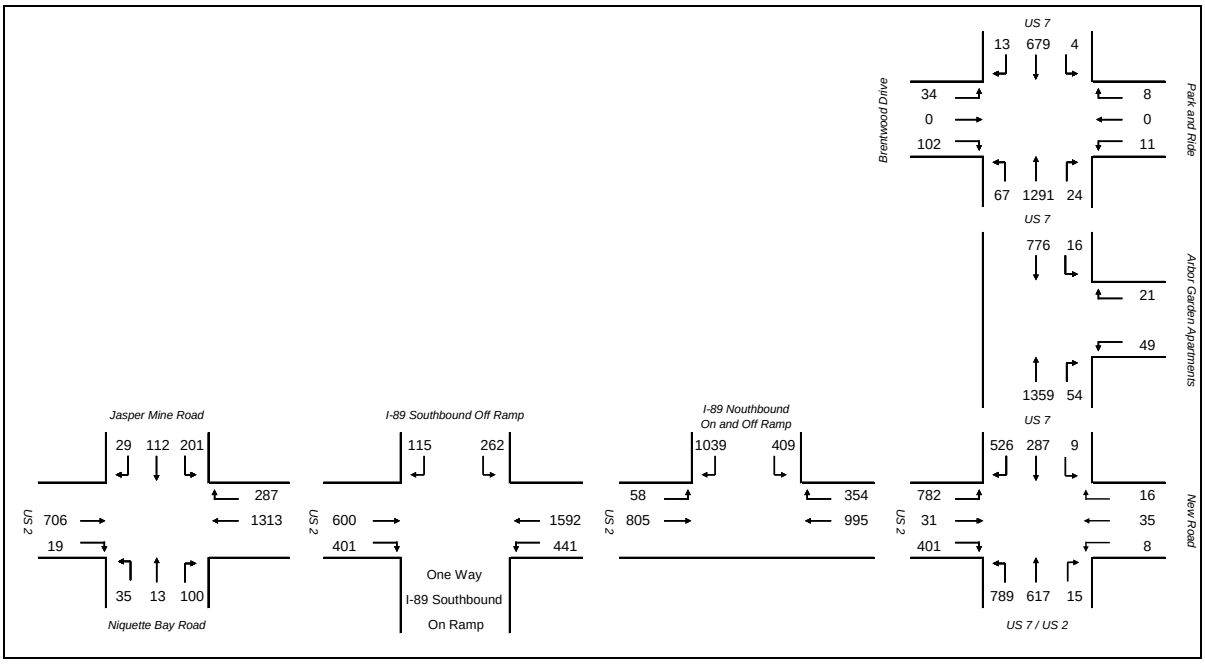


Figure 32: 2025 PM –Background Plus Phase 2 Traffic

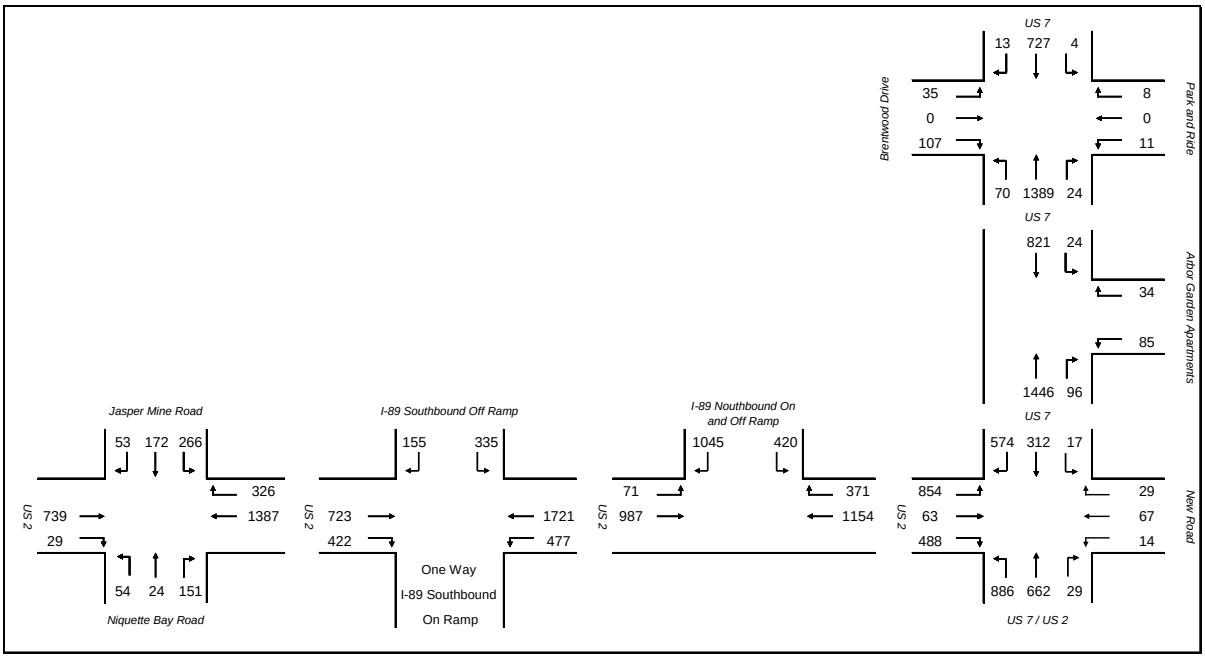


Figure 33: 2025 PM –Background Plus Phase 1 Traffic with Circ and West Milton Road Exit

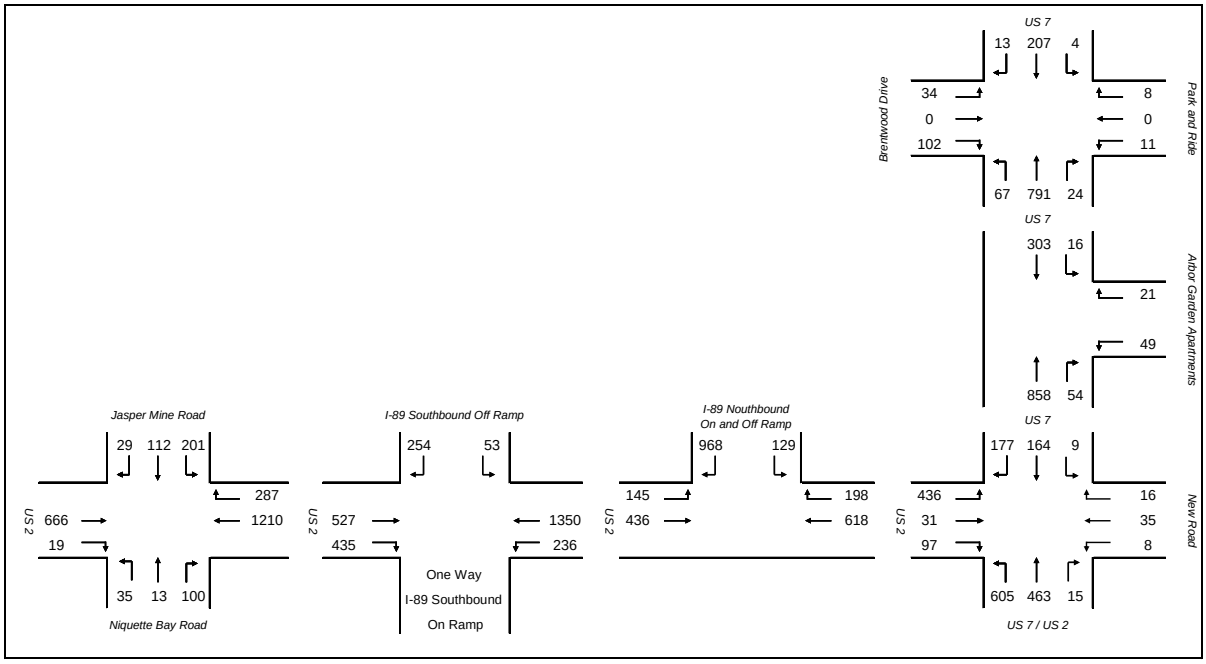


Figure 34: 2025 PM –Background Plus Phase 2 Traffic with Circ and West Milton Road Exit

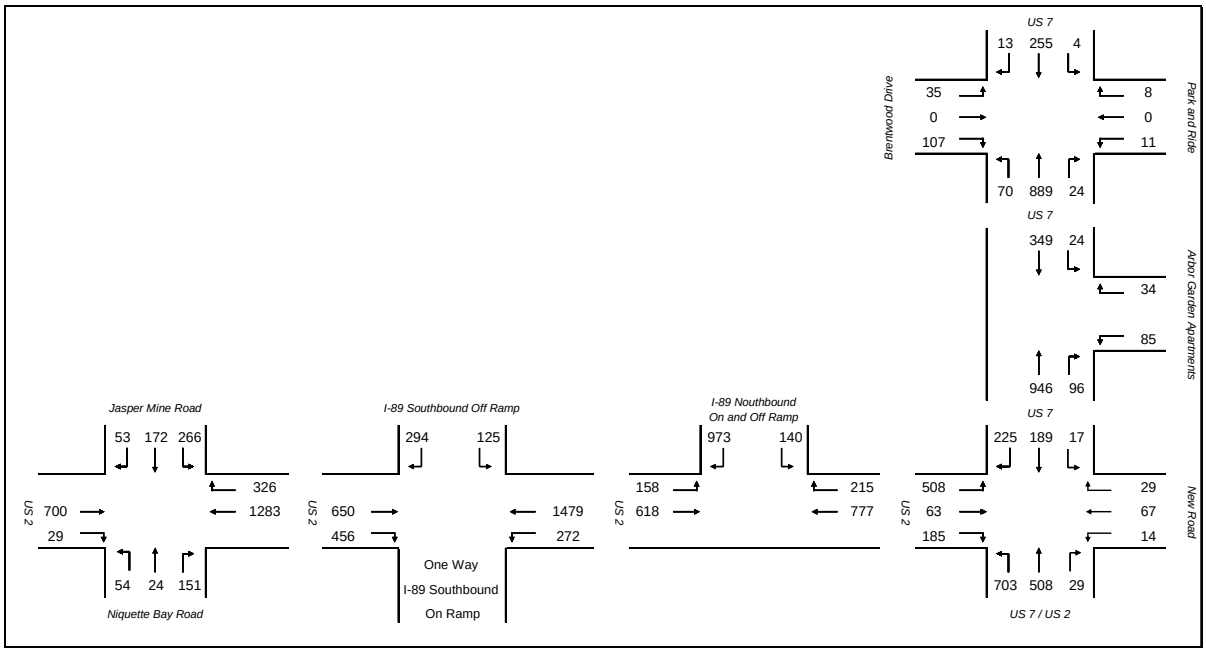
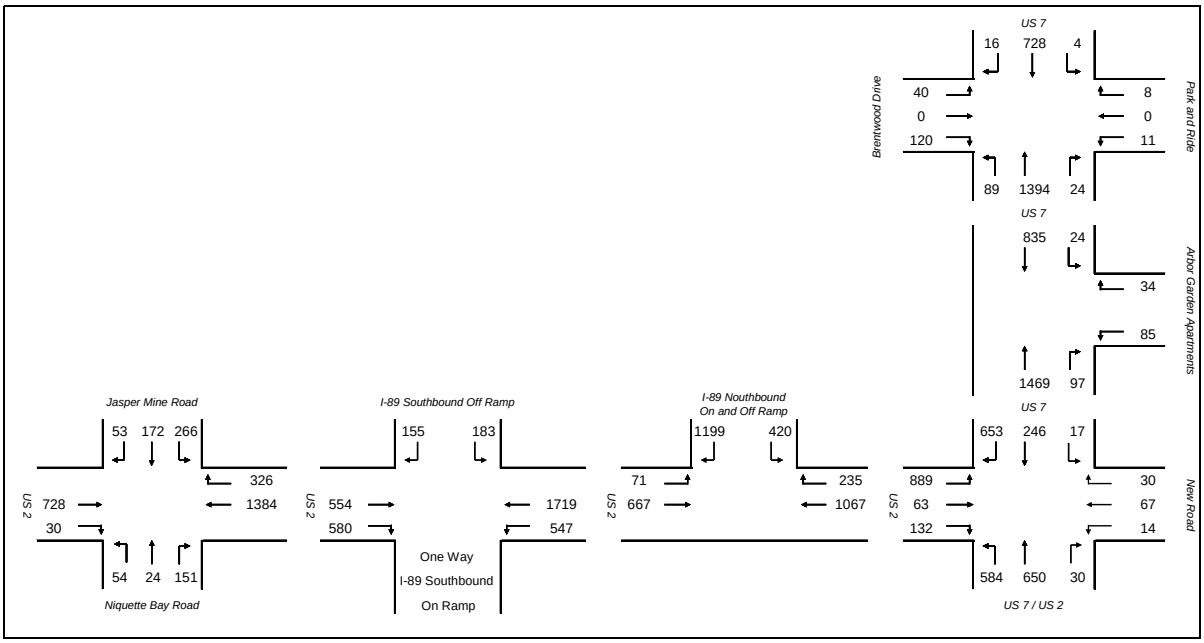


Figure 35: 2025 PM –Background Plus Phase 2 Traffic with Circ, without West Milton Road Exit



PART III: ALTERNATIVES ANALYSIS

This section presents concept plans for the following components of the study area:

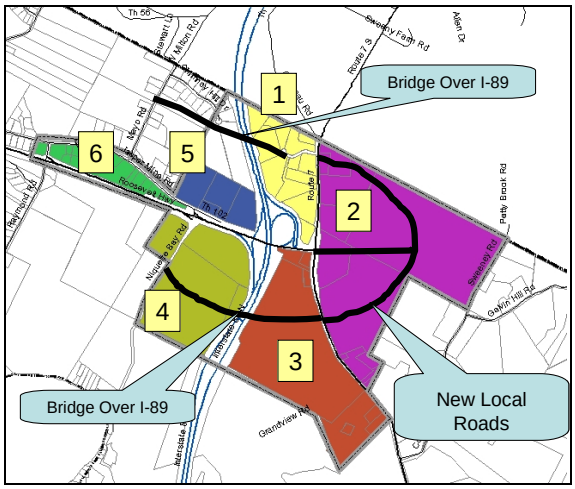
- Exit 17 Ramps and Chimney Corners: The intersections of US 2 with the I-89 northbound and southbound ramps and US 2-US 7 (Chimney Corners) are in close proximity and all three operate as a system. Therefore, alternatives are developed for all three intersections together.
- Other major study area intersections: Alternatives are developed separately for the intersections of US 2-Jasper Mine Road, US 7-Abor Gardens, and US 7-Brentwood Drive because their design and operation is not influenced by each other or the Exit 17 Ramps/Chimney Corners intersections.
- Road sections: Roadway cross-section recommendations are presented for US 2/7 south of Chimney Corners, US 7 from Chimney Corners to Brentwood Drive, and US 2 from US 7 to Jasper Mine Road.

Concept plans are provided for each alternative supplemented with discussion on notable operating characteristics, and advantages and disadvantages. An evaluation matrix is provided to compare the costs, congestion, and other impacts for the alternatives developed for each component.

The alternatives analyzed in this study are designed to accommodate traffic volumes that were developed with the following assumptions as directed by the steering committee:

- Traffic passing through the study area will grow by 42% between 2005 and 2025 even if no new development occurs within the Growth Center.
- Phase 2 of the 2003 Decentralized Wastewater Study (DWW) will be implemented allowing the Growth Center to accommodate 1,200 dwelling units and 462,000 square feet of commercial uses. This development will generate approximately 2,100 vehicles per hour during the PM peak hour and 1,450 in the AM peak hour.

Figure 36: Growth Center Traffic Analysis Zones and Conceptual Local Street Networks



- Connections are assumed between the different areas of the Growth Center as shown in Figure 36. Because of the benefits of mixed use development, ten percent of the traffic generated by Exit 17 development will

remain internal to the development, and is therefore not added to the adjacent street network. Another eleven percent of these trips will be made between different areas of the Growth Center, underscoring the importance of connecting the different sections of the Growth Center with a local roadway, pedestrian, and bicycle network.

- The Circumferential Highway will be constructed in its entirety from I-89 in Williston to VT 127 in Colchester.
- A new I-89 interchange with West Milton Road between Exit 17 and Exit 18 is not assumed to be complete within the planning horizon of this study. Given the complexities involved in constructing interstate interchanges, the steering committee decided it is not reasonable to assume that the West Milton Road exit will be completed within the planning horizon of this study.

Figure 37 presents the 2025 PM peak hour traffic volumes based on the assumptions above. The 2025 AM peak hour volumes are presented in Figure 39. In general, the designs were developed to accommodate the PM volumes. At most locations, the PM peak hour volumes are the deciding factor. At the US 2-I89 Southbound Ramps, AM peak hour volumes are the deciding factor.

Figure 37: 2025 PM Peak Design Hour Analysis Volumes

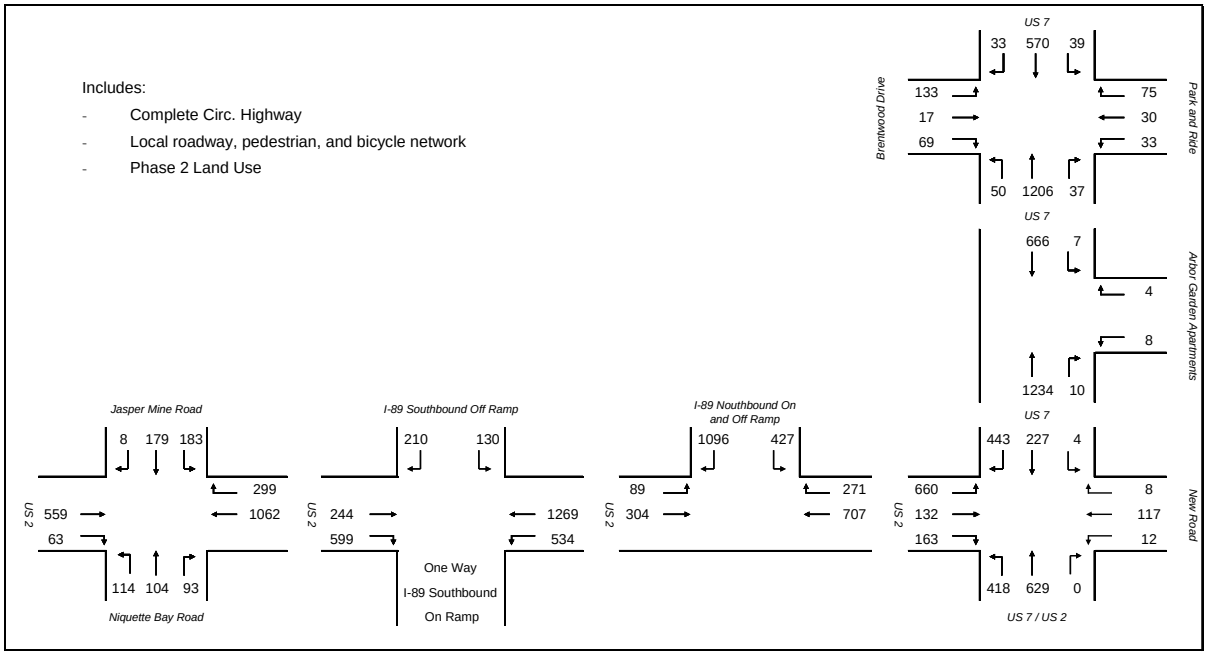
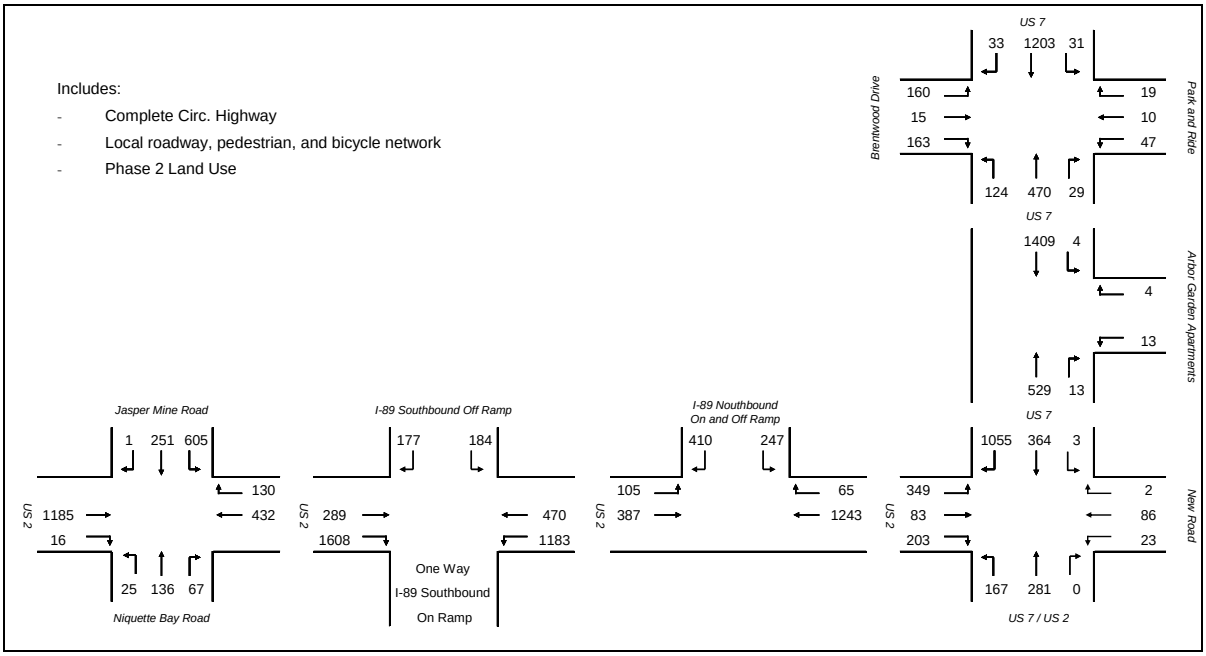


Figure 38: 2025 AM Peak Design Hour Analysis Volumes



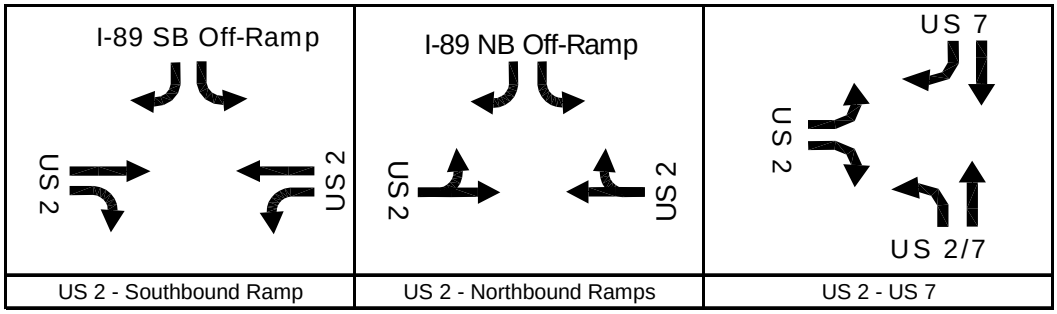
EXIT 17 RAMPS/CHIMNEY CORNERS

The Exit 17 I-89 interchange includes the southbound and northbound I-89 on and off ramps and the US 2-US7 intersection (Chimney Corners). The following alternatives are evaluated: Do Nothing; (1) Traffic Signal improvements with lane geometry changes; (2) Roundabouts; (3) Northbound off-ramp Fly-Over ; (4) Single-Point Urban Interchange; and (5) Tight-diamond interchange.

Do Nothing

The Do Nothing alternative provides a base-case condition for comparison purposes. The existing lane geometry conditions are assumed, but the traffic signals were optimized for the future volumes.

Figure 39: Existing Lane Geometry



Exit 17/Chimney Corners Alternative 1: Traffic Signal Improvements

Figure 40 shows the recommended lane configuration if traffic signals are used to accommodate the 2025 traffic volumes. The existing intersections can be modified by adding turn lanes and additional through lanes along US 2 to maintain adequate level of service.

The high volume of through traffic requires two through lanes and protected left-turn phases at intersections along US 2. The intersections would include marked pedestrian crossings and concurrent pedestrian phasing where appropriate. The right-turn slip lane from the I-89 northbound off-ramp would need to remain. The slip lane's intersection with US 2 would be controlled with a yield sign (under existing conditions, the ramp merges with a dedicated lane over the bridge and is uncontrolled).

During the AM peak hour, there is a large amount of traffic projected to enter the I-89 southbound on-ramp from eastbound and westbound US 2. On the westbound approach, a double-barrel left turn lane is necessary as shown in Figure 40. The right-turn slip lane from the US 2 eastbound approach will accommodate the projected 1,600 vehicles per hour accessing I-89 southbound from that approach. The on-ramp will need to be widened from one to two lanes from US 2 to its junction with the I-89 main line.

A sidewalk is included along the south side of US 2 because there are fewer locations where cross-walks over ramps are necessary. Four foot shoulders are provided to accommodate cyclists.

This alternative design will require that the bridge over I-89 be widened from its existing three lane cross-section to accommodate five travel lanes, four foot wide shoulders to provide for shared use by bicyclists, and a sidewalk on one side.

Figure 40: Exit 17/Chimney Corners Alternative 1 - Traffic Signals with Additional Lanes

Exit 17/Chimney Corners Alternative 2: Roundabout and Roundabout/Traffic Signal Mix

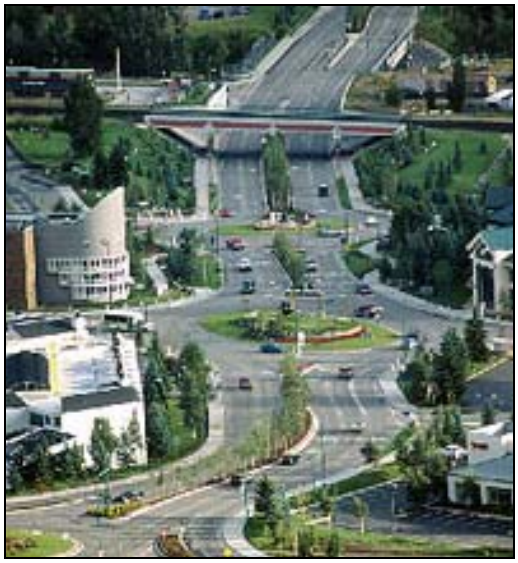
This alternative includes the following three sub-alternatives: 2A - roundabouts at three intersections, 2B - roundabouts at the southbound ramps and Chimney Corners with a traffic signal at the northbound ramps, and 2C - roundabouts at the northbound and southbound ramps with a traffic signal at Chimney Corners. All of the roundabouts require two lanes to accommodate projected traffic volumes.

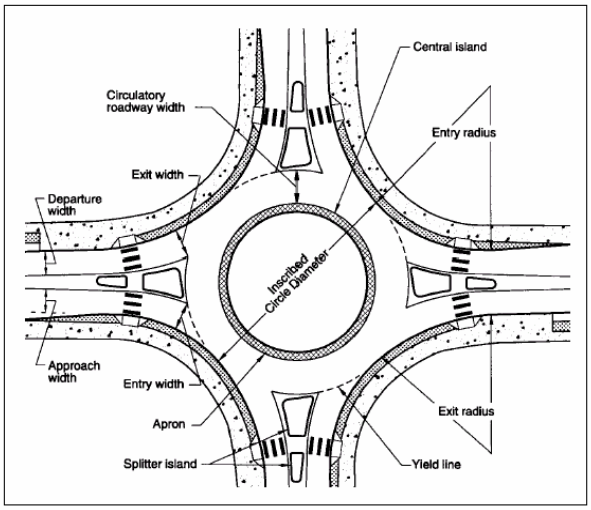
Roundabouts have been constructed in Vermont at several locations and many more are currently being evaluated as an alternative to signalized intersections. A roundabout is a circular intersection traffic control device that assigns the right of way to circulating vehicles. There are three basic principles that define a roundabout:

- Yield at Entry: At roundabouts the entering traffic yields the right-of-way to the circulating traffic. This yield-at-entry rule prevents traffic from locking-up and allows free flow movement;
- Deflection: The entry and center island of a roundabout deflects entering traffic to slow traffic and reinforce the yielding process; and
- Flare: The entry to a roundabout often flares out from one or two lanes to two or three lanes at the yield line to provide increased capacity.

Figure 41 shows these features on a typical roundabout and provides an example of two-lane roundabouts in an urban environment with a 4 lane arterial roadway.

Figure 41: Example of 4-Lane Arterial with Roundabouts (left), Typical Roundabout Design Elements (right)





Roundabouts are often confused with rotaries and traffic circles, but are different in many important ways. In general, roundabouts are designed for slow speeds (15-25 miles per hour) and are much smaller than rotaries. Table 31compares the characteristics of roundabouts and rotaries. Table 32 presents the advantages and disadvantages of traffic signals and roundabouts.

Table 31: Differences between Roundabouts and Rotaries[1]

Characteristics	Roundabout	Traffic Circle or Rotary
Traffic Control	Yield control is used on all entries. The circulatory roadway has no control.	Some traffic circles use stop control, or no control, on one or more entries.
Right-of-way	Circulating vehicles in the roundabout have the right-of-way.	Some traffic circles require circulating traffic to yield to entering traffic.
Pedestrian Access	Pedestrian access is allowed only across the legs of the roundabout, behind the yield line.	Some traffic circles allow pedestrian access to the central island.
Parking	No parking is allowed within the circulatory roadway or at the entries.	Some traffic circles allow parking within the circulatory roadway.
Direction of Circulation	All vehicles circulate counter-clockwise and pass to the right of the central island.	Some neighborhood traffic circles allow left-turning vehicles to pass to the left of the central island.

Table 32: Advantages and Disadvantages of Traffic Signals and Roundabouts[2]

	Advantages	Disadvantages
Traffic Signals	▪ Eliminate certain types of crashes ▪ Often reduce overall delay ▪ Can be optimized for a variety of traffic patterns ▪ Reduce delay for side street traffic ▪ Can improve pedestrian safety by including protected phases	▪ Utilize signal equipment that requires constant power, periodic light bulb and detection maintenance, and regular signal timing update ▪ Create visual clutter ▪ Increases delay for major street traffic
Roundabouts	▪ Reduce amount and severity of crashes relative to an intersection controlled by a stop sign or traffic signal. 51% decrease in total crashes, 73% decrease in injuries and 32% decrease in property damage only crashes.[3] ▪ Their ability to reduce speed while providing capacity for traffic can be incorporated into traffic calming for village centers. ▪ Do not have electrical/mechanical equipment that requires constant power, periodic light bulb and detection maintenance ▪ Service life is approximately 25 years compared with 10 years for a typical signal ▪ Offer the opportunity to provide attractive entries or centerpieces to communities. ▪ May provide environmental benefits if they reduce vehicle delay and the number and duration of stops compared with an alternative ▪ Generally are safe for experienced cyclists due to slower speeds.	▪ Roundabouts usually require more space for the circular roadway and central island than the rectangular space inside traditional intersections. Therefore, roundabouts often have a significant right-of-way impact on the corner properties at the intersection. ▪ Can not be optimized for changing traffic patterns over time. ▪ Roundabouts can be difficult for people with visual disabilities. ▪ May have higher landscape maintenance costs, depending on the degree of landscaping provided on the central island, splitter islands, and perimeter. ▪ All movements are given equal priority. This may result in more delay to the major movements than might otherwise be desired. • Complicates snow removal compared to a typical intersection.

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[1] Adapted from "Roundabouts An Informal Guide"; US DOT, Federal Highway Administration Publication No.. FHWA-RD-00-67

[2] Adapted from "Roundabouts An Informal Guide"; US DOT, Federal Highway Administration Publication No.. FHWA-RD-00-67

[3] Based on an analysis of crashes at eight intersections in the United States that were converted to single lane roundabouts.

Figure 42 presents a concept plan with two lane roundabouts at all three intersections. The two additional alternatives presented in Figure 43 and Figure 44 include a traffic signal at the I-89 northbound off-ramp or at US 2-US 7 in combination with roundabouts.

The roundabout-traffic signal alternatives were evaluated because of concerns that there may not be enough space along US 2 between the northbound off-ramp and Chimney Corners to accommodate vehicle queues that could form between the two intersections. However, as shown in Table 32, projected queues do not exceed the available storage of 330 feet for any of the three alternatives. Table 33 also shows that the all-roundabout alternative results in the least amount of queuing between the two intersections.

Table 33: 2025 Projected Vehicles Queues on US 2 Between Northbound Ramps and US 7

	Alternative		
US 2-Northbound Ramp:	Roundabout	Signal	Roundabout
US 2-US 7:	Roundabout	Roundabout	Signal
Queues extending back from nortbound ramp towards US 7	44 ft.	214 ft.	44 ft.
Queues extending back from US 7 towards Northbound Ramp	72 ft.	72 ft.	272 ft.

Available Storage is 330 feet

All three roundabout alternatives require that:

- The right-turn slip lane from the I-89 northbound off-ramp remains. The slip lane's intersection with US 2 would be controlled with a yield sign; and
- The existing bridge over I-89 is widened from its existing three lane cross-section to accommodate four travel lanes, four foot wide shoulders to provide for shared use by bicyclists, and a sidewalk on one side.

Figure 42 : Exit 17/Chimney Corners Alternative 2A – All Roundabouts

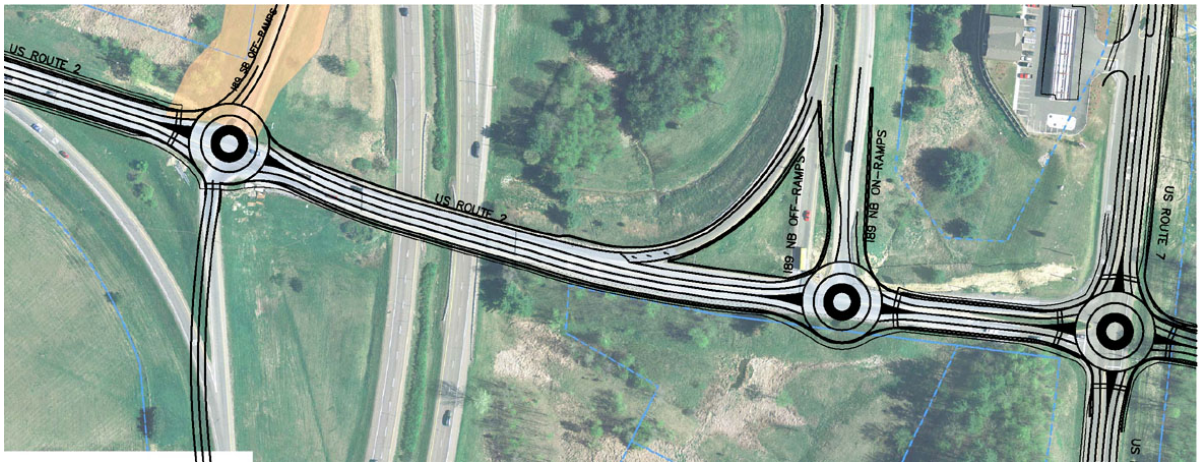


Figure 43: Exit 17/Chimney Corners Alternative 2B – Roundabouts and Traffic Signal at Northbound Ramps

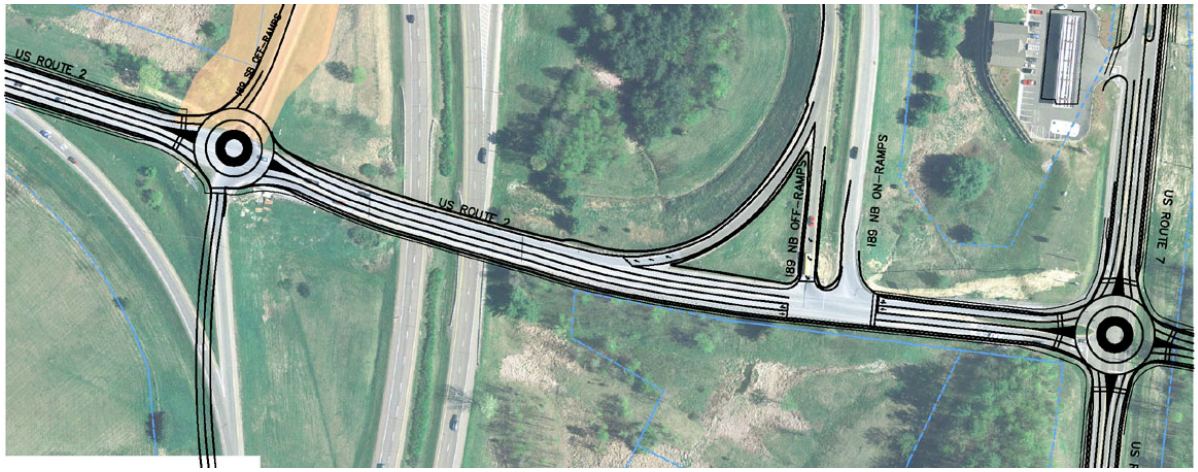
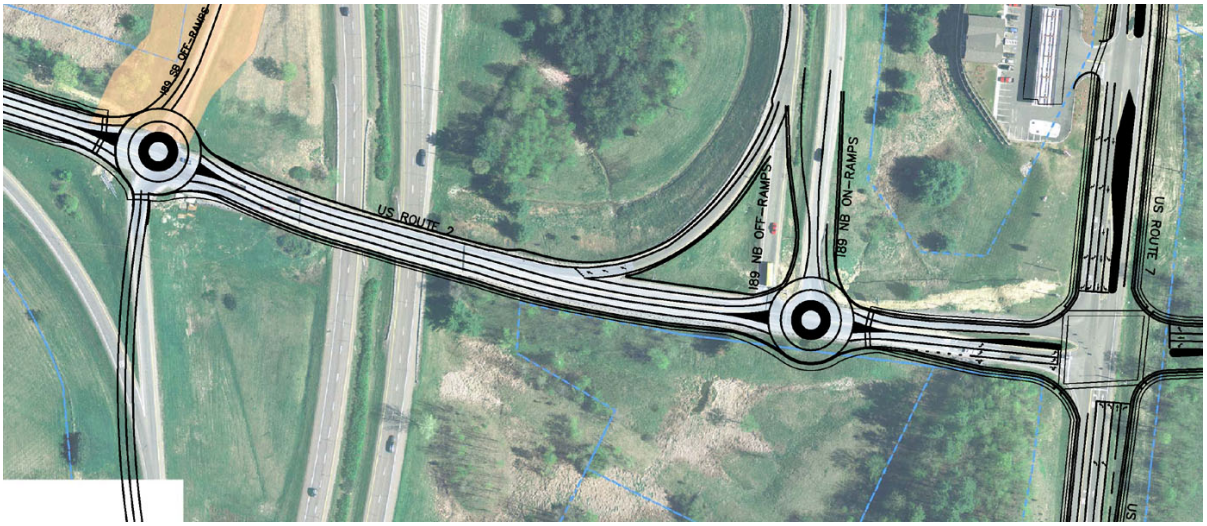


Figure 44: Exit 17/Chimney Corners Alternative 2C – Roundabouts and Traffic Signal at Chimney Corners

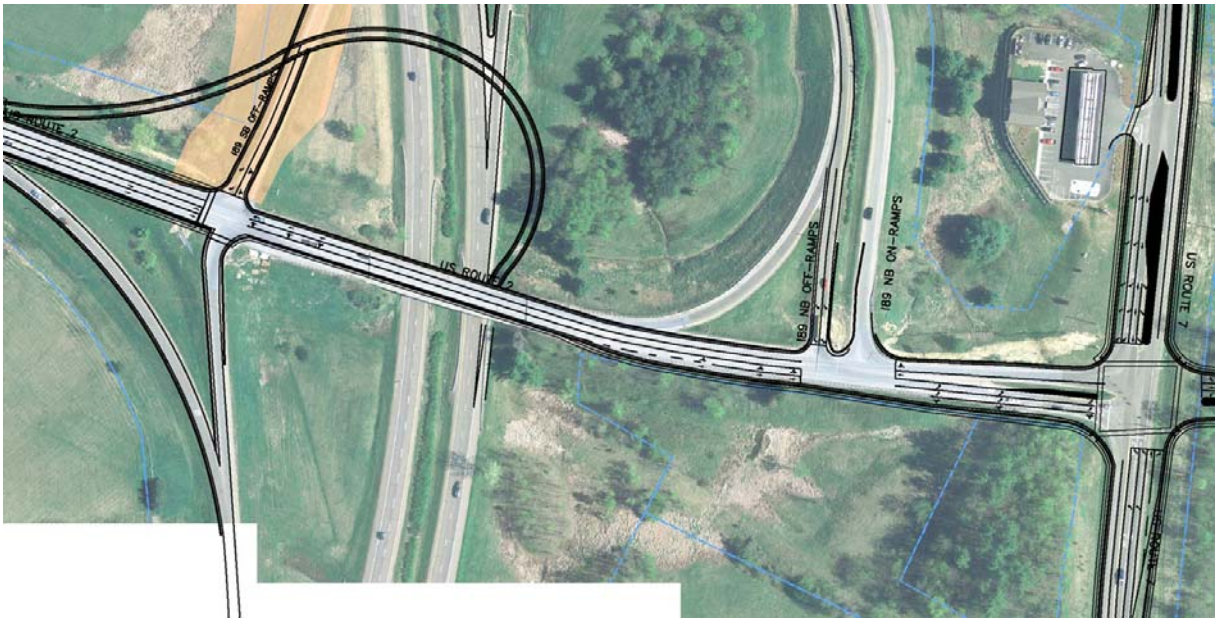


Exit 17/Chimney Corners Alternative 3: I-89 Northbound Off-Ramp Fly-Over

A direct connection from the northbound off-ramp to westbound US 2 was analyzed to accommodate the large volume of traffic destined to Grand Isle County and New York State west of Jasper Mine Road. Figure 45 shows the general concept for the fly-over. It would start at or near where the existing northbound off-ramp diverges from the I-89 mainline, continue over I-89 and the southbound off-ramp, and merge with US 2 east of Jasper Mine Road.

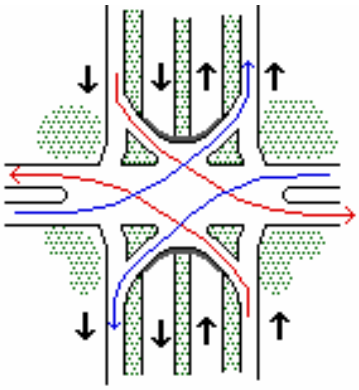
The fly-over allows the westbound traffic to bypass the critical signalized intersections in the study area improving flow on US 2 between the northbound and southbound ramps. The fly-over eliminates the need to widen the existing US 2 bridge over I-89, but also requires the construction of its own bridge. The fly-over also makes it possible to close the existing right-turn slip lane from the northbound off-ramp.

Figure 45: Exit 17/Chimney Corners Alternative 3 –Northbound Off-Ramp Fly-Over



Exit 17/Chimney Corners Alternative 4: Single-Point Urban Interchange (SPUI)

This alternative replaces the two I-89 ramp intersections with a Single Point Urban Interchange (SPUI). A SPUI is essentially one large centralized intersection controlled by one traffic signal.



SPUI: opposing left turns (red pair or blue pair) can proceed concurrently.

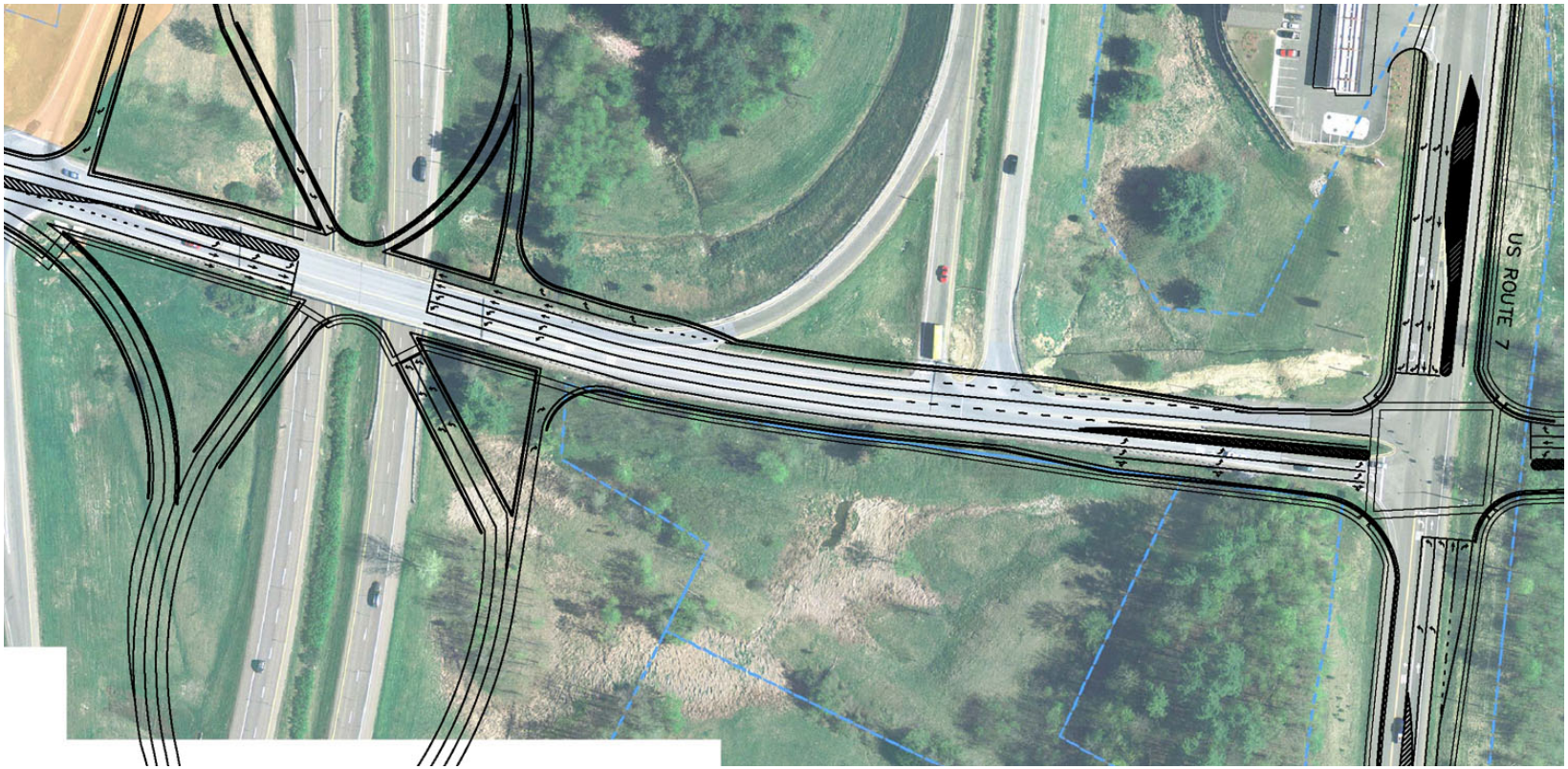
The I-89 southbound and northbound ramps would be re-aligned to meet in a single intersection where one traffic signal controller would operate all east-west through traffic and all left-turns from the ramps. As shown in Figure 46, a SPUI would require a six lanes on the bridge over I-89. This alternative also assumes a traffic signal and associated turn lanes at the US 2-US 7 intersection, although a roundabout could also be included.

The SPUI design first appeared in the United States in the 1970's and since has been installed in about 200 locations nationwide. The SPUI has been an extremely effective interchange design to accommodate large volumes of traffic in a small amount of right-of-way. Several benefits include:

- Uses less right-of-way than most other interchange designs;
- Can accommodate very large left turn volumes; and
- Often significantly reduces delay over other alternatives.

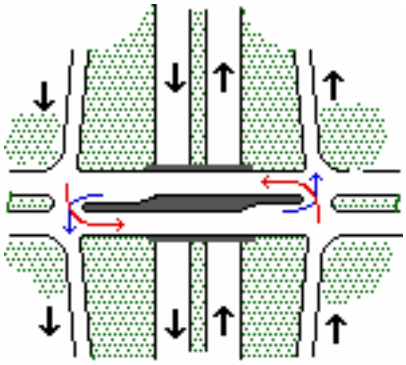
The SPUI concept shown in Figure 46 requires some complex bridge design and construction work at the intersections of the northbound off-ramp and southbound on-ramp with US 2. The SPUI does not provide a pedestrian friendly environment because it creates vast areas of pavement that result in larger pedestrian crossings. It also creates an environment that may be intimidating for some cyclists.

Figure 46: Exit 17/Chimney Corners Alternative 4 - Single Point Urban Interchange



Exit 17/Chimney Corners Alternative 5: Tight-Diamond Interchange

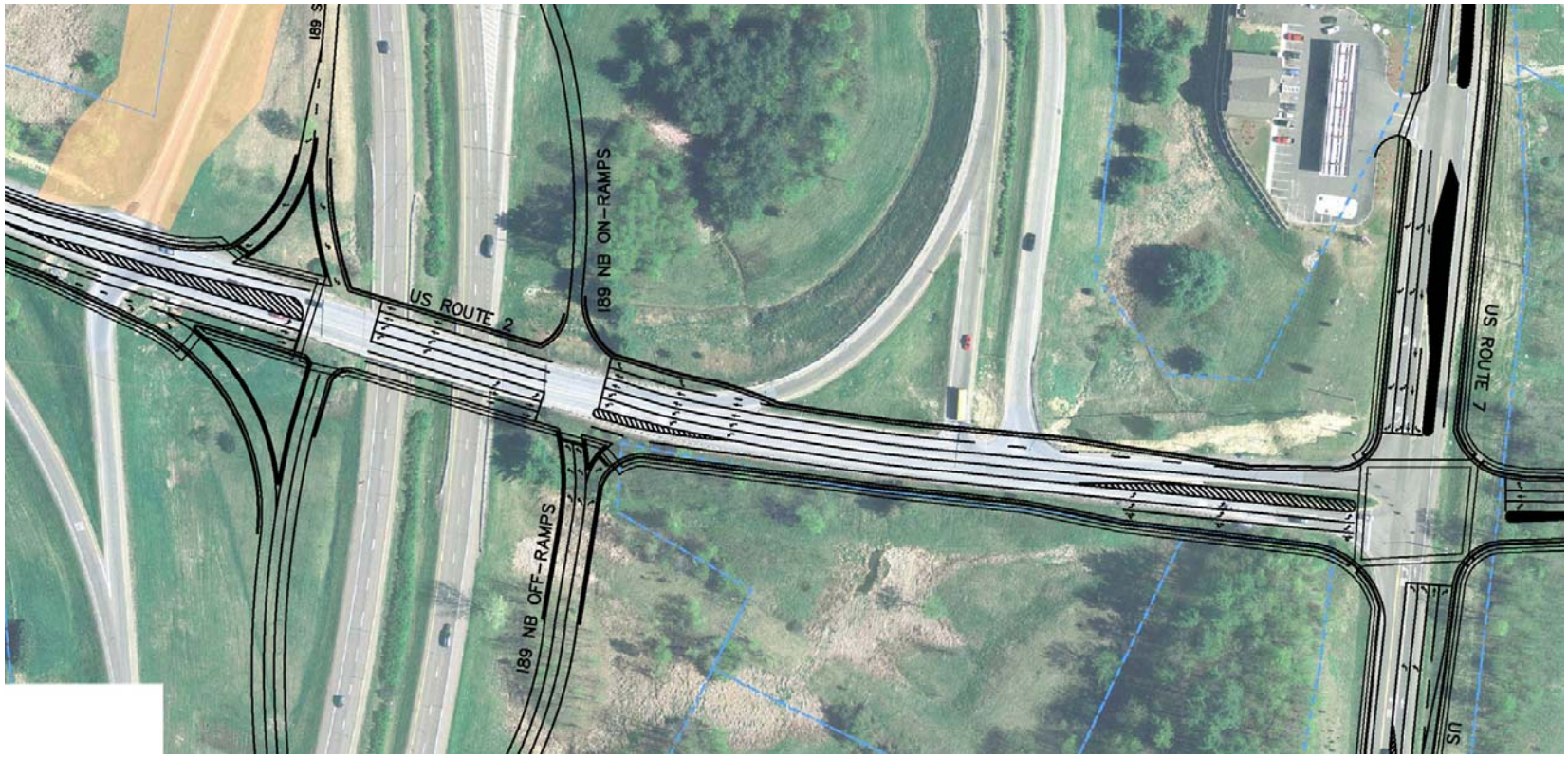
This alternative separates the northbound on and off ramps to opposite sides of US 2, and moves the northbound and southbound ramps closer together. Conventional diamond interchanges are the most prevalent in the United States with the tight-diamond being the newest variation of the traditional interchange design. The tight diamond typically has the signalized ramp junctions spaced 200 to 400 feet apart with the two signals coordinated to operate as one system. This operating configuration is different from a SPUI which combines all of the ramps in a manner that creates one large intersection.


Diamond interchange.

The tight diamond and the SPUI have similarities such as using a limited amount of right-of-way and providing capacity for large volumes of traffic. The tight diamond is less cost prohibitive than a SPUI and allows better pedestrian and bicycle access, but delay and operational conditions vary significantly based on the flows and volumes of critical left-turns and through movements within the interchange.

The Tight Diamond would require 7 travel lanes on the bridge over I-89.

Figure 47: Exit 17/Chimney Corners Alternative 5 - Tight Diamond Interchange



Comparison of Exit 17/Chimney Corners Alternatives

Table 35 on page 81 presents the projected level of service and delay for each alternative during the 2025 PM peak hour. Level-of-Service (LOS) is a qualitative measure describing the operating conditions as perceived by motorists driving in a traffic stream. The 2000 Highway Capacity Manual defines six grades to describe the level of service at an intersection. Level-of-service is based on the average delay per vehicle. Table 34 shows the various level-of-service grades, qualitative descriptions, and quantitative definitions for unsignalized and signalized intersections.

Table 34: LOS Criteria for Intersections

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

The VTrans policy on LOS states that, principal and minor arterials in urban or village areas will generally be designed for a level of service C or better. However, in heavily developed urban areas, reduced level of service criteria such as E or F may be appropriate as judged on a case by case basis.

US 2/7, south of Chimney Corners is classified as an urban principal arterial. US 7 and US 2 in the rest of the study area are classified as urban minor arterials. This study assumes that the desired level of service for the Exit 17 area is "C" for an overall intersection, with LOS "D" acceptable on individual approaches.

Table 35 indicates the following:

- If no modifications are made, the US 2-Southbound Ramp intersection is projected to operate with acceptable LOS during the PM Peak hour. However, during the AM peak hour, the southbound ramp is projected to operate at LOS E.
- If no modifications are made, the US 2-Northbound Ramp and US 2-US 7 intersections are projected to operate at LOS F and E respectively.
- All of the alternatives have been designed to provide acceptable level of service and meet or exceed the goal of providing and overall intersection LOS of C or better. The one approach with poor level of service is the I-89 southbound off-ramp which has a projected LOS of E during the PM peak hour.

Table 36 on page 82 compares the order of magnitude capital cost for each alternative, the right-of-way implications, and the effect on vehicle mobility, safety, pedestrian access, and bicycle mobility.

Order of magnitude costs are based on unit costs for construction items, 15 % for engineering design and permitting, and a 20% contingency. The cost for the SPUI is based on average costs published by the Transportation Research Board and the cost of a similar SPUI constructed in Keene, NH. The cost of the Tight Diamond Interchange is based on average costs published by the Transportation Research Board. The cost for removing the existing US 2 bridge over I-89 and constructing a new bridge is based on square foot costs provided by VTrans.

Table 36 indicates the following:

- The Traffic Signal Alternative, SPUI, Tight Diamond, and Fly-Over alternatives would cost three to four million dollars more to construct than the roundabout alternatives. This cost difference is caused by the need to widen the bridge to accommodate five to seven travel lanes. The roundabout alternative also requires widening the bridge, but only four lanes are necessary.
- Widening the bridge contributes almost 90% of the total cost of the Alternative 1 – Traffic Signals and approximately 85% for the roundabout alternatives.
- Alternative 1-Traffic signal with additional lanes:
    - Can be implemented incrementally. The addition of turn lanes could be implemented incrementally as growth occurs around Exit 17.
    - Provides an improvement for all pedestrians, including people with disabilities, because it offers protected pedestrian crossings that can include audible crossing indicators for the visually impaired.
    - Has one poor LOS rating on the I-89 southbound off-ramp
- Alternatives 2A, 2B, and 2C-Roundabouts and Roundabouts/Traffic Signal:
    - Provides shorter vehicle queues and good LOS for all approaches.
    - Provides an opportunity to enhance the aesthetics of the Growth Center.
    - Improves safety relative to traffic signals.
    - Requires less right-of-way than the traffic signal alternatives because the approaches are not as wide.
    - Does not serve pedestrians with disabilities well.
    - Provides acceptable mobility for experienced cyclists but requires basic cyclists to dismount.
    - Requires additional time for snow removal.
- None of the operational and safety advantages make either the traffic signal or the roundabout alternative the obvious choice and none of the disadvantages suggest that either alternative should be eliminated. Both the traffic signal and roundabout alternatives are feasible, effective, and should be considered in more detail through the scoping process.

Table 35: 2025 PM Peak Hour I-89 Exit 17 Interchange Level of Service

	Existing Geometry		Alt. 1 Upgraded Signals		Alt 2A Roundabouts All		Alt 2B Roundabouts, Sig NB Ramps		Alt. 2C Roundabouts, Sig US2-US7		Alt. 3 Fly Over		Alt. 4 SPUI		Alt. 5 Tight Diamond	
US 2- SPUI													LOS	Delay (sec/veh)		
													Signalized			
Overall													C	24		
Eastbound: US 2													C	27		
Westbound: US 2													C	20.5		
Northbound I89: NB On/Off Ramp													C	21		
Southbound I89: SB On/Off Ramp													B	14		
US2-I89 SB Ramps On/Off (1)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)			LOS	Delay (sec/veh)
	Signalized		**Signalized**		**Roundabout**		**Roundabout**		**Roundabout**		**Signalized**				**Signalized**	
Overall	B	14	B	19.7	LOS B	12.5	LOS B	12.5	LOS B	12.5	B	15.7			C	30.9
Eastbound: US 2	B	17	A	4.5	LOS B	15.2	LOS B	15.2	LOS B	15.2	B	17.1			C	24.8
Westbound: US 2	A	9	B	19.3	LOS A	9.6	LOS A	9.6	LOS A	9.6	A	14.9			D	36.4
Southbound: I89 SB Off Ramp	D	35	E	63	LOS C	20	LOS C	20	LOS C	20	C	29			B	20
US2-I89 NB Ramps On/Off	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)			LOS	Delay (sec/veh)
	Signalized		**Signalized**		**Roundabout**		**Signalized**		**Roundabout**		**Signalized**				**Signalized**	
Overall	F	>100	B	12.1	LOS B	11.2	A	10	LOS B	11.2	A	8.3			B	19.5
Eastbound: US 2	F	>100	A	3	LOS B	10.2	B	14	LOS B	10.2	A	1			B	19
Westbound: US 2	F	>100	A	4	LOS A	7.9	B	16	LOS A	7.9	A	2			B	17
Northbound: I89 NB On/Off Ramp	-	-	-	-	-	-	-	-	-	-	-	-			C	21
Southbound: I89 NB On/Off Ramps	-	-	C	20	LOS B	39.9	A	5	LOS B	39.9	-	-			-	-
Southbound Left: I89 NB On/Offf Ramp	C	24	E	65.9	-	-	B	11.6	-	-	C	30.7			-	-
US2-US7	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)
	Signalized		**Signalized**		**Roundabout**		**Roundabout**		**Signalized**		**Signalized**		**Signalized**		**Signalized**	
Overall	E	59	C	22.6	LOS B	14.6	LOS B	14.6	C	22.2	C	25	C	26	C	25.6
Eastbound: US 2	F	>100	C	23.7	LOS B	14.3	LOS B	14.3	B	12.3	C	22.5	B	17	C	26.8
Westbound: New Local Road	D	37	C	28.4	LOS B	19.4	LOS B	19.4	C	28	C	31.1	D	40	D	36.1
Northbound: US 2/ US 7	E	57	C	20.2	LOS B	16.2	LOS B	16.2	B	13.1	C	25.6	B	17.7	C	24.0
Southbound: US 7	C	31	C	27.2	LOS B	11.3	LOS B	11.3	C	25.4	C	26.3	C	28	C	24.2

(1) Critical Time period is AM for US 2-Southbound Ramp. With Existing Geometry: overall LOS iS E, US 2 Eastbound is LOS F, US 2 Westbound is LOS E, and Soutbound Ramp is LOS F

Table 36: I-89 Exit 17 Interchange Evaluation Matrix

Item	Do Nothing	Alt 1 Traffic Signal	Roundabout			Alt 3 Fly-Over	Alt 4 SPUI	Alt 5 Tight Diamond
			Alt 2A All	*Alt 2B Sig NB Ramps*	*Alt 2C Sig US2-US7*			
Total Cost	-	**11,530,000**	**8,180,000**	**7,990,000**	**8,240,000**	**11,270,000**	**12,600,000**	**11,600,000**
Bridge	-	10,174,050	6,903,450	6,903,450	6,903,450	-	-	11,000,000
Signals	-	434,700	-	75,000	165,000	388,125	207,000	207,000
Intersection/Ramp Widening	-	869,400	193,200	270,000	430,000	483,000	386,400	386,400
Roundabouts	-	-	1,035,000	690,000	690,000	-	-	-
Sidewalks	-	50,784	50,784	50,784	50,784	50,784	50,784	50,784
FlyOver	-	-	-	-	-	10,350,000	-	-
SPUI	-	-	-	-	-	-	12,000,000	-
Right-of-Way Impacts	**Neutral** - No Change from Existing	**Additional ROW Needed** - 0.10 Acres. South side between NB Ramps and US2-US7 Intersection	**Neutral** - No Change from Existing	**Additional ROW Needed** - 0.10 Acres. NB Ramps Intersection	**Neutral** - No Change from Existing	**Additional ROW Needed** - 0.39 Acres. South side between NB Ramps and US2-US7 Intersection & Northwest of SB Ramps	**Additional ROW Needed** - 0.28 Acres. South side between NB Ramps and US2 US7 Intersection	**Neutral** - No Change from Existing
Vehicle Mobility								
US2-US7	**Poor** - Overall LOS E	**Good** - Overall LOS C	**Good** - Overall LOS B	**Good** - Overall LOS B	**Good** - Overall LOS C	**Good** - Overall LOS C	**Good** - Overall LOS C	**Good** - Overall LOS B
US2-NBRamps	**Poor** - Overall LOS F	**Good**- Overall LOS Adequate	**Good** - Overall LOS B	**OK** - Overall LOS Adequate	**Good** - Overall LOS B	**Excellent** - Overall LOS A	**Good** - Overall LOS C	**Good** - Overall LOS B
US2-SBRamps	**Poor** - Overall LOS E in AM	**Good** - Overall LOS C	**Good** - Overall LOS B	**Good** - Overall LOS B	**Good** - Overall LOS B	**Good** - Overall LOS B		**Good** - Overall LOS B
Safety	**Made Worse** - US 2-US 7 is a High Crash Location that will remain if no changes are made	**Improved** - Modifications could be incorporated to address safety issues	**Improved -** Roundabouts have been shown to result in a 51% decrease in total crashes, 73% decrease in injuries and 32% decrease in property damage only crashes compared to traffic signals (1)			**Neutral -** The flyover by itself does not offer any safety enhancements	**Neutral** - No evidence available suggests SPUIs improve or degrade safety conditions	**Neutral -** No evidence available suggests a tight diamond improves or degrades safety conditions
Pedestrians								
General Access	**Poor** - No Existing Facilities	**Improved** - Controlled Marked Ped Crossings	**Neutral** - Uncontrolled Marked Ped Crossings			**Improved** - Controlled Marked Ped Crossings	**Improved** - Controlled Marked Ped Crossings	**Improved** - Controlled Marked Ped Crossings
Disabled Access	**Poor** - No Existing Facilities	**Improved** - Controlled Marked Ped Crossings	**Poor** - Uncontrolled Marked Ped Crossings			**Improved** - Controlled Marked Ped Crossings	**Improved** - Controlled Marked Ped Crossings	**Improved** - Controlled Marked Ped Crossings
Bicycle Mobility	**Poor** - No shoulder Westbound over I89. Eastbound has adequate shoulder width	**Improved** - Provides Shoulder Width Adequate for Bike Travel	**Neutral** - Inexperienced cyclists need to dismount. Experienced cyclists can travel in roundabout where traffic is moving at slower speeds.			**Improved** - Shoulder Width Adequate for Bike Travel	**Improved** - Shoulder Width Adequate for Bike Travel	**Improved** - Shoulder Width Adequate for Bike Travel

(1) Based on an analysis of crashes at eight intersections in the United States that were converted to single lane roundabouts.

ISOLATED INTERSECTION ALTERNATIVES

For each of the three individual intersections of US 2-Jasper Mine Road, US 7-Arbor Gardens, and US 7-Brentwood, three alternatives were evaluated: (1) Do Nothing; (2) Traffic Signal improvements with lane geometry changes; and (3) Roundabouts. This section provides concept sketches, level of service projections, and evaluation matrices.

US Route 2-Jasper Mine Road Intersection

This intersection is currently configured as a jug-handle and is stop-controlled. If no modifications are made to the intersection, the Jasper Mine Road and Niquette Bay Road approaches to US 2 will operate with high levels of delay. Figure 48 shows the concept plan for the traffic signal alternative. Two through lanes are necessary on US 2 to maintain level of service of C or better at this intersection. The basic jug handle configuration would remain, but additional lanes are recommended on the US 2 and Jasper Mine Road approaches. The traffic signal alternative provides acceptable levels of service for the overall intersection and for each approach.

A two-lane roundabout is shown in Figure 49. This alternative would also provide excellent levels of service.

Table 37: 2025 PM Peak LOS for US 2-Jasper Mine Road Alternatives

US7 - Jasper Mine Road	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)
	Unsignalized		**Signalized**		**Roundabout**	
Overall			B	16.8	LOS B	11.3
Eastbound: US 2	A	0	C	23.7	LOS A	9.6
Westbound: US 2	A	0	B	13.8	LOS A	9.6
Northbound: Niquette Bay Road	F	>500	C	27.3	LOS B	16.1
Southbound: Jasper Mine Road	F	>500	B	11.2	LOS C	21.1

Table 38 compares the order of magnitude capital cost for each alternative, the right-of-way implications, and the effect on vehicle mobility, safety, pedestrian access, and bicycle mobility. The roundabout is the more expensive alternative. Both the roundabout and the traffic signal provide excellent level of service at this intersection. Since the traffic signal is optimized to balance the side street and through traffic movements, the side streets have less delay than would occur with the roundabout.

The roundabout would minimize delay for the US 2 through traffic while still providing minimal delay for the side streets. The traffic signal could provide the same distribution of delay if a different timing plan was used. Relative to congestion, each alternative performs equally well. Although the roundabout would cost more to construct, it would enhance safety, and at this particular location has the advantage of creating a gateway into the Growth Center.

Table 38: US 2-Jasper Mine Road Alternatives Evaluation Matrix

Item	Do-Nothing	Traffic Signal	Roundabout
Cost	**Not Addressed** - No Change from Existing	$150,000	$250,000
Right-of-Way Impacts	**Neutral** - No Change from Existing	**Neutral** - No Change from Existing. Use Existing ROW to widen US2 to 2 lanes in each direction	**Neutral** - No Change from Existing. Use Existing ROW to widen US2 to 2 lanes in each direction
Mobility	**Poor** - Side Streets LOS F	**Good** - Overall LOS B	**Good** - Overall LOS B
Safety	**Poor** - Side street congestion may lead to drivers taking risks to enter US 2	**Improved** - The traffic signal will provide protected entrance to US 2	**Improved -** Roundabouts improve safety relatibe to traffic signals.
Pedestrian General Access	**Not Addressed** - No Existing Facilities	**Improved** - Controlled Marked Ped Crossings	**Neutral** - Uncontrolled Marked Ped Crossings
Disabled Access	**Not Addressed** - No Existing Facilities	**Improved** - Controlled Marked Ped Crossings	**Poor** - Uncontrolled Marked Ped Crossings
Bicycle Mobility	**Neutral** - Adequate shoulder width along US 2	**Neutral** - Adequate shoulder width along US 2	**Neutral** - Inexperienced cyclists need to dismount. Experienced cyclists can travel in roundabout where traffic is moving at slower speeds.

Figure 48: US2-Jasper Mine Road Signalized Intersection

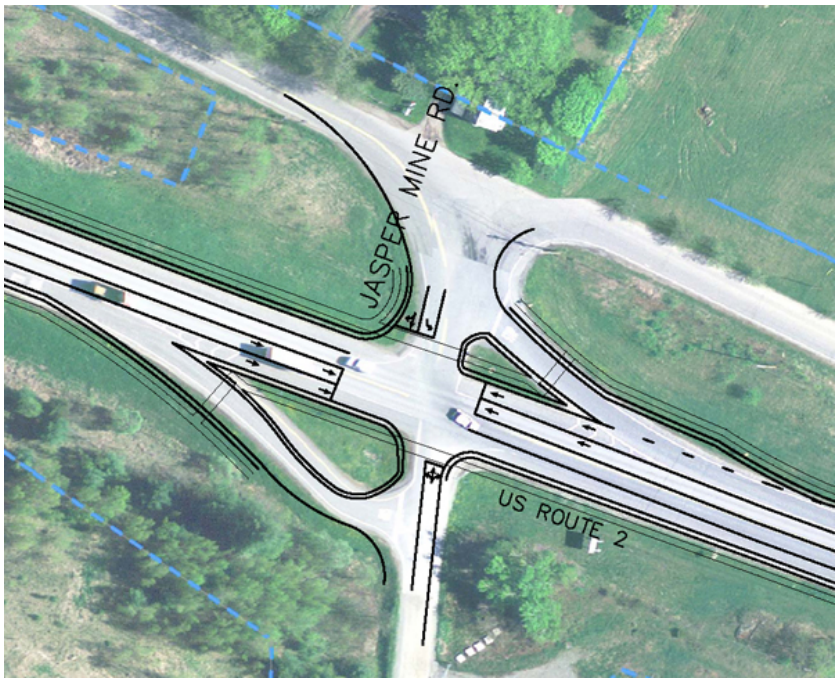
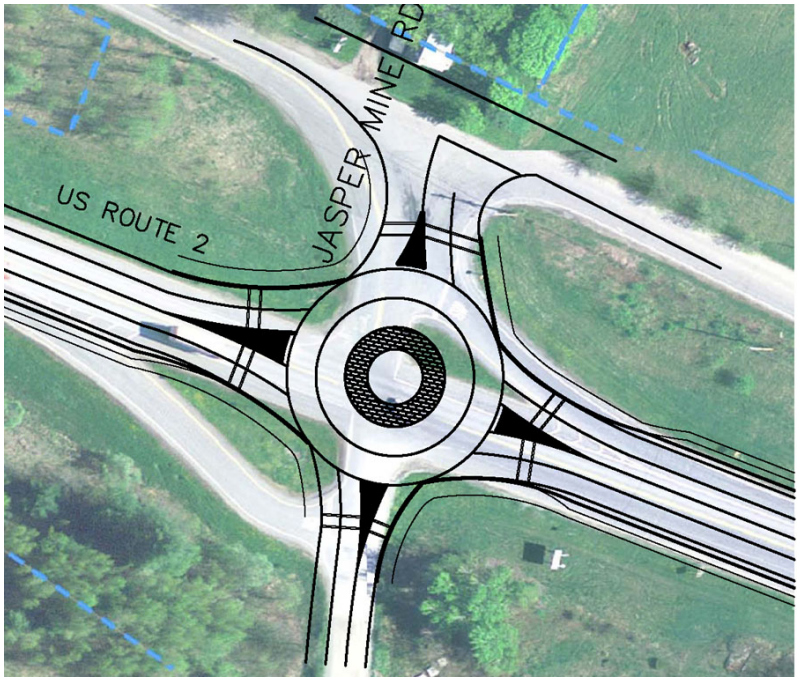


Figure 49: US2-Jasper Mine Road Roundabout Intersection



US Route 7-Arbor Gardens Intersection

The US 7-Arbor Gardens intersection was not evaluated for any further intersection improvements beyond adding a southbound left-turn lane on US 7. The projected traffic volumes out of Arbor Gardens, (17 entering and 12 exiting vehicles per hour during the 2025 PM Peak hour) did not suggest extensive improvements such as a traffic signal or roundabout would be necessary. Figure 50 shows the additional left turn lane on US 7. As indicated in Table 39, the level of service is projected to improve. This improvement is due to the widening of US 7 from 2 to 4 lanes (as discussed in below) which would provide additional gaps for traffic exiting Arbor Gardens.

Table 39: US 7-Arbor Gardens 2025 PM Peak Hour Conditions

	Existing Geometry		Upgraded US 7	
	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)
US7 - Arbor Gardens	**Unsignalized**		**Unsignalized**	
Westbound: Arbor Garden Apartments	F	181	E	35.2
Northbound: US 7	-	-	-	-
Southbound: US 7	A	1	-	-
Southbound Left: US 7	-	-	B	11.6

Figure 50: US7-Arbor Gardens Concept Plan

US 7-Brentwood Drive/Park & Ride Lot

This intersection is controlled by stop signs on the minor streets from Brentwood Drive and the Park Ride Lot. Turn lanes are provided on all four approaches and US 7 has one through lane in each direction as it passes this intersection.

The concept plan for the traffic signal alternative is shown in Figure 51. Two through lanes are necessary on US 7 to maintain level of service of C or better at this intersection.

The concept plan for the roundabout is shown in Figure 52. Projected traffic volumes necessitate a two-lane roundabout.

Table 40: US 7-Brentwood Drive 2025 PM Peak Hour Conditions

US7 - Brentwood Drive	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)
	Unsignalized		**Signalized**		**Roundabout**	
Overall	-	-	B	10.8	LOS A	9.4
Eastbound: Brentwood Drive	F	>500	B	17.1	LOS B	15.5
Westbound: Park and Ride	F	>500	C	24	LOS B	16.3
Northbound: US 7	A	0	A	9.3	LOS A	8.3
Southbound: US 7	A	1	A	9.2	LOS A	8.1

Table 41 compares the order of magnitude capital cost for each alternative, the right-of-way implications, and the effect on vehicle mobility, safety, pedestrian access, and bicycle mobility. The roundabout is the more expensive alternative. Both the roundabout and the traffic signal provide excellent level of service at this intersection.. Although the roundabout would cost more to construct, it would enhance safety, and at this particular location has the advantage of creating a gateway into the Growth Center.

Table 41: US 7-Brentwood Drive Alternatives Evaluation Matrix

Item	Do-Nothing	Traffic Signal	Roundabout
Cost	**Not Addressed** - No Change from Existing	$150,000	$250,000
Right-of-Way Impacts	**Neutral** - No Change from Existing	**Additional ROW Needed** - 0.25 acre around intersection	**Additional ROW Needed** - 0.75 acre around intersection
Mobility	**Poor** - Side Streets LOS F	**Good** - Overall LOS B	**Excellent** - Overall LOS A
Safety	**Poor** - Side street congestion may lead to drivers taking risks to enter US 2	**Improved** - The traffic signal will provide protected entrance to US 2	**Improved -** Roundabouts improve safety relatibe to traffic signals.
Pedestrian General Access	**Not Addressed** - No Existing Facilities	**Improved** - Controlled Marked Ped Crossings	**Neutral** - Uncontrolled Marked Ped Crossings
Disabled Access	**Not Addressed** - No Existing Facilities	**Improved** - Controlled Marked Ped Crossings	**Poor** - Uncontrolled Marked Ped Crossings
Bicycle Mobility	**Neutral** - Adequate shoulder width along US 2	**Neutral** - Adequate shoulder width along US 2	**Neutral** - Inexperienced cyclists need to dismount. Experienced cyclists can travel in roundabout where traffic is moving at slower speeds.

Figure 51: US7-Brentwood Drive Signalized Intersection Alternative

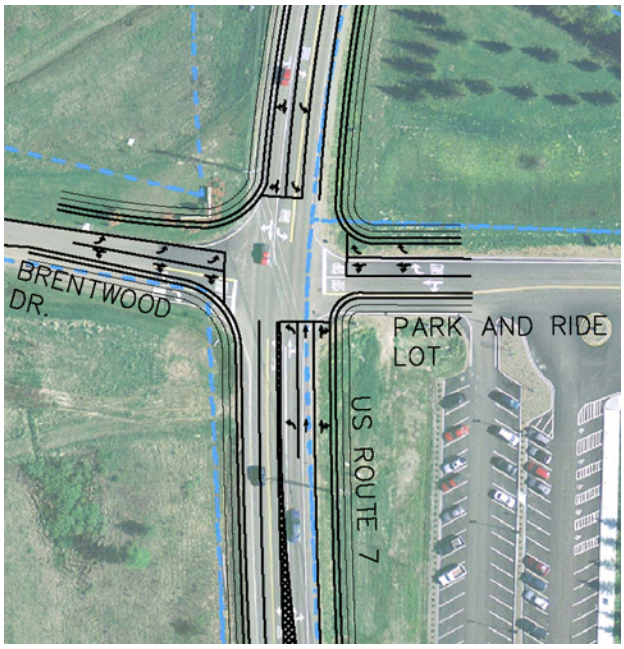
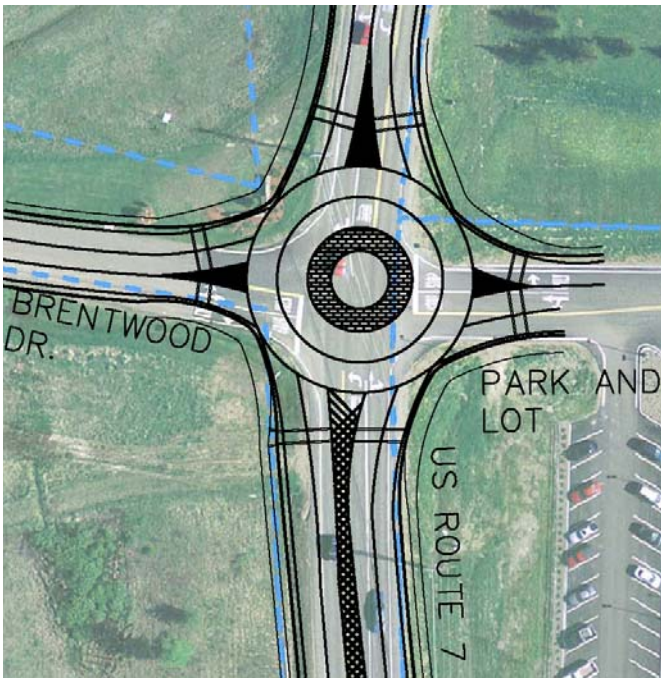


Figure 52: US7-Brentwood Drive Roundabout Intersection Alternative



ROADWAY CROSS-SECTIONS

US 2 and US 7 in the vicinity of Exit 17 and Chimney Corners currently pass through mostly open land that most people would consider rural. Therefore, under existing conditions, these roadways function as rural two-lane highways where drivers expect higher speeds. However, as development continues in the Growth Center, and traffic signals and/or roundabouts are installed at the intersections, the road sections will no longer operate as higher speed rural highways. This change is important from a traffic engineering perspective and is relevant to the question about whether or not additional through lanes are necessary to carry projected traffic volumes.

While the Highway Capacity Manual provides a methodology for estimating level of service on rural two lane highways, it does not provide a methodology for estimating LOS on two lane suburban or urban arterials. Level of service on urban arterials is based on the capacity of the signalized intersections located along the subject arterial. The capacity analyses conducted for the intersection alternatives presented above indicate that two through lanes are necessary on the US 2, US 2/7, and US 7 approaches to all of the study intersections. Theoretically, one through lane in each direction could be dropped between intersections. This type of design would create locations between all of the study intersections where two lanes of traffic would merge into one lane, only to widen again to two lanes at the next intersection. That type of design creates driver confusion and is not recommended.

Therefore, it is recommended that two through lanes be provided in each direction on:

- US 7 between US 2 and Brentwood Drive. This segment will also include a median to allow for the turn lanes at US 7, Arbor Gardens, and Brentwood Park.
- US 2 between the Exit 17 southbound ramps to Jasper Mine Road. The cross-section would transition to a two lane rural road segment west of the Jasper Mine Road intersection.
- US 2/7 south of US 2 to a future, intersection with a new local roadway.

All of the road sections would include sidewalks and green strips. Concept plans showing the proposed layout for each road section are contained in Appendix D. The capital costs for each section are summarized in Table 42.

Table 42: Road Section Cost Estimates

Road Section	Cost
US 7: US 2 to Brentwood	$ 4,794,120
US 2: I-89 to Jasper Mine Road	$ 3,808,800
US 2/7: US 2 to New Local Road	$ 1,656,000
Total	$ 10,258,920

ALTERNATIVES ANALYSIS SUMMARY

Several design alternatives have been evaluated for the I-89 Exit 17-US 2 interchange, the US 2-US 7 (Chimney Corners) intersection, three other intersections in the Exit 17 Growth Center and the connecting road segments along US 2, US 7, and US 2/7.

The alternatives have been designed to accommodate a projected traffic increase of 42% in regional growth between 2000 and 2025 plus traffic to be generated by development in the Exit 17 Growth Center assuming Phase 2 of the 2003 Decentralized Wastewater Study (DWW) is implemented. The Exit 17 Growth Center development assumptions include 1,200 dwelling units and 462,000 square feet of commercial uses. This development will generate approximately 2,100 vehicles per hour during the PM peak hour and 1,450 in the AM peak hour. The traffic projections also assume that the Circumferential Highway is completed between I-89 in Williston and VT 127 in Colchester and that a local network of streets and bicycle and pedestrian facilities connect the different quadrants of the Growth Center is provided.

The total cost of the roadway and intersection projects ranges between $18 and $22 million, depending on which alternative is constructed at the Exit 17/Chimney Corners area. Findings and recommendations are summarized below for each specific section of the study area.

I-89 Exit 17 Ramps and Chimney Corners Findings:

- The following alternatives were evaluated: Do Nothing, Traffic Signal improvements with additional lanes, Roundabouts, Traffic Signal/Roundabout Mix, Northbound off-ramp Fly-Over, Single-Point Urban Interchange, and Tight-Diamond Interchange.
- The Traffic Signal Alternative, SPUI, Tight Diamond, and Fly-Over alternatives would cost three to four million dollars more to construct than the roundabout alternatives. This cost difference is caused by the need to widen the bridge to accommodate five to seven travel lanes. The roundabout alternative also requires widening the bridge, but only four lanes are necessary.
- Widening the bridge contributes almost 90% of the total cost of the Alternative 1 – Traffic Signals and approximately 85% for the roundabout alternatives.
- None of the operational and safety advantages make either the traffic signal or the roundabout alternative the obvious choice and none of the disadvantages suggest that either alternative should be eliminated. Both the traffic signal and roundabout alternatives are feasible, effective, and should be considered in more detail through the scoping process.

US 2-Jasper Mine and US 7-Brentwood Drive Intersection Findings:

- These intersections are similar because they both provide gateways at the edge of the Exit 17 Growth Center. Traffic signals with additional lanes ($150,000) and double lane roundabouts ($250,000) were evaluated.

- Relative to congestion, each alternative performs equally well. Although the roundabouts would cost more to construct, they enhance safety, and at these particular locations have the advantage of creating gateways into the Growth Center.

US 7-Arbor Garden Intersection Findings:

- Because the projected traffic volume entering and exiting the intersection is low, only a left turn lane on US 7 is recommended. Traffic signals or roundabouts are not necessary. The cost of the lane is included in the roadway widening summarized below.

Road Segment Cross-section Recommendations:

- Two through lanes should be provided in each direction on:
    - US 7 between US 2 and Brentwood Drive. This segment will also include a median to allow for the turn lanes at US 7, Arbor Gardens, and Brentwood Park.
    - US 2 between the Exit 17 southbound ramps to Jasper Mine Road. The cross-section would transition to a two lane rural road segment west of the Jasper Mine Road intersection.
    - US 2/7 south of US 2 to a future, intersection with a new local roadway.
- This design will provide a consistent, logical flow of traffic between the intersections and will eliminate the need to create confusing merge and diverge transition areas. The cross-section also includes sidewalks, green strips, and shoulders to accommodate shared use by cyclists through the Growth Center.

PART IV: PHASING PLAN AND FUNDING OPTIONS

This section presents a phasing plan for the all traffic signal alternative and the all roundabout alternative and describes funding sources.

PHASING PLAN

The phasing plan assumes that traffic from regional background growth occurs at a constant rate and that development occurs uniformly within the Exit 17 Growth Center. No attempt was made to decide which parcels would develop first.

Sheets 1-3 in Appendix E present schematics of the study area assuming an all-traffic-signal-alternative. The schematics show the existing lane configurations and the additional lanes at intersections and on road sections required to accommodate projected traffic volumes for 2010, 2015, 2020, and 2025. The incremental changes shown for the years 2010, 2015, and 2020 ultimately add up to the full design developed for 2025.

Sheet 4 in Appendix E presents the phasing for the same years assuming roundabouts are constructed at each of the study intersections.

The schematics present the theoretical timing of improvement based solely on traffic engineering and demonstrate the inefficiencies of implementing changes one lane, one intersection, and one section of roadway at a time. A good example of this situation is the road section on US 7 from Chimney Corners to Brentwood Drive. In 2015, the northbound direction of US 7 should be widened from one to two lanes. The traffic volumes in 2015 do not justify widening the southbound direction until 2020. However, it would be more cost efficient and practical from a construction point of view, to widen both directions of US 7 at the same time.

The study area contains specific intersections, road sections, and the US 2 bridge over I-89. The phasing plan has grouped these individual components into the following major project areas based on proximity and operational relationships:

- US 2 intersections with I-89 northbound on/off ramps and US 2/US 7;
- US 2 intersection with southbound on/off ramps and the US 2 bridge over I-89;
- US 2 intersection with Jasper Mine Road, including sections of US 2 east and west of the intersection;
- US 7 intersection with Brentwood Drive and the section of US 7 to Chimney Corners; and
- US 2/7 road section south of Chimney Corners.

The modifications shown in the phasing schematics assume that background traffic growth is constant and that development is evenly distributed in the Exit 17 Growth Center over the next twenty years. In reality, development will occur in spurts focused within certain quadrants. Since traffic volumes will drive the need for modifications, the phasing plan suggests traffic volume

triggers, in addition to years, for each of the major project areas. The use of traffic volume triggers eliminates the uncertainties of time and development distribution. Traffic volume triggers will also provide a simple monitoring tool, because counts are already conducted on a regular basis.

Table 43 presents the phasing plan. It identifies the specific location or locations within each project area that should be monitored to track the need for improvements. The US 2-Northbound Off Ramp/Chimney Corners project area is unique because it has two trigger locations. Depending on how development occurs in the Growth Center, either intersection may reach its trigger volume first. Regardless of which intersection reaches its trigger volume first, both intersections should be reconstructed at the same time.

Table 43: Exit 17 Phasing Plan

Project Area	Trigger Location	Critical Time Period	Existing 2005 Traffic Volume (1)	Traffic Volume Trigger (1)	Approximate Year (2)
Chimney Corners and US 2/Northbound Ramps	Peak Hour Traffic Through: US 2-I-89 NB Ramps, or	PM	2160	2527	2010
	US 2/US 7 Intersection	PM	1955	2413	2015
US 7/Brentwood Drive and US 7 to Chimney Corners	Two traffic volume on US 7	PM	1301	1610	2015
US 2/Jasper Mine Road	Peak Hour Traffic Through: US 2/Jasper Mine Road	AM	1320	2077	2015
US 2-Southbound Ramps, Bridge Widening, and US 2 widening to Jasper Mine Road	Peak Hour Traffic Volume Through: US 2/Southbound Ramps	AM	2096	3435	2020
US 2/7 South of Chimney Corners	Two traffic volume on US 2/7	PM	1203	1505	2025

(1) Vehicles per hour

(2) Assumes constant growth in background traffic and that development occurs at a constant rate and is evenly distributed in the Exit 17 Growth Center

Traffic volume triggers provide a simple way to monitor the need for action at a particular location. However, a decision on what if any modifications are necessary at that time should be verified with updated traffic counts and detailed traffic engineering and capacity analyses.

Table 44 shows the costs for the major project areas assuming the following alternatives: (1) all traffic signals, (2) all roundabouts, and (3) a combination of traffic signal and roundabouts. The third alternative is based on the least cost and includes roundabouts at the intersections with US 7 and the I-89 northbound and southbound ramps. Providing a roundabout at the southbound ramp reduces the number of lanes required over the bridge from five to four. This reduced the cost of the bridge by $3.2 million.

Table 44: Costs and Alternatives

Traffic SignalAlternative

Traffic SignalAlternative	Chimney Corners and US 2/Northbound Ramps	US 7/Brentwood Drive and US 7 to Chimney Corners	US 2/Jasper Mine Road	US 2-Southbound Ramps, Bridge Widening, and US 2 widening to Jasper Mine Road	Wideing of US 2/7 South of Chimney Cornsers	Total Exit 17 Area
Approximate Year	2010	2015	2015	2020	2025	2025
Bridge	$ -	$ -	$ -	$ 10,174,050	$ -	$ 10,174,050
Signals	$ 331,200	$ 207,000	$ 207,000	$ 103,500	$ -	$ 848,700
Intersection Widening	$ 469,200	$ 82,800	$ 82,800	$ 207,000	$ -	$ 841,800
Roadway Section	$ -	$ 4,794,120	$ -	$ 3,808,800	$ 1,656,000	$ 10,258,920
SB Ramp Widening	$ -	$ -	$ -	$ 193,200	$ -	$ 193,200
Total	$ 800,400	$ 5,083,920	$ 289,800	$ 14,486,550	$ 1,656,000	$ 22,316,670

Roundabout Alternative	Chimney Corners and US 2/Northbound Ramps	US 7/Brentwood Drive and US 7 to Chimney Corners	US 2/Jasper Mine Road	US 2-Southbound Ramps, Bridge Widening, and US 2 widening to Jasper Mine Road	Wideing of US 2/7 South of Chimney Cornsers	Total Exit 17 Area
Approximate Year	2010	2025	2015	2020	2025	2025
Bridge	$ -	$ -	$ -	$ 6,903,450	$ -	$ -
Roundabout	$ 690,000	$ 345,000	$ 345,000	$ 345,000		$ 1,725,000
Roadway Section	$ -	$ 4,794,120	$ -	$ 3,808,800	$ 1,656,000	$ 10,258,920
SB Ramp Widening	$ -	$ -	$ -	$ 193,200	$ -	$ 193,200
Total	$ 690,000	$ 5,139,120	$ 345,000	$ 11,250,450	$ 1,656,000	$ 19,080,570

Traffic Signal/Roundabout Combination	Chimney Corners and US 2/Northbound Ramps	US 7/Brentwood Drive and US 7 to Chimney Corners	US 2/Jasper Mine Road	US 2-Southbound Ramps, Bridge Widening, and US 2 widening to Jasper Mine Road	Wideing of US 2/7 South of Chimney Cornsers	Total Exit 17 Area
Approximate Year	2010	2015	2015	2020	2025	2025
Bridge	$ -	$ -	$ -	$ 6,903,450	$ -	$ 6,903,450
Signals	$ -	$ 207,000	$ 207,000	$ -	$ -	$ 414,000
Intersection Widening	$ -	$ 82,800	$ 82,800	$ -	$ -	$ 165,600
Roundabout	$ 690,000	$ -	$ -	$ 345,000	$ -	
Roadway Section	$ -	$ 4,794,120	$ -	$ 3,808,800	$ 1,656,000	$ 10,258,920
SB Ramp Widening	$ -	$ -	$ -	$ 193,200	$ -	$ 193,200
Total	$ 690,000	$ 5,083,920	$ 289,800	$ 11,250,450	$ 1,656,000	$ 18,970,170

The costs shown in Table 44 do not include the local network of streets, sidewalks, paths and bicycle facilities to connect the different areas of the Growth Center. The length of the local network will depend on final alignments and site plans for specific developments, but will be on the order of 15,000 feet. In addition, two bridges over I-89 would be necessary to connect the east and west sides of the Growth Center. Each bridge would be approximately 200 feet long. The total value of the local network is approximately $7 million ($4 million for the roadways and $3 million for the bridges). This cost assumes that bridges would be designed to carry vehicles. Bridges designed for bicycle and pedestrian travel would cost approximately $1 million[1].

[1] According to the February 10, 2006 "Report on Shared-use Path and Sidewalk Unit Costs", the unit cost for construction of structures for bicycle and pedestrian travel is $1200 per linear foot. This unit cost is only valid on bridges up to 100 feet long. The bridges over the interstate at the Exit 17 Growth Center would be approximately 200 feet long. Applying the VTrans unit cost with a factor of safety of 2 result in a order of magnitude cost of $480,000 per bridge or $1 million for both bridges.

These streets will be incorporated into the site plans of development projects within the Growth Center and will therefore be built and paid for by the developers.. Bridges should be considered as a long-term need dependent on how much development occurs on each side of the interstate. At a minimum, right-of-way or easements should be secured to locations where bridges may cross the interstate.

FUNDING OPTIONS

State and Federal Transportation Funds This is the most likely funding source and would require inclusion of projects on the CCMPO transportation improvement program and state capital program. The first step towards securing these funds is completion of a project definition study (often referred to as scoping).

Scoping projects begin by defining the purpose and need of a project based on an assessment of existing and future conditions and input from local and regional officials and the public. Alternatives are evaluated relative to the purpose and need statement; preliminary right-of-way needs are identified; potential impacts to natural, cultural, and community resources are documented; and costs are estimated. A preferred alternative is selected by the municipality and submitted to the VTrans project definition team (PDT) for approval. If the PDT endorses the preferred alternative, the project moves forward into more detailed design, permitting, right-of-way acquisition and finally construction.

This study has provided the information necessary to develop a purpose and need statement, and has identified the alternatives that should be further refined and evaluated in a scoping study. It has provided a long-term framework from which specific projects can be scoped and constructed (for example – focusing on the Exit 17 interchange and Chimney Corners) that fit into an overall plan for the Growth Center.

Municipal Bonds. The Town of Colchester could also fund transportation projects in its municipal capital budget. Locally raised revenue is often used to match Federal or State funded projects, or may also finance all of a project. Large projects, such as those identified in this study, are often funded through municipal bonds. Additional revenue beyond a municipality's general fund are typically raised to pay for bonds. Municipal bonds can be funded using special assessment taxes, tax incremental financing, or traffic impact fees.

- Special Assessment Tax District: A special assessment district can be created where property owners, which presumably benefit from the investment, pay a special tax to cover the cost of bond payments. Special assessment districts could be established for a designated area of the town or can be designated town-wide.
- Tax Increment Financing District: A tax increment financing district (TIF) can be established that dedicates the non-school taxes generated by increased property value to paying off the bond. A TIF is most appropriate where property values are expected to increase significantly.

- Transportation Impact Fees. 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.

These three local funding sources are complex and estimating potential revenue is based on numerous assumptions such as rate of growth, future value of undeveloped land, increased cost of other local services (fire, police, recreation, etc), and the effect of legislation such as Act 60. In addition, the special assessment taxes and impact fees may be a disincentive to developers. Their advantages are that they connect the cost of infrastructure investment to the development it is intended to serve and provide municipalities with control over implementation.

Standard Development Review Process. Typically, developers pay for their specific impacts to the transportation system through conditions imposed in local and state permits. The projects are negotiated through the local and state permitting processes. This approach, though quite common, is not necessarily fair. It can assign all of the improvement cost to the last developer that happens to file an application after previous developers have consumed available capacity. This last developer ends up financing a capacity expansion that can then be consumed by subsequent applicants. Impact fees, notwithstanding their disadvantages, address this inequity because all developers contribute funds based on an established formula regardless of the timing of a congestion problem.

RECOMMENDATION

A project definition study should be conducted that focuses on the Exit 17 interchange and the Chimney Corners intersection with the following purpose:

The purpose of this transportation project is to preserve the operation of the Exit 17 interchange so that it continues to provide a safe and efficient connection between the interstate and arterial highway systems while also accommodating travel demand anticipated as the surrounding Growth Center develops.

The project definition study should include the all-traffic signal, all-roundabout, traffic signal/roundabout mix alternatives. The redesign of the interchange into different configurations (single point urban interchange, tight diamond interchange, or northbound off-ramp fly-over) should not be considered further.

Reconstruction of the US 2 bridge over I-89 is a critical element. The preferred alternative resulting from the project definition study will finalize how the bridge should be re-constructed. As noted in the phasing plan presented above, widening of the bridge will be triggered by the need to reconstruct the US 2-Southbound on/off ramp intersection which could occur within fifteen years.

The project definition study should include the northbound and southbound ramp intersections and Chimney Corners but construction should occur in two major phases. The first phase will reconstruct on Chimney Corners and the US 2/northbound ramps. The second phase will reconstruct on the US 2/southbound ramps and the bridge. Initiating the project definition study

now will provide enough time to plan for widening the bridge while allowing other improvements to be implemented.

The study area also includes the following major components:

- US 7 from Chimney Corners to Brentwood Drive
- US 2 from the southbound ramps to Jasper Mine Road
- US 2/7 south of Chimney Corners

Project definition studies should also be conducted for these components. However the need for projects on these sections will depend on the location and pace of development in the Growth Center. The Town and CCMPO should use the traffic volume triggers presented in this study to determine if and when a project definition study should be initiated[1].

The local street network will be an important part of the Growth Center's transportation system and is necessary to accommodate 20% of the travel demand generated by development. These streets will be incorporated into the site plans of development projects within the Growth Center and will therefore be built and paid for by the developers.

New bridges over I-89 will be part of the local street system, built and paid for by developers, and should be considered as long-term needs dependent on how much development occurs on each side of the interstate. The bridges may serve vehicular travel but could also be dedicated to pedestrians and cyclists. In short-term, right-of-way or easements should be secured to locations where bridges may cross the interstate.

SUMMARY

The purpose of this study is to identify transportation system improvements for the Exit 17 Growth Center in Colchester, VT. The study recommends design changes to Exit 17 and the surrounding road network that support local development while maintaining mobility through the interchange. The study focuses on the intersections of, and connecting road segments between, the I-89 Exit 17 interchange, US 7-US 2 (Chimney Corners), US 2-Jasper Mine Road, US 7-Bretnwood Drive, and U7-Arbor Gardens Residential Complex.

The existing transportation system is described and analyzed relative to congestion, safety, and access management. Two future land use scenarios are developed based on the capacity of different phases of an off-site waste water system studied by the Town in the 2000 Decentralized Waste Water study.

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[1] This recommendation addresses the need to initiate a project definition study from a technical perspective. The decision to actually fund a project definition study will be made by the CCMPO (of which Colchester is a member) and VTrans based on an evolving project prioritization system and the availability of funds.

The amount of traffic that would be generated by the two land use scenarios and background growth is estimated for 2025 and levels of congestion are projected at the study intersections assuming no modifications are made. It also evaluates the effect of constructing the complete Circumferential Highway with and without a new interchange between I-89 and West Milton Road in Milton. Under existing conditions, the congestion is limited. However modifications are necessary to accommodate future traffic projections.

Several design alternatives are evaluated for the I-89 Exit 17-US 2 interchange, the US 2-US 7 intersection, the other three study intersections, and the connecting road segments along US 2, US 7, and US 2/7. The alternatives have been designed to accommodate refined traffic projections that include regional growth between 2000 and 2025 plus traffic to be generated by development in the Exit 17 Growth Center assuming Phase 2 of the 2003 Decentralized Wastewater Study is implemented. The alternatives assume that the complete Circumferential Highway is constructed but a new interchange at West Milton Road is not completed within the planning horizon.

The total cost of the roadway and intersection projects along US 2 and US 7 ranges between $18 and $22 million, depending on which alternative is constructed at the Exit 17/Chimney Corners area. A phasing plan is presented based on traffic volume triggers and potential funding options are described.

The study acknowledges that the recommendations will most likely be financed with federal and state transportation funds which require completion of a project definition study. The project definition study should focus on the Exit 17 interchange and the Chimney Corners intersection first. It should be initiated now to allow adequate time for reconstruction and widening of the US 2 bridge over I-89. Construction would occur in two major phases. The first phase will reconstruct on Chimney Corners and the US 2/northbound ramps. The second phase will reconstruct on the US 2/southbound ramps and the bridge.

The Town and CCMPO should use the traffic volume triggers presented in this study to determine if and when project definition studies should be initiated for the other road segments and intersections in the study area. The timing and funding of any project definition study will depend on regional and state priorities and funding availability.

The local street network will be an important part of the Growth Center's transportation system and will be built and paid for by developers as part of their site design. New bridges over the intestate to accommodate travel between the different areas of the Growth Center are long-term needs may serve vehicular travel but could also be dedicated to pedestrian and cyclist. In short-term, right-of-way or easements should be secured to locations where bridges may cross the interstate.