SPEAR STREET CORRIDOR STUDY
SOUTH BURLINGTON, VERMONT

-Final Report-

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SPEAR STREET CORRIDOR STUDY

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SPEAR STREET CORRIDOR STUDY
South Burlington, VT

EXECUTIVE SUMMARY

Purpose

The Spear Street Corridor Study is a transportation study of a four (4) mile corridor of Spear St. in South Burlington, extending from the Shelburne Town Line north to Main St. (Route 2). The study purpose was to identify existing and future deficiencies in this corridor, identify the probable transportation impacts of proposed development and candidate transportation system improvements, and recommend specific actions that the City of South Burlington and developers need to undertake in order to improve the function of the roadway. A key work task was to develop a preliminary improvement plan for the Spear St.- Swift St. intersection.

The study was conducted under the direction of the City of South Burlington through the Department of Planning and Zoning, in conjunction with the Chittenden County Metropolitan Planning Organization.

Work Tasks

The project was conducted in two phases:

1. Identification of Issues and Opportunities Relative to existing (year 2003) and future (year 2008) traffic volumes
2. Preparation of a plan with recommendations for feasible solutions that address identified deficiencies.

This final report includes a discussion of the following:

- Project Goals and Objectives
- Existing Corridor Land Use
- Summary of Existing Conditions and Issues
- Programmed Development In The Corridor
- Future Traffic Conditions and Issues
- Improvement Strategies Considered
- Evaluation Of Improvement Strategies
- Corridor Improvement Recommendations
- Implementation Plan.

Existing and Future Traffic Conditions And Issues

The concerns and deficiencies identified along the Spear St. corridor were a result of an evaluation of physical roadway conditions and traffic operations conditions. An evaluation of base year (year 2003) morning (AM) peak hour traffic volumes and design hour traffic volumes (typical of the late afternoon peak hour) as well as a review of the accident history along the corridor revealed the following concerns:

1. Intersection Operation Problems

- § Poor levels of service during peak hours at the Allen Rd, Deerfield Dr. and Spear / Swift intersections;
- § Poor lane alignment, high accident location, old signal equipment, and narrow lane width at the Spear / Swift intersection;

2. Roadside Area Concerns

   - § Lack of shoulder area and utility pole clearance at Spear / Swift intersection
   - § Lack of protection against bridge abutment in I-189 overpass area;

3. Pedestrian and Bike Accommodation

   - Lack of shoulder area at Allen Rd. intersection
   - Bike lane disconnect southbound in area of Overlook Park
   - Lack of uniform roadway section (i.e. bike lanes) for bike travel in both northbound and southbound directions between Allen Rd. and Swift St.
   - Unsafe pedestrian crossing area and lack of bike accommodation at Spear / Swift St. intersection
   - Lack of bike and pedestrian accommodation along Spear St. north of Swift St.
   - Lack of pedestrian crosswalk in Quarry Hill Rd. area.

Analysis of future (year 2008) traffic conditions revealed a worsening of the existing deficiencies as noted above. The expected increase in design hour traffic over the next five years due to normal traffic growth plus programmed corridor development traffic is in the order of 25% at the Spear St. / Swift St. intersection, and about 34% at the Allen Rd / Spear St. intersection.

Figure 10 in the report shows the location of the major deficiencies based on the year 2008 design hour traffic.

Corridor Improvement Recommendations

After considering various improvement strategies (see Section 7. for the four categories of strategies considered) the recommended improvements were developed and are summarized below. See Figure 20 for the location plan, and Section 9. for more detailed descriptions.

1. Traffic Operations Improvements At Intersections

1.1 Spear St. At Allen Rd.:
- Complete a traffic signal warrant study
- Provide additional shoulder width on Spear St.

1.2 Spear St. at Deerfield Dr/Nowland Farm Rd.
- Evaluate impacts of widening the Deerfield Dr. approach to two lanes
- Conduct traffic signal warrant study in future

1.3 Spear St. At Swift St.

- Make immediate improvements that change the northbound lanes to an exclusive left turn lane, and a combined thru-right lane, move the crosswalk and northbound stop bar, and make other traffic signal equipment upgrades
- Within 2 years, based on actual traffic demands, reconstruct the intersection with new approach lanes on the northbound and eastbound approaches, provide new signal span poles and signal heads, including the addition of pedestrian signals and relocated crosswalks.

1.4 Spear St. at Quarry Hill Rd.

- Provide a crosswalk that makes a connection to the UVM bike/pedestrian path

2. Roadway Improvements At Non-Intersection Areas

2.1 Spear St. Between Allen Rd. and Swift St.

- Provide a uniform width shoulder on each side, typically providing an eleven (11) foot travel lane with a 4 foot bike lane/shoulder in each direction;

2.2 Spear St. North of Swift

- Provide travel lane of minimum eleven (11) feet with a minimum four (4) feet of paved shoulder area for bikes in each travel direction;

2.3 Spear St. At I-189 Overpass Area

- Provide marked bike lane along shoulder area, provide guard rail protection at abutment areas on west side and at the brook culvert crossing, provide sidewalk or paved path (shared use) on east side of road, and conduct study of drainage ditches and drainage outlets in order to accommodate roadway shoulder improvements;

2.4 Spear St. North of Quarry Hill Rd

- Provide a uniform pavement width of 28 feet (minimum), accommodating 2 travel lanes at eleven (11) feet wide and a paved shoulder of three (3) feet on each side;

3. Pedestrian Improvements

3.1 Sidewalk & Pedestrian Path Recommendations

- Provide sidewalk or recreation path along Spear St. between Allen Rd. and Swift St.; construct sidewalk or shared use path along east side of Spear St. between the proposed Forest Glen project and USDA Research Center

3.2 Add Pedestrian Crosswalks

- Gutterson Field House area (at least 2 crosswalks)
- Quarry Hill Rd. Intersection
- USDA Research Center Area
- Swift St./ Spear St. Intersection
- Pinnacle Dr. (or Cedar Glen) Area
- Allen Rd. Intersection

4. Bike Accommodation Improvements

4.1 Overlook Park Frontage Area

4.2 Allen Rd. To Swift St.

- Provide 4 foot (or 5 foot where roadside curb is present) bike lanes on both sides of Spear St.

4.3 Swift St. To Quarry Hill Rd.

- Provide uniform bike lane of 4 feet (minimum) on each side of Spear St. where possible; where shoulder width is less than 4 feet, designate as a bike route.

5. Access Management Actions

The City of South Burlington has regulations and guidelines that encourage access management features in development plans submitted to the city. Specific requirements of subdivision plans and PUD projects should be maintained relative to design requirements of access to projects, such as consolidating curb cuts, alignment of access points with other curb cuts or intersections, turn lanes, and other requirements.

6. Transportation Demand Management Actions

On-going and planned programs that reduce single-occupant vehicle trips in the Spear St. corridor need to be encouraged, such as CATMA programs . The City needs to support and implement policies and programs such as:

- Public transportation subsidies
- Flex time at area employers
- Improving pedestrian and bicycle facilities and systems
- Carpool / vanpool programs and incentives
- Ridesharing programs
- Educational outreach events

7. Public Transportation Service Improvements

Improvements to roadways and intersections that encourage safe pedestrian movement and connection to existing bus transit routes (e.g. in the Shelburne Road corridor) need to be encouraged. The designation of transportation management coordinators at larger developments with the function of promoting and developing ridesharing, carpooling, and other transit related programs can help to reduce peak hour vehicle trip generation.

8. Traffic Calming/Traffic Control Recommendations

8.1 Radar Speed Display Signs
8.2 Speed Enforcement
8.3 Wide Roadway Edge Line Pavement Markings

9. Land Use Planning & Development Policies

Continue to encourage policies in place with regard to site plan development and approval procedures for major developments along the Spear St. corridor, as found in the city's Land Development Regulations. These include reviews by the Development Review Board, and traffic impact study requirements.

10. Roadway Maintenance

10.1 Pavement Management
10.2 Winter Maintenance
10.3 Roadside Drainage

SPEAR STREET CORRIDOR STUDY
South Burlington, VT

1. PROJECT OVERVIEW

The Spear Street Corridor Study is a transportation study conducted along the four (4) mile corridor of Spear Street from the Shelburne Town Line north to Main Street (Route 2). Exhibit 1 shows the study section in the context of the local street system. The purpose of this traffic study as stated in the request for proposal is "to identify existing and future transportation system deficiencies in the corridor, identify the probable impacts of proposed housing developments and transportation system improvements, and recommend specific actions that the City and developers need to undertake to make the corridor function as well as possible. A key work task in this project is development of a preliminary engineering plan for realignment of the Spear Street-Swift Street intersection, which has been the most problematic intersection in the corridor."

The project was conducted in two phases: 1.) Identification of Issues and Opportunities, and 2.) Preparation of a Corridor Plan with recommendations for feasible solutions to identified deficiencies. The first phase provided a summary of the existing corridor traffic operations at intersections and along roadway sections, discussed safety deficiencies relative to accident history, and indicated areas of concerns relative to physical roadway characteristics, and bicycle and pedestrian accommodation. It was based on current conditions in the corridor, using traffic volumes representing a base year of 2003.

The second phase of the study evaluated the likely projected traffic for the future (year 2008), and developed improvement alternatives to address traffic deficiencies in the corridor.

This study was conducted under the direction of the City of South Burlington through the Department of Planning and Zoning, in conjunction with the Chittenden County Metropolitan Planning Organization.

2. PROJECT GOALS AND OBJECTIVES

The goals and objectives of this project followed those developed and adopted by the City in the Comprehensive Plan.

The transportation goal statement is as follows:

"It is a goal of this City to improve and expand all modes of transportation including private automobile, public bus transit, air, rail, biking, walking, ride sharing and private sector involvement. Such expansion and improvement shall be consonant with equal access for all income levels and abilities, reasonable costs, orderly and continued economic growth, existing and proposed land use, the fixed supply of land, the increasing cost of energy, and other goals of this plan."

General transportation objectives as stated in the City's Comprehensive Plan are as follows:

1. Promote a well-rounded transportation system that provides, in as economical a manner as possible, safety, efficiency, attractiveness, convenience and service commensurate with need.
2. Encourage greater use of mass transit of all forms, and other alternative modes of transportation including walking, biking and ride sharing. It should be recognized that high residential densities and high intensity land use often provide opportunities for great use of mass transit.
3. Promote good access management when planning new roads, improving existing roads, and reviewing new development.
4. Support the concept of a transportation corridor where a single right-of-way is used by different modes of transportation thereby resulting in fewer land use conflicts and greater efficiency in the use of remaining land.
5. Promote the expansion and improvement of transportation systems within existing corridors, right-of-way, or property lines, unless alternative locations that conforms with the balance of the plan are necessary.

Those objectives formed the basis for this study, with other considerations made by the study committee and stakeholders group.

3. EXISTING CORRIDOR LAND USE

Existing land use along Spear Street consists primarily of single-family residential and open-space/agricultural use in that section between the Shelburne town line and Swift Street. Between Swift Street and Quarry Hill Road to the north, the existing land use is a mix of residential, institutional, forest, and agricultural. North of Quarry Hill Road the development is institutional along the west side (UVM facilities) and residential along the east side. Exhibit 2 is a map of the existing land use in South Burlington in the context of city-wide land development.

Surrounding land use to the north, east, south and west of Spear Street in a more regional perspective also has an influence on the Spear Street corridor. To the north is the University of Vermont campus, Fletcher Allen Health Care Center, and City of Burlington commercial and service area of the region. To the south and southeast is a growing residential area. West of Spear Street is the commercial and shopping area of Shelburne Road/Route 7, with important roadway links via Allen Road and Swift Street. East of the Spear Street corridor is the location of major recreational facilities such as Dorset Park and the Vermont National Country Club.

Zoning and Land Development Regulations are guides that help shape the existing and future land development relative to type and intensity of development. The type and intensity of allowed and approved development has a resulting impact on transportation demand and other service demands in the Spear Street corridor. Exhibit 3 is the City's Zoning Map. It shows Spear Street having residential districts to the south of the I-189 overpass, and a mix of residential and institutional/agricultural districts to the north of I-189. Zoning for the Southeast Quadrant as adopted by the City is shown in Exhibit 4.

It is important to note that the City has in place a very comprehensive set of Land Development Regulations (as adopted May 2003) for the purpose of implementing the Comprehensive Plan. These regulations help guide and manage future development projects. The area east of Spear Street between the Shelburne town line and Swift Street is in the relatively new Southeast Quadrant District (SEQ). This district has regulations influencing the allowable uses, designation of restricted areas, allowable residential development density, standards of dimensions, and review process by the Development Review Board.

There are also Overlay Districts in the Spear Street corridor. These are geographic areas (zones) within which certain zoning or other land development regulations apply. Adjacent to the Spear Street corridor along the southern section are specific Scenic View Protection districts including the Dorset Park district (Nowland Farm Road vicinity), Overlook Park district, Ridge district, and Allen Road district.

4. SUMMARY OF EXISTING CONDITIONS AND ISSUES

The following is a summary of concerns and deficiencies along the Spear Street corridor based on existing physical roadway and traffic operations conditions. These are discussed in the categories of Traffic Operations (Intersections, Roadway Sections, Accidents & Safety), Roadway Geometrics, Pedestrian Considerations, and Bicycle Considerations. The deficiencies and concerns discussed are based primarily on readily available data provided by others, including data, reports and plans from the City, CCMPO, VTRANS and others.

Figure 5 presents a graphical display of the major existing deficiencies identified.

4.1 Traffic Operations - Intersections

Traffic count data was obtained for nine intersections along Spear Street between Allen Rd. at the south end of the study corridor and Main Street (Route 2) at the north end. This count data was obtained from CCMPO and VTRANS based on field counts that were conducted in years 2001, 2002 and 2003.

These peak hour counts were then factored to a "design hour volume" (DHV) which is used as a basis for further traffic operations analysis. These design hour volumes represent the typical 30th highest traffic hour of the year, and are used to assess traffic capacity and level of service conditions. They typically reflect the weekday afternoon commuter peak hour traffic conditions on roadways such as Spear Street and the surrounding collector and arterial streets. Figure 1 indicates the 2003 design hour volumes for intersections along the Spear Street study area.

The weekday morning peak hour periods were also reviewed, since traffic count data was available. This traffic period was of interest for purposes of seeing traffic patterns at intersections and how the morning traffic differed in volume and directional pattern from the afternoon design traffic. Figure 2 indicates the data factored to 2003 AM Peak Hour traffic conditions.

Capacity Analysis

A capacity analysis of traffic during the peak periods of the day was conducted to determine the relative quality of traffic operation, defined as level of service (LOS), for traffic at the study area intersections. Level of Service has been determined by the methodology of the "2000 Highway Capacity Manual", published by the Transportation Research Board to describe the operating condition of intersections. LOS is a measure of the Control Delay experienced by stopped vehicles at an intersection, which is rated on a scale from A to F, with each letter grade assigned a range of delay values in seconds per vehicle. LOS A describes a condition of very low delay (less that 10 seconds per vehicle), and LOS F describes a condition where delays will exceed 50 seconds per vehicle for an unsignalized intersection, or exceeds 80 seconds per vehicle for a signalized intersection. Control Delay measures the time accumulated when a motorist approaches an intersection including the initial deceleration, queue move-up time, stopped delay, and final acceleration delay.

Therefore, intersections with longer Control Delay times are less acceptable to most drivers. For unsignalized intersection capacity analyses, LOS provides a description of the delay and operational characteristics of the movements from the minor street (stop sign controlled) and left turns from the major street to the minor street. Major street through and right turn vehicles do not experience delay. Therefore, they are not rated with a LOS.

Table 1 (located in the appendix) summarizes the level of service for traffic movements at the various Spear Street intersections.

Spear Street at Swift Street

This four-way signalized intersection has seen increased traffic volumes on its approaches over the years. Based on existing traffic demand, lane configuration and geometrics, and signal operation, the following deficiencies and issues are of note.

1. Highest accident frequency location along the study section of Spear Street.
   - 26 accidents reported at intersection during 36-month period (Jan. 2001-Dec. 2003)
   - Actual accident rate exceeds critical rate

2. Lane alignment – northbound through lane traffic alignment conflicts with southbound left turn traffic.

3. Poor traffic signal head visibility and placement (no far side signals to advise traffic of end of signal phase)

4. Poor traffic signal operation during peak traffic hours

5. Semi-actuated traffic control not operating efficiently.
   - Obsolete signal controller and controller equipment.
   - Poor level of service for Swift Street westbound left turns during PM Design Hour (Level "F")
   - Long vehicle queue on northbound approach in AM peak hour. (Level of Service "E")

Spear Street Southbound at Swift St. Intersection

6. Lane assignment – left turn traffic combined with thru traffic is problematic for Spear Street northbound and Swift Street eastbound.

7. Recreation path crossing of Spear Street is in unsafe location relative to northbound vehicle stop bar – poor pedestrian crossing visibility.

8. Intersection does not provide for safe pedestrian crossings on approaches.
9. Narrow width of thru lane northbound is not conducive to safe bike travel.

Spear Street at Allen Road

1. Relatively heavy turning movement volumes with no shoulder areas for pedestrians or snow storage.

2. Poor level of service for left turns onto Spear Street. (Level "E" and "F" for AM and PM peak hour design volumes).

3. 9 accidents reported over 36-month period (Jan. 2001 – Dec. 2003).

Allen Road Approach At Spear Street

4. Increasing pressure as major traffic connector between Shelburne Road (Route 7) and Spear Street.

Spear Street at Deerfield Drive

1. Poor level of service for movements out of Deerfield Drive during afternoon peak hour conditions (level "F").

2. Poor level of service for left and thru movement out of Nowland Farm Road during afternoon peak hour conditions (level "F").

4.2 Traffic Operations - Roadway Sections Between Intersections

Spear Street is classified as a collector street, as are other surrounding streets such as Swift Street, Allen Road, and Nowland Farm Road. Spear Street functions as a collector roadway in that section between Allen Road and Swift Street, whereby it "collects' vehicles from the adjacent residential homes and developments and feeds these vehicles to other collectors, such as Swift Street, and eventually to arterials (like Route 2) and the interstate system.

In between intersections, Spear Street south of Swift Street has a basic roadway cross-section width of about 31 feet, consisting of one travel lane in each direction, with a wide shoulder for bike travel in the southbound direction (west side of road), and a very narrow (no shoulder to about 2 ft. of shoulder) in the northbound direction (east side of road). Figure 3 shows the typical cross-section widths for three sections of Spear Street. Spear Street has been widened to accommodate turn lanes into side streets

Spear Street Southbound from Overlook Park

at Pinnacle Drive, Nowland Farm Road, and Allen Road. The right-of-way width on Spear Street is 66 feet.

Spear Street south of Swift Street is currently operating at a level of service of D during the peak hours, if it is evaluated as a 2-lane class II highway.

North of Swift Street, between Swift and Quarry Hill Road, Spear Street operates like a rural two lane roadway since there is very little roadside development and corresponding roadside friction. Spear Street has a pavement width of about 28 to 30 feet in the vicinity of the I-189 overpass. Spear Street in this area is operating at a level of service of D during the peak traffic hours, based on an evaluation as a 2-lane class II highway.

North of Quarry Hill Road, Spear Street narrows to about 24 to 27 feet of pavement and has a posted speed limit of 25 mph. This is a segment of single family homes along the east edge of Spear Street, with the Gutterson area of the UVM Campus along the west border of Spear Street. The UVM parking lot activity in this northern end of Spear Street influences the volume of traffic at this end. Given these physical roadway conditions and lower operating speeds, the level of service in this area during the peak hour is also around a level D.

4.3 Traffic Operations - Accidents And Safety

Accident data was available from summaries provided by the South Burlington Police Department and historic data from VTRANS. Figure 4 indicates the accident locations based on data provided by the City's police department. Table 2 summarizes the accident frequency by location. Based on frequency of accidents and yearly traffic volumes, an accident rate was derived for the corridor intersections. This rate is indicated in Table 3. The Spear/Swift Street intersection has an actual accident rate that exceeds the critical rate, thereby indicating need for safety improvements. The critical rate is established by VTRANS as the statewide average number of crashes at intersections of roadways of various functional classes. A historical crash rate higher than the critical rate is deemed to be abnormal and warranting investigation into the contributing factors.

4.4 Roadway Geometrics

Spear Street is unencumbered by significant horizontal or vertical alignment problems. The street layout is relatively flat throughout most of it's length, with the exception of the "dip" under I-189 north of Swift Street. There are no restrictive curves in the roadway that significantly impact sight distance or vehicle operating conditions.

For roadways that serve through traffic and have vehicle operating speeds over 30 mph, such as Spear Street, shoulders along the roadway help to improve both capacity and safety. There are locations along Spear Street that have little or no paved shoulder in addition to the 11 or 12 foot travel lane. An unobstructed clearance area next to the travel lane is important for vehicle "recovery" area, pedestrian and/or bicycle travel, snow storage and storm drainage accommodation. Spear Street south of Quarry Hill Road generally has a pavement width of 30 feet or more (more at widened intersection areas), with through traffic lanes having a width generally of 11 to 12 feet.

Specific areas of concern due to lack of shoulder width or poor roadside clearance are discussed below.

Spear Street at Allen Road

Spear Street has been widened to accommodate turn lanes into Allen Road. There are no paved shoulder areas here in which to accommodate bike traffic. The lane width northbound (currently 12 to 13 feet) through this area should be wider in order to safely accommodate bike traffic in a shared lane with vehicular traffic, based on typical operating speeds thru this area.

Spear Street Southbound at Allen Road

Spear Street Just North of Swift Street

There is a lack of shoulder area and clearance to roadside utility poles for the northbound lane just north of Swift Street, in front of the All Saints Church.

Spear Street at I-189 Overpass

The bridge abutments for the I-189 ramps over Spear Street are relatively close to the edge of Spear Street on the west side. Vehicle speeds are relatively high through this area despite a posted speed limit of 35 MPH. Consideration should be given to guard rail protection around these abutments. There is also roadside erosion noted on the embankment at the drainage culvert at this sag curve.

Vicinity of I-189 Overpass

4.5 Pedestrian Considerations

Land development in the Spear Street corridor and the area between Dorset Street on the east and Shelburne Road (Route 7) on the west contributes to areas of pedestrian activity along and across Spear Street. There are no sections of Spear Street with sidewalks running along the roadway other than the sidewalk along the frontage of Overlook Park, just north of Deerfield Drive. The only other area where there is a pedestrian walk is the recreation path on the west side of Spear Street in the area between Quarry Hill Road and the USDA Research Center.

Field observations indicated occasional pedestrians (including joggers) on weekdays along the side of Spear Street between the USDA Research Center and Swift Street and in other sections of Spear Street south of Swift Street.
With regards to noticeable crossings of pedestrian paths along Spear Street, these are as follows:

1. Recreation Path crossing at Swift Street intersection (marked crosswalk), and
2. Recreation Path crossing at Nowland Farm Road intersection (marked crosswalk).

Recreation Path Crossing of Spear Street

The recreation path along Swift Street is a shared use path (bike and pedestrian) that provides a connection between Dorset Park Athletic Fields and the Vermont Botanical Garden area, and Farrell Park and the East Woods Natural Area. The path along Nowland Farm Road connects the Dorset Street/Vermont National Country Club area with Overlook Park and Symanski Park. Exhibit 5 shows the location of those shared use paths along the corridor including existing and proposed pedestrian and recreation paths.

Concerns of note with regard to existing pedestrian movements are as follows:

1. Lack of pedestrian crossing facilities and markings at Quarry Hill Road (access to UVM path);

2. Lack of provisions for pedestrians along Spear Street between the USDA Research Center and Swift Street intersection;

3. Lack of adequate traffic markings, signage, and poor visibility and location of the Recreation Path Crossing at Swift Street;

4. Lack of provisions for pedestrians along Spear Street in the residential area between Swift Street and Allen Road.

4.6 Bicycle Considerations

Spear Street is a popular bike route and its use in this regard appears to be growing. The section of Spear Street between Swift Street and Allen Road, a distance of approximately 1.6 miles, has a wide (approximately 6 feet) paved shoulder along the west pavement edge that serves as a bike lane. On the east side of Spear Street, there is a narrow shoulder area, with the white edge line only one to two feet off the edge of pavement. Bikes traveling northbound must share the lane with vehicular traffic. The northbound travel lane in this section is typically 12 feet in width.

North of Swift Street there are no marked bike lanes and white edge lines are worn and hardly visible. The paved shoulder width varies from 6 inches (or less) north of Quarry Hill Road to about 2 feet in the area of the I-189 overpass.

Exhibit 6 indicates the type and extent of bike facilities along Spear Street.

Issues with existing bicycle activities are as follows:

1. Lack of uniform roadway cross-section (i.e. bike lanes) for bike travel in both northbound and southbound directions in Spear Street area between Swift Street and Allen Road; wide bike lane on only one side of road tends to encourage two-way bike movement;

2. Bike lane shoulder disconnect section (i.e. no paved shoulder) southbound along Overlook Park frontage.

3. Lack of adequate traffic markings and signing for bicycle activity north of Swift Street.

Bike Shoulder Southbound

Shoulder Ends at Overlook Park

5. PROGRAMMED DEVELOPMENT IN THE CORRIDOR

The City of South Burlington is currently reviewing a number of proposed development projects that will have an influence on the traffic complexion of Spear Street. These projects, and other land use plans being formulated in this Southeastern Quadrant Area as well as in the Towns to the south and east of the City will result in a continuing increase in traffic demands on the corridor. Table 4 summarizes the anticipated future development in the corridor, based on information provided by the City.

Exhibit 7 shows the location of these future developments within the Spear Street corridor. Assigning this development traffic to Spear Street results in added traffic at the intersection areas as shown in Figure 6 for the morning (AM) peak hour period. Figure 7 shows the estimated added traffic for the afternoon (PM) peak hour, or the design hour traffic. These traffic volumes are based on traffic studies by others where available. Where traffic study data was not yet available, estimates were made based on Institute of Transportation Engineers (ITE) trip rates. Table 5 indicates the peak hour traffic generated by the various future development projects proposed in the Spear Street corridor area.

TABLE 5
Peak Hour Traffic Estimates
Programmed Corridor Development

Development Name	No./Type of Units	Peak Hour Traffic Estimates
UVM	Housing Parking Garage	AM – None Provided PM 350 Trips (136 In 214 Out)
Quarry Hill	281 Units Residential	AM 125 Trips (20 In 105 Out) PM 155 Trips (105 In 50 Out)
Forest Glen	89 Units Residential	AM 67 trips (17 In 50 Out) PM 97 Trips (62 In 35 Out)
Farrell	30 Units Residential	AM 23 Trips (6 In 17 Out) PM 31 Trips (20 In 11 Out)
Snyder	32 Units Residential	AM 24 Trips (6 In 18 Out) PM 33 Trips (21 In 12 Out)
South Village	310 Units Residential	AM 321 Trips (101 In 220 Out) PM 345 Trips (202 In 143 Out)
Redstone	145 Units Residential	AM 72 Trips (14 In 58 Out) PM 89 Trips (58 In 31 Out)

6. FUTURE TRAFFIC CONDITIONS AND ISSUES

An estimate was made of expected traffic in the Spear Street corridor area for the year 2008. It was based on assuming a normal annual growth in background traffic using Spear Street, plus the traffic to be added by the seven programmed land development projects discussed above. The resulting projected traffic volumes and corresponding traffic operations at intersections are discussed below.

6.1 Year 2008 Traffic Projections

Figures 8 and 9 indicate the estimated morning (AM) and afternoon (design Hour) traffic volumes for a 5-year future projection to the year 2008. The expected change in total intersection traffic volumes during the design hour period at the three busiest intersections in the corridor are shown in Table 6 below.

TABLE 6
Expected Design Hour Traffic Growth

Intersection	Existing Traffic Year 2003	Background Traffic Growth Only Year 2008	Traffic With Programmed Corridor Development Growth Year 2008
Allen Rd./Spear St.	1,471	1,546	1,974
Spear St./ Swift St.	2,274	2,390	2,856
Main/Spear East Ave.	4,623	4,859	5,213

6.2 Traffic Operations and Level of Service

Table 7 (located in the Appendix) summarizes the level of service for traffic movements at the various Spear Street intersections based on the 2008 forecasted traffic conditions. These levels of service for traffic movements are based on the existing (year 2003) physical conditions (i.e. intersection layout) and signal operations at these locations.

Spear Street at Swift Street

Traffic conditions on certain approaches will further degrade compared to existing deficiencies as discussed in Section 4. Without any improvement made to the intersection, it is expected to have an overall intersection level of service of "F" for the morning peak hour, and level "F" for the design hour (PM) condition. The problem for movements will continue to be the northbound Spear Street movement in the morning, and the westbound left turn lane on Swift Street in the afternoon.

Spear Street at Allen Road

Traffic delays on the Allen Road approach will continue to increase as traffic volumes increase. The right turn lane from Allen Road onto Spear Street, at level "C" for the existing (2003) design hour condition, will go to level "F" with the 2008 traffic projections. Also,

the proposed South Village development will add a fourth leg to the intersection by virtue of adding its main site access opposite Allen Rd. As an unsignalized intersection, the traffic out of this access will operate at level "F".

Spear Street at Deerfield Drive

The Deerfield Drive eastbound approach currently operates with long traffic delays (level "F") during the afternoon design hour period. For the projected 2008 traffic condition, this approach will go to a level "F" in the AM peak hour as well, compared to a level "D" currently.

6.3 Roadside Area Concerns

These concerns were discussed under the Existing Condition Section and include areas that have a lack of shoulder width and/or poor roadside clearance to fixed objects. These areas include:

Spear Street at Allen Road

There are currently no paved shoulder areas here to accommodate bike traffic. The lane width northbound (currently 12 to 13 feet) through this area should be wider in order to safely accommodate bike traffic in a shared lane with vehicular traffic, based on typical operating speeds thru this area.

Spear Street Just North of Swift Street

There is a lack of shoulder area and clearance to roadside utility poles for the northbound lane just north of Swift Street, in front of the All Saints Church.

Northbound Just North of Swift Street

Spear Street at I-189 overpass

The bridge abutments for the I-189 ramps over Spear Street are relatively close to the edge of Spear Street on the west side. Consideration should be given to guard rail protection around these abutments. There is also roadside erosion noted on the embankment at the drainage culvert at this sag curve, and guardrail should be installed at the top of these culvert areas.

6.4 Pedestrian Issues

Pedestrian concerns in the corridor area are related to a lack of adequately marked pedestrian crosswalks and a lack of sidewalks or pedestrian pathways that remove pedestrians from the roadway shoulders or edge of vehicle travel lanes. These issues are as described for existing conditions. Some areas will see new pressures for pedestrian accommodation due to new residential development. These areas include the area around

the Allen Road intersections as a result of the proposed South Village development, the Forest Glen project north of Swift Street, and the proposed Quarry Hill development on Quarry Hill Road.

6.5 Bicycle Considerations

The main issues related to bike use in the corridor were described in the Existing Conditions section. These relate to the following:

- Lack of uniform roadway cross-section (i.e. bike lanes) for bike travel in both northbound and southbound directions in Spear Street area between Swift Street and Allen Road; wide bike lane on only one side of road tends to encourage two-way bike movement.
- Bike lane shoulder disconnect section (i.e. no paved shoulder) southbound along Overlook Park frontage.
- Lack of adequate traffic markings and signing for bicycle activity north of Swift Street.

6.6 Other Issues

Throughout the study period there were informational meetings held with the public as well as with the Technical Study Group. Comments and concerns which were raised during those meetings are included in meeting memos which are included in the Technical Appendix, bound separately.

In general, there were four common concerns from the Spear Street residents that attended the public meetings. These were:

- Improving the safety for vehicle turning movements at the Spear / Swift intersection
- Reducing the amount of traffic on Spear Street
- Reducing the speed of traffic on Spear Street
- Improving the ability to get out of their driveways during heavy traffic periods.

6.7 Summary of Future Deficiencies

Figure 10 summarizes the areas of concern for pedestrians and bikes in the corridor, as well as intersection operation and other roadside area concerns.

7. IMPROVEMENT STRATEGIES CONSIDERED

There were various improvements considered to address the problems and issues that were identified as a result of the existing and future traffic conditions analysis. These improvement strategies fall into four basic categories:

1. **Engineering / Traffic Operations Strategies**
   a. Traffic Operations Improvements
   b. Roadway and Intersection Geometric Improvements
   c. Pedestrian Improvements
   d. Bike Accommodation Improvement

2. **Transportation Management Strategies**
   a. Access Management
   b. Transportation Demand Management
   c. Public Transportation / Transit Service

3. **Land Use Planning & Development Strategies**

4. **Roadway Maintenance**

The following discusses those improvements that were determined to be the most feasible strategies to consider to address the project goals and objectives.

7.1 Intersection Improvements

Traffic congestion and pedestrian / bicycle conflicts at street intersections along Spear Street are probably the most apparent problems that need to be addressed in the corridor. Among the list of potential improvement options that were considered for intersections were:

- Improvements to traffic signal operation (timing and/or phasing) for the existing signalized intersection of Spear and Swift.
- Addition of lanes (e.g. turning lanes, thru lanes) or changes to existing lane patterns/use on intersection approaches.
- Use of a roundabout as an alternative to traffic signals at the Spear/Swift intersection.
- Other traffic control signage, such as three-way or four-way stop sign control.

7.2 Roadway Sections

Certain areas of Spear Street which are between intersections are in need of improvements such as the following:

- Adding guard rails or similar protective devices along the roadway edge in order to provide a safer separation of the roadway travel lane from fixed roadside objects or features, such as drainage ditches, utility poles, or bridge abutments.

- Improvement to pavement markings to better mark travel lane edges, bike lanes, and pedestrian crossing areas.
- Addition of shoulder areas or minor pavement widening in order to obtain a safe lane width for accommodation of motor vehicles and bikes.

7.3 Pedestrian Accommodation

There are improvements to the travel corridor that need to be made to more efficiently and safely accommodate existing pedestrian travel and encourage walking as a mode of travel in the corridor. These considerations include:

- Improving existing crosswalk areas by addition of more pavement markings and uniform traffic signs.
- Construction of new crosswalks on Spear Street at strategic neighborhood crossing locations.
- Providing sidewalks along the border of the roadway in areas of existing or potential pedestrian generators, such as residential areas and near recreational facilities.

7.4 Bicycle Accommodation

Some of the improvements suggested for safe movement of bike traffic along the corridor include the following:

- Providing a more uniform width of bike lane along **both** sides of Spear Street, and increasing the bike lane or shoulder width along the east side of Spear Street.
- Providing more lane or shoulder width for bike travel through intersection areas, including both at signalized and unsignalized intersections.
- Improving bike lane or bike route signage so as to make drivers more aware of bike use and to provide guidance for bicyclists.

7.5 Transportation Management

Transportation management strategies involve methods to better manage our existing facilities and try to get the most efficiency and safety out of the existing transportation infrastructure without adding more capacity. Considerations for the Spear Street corridor included the following:

- Access Management Strategies:
  These include measures to better control (i.e., make it safer and more efficient) traffic turning in and out of roadside development, or eliminate or reduce such turning traffic. Ways to do this include:

  a. Restricting driveway or side-street turning movements to right-turn-in, right-turn-out only;
  b. Constructing left-turn lanes and/or right-turn lanes on the main road in order to separate slowing or stopped turning vehicles from through traffic;

c. Constructing traffic signal control where warranted by traffic volume, pedestrian, and/or accident warrants.

- Transportation Demand Management (TDM)
  Ways to reduce the demand for motor vehicle travel during peak traffic times (e.g. commuter times or during special events) can help to reduce the volume of through traffic on the street, and accordingly improve safety and capacity on the roadway. The following are some techniques considered:

  a. Provide park and ride facilities where commuters can leave their vehicles and carpool or take a bus or commuter van to their work destination;
  b. Encourage larger businesses to have flex time policies which helps to spread out the peak times of employee arrival and departure;
  c. Encourage car pooling or van pooling by employers (particularly larger businesses) in order to reduce single occupant vehicle trips.

- Bus Transit Service
  Another means of transportation demand management is public transportation/transit service. Although it is more difficult to support from a ridership and operational funding standpoint in the more rural areas, public transportation services in developing corridors such as Spear Street should be encouraged.

7.6 Land Use Planning & Development Policies

The City of South Burlington currently has a good comprehensive plan which frames and guides the growth and development of land in the City. The City also has Land Development Regulations which implement the City Comprehensive Plan and establish the policies, regulations, and procedures by which land development in the City gets accomplished. Such policies and procedures have a direct impact on the future transportation consequences in roadway corridors such as the Spear Street area.

The City's regulations detail certain requirements regarding site plan review and approval that proposed developments for the Spear Street corridor area must adhere to in order to be approved. These include submission of a traffic impact report. The City also has Access Management policies that encourage use of traffic and design techniques to control and better manage traffic movement on and off major roadways.

7.7 Roadway Maintenance

Maintenance of the roadway surface, drainage features, and traffic control and pavement marking features of the Spear Street corridor are important considerations regarding the safe movement of people and goods over the roadway. Some of the important features regarding the Spear Street corridor include the following:

- Pavement resurfacing and/or pavement reclamation in areas where the street has been widened (i.e. open or irregular pavement joints or seams where turn lanes or

shoulder widening has occurred), or where the pavement surface is cracking or otherwise in poor condition.

- Improvements to shoulder areas where stormwater runoff has eroded the roadside shoulders or ditch areas; maintenance of drainage ditch areas are important especially in the Allen Road area and that section of Spear Street (east side) between Swift Street and Allen Road.

- Maintenance of warning signs, regulatory signs, and guide signs are important, particularly speed limit signs, stop signs, and pedestrian crossing warning signs.

- Winter roadway maintenance, including snow and ice control, keeping lanes plowed and keeping the surface treated in icy conditions is important particularly at turn lanes at intersections such as Swift/Spear and Allen Road at Spear; also important is keeping snow banks at intersection corners of major side streets winged-back so as to keep sight lines as open as possible.

8. EVALUATION OF IMPROVEMENT STRATEGIES

Alternative improvement options were investigated to address the traffic operations and/or safety problems identified for the existing and projected traffic conditions in the corridor. In particular the improvements were evaluated based on certain measures developed with the help of the study committee and input from the public. The evaluation criteria used related mostly to the engineering-type improvements due to their more quantifiable nature. Table 8 summarizes the general criteria used.

Table 8
EVALUATION CRITERIA
Spear Street Corridor Study

CRITERIA	MEASURE
Safety	Potential For Accident Reduction
Traffic Movement	Level of Service, Side St. Delays
Pedestrian/Bike Access	Design Accommodation
Access Management Considerations	Consistency with City's Standards
Environmental & Resource Area Impacts	Degree of Involvement with City Resources
Abutter/Owner Considerations	Degree of Private Property Impact, Aesthetics, Other
Construction Cost	Cost

8.1 Traffic Operations Improvements At Intersections

Spear Street at Allen Road

Two basic alternatives were evaluated for this intersection: maintaining the existing Stop sign control on the Allen Road approach, and full-time traffic signal control. For the five-year future traffic projections, the Allen Road approach will be significantly over capacity with a level of service "F" assuming the current Stop sign control. These very long stop delay times during peak traffic periods will occur for both the Allen Road left and right turn lanes. With the addition of the South Village project, the new site road will have long vehicle delays (Level "F") for the peak hour.

Traffic signal control, with the addition of a southbound left-turn lane on Spear Street for the South Village access, is the likely best improvement for this intersection. Table 9 indicates the resulting level of service assuming traffic signal operation. Further evaluation of traffic signal warrants and turn-lane requirements should be conducted based on the final traffic characteristics and trip generation for the South Village project.

Spear Street at Deerfield Dr./Nowland Farm Rd.

Based on the five-year projected traffic, the Deerfield Drive eastbound approach will experience very long delays at Spear Street based on its current Stop sign control operation. One short-term alternative considered was to provide some widening of the Deerfield Drive approach so as to provide a separate right and left turn lane. During peak periods on Spear Street, traffic exiting Deerfield Drive would be able to turn right without being as delayed by the left-turn traffic. However, more evaluation of property impacts of widening need to be undertaken, since there is residential property immediately to the south and park property immediately to the north. Also, the volume of right-turn traffic is very small (less than five vehicles during the peak hour) compared to the left-turn traffic (25 vehicles during the peak hour).

A roundabout was considered but there appear to be serious design and operation constraints with this alternative. These constraints relate to private property impacts (including residential property in the southwest corner and parkland impact in the northwest corner), as well as topographic and grade constraints involving particularly the north, east, and west intersection approaches.

In the future, an evaluation should be made of the traffic signal warrants at this location. The evaluation of future traffic volumes using Nowland Farm Road due to the Marceau Meadows and Cider Mill projects buildout should be conducted within five years.

Spear Street at Swift Street

Three improvement alternatives were considered for the Spear Street/Swift Street intersection:

1) minor lane use changes with signal improvements
2) addition of turn lanes with signal improvements and realignment of Swift Street approaches
3) construction of a Roundabout intersection

Figures 11, 12, and 13 indicate a sketch of each of these alternatives.

Alternative 1 is an immediate, short-term improvement which addresses some of the current safety concerns and delay problems. It addresses the northbound traffic concern on Spear Street relative to the left-turn traffic and through traffic sharing the same lane, and the recreation path crossing in advance of the northbound stop bar. This alternative does not, however, solve the capacity and vehicle delay problems at the intersection which are associated with the future five-year projected traffic volumes.

Alternative 2 involves the addition of turning lanes on the northbound Spear Street and eastbound Swift Street approaches. It also involves shifting the alignment of Swift Street somewhat by moving the west side of the intersection to the south. A new traffic signal controller, span wire installation, and traffic signal heads would be constructed. A realignment of the recreation path crossing would be accomplished so as to put the

pedestrian crossings of Swift and Spear Street in front of stopped vehicles. Pedestrians would cross by means of a push-button actuated pedestrian signal.

Alternative 3 was the consideration of a roundabout, or traffic circle, to replace the existing traffic signal operation. As indicated on Figure 13, this alternative would not have traffic signal control. An interior island area about 80 feet in diameter would be central to this design, and traffic would circulate around in a counterclockwise pattern. Traffic entering the roundabout from one of the four street connections would yield to traffic already circulating on the roundabout before entering.

Concerns were raised during the public involvement process for school children and visually impaired individuals crossing the roundabout crosswalks without the protection of a signal. Industry safety reports have found that the crossings at roundabouts can be very safe if designed properly to allow pedestrians to cross to a sheltered island and only worry about traffic in one direction at a time. An additional concern with the roundabout is that the intersection will operate at LOS F during the design year traffic conditions. The eastbound Swift Street approach would experience the most significant delay, while other approaches would operate with acceptable delay. The public concern for pedestrian safety, and capacity issues were both taken into consideration in developing final recommendations.

Table 10 is a summary of some evaluation items comparing the traffic signal improvement (Alternative 2) with the roundabout (Alternative 3).

The improvement alternatives for this intersection were discussed in detail with the Technical Study Group and during the public involvement meeting on May 25, 2004. Public comment at the meeting highlighted their desire to implement short term safety improvements, and to avoid the creation of additional capacity at the intersection. The public objective was to avoid creation of opportunities for Route 7 traffic to relocate to the Spear Street corridor. Fuss & O'Neill's suggestion was that improvements be designed to allow phased construction at the intersection such that new capacity will be added as demand increases and delay becomes excessive. This phased approach to intersection improvements was an additional consideration as each of the alternatives was evaluated.

Spear Street at Quarry Hill Rd.

The Quarry Hill Road intersection was recently studied by others as part of the Quarry Hill Development Traffic Impact Study. That study looked at the traffic implications of a proposed residential development (townhouses and condominium units) at the end of Quarry Hill Road. Two access alternatives were evaluated: one utilizing access via Quarry Hill Road/Spear Street intersection only, and another using a connection to East Terrace as a secondary access to Spear Street near the Williston Road/Spear Street jughandle.

The corridor study evaluation of the Quarry Hill Road intersection with the 2008 traffic conditions indicated that a level of service "D" was projected for the Quarry Hill Road approach for the design hour, and that this intersection would likely not meet the warrants for a traffic signal. The findings of the Quarry Hill Development consultant's study included the following:

a.) The Spear Street/Quarry Hill Road intersection meets the warrants for a left turn lane on Spear Street (based on the proposed development), and an exclusive southbound left turn lane should be provided;

b.) Separate right and left turn lanes on Quarry Hill Road (at the approach to Spear Street) should be provided.

In addition to providing added turn lanes at the intersection, pedestrian improvements are also needed. A marked crosswalk should be constructed on Spear Street at this intersection area to provide a safe pedestrian crossing from the Quarry Hill neighborhood to the UVM bike/pedestrian path located just west of Spear Street.

TABLE 10
Traffic Signal vs Roundabout Comparison
Spear/Swift Street Intersection

ITEM	TRAFFIC SIGNAL	ROUNDABOUT
Traffic Safety	Lane additions & realignment improves vehicle safety	Slower speeds reduce accident frequency and severity for motor vehicles
Pedestrian Access	Improved: Crosswalks relocated; added Pedestrian Push Buttons	Concern for school children and visually impaired
Bike Access	Improved: Widened Lanes; Add Shoulders	Bikes in the roundabout flow with traffic
Drainage	Widening & realignment requires additional drainage improvements; more paved area	Less pavement may mean less drainage structures
Truck/Emergency Vehicle Movement	Improved: Can add emergency vehicle pre-emption	Emergency vehicles must negotiate the roundabout; Minimal effect on response time
Traffic Delay & Level of Service	LOS D (Design Hour) LOS C (AM Peak) (Year 2008 Projections)	LOS F (Design Hour) LOS C (AM Peak) (Year 2008 Projections)
Aesthetics	Requires more vehicle signal heads and pedestrian signal heads	Enhances the corridor; plantings create a "Gateway"
Utilities	Overhead & underground utilities impacted by widening	Overhead & underground utilities impacted by widening
Adjacent Driveway Access	UVM Barn driveway Impacted; Church Driveway Likely Improved	UVM Barn Driveway impacted
Right-of-Way	Minor additional right-of-way needed from UVM	Major right-of-way needed from UVM
Construction Cost*	$400,000 - $450,000±	$300,000 - $350,000±

*Excludes Drainage Features, Utility Relocation/Adjustments, and Design Engineering Costs

8.2 Roadway Improvements At Non-Intersection Areas

Spear Street North of Swift Street

Immediately north of Swift Street, the cross-section of Spear Street becomes more constricted with poles, trees, and roadside slopes or embankments closer to the edge of the roadway. With the recommended improvements to the approaches of Spear Street at the Swift Street intersection, there should be enough lane width and/or paved shoulder area to more safely accommodate bike travel. A travel lane of eleven (11) feet (minimum) with a bike lane of 4 feet (minimum) is recommended for consideration in this area. This results in a paved roadway width of 30 feet minimum. Where there is a hilly section of roadway, such as the upgrade southbound on Spear Street opposite house #1098, a wider shoulder area or bike lane of at least 5 feet in width is recommended. This would result in a paved roadway width of 31 feet.

Figure 14 shows a typical cross-section with these recommended lane widths.

Spear Street @ I-189 Overpass Area

In the area where Spear Street passes under I-189, north of Swift Street, alternatives were developed to better accommodate bikes within the roadway cross-section. Figure 15 shows a typical cross-section with proposed bike lane markings adjacent to the travel lane.

Because of the close proximity of the concrete bridge abutments to the west edge of the roadway, it is recommended that guard rail be placed in front of these structures.

In order to more safely accommodate pedestrians along this area, a sidewalk or pedestrian path along the east side of Spear Street should be considered, specifically between the USDA Research Center and the proposed Forest Glen residential project. This is discussed in more detail in section 8.3 Pedestrian Improvements.

There is a large culvert crossing for the brook under Spear Street in this area of the sag curve. Consideration needs to be given to stabilization of the embankment area along the edge of the roadway where erosion of the top bank area is evident. Placement of guard rail also should be considered at the top of this drainage area slope.

Figure 16 indicates a typical section of Spear Street at this location.

8.3 Pedestrian Improvements

Review of existing corridor features, observations of pedestrian movements and input obtained from others during the study led to the consideration of pedestrian improvements in two general areas: Pedestrian Sidewalks or Paths; and Pedestrian Crosswalks.

A. Pedestrian Sidewalks

Although there is residential development along both sides of Spear Street, there is only one short section that has sidewalk adjacent to the roadway. This is in front of Overlook Park, in the south-central corridor area. There appears to be a need to provide more north-south pedestrian facilities (such as a path or sidewalk) along Spear Street to complement and improve accessibility to existing pedestrian paths, such as the east-west South Burlington Recreation Path that crosses Spear Street at Swift Street.

Further engineering design consideration should be given to evaluation of a sidewalk and/or pedestrian path along the side of Spear Street between Allen Road and Swift Street. The goal of this should be to get pedestrians off the roadway shoulder and be separated from motor vehicle and bike traffic that currently operates within the roadway area.

There appears to be sufficient City street right-of-way to accomplish this (approximately 66 feet along Spear Street). Utility pole locations and roadside drainage ditches offer a challenge to a continuous sidewalk along the edge of Spear Street.

Figure 17 indicates a cross-section view of Spear Street with a proposed 5 foot sidewalk along the west side. The sidewalk could be separated from the roadway with a grass/utility border.

North of Swift Street, a pedestrian path or sidewalk which connects the USDA Research Center area with the proposed Forest Glen residential project should be further developed. The Forest Glen project will be providing a recreation path connection (east-west) between Dorset Street and Spear Street. A pedestrian link along Spear Street that meets the existing UVM path would be an asset. A typical section of how a shared use paved path or sidewalk might be accommodated along the I-189 underpass area is shown in Figure 15.

B. Pedestrian Crossings

The following are locations along the corridor where more specific crosswalk designs should be developed:

- Gutterson Field House Area – UVM
  Connect the East Terrace neighborhood area with the UVM path and Gutterson Field House area; UVM is currently developing a plan for crosswalks at strategic locations along this area between Quarry Hill Road and the Spear Street/East Avenue jughandle.

- Quarry Hill Road Intersection
  Provide a crosswalk to connect with the UVM path on the west side of Spear Street.

- Vicinity of USDA Research Center
  Provide a crosswalk in conjunction with a pedestrian path/sidewalk connection along the east side of Spear Street to the proposed Forest Glen residential project.

- Swift Street @ Spear Street
  Provide a north-south crossing of Swift Street by means of a marked crosswalk that has an actuated pedestrian button crossing as part of an improved traffic signal control.

- Pinnacle Drive (or Cedar Glen)
  Provide a marked cross-walk in the vicinity of Pinnacle Drive or Cedar Glen in conjunction with a future sidewalk or pedestrian path along Spear Street in this area.

- Allen Road Intersection
  Provide a crosswalk connecting the future South Village development (pending approval) to the Allen Road area.

8.4 Bike Improvements

The following improvements to enhance bicycle accommodation were considered:

- Bike lane improvements at Overlook Park
  Move the edge of road to the west in order to provide a continuation of the existing bike lane along the frontage of Overlook Park. Some utility pole relocation will likely be necessary.

- Bike Lane improvements: Allen Road to Swift Street
  Provide new bike lane markings which establish uniform width bike lanes on each side of Spear Street. Minimum (4) foot lanes are recommended where there are no curbs, and 5 ft. lanes (minimum) at curbed areas. Figures 17 and 18 indicate the typical roadway cross-sections.

- Bike Lane Markings: Swift Street to Vicinity of USDA Center.
  Provide new bike lane pavement markings along the travel lane; 5 foot lanes in area of uphill grades (southbound) from the brook crossing between the I-189 ramps to the top of the hill. Other areas are recommended at four (4) foot minimum width bike lane.

9. CORRIDOR IMPROVEMENT RECOMMENDATIONS

After consideration of those improvement strategies discussed previously, recommendations have been made for the corridor area. These are discussed in summary below. Figure 20 is a location plan of these improvement recommendations.

9.1 Intersections

A. Spear Street at Allen Road

1. Complete a traffic signal warrant study.
   Collect additional hourly traffic count data on the approaches to this intersection in order to document meeting the warrants for traffic signalization. This evaluation should be based upon existing traffic conditions and the projected 5-year traffic volumes. The most feasible improvement based on the peak hour traffic evaluation of this corridor study appears to be traffic signalization of this intersection.

2. Provide additional shoulder width on Spear Street
   Any intersection lane improvements which are made to accommodate traffic signal operation should incorporate wider curb lane shoulders. Minimum 4 feet wide bike shoulders (5 feet wide if curbs are present) should be provided in each travel direction.

B. Spear Street at Deerfield Drive/Nowland Farm Road

1. Determine the location of the Deerfield Drive right-of-way and evaluate the impacts of widening the Deerfield Drive approach to two lanes (separate right and left turn lanes).

2. In three years, conduct a traffic signal warrant study evaluating whether traffic volumes and other traffic conditions meet the warrants for a traffic signal.

C. Spear Street at Swift Street

1. As an immediate improvement, change the northbound lane utilization on Spear Street to a northbound exclusive left turn lane, and a combined thru-right lane. The following modifications are recommended(see Figure 11):
   a.) On the Spear Street northbound approach, move the stop bar to the south (about 25 to 30 feet) and relocate the marked crosswalk for the Rec. Path to the north; northbound traffic will then stop in advance of the crosswalk on the red signal indication.
   b.) Change the lane markings on the Spear Street northbound approach to indicate an exclusive left turn lane (inside lane), and a shared thru-right turn lane (outside lane). Remove the painted channelizing island which is now for the exclusive right-turn lane. The left turn lane should be a minimum of 10 ft. wide (11 ft. preferred) and the thru-right lane a minimum of 11 ft. wide (12 ft preferred).

c.) Realign the recreation path at it's approaches to Spear Street on the east and west sides of the road so that it meets the relocated crosswalk.
d.) Install some roadside delineators (reflectorized) along the east side of Spear Street on the north side of the intersection in order to make the edge of road more visible to thru traffic; in the future this edge of roadway needs to be widened slightly and the utility poles moved back in order to provide more roadside clearance.
e.) Install a new traffic signal controller unit with the added capability of exclusive left turn phasing, as well as future pedestrian phasing and emergency pre-emption capability; the immediate improvement recommendation assumes the addition of a left turn advance phase (with arrow) for Spear St. traffic. The analysis also assumes an advance for Swift St. westbound traffic as well (due to the heavy PM peak hour volume).
f.) Add new signal heads (5-section heads) for the addition of left turn arrows (green and yellow) for the northbound and southbound left turn lanes on Spear Street; an analysis should be conducted of the ability of the existing span wire, span wire connections, guy wires, and wooden span poles to accept the addition of new signal heads for the left turn lanes.
g.) Add new traffic signs at approaches to intersection, including pedestrian crossing warning signs, lane use signs, stop bar location signs, others as needed.
h.) Add new pavement markings on Spear Street northbound approach, including crosswalk markings, lane arrows.

2. Within the short term (within 2 years), reconstruct the intersection to include the following (see Figure 12):
   a.) Addition of a separate thru-lane on the northbound approach;
   b.) Addition of separate left turn lane on the Swift Street eastbound approach;
   c.) Shift of Swift Street eastbound approach to the south, in order to improve the alignment of Swift Street thru traffic;
   d.) Re time signal controller unit, new signal cable and wiring; new lane detection, signal heads, span wire, and span poles;
   e.) Relocation of the recreation path in order to provide for crosswalks located at the intersection area;
   f.) Addition of pedestrian push-button signal indications for the recreation path crossing at the intersection; count-down time displays are desired by the City.
   g.) Utility and drainage modifications necessary to accommodate the geometric changes in the layout of the intersection;

D. Spear Street at Quarry Hill Road

1. Provide a pedestrian crosswalk on Spear Street
   Provide a pedestrian connection to the UVM bike/pedestrian path. Install a crosswalk with appropriate pavement markings and pedestrian crosswalk warning signs consistent with state and local standards.

9.2 Non-Intersection Areas

A. Spear Street between Allen Road and Swift Street

Provide a uniform pavement cross-section which includes a marked shoulder of equal width on each side of Spear Street. A minimum pavement width of 30 feet is recommended along sections where no curbing is required. This would allow for 11 foot travel lanes and a 4 foot bike lane in each travel direction. Where curbs are required, a 5 foot minimum bike lane is recommended, thereby requiring a minimum pavement width between curbing of 32 feet.

B. Spear Street North of Swift Street

The pavement area north of Swift Street should be of sufficient width to provide for a travel lane that is 11 feet (minimum) in each travel direction, plus a paved shoulder area that can accommodate bike travel in each direction. This would be a total paved width of 30 feet (minimum) assuming 4 foot shoulders for bike travel on each side in the section where there are no steep grades. Adequate setback from the edge of the road to utility poles, trees, and roadside drainage ditches and embankments needs to be provided to allow for snow storage and general vehicle and bicycle travel safety.

C. Spear Street at I-189 Overpass Area

The following roadway improvements are recommended in the area of Spear Street under the I-189 ramps and extending to the vicinity of Quarry Hill Road:

1. Provide a uniform roadway pavement width of a minimum of 30 feet in order to accommodate 11 foot travel lanes and a 4 foot bike lane in each direction.

2. Conduct additional study of the drainage pipe locations along the roadway shoulder area (i.e. drop inlets and exposed pipe outlets) in order to better determine drainage modifications at drainage ditches and outlets to the brook in order to accommodate edge of roadway improvements (i.e. minor widening for bike lanes);

3. Provide guard rail protection at the roadside for the top of bank at the culvert crossing, and for the concrete bridge abutments on the west side of the road;

4. Provide a sidewalk or paved path (shared use) on the east side of the road in order to allow a pedestrian connection along Spear Street between the proposed Forest Glen pedestrian path and the existing paved recreation path in the vicinity of the USDA Research Center.

D. Spear Street North of Quarry Hill Road

On Spear Street between Quarry Hill Road and the jughandle area near East Terrace a uniform pavement width of 28 feet should be provided, thereby accommodating 2

travel lanes at 11 foot width, and a paved shoulder area of 3 feet on each side. The City should continue to pursue sidewalk and pedestrian crossing improvements along this section with the abutting Spear Street residents and the University of Vermont as part of the UVM parking garage and resident building construction program.

9.3 Pedestrian Improvements

A. Sidewalk or Pedestrian Path Recommendations

1. Provide a sidewalk along the Spear Street roadside, or provide a combination of sidewalk and recreation path between Allen Road and Swift Street;

2. Construct a sidewalk or recreation path along the east side of Spear Street between the proposed Forest Glen project and the USDA Research Center;

B. Pedestrian Crosswalks

1. Gutterson Field House Area:
   Provide at least two pedestrian crosswalks on Spear Street north of Quarry Hill Road in the Gutterson Field House Area; these should be located in conjunction with on-going coordination among the City, the abutting residential property owners, and UVM.

2. Quarry Hill Road Intersection:
   Provide a crosswalk at this intersection in order to provide a marked pedestrian crossing which connects the UVM recreation path on the west side of Spear Street with the Quarry Hill Road neighborhood on the east side.

3. USDA Research Center Area
   Provide a crosswalk in conjunction with a recommended pedestrian path-sidewalk connection along the east side of Spear Street to the proposed Forest Glen residential project.

4. Swift Street
   Provide a north-south crossing of Swift Street by means of a marked crosswalk that has an actuated pedestrian button crossing as part of an improved traffic signal control; Also provide a push-button actuated pedestrian crossing of the recreation path across Spear Street. Pedestrian count-down indicators are recommended at this location by the City.

5. Pinnacle Drive (or Cedar Glen)
   Provide a marked crosswalk in the vicinity of Pinnacle Drive or Cedar Glen in conjunction with a future sidewalk or pedestrian path along Spear Street in this area; the location of this crosswalk should result from a subsequent design study involving the street right of way location and utility locations.

6. Allen Road Intersection

Provide a crosswalk connecting the future South Village development (pending approval) to the Allen Road area; the location should be determined in conjunction with the site plan and pedestrian/access road design of the South Village project.

9.4 Bike Accommodation Recommendations

A. Overlook Park Frontage

Move back the west edge of Spear Street in order to provide a continuation of the bike lane adjacent to the vehicle travel lane;

B. Allen Road to Swift Street

Provide a uniform, equal bike lane width on each side of Spear Street in order to more safely accommodate bike travel in both directions; Use a 4 foot minimum bike lane width in areas of no curbs; use a 5 foot minimum bike lane width in curbed areas.

C. Swift Street to Quarry Hill Road

Provide a uniform bike lane on each side of Spear Street where the roadway pavement width can be established at 30 feet minimum. Use a marked shoulder lane of at least 4 feet for a designated bike lane where there is no roadside curbing. North of Quarry Hill Road where the pavement width is less than 30 feet (28 foot width proposed in this section) provide a 3 foot marked shoulder and use this as a bike route (not a marked bike lane). Figure 19 shows this typical cross-section for this 28 foot width.

9.5 Access Management Actions

The City of South Burlington should continue to encourage development plans that include access management features with the goal of better controlling and management of vehicular traffic at driveways and side-street locations along Spear Street.

Specific requirements of the City's subdivision and planned unit development (PUD) projects should be maintained. The design requirements (1) regarding the location and design of project access include the following:

1.) Maximize the use of secondary streets for access and circulation
2.) Align access points with existing intersections and/or curb cuts
3.) Consolidate existing curb cuts within the PUD property
4.) Provide for safe access to abutting properties

(1) Taken from South Burlington Land Development Regulations, Article 15, Section 15.12, Paragraph E.

5.) Make provisions for safe access, with provisions for appropriate sight distances and accommodations for high-accident locations
6.) Provide deceleration, acceleration and/or turn stacking lanes as appropriate to meet the standards in the city regulations.

The city standards for entrances to subdivisions and PUDs also specify that the minimum level of service for nearby intersections and through movement on the major adjacent roadway shall be a certain level of service or better at full buildout (LOS "D" or better).

9.6 Transportation Demand Management Actions

The City of South Burlington should encourage the use of programs on-going or planned that reduce single-occupant vehicle trips in the Spear Street (and adjacent) roadway corridors. Such programs sponsored by CATMA (Campus Area Transportation Management Association) include the following:

- RidesWork (carpool matching service)
- CCTA Bus Subsidies
- Bike/Walk Bucks

Since the north end of the Spear Street corridor ends right at the dense employment area of the "hill" in Burlington, coordination of the large employers to jointly plan, manage, and share transportation resources and parking resources can have an impact on vehicular travel to and from the south via Spear Street. In the short term and in the future, the City of South Burlington and the CCMPO should work toward supporting and implementing those policies and programs that might involve:

- Flex time policies at area employers
- Staggered work shifts
- Public transportation subsidies
- Improving bicycle and pedestrian facilities/systems
- Carpool/vanpool programs and incentives
- Ridesharing programs
- Educational Outreach events

9.7 Public Transportation Service Improvements

The Chittenden County Transportation Authority (CCTA) does not currently provide bus service along Spear Street, nor are there any plans for service in this corridor over the short or long term. However, there is frequent bus service to the west of Spear Street on Shelburne Road which runs between the Shelburne Museum and Cherry Street (Downtown Burlington). Improvements to cross-street access between Spear Street and Shelburne Road that promote use of this transit route should be encouraged. Improvements to the Allen Street and Swift Street corridors, for example, that would encourage pedestrian and bicycle travel from the Spear Street area during fair weather seasons could enhance transit use. Such improvements would relate to sidewalks and improved shoulder width or bike lanes.

Also, financial contribution to public transportation accounts through impact fees may be a possible source of funds to contribute to such things as shuttle van services that could feed certain fixed route bus stops from major residential generators or village centers. This is a change in direction of using impact fees for mitigating the traffic impact of new developments from improving the road system to improving the public transportation system. Through designation of transportation management coordinators at larger developments, an on-site representative could be assigned to promote and develop ride-sharing, carpooling, or other transit related programs to reduce peak hour vehicle trip generation.

9.8 Other Traffic Calming/Traffic Control Recommendations

A. Radar Speed Display Signs

A method to reduce speeds along roadways which is proving effective is use of radar speed display signs. These speed display signs may take the form of a portable speed trailer which the local police departments sometime use, or newer fixed display signs that mount on a permanent post beside the roadway. These units display the actual speed of the driver in a brightly flashing format as the vehicle approaches. The speed limit sign is posted with this display unit. It is recommended that the city consider the installation of pole-mounted radar signs on Spear Street. Two locations for consideration would be within the area between Pheasant Way and Swift Street, and in the Quarry Hill road area. Additional coordination among the Department of Public Works, the City Police Department, and local resident representatives is needed to determine the most effective locations.

A typical radar speed display sign is shown below.

Source: RU2 Systems Inc., Sign Manufacturing & Sales

B. Speed Enforcement

Police enforcement of speed limits has been a primary tool to reduce speeds, but it is a technique with long-recognized limitations. In general, speed enforcement will have the greatest effects on drivers if it is: 1) believed likely to occur, 2) meaningfully costly to the offenders, 3) associated with driving in general rather than any specific time of day or roadways, and 4) not associated with any specific cues (that show when enforcement is occurring and, by their absence, when enforcement is absent).

Overall, speed control by providing a mix of enforcement and public information has proven to have modest but real effectiveness. The approach operates through education, to inform and educate drivers that slower speeds are appropriate and reasonable and, through enforcement, to increase the perceived negative consequences of driving fast. It is recommended that the City maintain regular speed patrols in the corridor area to provide enforcement of the existing speed limit.

C. Wider Edge Line Pavement Markings

Along Spear Street the travel lane edge line markings which separate the travel lane from the paved shoulder area are recommended to be a minimum of 6 inches wide, white line. These lines should also be retro-reflective for visibility at night.

9.9 Land Use Planning & Development Policies

The City of South Burlington already has the basic tools in place for dealing with the interaction of land development and the transportation demands that it produces. The City has a Comprehensive Plan for guiding growth, and has Land Development Regulations which establish zoning districts and site plan and development review procedures, guidelines, and standards. Within the Land Development Regulations is an authorization for a Development Review Board and a Design Review Committee that reviews proposed development activity and plans in certain districts and can impose conditions relative to the review and approval of the project plan via the major subdivision and planned unit development approval procedure. Ensuring site design and performance standards are met for developments in the Spear Street corridor between the Shelburne Town Line and Swift Street along the east side of Spear Street is particularly important, since this area lies in the Southeast Quadrant.

A traffic impact study is required for projects in the traffic overlay district, and/or if required by the Development Review Board. This is an important requirement to maintain relative to promoting safe traffic levels and proper access management.

The following strategies to better manage access to proposed land development projects are already recognized by the City of South Burlington and are candidates for recommendation/implementation as part of the City's development review process for projects in the "Traffic Overlay District". Application of these techniques in site plan development and approval stages for major developments off Spear Street should be encouraged.

(a) Change or reduction in the number and location of curb cuts.

(b) The creation of secondary access points within lots sufficient for two-way, year-round vehicular and pedestrian movements that provide for suitable internal circulation between properties (i.e. the access points need to be kept free of snow).

(c) The elimination of left turns or through movements across an arterial through the creation of raised medians, subject to approval by the Director of Public Works.

(d) Reductions in the width of curb cuts or access points or their definition in a manner that substantially improves the definition of turning and traffic movements into and out of the property, and to a width no greater than the specified maximum width for the applicable type of driveway as indicated in the Regulations, subject to approval by the Director of Public Works.

(e) The relocation of access points farther away from high-volume intersections, subject to all other applicable dimensional and traffic management standards.

(f) The impact of the proposal on the overall traffic volumes and levels of service at intersections in the immediate vicinity of the project.

(g) Any other criteria within PUD review or other factors as the Development Review Board deems relevant, subject to consultation with and approval by the Director of Public Works.

9.10 Roadway Maintenance

A. Pavement Management

Preventative maintenance of the pavement structure is the key to cost effectiveness in the conservation of the transportation infrastructure, so that paved assets are prevented from deteriorating to the point of requiring major rehabilitation or reconstruction before their design life has expired and safety is compromised. The City of South Burlington already has elements of an effective pavement management system in place for the evaluation, documentation, and analysis of the amount, quality and type of pavement under its jurisdiction, and the planning and budgeting for the upkeep and replacement of paved assets.

Widening of intersection areas to add turn lanes, such as at Allen Road and at Nowland Farm Road has created uneven paved areas and open seams between old and new pavement. There are also sections of Spear Street where longitudinal pavement cracking has become extensive. Crack sealing has been accomplished on Spear Street north of Swift Street. It is recommended the entire length of Spear Street between Main Street and Allen Road be considered for pavement reclamation.

B. Winter Maintenance

Roadway ice and snow control is a vital traffic safety measure. Measures to enhance the effectiveness of winter maintenance will have significant safety and operational benefits. Such measures include:

- Use of advanced removal technology such as new equipment and vehicle designs and snow and ice control treatment materials
- Effective wing plowing to maintain safe visibility
- Use of snow fences to control blowing and drifting
- Implementation of driver information systems using changeable message signs on the roadside or on maintenance vehicles to advise motorists of the need to reduce speed or choose a different route.

The following locations should be given special consideration for sanding and anti-icing control, and special snow bank treatment:

a. Allen Road approach to Spear Street – roadway grade in icy condition, and impact of roadside snow banks at northwest and southwest corners of the intersection;
b. Deerfield Drive approach to Spear Street – impact of roadside snow bank at northwest corner of intersection;
c. Spear Street/Swift Street intersection – keeping turning lanes clear relative to icing and snow drifting potential.

C. Roadside Drainage

It is likely that improvements to roadway drainage will be necessary as part of the improvements recommended at various intersections and roadway segments along the Spear Street corridor. The following areas will need further engineering study of the existing and proposed drainage features associated with any roadway and/or pedestrian facility improvements:

a. Allen Road/Spear Street intersection – open drainage ditch along immediate edge of east side of Spear Street and low grade of edge of right turn lane on west side;
b. Spear Street/Swift Street intersection – new drainage features for intersection reconstruction with turn lane additions;
c. I-189 Overpass area – modification of drainage system to accommodate sidewalk or shared path construction;
d. I-189 area sag curve – likely that a separate drainage and side-slope erosion control project will be needed to address slope-stabilization and guard-rail protection needs.

10. IMPLEMENTATION PLAN

Table 11 summarizes the proposed implementation schedule for various improvement actions recommended for the Spear Street Corridor.

Table 11
Implementation Plan For Spear Street Corridor Improvements

	ITEM	ACTION	IMPLEMENTATION SCHEDULE	RESPONSIBLE PARTY
1.A	Allen Road Intersection	• Signal Warrant Study • Add Shoulder Width	Immediate	City/Developer
1.B	Deerfield Dr./Nowland Farm Road Intersection	• Evaluate 2-Lane Approach • Monitor Traffic For Signal Warrants	Short Term	City
1.C1	Swift Street Intersection	• Change Lane Utilization & Crosswalk Location	Immediate	City
1.C2	Swift Street Intersection	• Major Lane & Signal Improvements • Pedestrian Crosswalk Improvements	Short Term	City
1.D	Quarry Hill Road Intersection	• Turn Lanes • Monitor For Signal Warrants	Short Term	City/Developer
2.A	Shoulder Width Improvement: Allen Road to Swift Street	• Uniform Bike Lanes Both Sides • Uniform Pavement Width	Short Term	City
2.B	Shoulder Width Improvement: North of Swift Street	• Bike Lanes Both Sides • Improve Roadside Clearance	Short Term	City
2.C	Roadway Improvements: I-189 Overpass Area To Quarry Hill Road	• Uniform Lane Width • Additional Drainage Study • Add Guard Rail Protection	Short Term	City
2.D	Shoulder Width Improvements: Quarry Hill Road to East Terrace	• Uniform Lane & Shoulder Width	Short Term	City
3.A1	Sidewalks: Allen Road to Swift Street	• Sidewalk or Path on One Side	Short Term	City/Developer
3.A2	Pedestrian/Recreation Path: Forest Glen Development to Vicinity of USDA Center	• Sidewalk or Path on East Side	Short Term	City/Developer

Table 11
Implementation Plan For Spear Street Corridor Improvements
(con't)

	ITEM	ACTION	IMPLEMENTATION SCHEDULE	RESPONSIBLE PARTY
3.B1	Pedestrian Crossing Improvements: Gutterson Area	• Provide 1 or 2 Crosswalks in Gutterson/UVM Section	Short Term	City/UVM
3.B2	Pedestrian Crossing Improvements: Quarry Hill Road Intersection	• Add Crosswalk & Signage	Short Term	City/Developer
3.B3	Pedestrian Crossing Improvement: Vicinity of USDA Research Center	• Add Crosswalk & Signage	Short Term	City/Developer
3.B4	Pedestrian Crossing Improvements: Swift/Spear Intersection	• New Crosswalks with Pedestrian Push Buttons`	Short Term	City
3.B5	Pedestrian Crossing: Pinnacle Drive Area	• Add Crosswalk & Signage	Short Term	City
3.B6	Pedestrian Crossing Improvements: Allen Road	• Add Crosswalk & Signage (Pending South Village)	Short Term	South Village Project
4.A	Bike Lane Improvement: Overlook Park Area	• Add Bike Lane on West Side	Immediate	City
5.0	Access Management	• City Regulations	Immediate & On-Going	City/Developer
6.0	Transportation Demand Management	• Support Current Programs	On-Going	City/Developer
7.0	Public Transportation Service	• Improve Access to Current Routes	Long term	City/CCTA
8.A	Traffic Calming: Speed Monitoring	• Radar Speed Display Signs	Short Term	City
8.B	Traffic Calming: Speed Enforcement	• Speed Enforcement • Public Education/Outreach	On-Going	City
8.C	Traffic Guidance	• Wide Edge Line Markings	Short Term	City
9.0	Land Development Policies & Regulations	• City Regulations	On-Going	City
10.0	Maintenance	• Pavement Reclamation • Winter Maintenance (Snow & Ice Control) • Roadside Drainage Improvements	On-Going to Long Term	City

Note: Refer to Report Section 9. For Description of Improvements; See Figure 20 for Locations
Immediate (yr. 2004-2005) Short Term (yr. 2006-2008) Long Term (after 2008)

APPENDIX

Tables, Exhibits, Figures

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TABLE A

LEVEL OF SERVICE CRITERIA
FOR
INTERSECTIONS

LEVEL OF SERVICE CRITERIA FOR SIGNALIZED INTERSECTIONS

LEVEL OF SERVICE	CONTROL DELAY PER VEHICLE (SEC)
A	≤10
B	>10 and ≤ 20
C	>20 and ≤ 35
D	>35 and ≤ 55
E	>55 and ≤ 80
F	>80

Source: Highway Capacity Manual, Special Report 209, 1998, Table 9-1.

LEVEL OF SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS

LEVEL OF SERVICE	CONTROL DELAY TO TRAFFIC (Sec. Per Vehicle)
A	≤10
B	>10 and ≤ 15
C	>15 and ≤ 25
D	>25 and ≤ 35
E	>35 and ≤ 50
F	>50

Source: Highway Capacity Manual, Special Report 209, 1998, Table 10-7.

Table 1
INTERSECTION CAPACITY ANALYSIS
Year 2003 Peak Hour Traffic Conditions

	Weekday AM Peak Hour		Design Hour	
	Delay	**LOS**	**Delay**	**LOS**
Spear Street @ Allen Road				
Northbound	8.3	A	10.3	B
Eastbound Left	35.4	E	212	F
Eastbound Right	9.2	A	16	C
Spear Street @ Pheasant Way				
Northbound	8.0	A	9.7	A
Eastbound	22.4	C	40.7	E
Spear Street @ Deerfield Drive/Nowland Farm Road				
Northbound	7.9	A	10.1	B
Southbound	9.0	A	8.7	A
Westbound Left / Through	23.6	C	58.3	F
Westbound Right	13.4	B	12.1	B
Eastbound	30.2	D	71.2	F
Spear Street @ Pinnacle Drive				
Southbound	9.3	A	8.8	A
Westbound	16.3	C	16.6	C
Spear Street @ Cedar Glen				
Northbound	8.0	A	10.3	B
Eastbound	31.7	D	46.4	E
Spear Street @ Swift Street				
Northbound Left / Through	56.2	E	31.8	C
Northbound Right	10.5	B	10.5	B
Southbound Left	11.2	B	13.3	B
Southbound Right / Through	10.7	B	12.9	B
Eastbound Left / Through	18.1	B	28.1	C
Eastbound Right	17.7	B	28.3	C
Westbound Left	20.5	C	167.9	F
Westbound Right / Through	21.5	C	20.2	C
Overall Intersection	36.1	D	35.8	D
Spear Street @ Quarry Hill Road				
Southbound	8.8	A	8.2	A
Westbound	14.8	B	14.0	B

Note: Delay is average control delay per vehicle in seconds
LOS is Level of Service

Table 2
Spear Street Accident Data Summary

Summary Accident Data by Month and Year

	2001	2002	2003
January	2	6	3
February	2	3	1
March	2	4	1
April	4	2	2
May	4	1	3
June	2	1	1
July	1	6	4
August	3	1	1
September	3	3	3
October	4	6	1
November	3	2	1
December	3	4	4
Totals	**33**	**39**	**25**

Summary Accident Data by During Peak Traffic Hours

Peak Time A.M. (7:00-9:00)	6	4	6
Peak Time P.M. (3:00-6:00)	7	5	7

Summary Accident Data by Location

	2001	2002	2003
Intersections			
Allen Rd / Spear St	3	2	4
Pheasant Way / Spear St	0	1	1
Deerfield Dr / Nowland Farm / Spear St	1	2	1
Pinnacle Dr / Spear St	1	0	0
Cedar Glen / Spear St	1	0	1
Swift St / Spear St	7	11	8
Quarry Hill Rd / Spear St	0	4	1
Williston Rd / Jughandle / Spear St	12	7	5
Main St/Spear St	1	1	0
Gutterson/Spear St	3	1	1
Overpass/Spear St	0	1	0
Spear Street Segments (By Address)			
0-1200 Spear St (Williston Rd to Swift)	1	4	0
1200+ Spear St (Swift to Shelburne Town Line)	2	4	2
Other	1	1	1
Totals	**33**	**39**	**25**

Table 3

Accident Rates – Study Area Intersection

Intersection	Number of Accidents (3 Year Period)	AADT (Vehicles / Day)	Actual Rate	Critical Rate
Allen Rd / Spear St	9	17,105	0.48	0.95
Pheasant Way / Spear St	2	15,663	0.12	0.97
Deerfield Dr / Nowland Farm Rd / Spear St	4	16,686	0.21	0.96
Pinnacle Dr / Spear St	1	16,849	0.05	0.95
Cedar Glen / Spear St	2	17,953	0.10	0.94
Swift St / Spear St	26	26,442	0.90	0.85
Quarry Hill Rd / Spear St	5	11,209	0.41	1.06

TABLE 4
Programmed Development in Spear Street Corridor

Development Name	No./Type of Units	Buildout Year	Access
UVM	Housing Parking Garage	2005	Spear & Main
Quarry Hill	281 Units Residential	2008/2010	Quarry Hill
Forest Glen	89 Units Residential	2006	Spear & Dorset
Farrell	30 Units Residential	2005	Spear
Snyder	32 Units Residential	2005	Spear
Retrovest	310 Units Residential	2008	Spear
Redstone	145 Units Residential	2006	Allen

Note: Build-out year subject to change

Table 4A
INTERSECTION CAPACITY ANALYSIS
Year 2008 NO BUILD Traffic Conditions*
(No Intersection Improvements)

	Weekday AM Peak Hour		Design Hour	
	Delay	**LOS**	**Delay**	**LOS**
Spear Street @ Allen Road				
Northbound Left	8.3	A	10.6	B
Southbound Left/Through	-	-	-	-
Eastbound Left	42.3	E	300.0	F
Eastbound Right/Through	9.3	A	17.0	C
Westbound Left	-	-	-	-
Westbound Right/Through	-	-	-	-
Spear Street @ Pheasant Way				
Northbound	8.0	A	9.9	A
Eastbound	24.7	C	48.4	E
Spear Street @ Deerfield Drive/Nowland Farm Road				
Northbound LT	8.0	A	10.3	B
Southbound/LT	9.1	A	8.8	A
Westbound Left / Through	25.4	D	69.5	F
Westbound Right	13.8	B	12.4	B
Eastbound	34.6	D	90.3	F
Spear Street @ Pinnacle Drive				
Southbound LT	9.5	A	8.9	A
Westbound	17.1	C	17.5	C
Spear Street @ Cedar Glen				
Northbound	8.1	A	10.5	B
Eastbound	37.2	E	57.0	F
Spear Street @ Swift Street				
Northbound Left/Through	72.4	E	44.0	D
Northbound Right	10.6	B	10.6	B
Southbound Left	11.5	B	14.0	B
Southbound Right / Through	10.8	B	13.1	B
Eastbound Left / Through	18.1	B	30.3	C
Eastbound Right	17.7	B	30.4	C
Westbound Left	20.7	C	233.0	F
Westbound Right / Through	22.0	C	20.3	C
Overall Intersection	44.1	D	44.8	D
Spear Street @ Quarry Hill Road				
Southbound LT	8.9	A	8.3	A
Westbound	15.5	C	14.6	B

Table 4A (cont.)

INTERSECTION CAPACITY ANALYSIS
Year 2008 NO BUILD Traffic Conditions*
(No Intersection Improvements)

	Weekday AM Peak Hour		Design Hour	
	Delay	**LOS**	**Delay**	**LOS**
Spear Street@Main St./East Ave.				
Eastbound	12.7	B	27.9	C
Westbound Through	26.0	C	24.7	C
Westbound Right	13.8	B	18.4	B
Northbound Left	31.7	C	18.9	B
Northbound Through	30.4	C	18.6	B
Northbound Right	28.7	C	21.0	C
Overall Intersection	20.8	C	24.4	C

*"NO BUILD" Traffic Assumes Normal Background Traffic Growth Only, and Does Not Include the 5-Year Programmed Site Development Traffic.

Table 7
INTERSECTION CAPACITY ANALYSIS
Year 2008 Forecasted Traffic Conditions
(No Intersection Improvements)

	Weekday AM Peak Hour		Design Hour	
	Delay	**LOS**	**Delay**	**LOS**
Spear Street @ Allen Road				
Northbound Left	8.6	A	11.7	B
Southbound Left/Through	8.5	A	8.4	A
Eastbound Left	638.9	F	3,404	F
Eastbound Right/Through	15.7	C	68.6	F
Westbound Left	52.7	F	596.8	F
Westbound Right/Through	25.8	D	60.0	F
Spear Street @ Pheasant Way				
Northbound	8.3	A	11.2	B
Eastbound	47.3	E	150.0	F
Spear Street @ Deerfield Drive/Nowland Farm Road				
Northbound	8.2	A	11.7	B
Southbound/Left	9.9	A	9.4	A
Westbound Left / Through	40.9	E	190.2	F
Westbound Right	16.9	C	14.3	B
Eastbound	77.6	F	315.6	F
Spear Street @ Pinnacle Drive				
Southbound	10.4	B	9.5	A
Westbound	23.0	C	25.3	D
Spear Street @ Cedar Glen				
Northbound	8.4	A	11.9	B
Eastbound	89.3	F	168.8	F
Spear Street @ Swift Street				
Northbound Left/Through	202.5	F	284.5	F
Northbound Right	10.8	B	10.9	B
Southbound Left	13.7	B	18.6	B
Southbound Right / Through	11.4	B	15.3	B
Eastbound Left / Through	18.2	B	35.7	D
Eastbound Right	17.9	B	49.7	D
Westbound Left	22.0	C	408.8	F
Westbound Right / Through	22.0	C	20.5	C
Overall Intersection	110.0	F	117.8	F
Spear Street @ Quarry Hill Road				
Southbound	9.6	A	8.9	A
Westbound	31.5	D	25.4	D

Table 7 (cont.)

INTERSECTION CAPACITY ANALYSIS
Year 2008 Forecasted Traffic Conditions
(No Intersection Improvements)

	Weekday AM Peak Hour		Design Hour	
	Delay	**LOS**	**Delay**	**LOS**
Spear Street@Main St./East Ave.				
Eastbound	12.7	B	32.5	C
Westbound Through	26.0	C	24.7	C
Westbound Right	13.8	B	18.4	B
Northbound Left	39.9	D	18.9	B
Northbound Through	35.5	D	20.1	C
Northbound Right	30.8	C	26.3	C
Overall Intersection	22.4	C	26.8	C

Table 9
INTERSECTION CAPACITY ANALYSIS
Year 2008 Forecasted Traffic Conditions
(With Intersection Improvements)

	Weekday AM Peak Hour		Design Hour	
	Delay	**LOS**	**Delay**	**LOS**
Spear Street @ Allen Road (Unsignalized)				
Northbound Left	8.6	A	11.7	B
Southbound Left	8.5	A	8.4	A
Eastbound Left	791.5	F	4,226	F
Eastbound Right/Through	17.3	C	122.6	F
Westbound Left	53.3	F	881.3	F
Westbound Right/Through	25.5	D	54.6	F
Spear Street @ Allen Road (Signalized)				
Northbound Left	6.6	A	94.7	F
Northbound Right/Through	6.9	A	6.6	A
Southbound Left	5.3	A	5.7	A
Southbound Right/Through	6.3	A	18.9	B
Eastbound Left	16.7	B	54.2	D
Eastbound Right/Through	13.7	B	32.0	C
Westbound Left	13.3	B	26.5	C
Westbound Right/Through	14.4	B	27.6	C
Overall Intersection	8.9	A	27.1	C
Spear Street @ Deerfield Drive/Nowland Farm Road				
Northbound	8.2	A	11.7	B
Southbound/Left	9.9	A	9.4	A
Westbound Left / Through	40.9	E	190.2	F
Westbound Right	16.9	C	14.3	B
Eastbound Left	75.9	F	311.6	F
Eastbound Right/Through	24.7	C	51.8	F
Spear Street @ Cedar Glen				
Northbound	8.4	A	11.9	B
Eastbound Left	93.0	F	172.4	F
Eastbound Right	11.4	B	23.6	C
Spear Street @ Swift Street (Lane Changes)				
Northbound Left	9.9	A	107.6	F
Northbound Right/Through	51.5	D	79.6	E
Southbound Left	21.5	C	50.7	D
Southbound Right / Through	14.1	B	35.7	D

Table 9(cont)

INTERSECTION CAPACITY ANALYSIS
Year 2008 Forecasted Traffic Conditions
(With Intersection Improvements)

	Weekday AM Peak Hour		Design Hour	
	Delay	**LOS**	**Delay**	**LOS**
Eastbound Left / Through	38.6	D	87.2	F
Eastbound Right	29.3	C	43.5	D
Westbound Left	29.4	C	42.1	D
Westbound Right / Through	29.5	C	17.8	B
Overall Intersection	36.6	D	58.2	E
Spear Street@Swift Street (Added Lanes)				
Northbound Left	9.8	A	51.4	D
Northbound/Through	43.4	D	38.8	D
Northbound Right/Through	7.1	A	10.6	B
Southbound Left	16.9	B	29.5	C
Southbound Right / Through	14.4	B	45.2	D
Eastbound Left	28.2	C	23.1	C
Eastbound Through	29.3	C	53.7	D
Eastbound Right	21.1	C	42.0	D
Westbound Left	23.2	C	26.7	C
Westbound Right/Through	23.4	C	22.1	C
Overall Intersection	28.6	C	38.6	D
Spear Street @ Quarry Hill Road				
Southbound	9.6	A	8.9	A
Westbound Left	28.6	D	37.0	E
Westbound Right	18.2	C	12.4	B