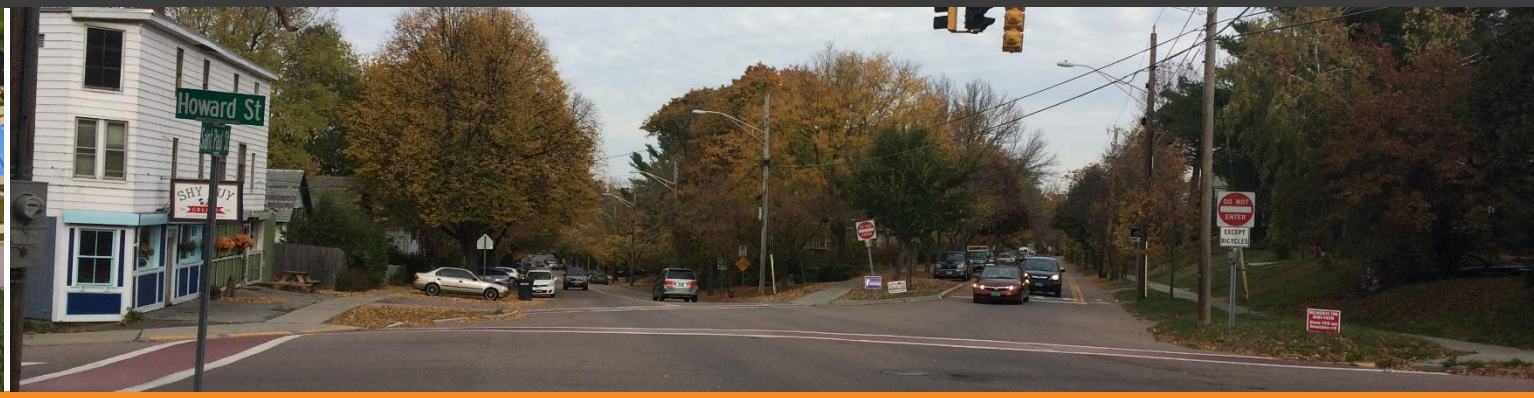
DRAFT ALTERNATIVES ANALYSIS REPORT

BURLINGTON BP15(17) WINOOSKI-HOWARD-ST PAUL INTERSECTION SCOPING STUDY

6/21/2017



PREPARED FOR:
BURLINGTON VERMONT DEPARTMENT OF PUBLIC WORKS

SUBMITTED BY:
RSG

180 Battery Street, Suite 350
Burlington, VT 05401
802.383.0118
www.rsginc.com

IN COOPERATION WITH:
HARTGEN ARCHAEOLOGICAL ASSOCIATES, INC.
POINT OF BEGINNING, LAND SURVEYING AND CONSULTING

This page is intentionally blank.

CONTENTS

This page is intentionally blank.

1.0 INTRODUCTION

Five alternatives are proposed for consideration at the intersection of St. Paul Street, South Winooski Ave, and Howard Street, located in the South End of Burlington, Vermont. This report describes the features, benefits, trade-offs, and potential impacts of each alternative on the project area (shown in Figure 1-1). The alternatives presented in this document are intended to address the specific goals of this study and compliment the citywide PlanBTV Initiatives.

FIGURE 1-1 STUDY AREA

The goals of this study are to:

1. Identify deficiencies in the existing intersection and transportation system
2. Propose and evaluate improvements for people to safely and comfortably walk, bike, wheel, drive, ride transit or otherwise travel through the intersection
3. Meet (and exceed where possible) accessibility standards
4. Foster the emerging neighborhood by creating a sense of place
5. Maintain a reasonable level of efficient vehicle travel

The previous phase of this project developed an Existing Conditions Report. The report condensed site characteristics and community outreach to document the Purpose and Need Statement. This Statement serves as a guiding document through alternative development and analysis, and forms the criteria to evaluate the alternatives.

The Purpose and Need Statement for improvements to the Winooski – Howard – St Paul intersection follows:

PURPOSE

Make the intersection easy and safe to cross for all modes of transportation, including pedestrians, bicycles, transit, and vehicles, while maintaining vehicle capacity. In addition, create an inviting and welcoming environment to foster the emerging neighborhood.

NEED

The need for this project is documented by the following issues:

a. Expansive pavement makes crossing the intersection unsafe for pedestrians, bicyclists, and vehicles.
    i. Pedestrians must walk over 50 feet (up to 80 feet) to cross several legs.
    ii. Bicyclists must travel from stop through a wide and long distance with no markings. Bicyclists have particular difficulty heading eastbound on Howard Street, when they must stop on a steep uphill grade.
    iii. Vehicles entering during yellow phase may not be able to cross the intersection before the light turns red.

b. There are no pedestrian signals or button actuation; it is not obvious to pedestrians when to safely cross, and motorists do not have guidance to yield to pedestrians.

c. There is no crosswalk across S. Winooski Ave.

d. There have been 33 vehicle crashes in the past five years.

e. Transit facilities are underdeveloped despite serving many people, including students taking the bus to school. There are no bus shelters, dedicated waiting areas, or dedicated bus pull-off zones, and snow can pile up in winter.

f. There is poor visibility to traffic signals for motorists.
    i. Signals are difficult to see in some lighting situations
    ii. Signals do not have back plates.
    iii. The signals are located in the center of the intersection.

g. There are many reports from neighbors that vehicles speed through the intersection. Speed data has not been collected to confirm this perceived issue.

h. There are many reports from neighbors that vehicles run red lights. This issue was confirmed by watching a video recording of the intersection.

i. There is a report from a neighbor that motorists do not always see the "Do Not Enter" sign for S. Winooski Ave and try to drive north on the street.

j. Trucks drive on S. Winooski Ave (Urban Principal Arterial) which is prohibited to trucks (neighborhood environment).

k. Right-turn on red rules of the intersection are unclear. Right turns on red from Howard Street westbound and S. Winooski southbound are particularly dangerous due to the five legs of the intersection.

l. Potvin Park is underutilized as a public space.

m. Pedestrians do not have space to linger, limiting the possibility of fostering a sense of community.

n. The bicycle lanes on S. Winooski Ave stop at the intersection. Bicyclists do not have dedicated facilities to continue to or from the southern leg of St. Paul Street.

2.0 DESIGN CRITERIA

To develop appropriate designs, the following design criteria have been established.

GEOMETRY

Design Speed = 25 MPH (all streets and approaches)

Lane and Shoulder Widths:

St Paul St / S. Winooski Ave: 11-foot lane, 3-foot shoulder

Howard St: 10-foot lane, 2-foot shoulder

Parking lane widths*: 8 feet

*On-street parallel parking is present on one side of each leg of the intersection

Bike lanes: 5 feet

Stopping Sight Distance, S = 165 feet

- Assume 25 MPH
- Assume 6% downgrade
- Refer to AASHTO Green Book Exhibit 3-2

Minimum Horizontal Curve Radius = 180 feet

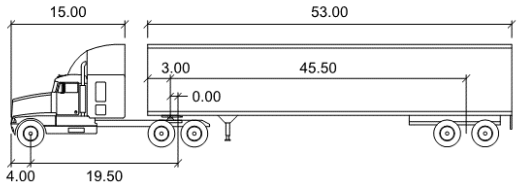
- Refer to VTrans Standard Detail A-76

Minimum Vertical Curve Length, L = 100 feet

- Refer to AASHTO Green Book minimum vertical curve length exhibits 3-71 and
- Acceptable for algebraic grade differences under 4% (crest) or 3.5% (sag)

DESIGN VEHICLES

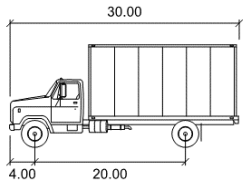
St Paul Street: WB-67



The WB-67 represents the largest interstate tractor-semitrailer that would be encountered on St Paul Street. The vehicle is expected to perform only through movements and remain on St Paul Street (no turns to or from Howard Street or South Winooski Avenue)

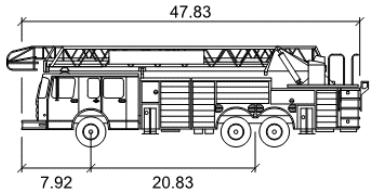
Howard Street / South Winooski Avenue: SU-30

The SU-30 single unit truck represents a typical local delivery truck. The SU-30 should be able to turn into and out of each street, but may need to encroach into opposing lanes.



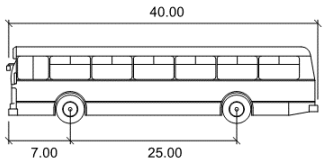
All Streets: City of Burlington Ladder Fire Truck

The ladder truck is a custom vehicle approximating the Burlington Fire Department's largest fire fighting vehicle.



All Streets: CITY BUS

The CITY BUS represents a typical intracity transit bus.



LEVEL OF SERVICE

This study aims to provide a **balanced analysis** of intersection alternatives based on the needs of all modes of transportation, with **an emphasis on the needs and desires of pedestrians and bicyclists**. Different metrics are used for motorized and non-motorized forms of transportation, since the goals for each group are often at odds with each other (see Figure 2-1 for common perspectives).

To measure how well each alternative meets the goals of **pedestrians and bicyclists**, they have been **evaluated based on the project-specific criteria shown in Table 3.1.** These criteria are based on the Purpose and Need Statement determined early in the project and described in Section 1.0, and are largely focused on safety, comfort, and accessibility for pedestrians and bicyclists.

To measure how well each alternative meets the goals of **drivers of motorized vehicles**, one of the primarily metrics used is **level of service (LOS)**. The LOS of an intersection is a rating of the traffic operations (as perceived by motorists) during the peak hour of an average day. It runs on a scale from A to F. (A full definition and analysis can be found in Section 6.1.)

In urban areas such as the project location, higher LOS's are not necessarily desirable. VTrans generally aims for an LOS of "C" on all its roads, but may accept a reduced LOS under certain circumstances, especially within densely settled areas, "as long as the safety and mobility of the traveling public is improved."[1]

[1] VTrans Highway Design "Level of Service Policy (2007) http://vtrans.vermont.gov/sites/aot/files/highway/documents/publications/LevelOfServicePolicy2007.pdf

FIGURE 2-1 MULTI-MODAL GOALS AND PERSPECTIVES

PEDESTRIANS

1 People crave activity and variety at street level. Streets with active storefronts, foot traffic design, and human scale design contribute toward an active and economically vibrant community. While activity is of paramount importance to the pedestrian realm, public safety, sidewalk width adequately spaced and apportioned, protection from rain, and shade from the sun together make the difference between a successful street and a barren one.

BICYCLISTS

2 Bicycle facilities should be direct, safe, intuitive, and cohesive. Bicyclists desire a high degree of connectivity and a system that functions well for cyclists of all skill levels, with minimal detour or delay.

Bicyclists benefit from feeling safe and protected from moving traffic. Bikeways that create an effective division from traffic and are well coordinated with the signal timing and intersection design of the traffic network form the basis of a accessible bicycle network. See Cycle Tracks

VEHICLES

3 Motorists want to get to their destination as quickly and safely as possible with limited friction, interruption, or delay. Vehicles typically benefit from limited access, higher speed roads with limited chance of conflict or surprise.

Due to their high speeds and overall mass, drivers feel safest when buffered from other moving vehicles, bicyclists, buses, trucks, and crossing pedestrians. Especially when making decisions at high speeds, motorists need adequate lighting and signage, as well as adequate parking provisions at their destinations.

TRANSIT

4 Transit service may be measured by its speed, convenience, reliability, and frequency of service. Trains and buses should permit easy loading and unloading, and be comfortable and not overcrowded. The overall level of access and scope of a transit network should be aligned to actual demand, meeting service needs without sacrificing service quality.

FREIGHT

5 Freight operators want to move goods from their origin to their destination as easily, quickly, and conveniently as possible. Trucks benefit from high, but not unsafe speeds, curb access or docks for easy loading and unloading, and overall safety throughout the traffic system.

EMERGENCY VEHICLES

Emergency responders are responsible for attending to crimes, crashes, fires, and other dire scenarios as quickly as possible. They benefit from safety and predictability along their routes, with minimal conflicts with vehicles, bicyclists, or pedestrians, and direct curb access at their destinations.

Source: Urban Street Design Guide (National Association of City Transportation Officials) https://nacto.org/publication/urban-street-design-guide/design-controls/performance-measures/

3.0 EVALUATION CRITERIA

To objectively evaluate each alternative, criteria have been developed based on the goals of the study and the specific issues identified in the project area. Table 3.1 illustrates how each issue affects one or more of the three goals and notes the City studies that reference these needs. Later in this report, all five alternatives will be evaluated based on these criteria - whether they will improve, worsen, or have no effect on each issue.

In addition to the primary criteria summarized below, **parking options, traffic operations, stormwater management, and estimated costs** are key elements of this study. These will be considered in the final evaluation in the following forms:

- **Parking options:** The net increase or decrease of on-street and off-street parking
- **Traffic operations:** The delays and queues that drivers experience
- **Stormwater management:** The net increase or decrease in permeable space. Opportunities for stormwater management are being considered throughout this study, including options such as permeable pavement.
- **Cost:** The relative cost of each intersection alternative

TABLE 3.1 PRIMARY EVALUATION CRITERIA

		Study Goals		
Plans that reference these needs	**Issues to Address**	Improve **safety** for people walking, bicycling, driving, and taking transit	Meet (and exceed) **accessibility** standards	Foster the emerging **neighborhood**
PlanBTV Walk Bike	**1** Crossing length for all modes	x	x	
PlanBTV Walk Bike	**2** Pedestrian crossing guidance	x	x	
PlanBTV Walk Bike	**3** Pedestrian crossing of S. Winooski Ave	x	x	
	4 Crash rate	x		
PlanBTV South End	**5** Comfortable transit facilities		x	x
	6 Visibility of traffic signals to motorists	x	x	
PlanBTV South End, PlanBTV Walk Bike	**7** Vehicle speeds	x		
	8 Running of red lights	x		
	9 Wrong-way driving on S. Winooski Ave	x		
	10 Trucks on S. Winooski Ave	x		x
	11 Right turns on red	x		
PlanBTV South End, OSPP	**12** Use of Potvin Park			x
PlanBTV South End	**13** Public gathering space			x
PlanBTV South End, PlanBTV Walk Bike	**14** Bicycle infrastructure	x	x	
PlanBTV South End, PlanBTV Walk Bike, OSPP	**15** Stormwater retention			
PlanBTV South End	**16** Support relationship between residents and businesses			x

4.0 ALTERNATIVES FOR CONSIDERATION

The following pages summarize the five alternatives for consideration. The alternatives include one immediately implementable project, a longer-term reconstruction of the existing signal system, and large-scale re-imaginings of the intersection.

The five alternatives are:

1. Demonstration Project - Existing Geometry
2. New Signal System - Existing Geometry
3. Dual Signal System - Realigned Roadway
4. Dual Roundabout - Realigned Roadway
5. Modern Roundabout - Existing Geometry

On top of the five action alternatives outlined above, this study also considers a "do-nothing" alternative (Alternative 0) in which the existing roadway geometry remains the same. At the end of this section, three additional alternatives that were considered but not advanced are briefly discussed.

For each alternative, the following information is given:

TIMEFRAME: Immediate (within one year), Short Term (within five years), and Long Term (five to ten years)

COST ESTIMATE: One to five dollar signs ($) are shown as a relative scale for the cost of each alternative.

PROJECT DESCRIPTION: A summary of the key aspects and benefits of an alternative

FEATURES: A bulleted list of the construction/installation items

CONSIDERATIONS: Potential challenges and impacts of the alternative

LONGEST CROSSWALK LENGTH: The longest crosswalk length and the roadway in which it crosses is identified

VEHICLE TRACKING: A discussion of how large vehicles, including firetrucks, transit buses, and freight vehicles travel through the intersection, including identification of restricting features

GOALS MET: This section qualitatively identifies how each alternative meets the goals of this study. Each project has been given a rating of **improvement (+)**, **no change (0)**, or **worse (-)** for each of the 16 issues to address in the three categories shown in Table 3.1. The number of "+" are subtracted by the number of "-", for each category, with a resulting score.

These ratings are shown collectively in Figure 6-1.

The "goals met" is intended as a metric for quickly comparing alternatives to the existing conditions. It does not account for how each criterion may have a higher "weight" than others, and therefore cannot be used as a prioritization tool at this point.

OPPORTUNITIES FOR ENHANCEMENT: In some cases, alternatives do not necessarily address a given issue unless an extra step is taken. This section suggests "add-on" opportunities to enhance a given alternative. Examples include bus stop improvements and turning a landscape or hardscape into a more pervious surface to retain more stormwater.

ALTERNATIVE 0: NO BUILD

TIMEFRAME: Immediate

COST ESTIMATE: 0

PROJECT DESCRIPTION: This alternative would maintain the features and operations of the existing intersection geometry. No changes to curb lines, sidewalks, crosswalks, transit features, signal placement or timing, or any other element is proposed.

FEATURES:

- Maintenance of existing conditions

CONSIDERATIONS:

- Does not address any goals
- Least expensive alternative

LONGEST CROSSWALK LENGTH: 78-feet **(a)**

VEHICLE TRACKING: This do-nothing alternative proposes no changes to the curb lines and offers the greatest vehicle maneuvering flexibility.

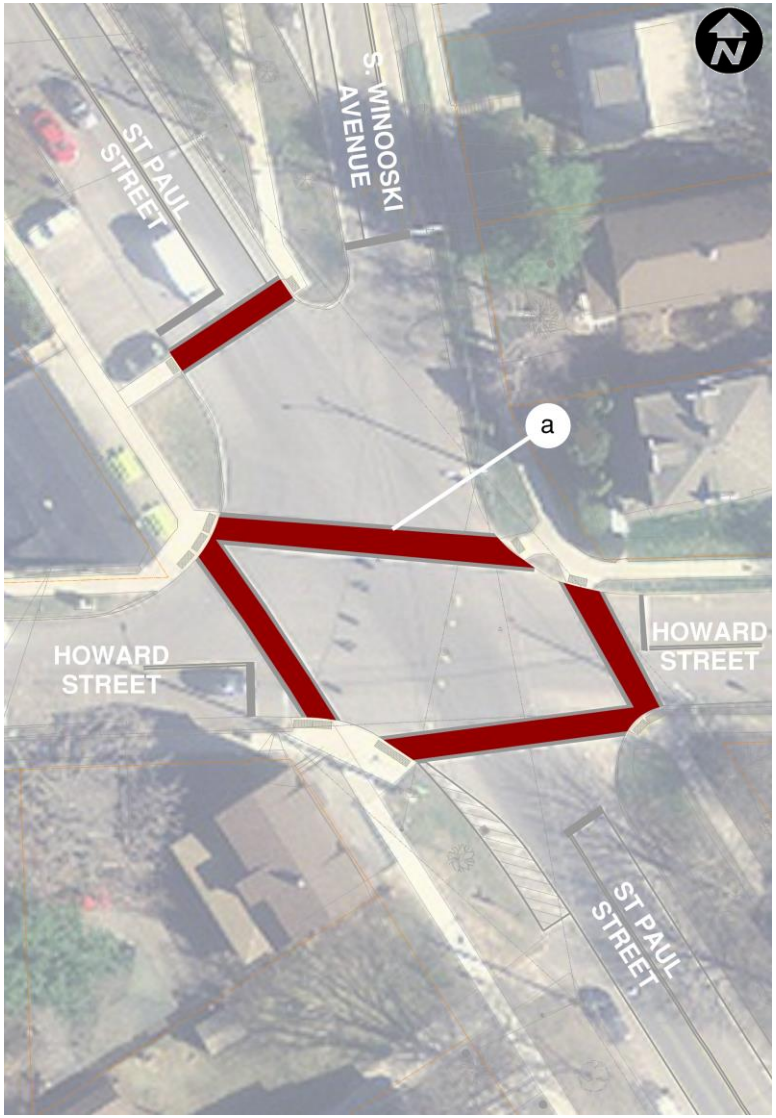
GOALS MET:

- Safety: 0 of 10
- Accessibility: 0 of 6
- Neighborhood: 0 of 5

OPPORTUNITIES FOR ENHANCEMENT:

- None

FIGURE 4-1: NO BUILD ALTERNATIVE



ALTERNATIVE 1: Demonstration Project

TIMEFRAME: Immediate

COST ESTIMATE: $

PROJECT DESCRIPTION: This alternative would be a temporary installation of curb extensions and lane markings at various locations around the intersection. Temporary curb extensions may be installed long-term with flexible post bollards, or shorter term with cones, haybales and planters. Between the existing curb and temporary curb extensions is an opportunity for a gathering space, benches and tables, street art, or other community opportunity, illustrated in blue. A bike box, green bike lane markings, and bike crossing markings may be installed with temporary paint to highlight the bicycle infrastructure.

The alternative would provide the neighborhood a low-cost, first-hand understanding of how curb extensions might change vehicle behavior and increase public gathering space. Chairs and tables could be set out in the new space to support businesses and foster a sense of community. People who already ride bicycles through this intersection and those who are interested could try out the enhanced bicycle facilities.

FEATURES:

- Temporary curb extensions **(a)**
- Chairs and tables, gathering space, and/or street art where the curb has been extended **(b)**
- Bike box, crossing markings, and bike lanes at the intersection **(c)**
- No turn on red signs

FIGURE 4-2: TEMPORARY DEMONSTRATION PROJECT ALTERNATIVE

CONSIDERATIONS:

- Visibility as a person walking from the "extended" crosswalk to the signals may be restricted. A short term (one-day) installation may be more appropriate to gauge how a more permanent installation may be installed. The northwest corner has the greatest visibility to the traffic signals and the highest potential for utilization of the reclaimed space due to the adjacent commercial development. Curb extensions at the other three corners would make it difficult for pedestrians to see the signals and know when to walk.

LONGEST CROSSWALK LENGTH: 43 feet

VEHICLE TRACKING: The single-unit truck design vehicle is able to maneuver around the corner, with encroachment into the opposite lane. In Figure 4-3, the design vehicle remains encroaches only on the minor leg approach to the intersection.

GOALS MET:

- Safety: 4 of 10
- Accessibility: 2 of 6
- Neighborhood: 2 of 5

ADDITIONAL CRITERIA:

- Net change in permeable area: No change
- Parking impacts: No change

OPPORTUNITIES FOR ENHANCEMENT:

- A one-day demonstration could take place on a Saturday in nice weather, possibly coordinated with OpenStreets BTV for maximum foot and bicycle traffic.
- A neighborhood art project may be planned in conjunction with this demonstration project.

FIGURE 4-3: SOUTHBOUND SU-30 VEHICLE TURNING RIGHT ONTO WESTBOUND HOWARD STREET

ALTERNATIVE 2: New Signal System, Existing Geometry

TIMEFRAME: Short Term

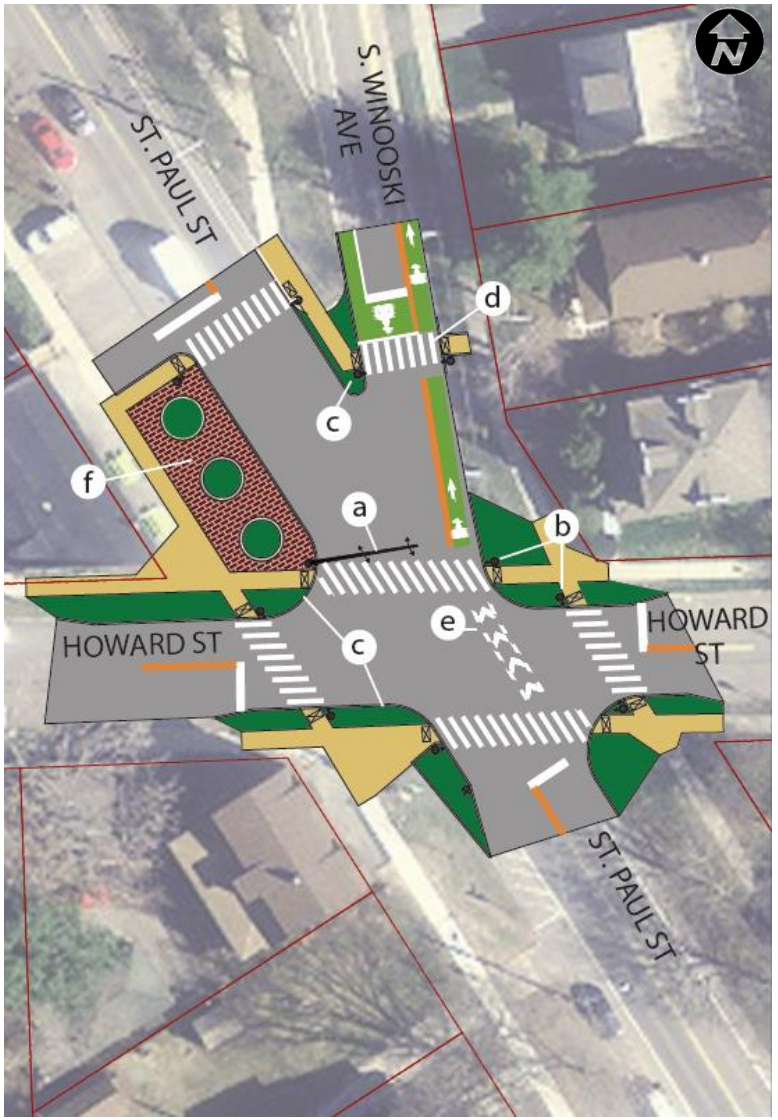
COST ESTIMATE: $$$

PROJECT DESCRIPTION: This alternative is a permanent, enhanced version of Alternative 1; it would include an upgraded signal system with pedestrian crossing buttons, curb extensions at all four corners and of Potvin Park, an accessible crossing of Winooski Ave, and bicycle crossing markings, and a bike box. The curb extensions would both slow traffic and provide more pedestrian space; a new plaza in front of 457 St Paul Street may be constructed with permeable pavers for stormwater management.

FEATURES:

- New signal system:
  - Mast arm for northbound and southbound traffic **(a)** (St. Paul Street and S. Winooski Ave)
  - Signal pedestals **(b)** for eastbound and westbound traffic (Howard Street) and all pedestrian crossings (10 total)
  - Pedestrian crossing buttons with countdown feature
  - Bicycle detection
  - Right turn on red rules part of signal system
- Curb extensions at four corners and of Potvin Park **(c)**

FIGURE 4-4: NEW SIGNAL SYSTEM, EXISTING GEOMETRY



- Reconstructed sidewalks and ramps
- Accessible marked crossing of S. Winooski Ave **(d)**
- Bike box, crossing markings, and bike lanes at the intersection **(e)**
- Plaza **(g)** in front of 457 St. Paul Street (Neighborhood Market, Shy Guy Gelato)

CONSIDERATIONS:

- The driveway of the house at the northeast corner **(h)**; vehicles must enter from S. Winooski Ave and exit to the south (the north leg of St. Paul Street would not be accessible to this driveway as it is now)
- Burlington DPW has word-of-mouth reports of shallow ledge in area making signal system potentially expensive

LONGEST CROSSWALK LENGTH: 43 feet

VEHICLE TRACKING: The curb layouts of Alternative 2 are the same as the temporary demonstration project curbs, with the same operating characteristics of turning vehicles. Figure 4-5 illustrates the CITY BUS design vehicle navigating the bus route through the project area.

GOALS MET:

- Safety: 7 of 10
- Accessibility: 5 of 6
- Neighborhood: 2 of 5

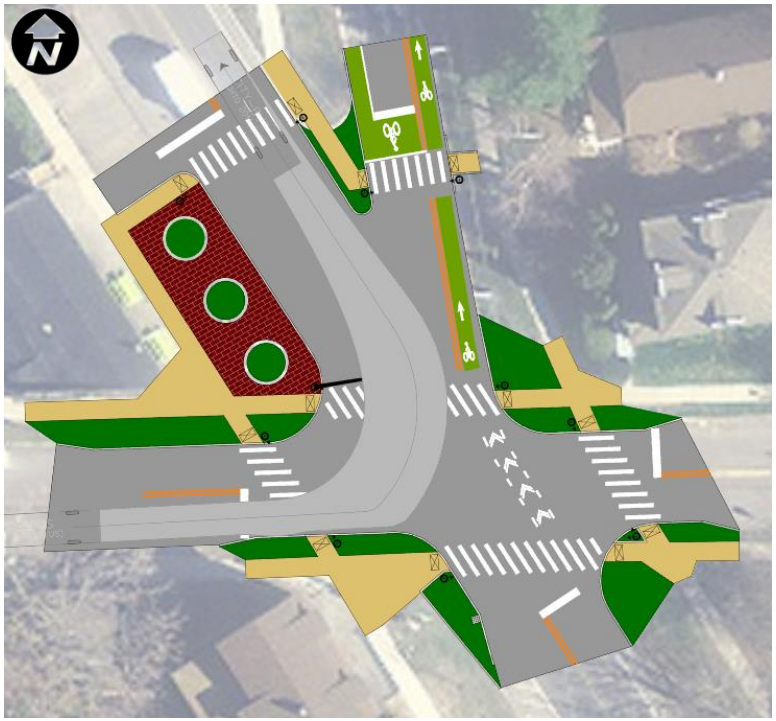
ADDITIONAL CRITERIA:

- Net change in permeable area: + 490 SF
- Parking impacts: No change

OPPORTUNITIES FOR ENHANCEMENT:

- Improved transit shelter(s)
- Use flex posts at beginning of bike contraflow lane
- Potential stormwater best management practices (BMP) at plaza: permeable pavers or infiltration area

FIGURE 4-5: WESTBOUND HOWARD STREET CITY BUS TURNS LEFT ONTO NORTHBOUND ST PAUL STREET



ALTERNATIVE 3: New Signal System, Realigned Roadway

TIMEFRAME: Long Term

COST ESTIMATE: $$$$

PROJECT DESCRIPTION: This alternative would greatly reduce the amount of pavement - and therefore crossing distances for all modes - by splitting up the five-way intersection into two signalized intersections. South Winooski Ave would curve west to "T" at St. Paul Street within current limits of Potvin Park. New green space would be gained in a triangular space between the two intersections, but this space would be traversed by driveways, limiting its use as a public space. Green bike lanes and crossing markings would guide bicyclists traveling south from S. Winooski Ave to the four-way intersection, while a northbound bike lane would run adjacent to the eastern sidewalk, distanced from traffic.

FEATURES:

- Existing five-leg intersection split into two intersections:
  - St. Paul Street and S. Winooski Ave
  - St. Paul Street and Howard Street
  - 170 feet between intersections, center to center
- New signal system:
  - Signal pedestals at both intersections (14 total)
  - Pedestrian crossing buttons with countdown feature
  - Bicycle detection
- New green space between S. Winooski Ave and the four-way intersection **(a)**, intersected by driveways

FIGURE 4-6: NEW SIGNAL SYSTEM, REALIGNED ROADWAY

- Curb extensions **(b)**
- Reconstructed sidewalks and ramps
- Accessible marked crossing of S. Winooski Ave **(c)**
- Southbound bike lane and crossing markings between the two intersections **(d)** to guide bicyclists between S. Winooski Ave and Howard Street
- Northbound bike lane separated from the road to replace a portion of the contraflow lane **(e)**
- Plaza area in front of 457 St. Paul Street (Neighborhood Market, Shy Guy Gelato) **(f)**

CONSIDERATIONS:

- The new green space would be intersected by three driveways, likely making it an underutilized public space.
- Potvin Park greatly impacted **(c)**
- Potential difficulty of vehicles entering and exiting driveways during peak hours
- South Winooski Avenue radius to T **(h)** is less than design criteria minimum (currently illustrated at 100-feet); maximum grade is 4%. Use advanced warning of the signal
- Intersection spacing is short; signals need to be coordinated and carefully timed
- Potential conflicts between vehicles turning right and bicyclists turning left on the southbound Winooski Ave approach

LONGEST CROSSWALK LENGTH: 43 feet

VEHICLE TRACKING: Many of the curb lines at the St. Paul Street / Howard Street intersection are similar to Alternatives 1 and 2; the realigned S. Winooski Avenue does impact fire vehicle maneuvering. Figure 4-7 illustrates this vehicle path. The firetruck must encroach onto the opposing lane on St Paul and Howard Streets.

GOALS MET:

- Safety: 9 of 10
- Accessibility: 5 of 6
- Neighborhood: 2 of 5

ADDITIONAL CRITERIA:

- Net change in permeable area: + 1,530 SF
- Parking impacts:
    - Off-street parking at 457 St Paul Street shifted to the south (no change to quantity)
    - Loss of approximately 7 on-street parking spaces

OPPORTUNITIES FOR ENHANCEMENT:

- Improved transit shelter(s)
- Stormwater retention: permeable plaza, enhance green space
- Bike signal for southbound bicyclists on Winooski Ave

FIGURE 4-7: SOUTHBOUND S. WINOOSKI AVE. BURLINGTON LADDER TRUCK MANEUVERING TO WESTBOUND HOWARD ST.

ALTERNATIVE 4: Dual Roundabout, Realigned Roadway

TIMEFRAME: Long Term

COST ESTIMATE: $$$$

PROJECT DESCRIPTION: This alternative consists of two connected mini-roundabouts, forming a peanut-like shape. The peanut-shape requires that left turning vehicles travel through both roundabouts before exiting. A sidewalk or shared use path may generally run where the existing sidewalk is now. Shared lane markings would be painted within the roundabout for bicyclists who are comfortable riding in traffic.

FEATURES:

- Peanut-shaped roundabout
  - Inscribed diameter of mini-roundabouts is 70-feet
  - No signals
  - Mountable islands on approaches **(a)**, mountable aprons **(b)** at roundabout centers, mountable edges **(c)** for tight turns. The location and amount of mountable space were determined based on truck tracking movements.
- Mew green space along east side of roundabout **(d)**
- Marked pedestrian crossings of all five approaches
- Sidewalk around perimeter for pedestrians or people walking bicycles

FIGURE 4-8: DUAL ROUNDABOUT, REALIGNED ROADWAY

- Shared lane markings with green background **(e)** for people riding bicycles to have the option to ride in the roundabout

CONSIDERATIONS:

- Potvin Park is significantly impacted **(f)**
- Vehicle access to three driveways along S. Winooski Ave into roundabout is uncommon **(g)**
- Less usable public gathering space than currently exists
- Loss of vehicle access and parking at 457 St. Paul Street **(h)**
- St. Paul Street bus stop to be moved further north

LONGEST CROSSWALK LENGTH: 41 feet

VEHICLE TRACKING: A WB-67 is able to traverse the splitter islands and central apron as needed to travel through the intersection; the CITY BUS must traverse the central island and overhang the green strip to maneuver from eastbound Howard Street to northbound St Paul Street. These vehicle paths are illustrated in Figure 4-9 and Figure 4-10.

GOALS MET:

- Safety: 8 of 10
- Accessibility: 4 of 6
- Neighborhood: -1 of 5

ADDITIONAL CRITERIA:

- Net change in permeable area: + 1,100 SF
- Parking impacts:
  - Loss of off-street parking at 457 St Paul Street
  - Loss of approximately 8 on-street parking spaces

OPPORTUNITIES FOR ENHANCEMENT:

- Improved transit shelter(s)
- Shared use path (instead of sidewalk) for bicyclists not comfortable riding in the roundabout
- Stormwater retention: enhance green space, permeable medians and apron

FIGURE 4-9: SOUTHBOUND WB-67 AT THE ST PAUL STREET ENTRANCE

FIGURE 4-10: EASTBOUND CITY BUS ENTERING AT THE HOWARD STREET ENTRANCE

ALTERNATIVE 5: Modern Roundabout, Existing Geometry

TIMEFRAME: Long Term

COST ESTIMATE: $$$$$

PROJECT DESCRIPTION: This alternative consists of a one-lane modern roundabout with five approaches. The space required for the large-radius roundabout and the way it must be situated for five entrance legs would require the full taking of the building at 457 St. Paul Street **(a)**. As with Alternative 4 (Dual Roundabout), a sidewalk or shared use path **(b)** would generally run where the existing sidewalk is now. Shared lane markings **(c)** may be painted within the approaches of the roundabout for bicyclists who are comfortable riding in traffic.

FEATURES:

- Single-lane modern roundabout with five approaches
  - 100 feet inscribed diameter
  - No signals
  - Mountable islands **(a)** on approaches, mountable apron **(b)** at roundabout center, mountable edges **(c)** for tight turns
- Potvin Park remains **(d)**
- Marked pedestrian crossings of all five approaches
- Sidewalk around perimeter for pedestrians or shared use path for both pedestrians and people walking bicycles **(e)**
- Shared lane markings with green background for people riding bicycles to have the option to ride in the roundabout **(f)**
- Bicycle exit from roundabout for northbound S. Winooski Ave bicyclists **(i)**

FIGURE 4-11: MODERN ROUNDABOUT, EXISTING GEOMETRY

CONSIDERATIONS:

- Full take of building at 457 St. Paul Street **(g)**
- Difficult vehicle access to two houses along S. Winooski Ave **(h)**
- Grade of sidewalk approaches may be higher than permitted by ADA standards

LONGEST CROSSWALK LENGTH: 33 feet

VEHICLE TRACKING: Some large vehicles were unable to stay within the tracking pads of the roundabout, particularly for the acute right turns (northbound St Paul to westbound Howard, or southbound S. Winooski to northbound St Paul). This maneuver could instead be completed by turning 270 degrees left. A single unit truck exceeding the design vehicle dimensions is illustrated in Figure 4-12.

GOALS MET:

- Safety: 8/10
- Accessibility: 4/6
- Neighborhood: -2/5

ADDITIONAL CRITERIA:

- Net change in permeable area: + 3,380 SF
- Parking impacts:
    - Loss of parking lot at 457 St. Paul St (along with the building)
    - Loss of approximately one on-street parking space

OPPORTUNITIES FOR ENHANCEMENT:

- Improved transit shelter(s)
- Shared use path (instead of sidewalk) for bicyclists not comfortable riding in the roundabout
- Stormwater retention: enhance green space, permeable medians and apron

FIGURE 4-12: A SU-40 TRUCK (LARGER THAN THE DESIGN VEHICLE) NAVIGATING THE ROUNDABOUT

This size and position of the roundabout is selected to:

- Fit all five approaches
- Create deflection so that incoming vehicles must slow down to enter
- Allow for trucks and buses to maneuver around it

ALTERNATIVES CONSIDERED BUT NOT ADVANCED

Several additional alternatives were considered but not advanced. These intersection configurations included:

1. **Various Intersection Controls within the Realigned South Winooski Avenue Alternative**

   These various alternatives included various intersection control mechanisms at the Realigned South Winooski Avenue / St. Paul Street intersection, and Howard Street / St. Paul Street intersection.

   - Signal / Roundabout Combination. The signal / roundabout combination intersection alternative was not considered as the two intersections are too close together to not operate in concert. The proposed realigned roadway alternatives both operate as a single intersection: the signalized intersections are proposed as a coordinated system, and the dual roundabouts are connected as a single intersection a single intersection. As two independent intersections, queued vehicles at a red light or lined up to enter the roundabout would interrupt the efficiency of the adjacent intersection.
   - Stop Control South Winooski Avenue Approach. It was determined that if the South Winooski Avenue approach was stop controlled with no control on St. Paul Street, South Winooski Avenue would experience significant delay and queueing.

2. **All-Way Stop**
   - It was determined the St. Paul Street approaches at Howard Street and South Winooski Avenue would experience significant delay and queueing if forced to stop at the study intersection.

3. **Single Mini Roundabout**
   - A single mini-roundabout would be too small to accommodate all five legs of the intersection.

By removing these options from the list of alternatives, the final list is a more concise list with one distinct alternative for each geometry and control type.

5.0 TRAFFIC EVALUATION

The five alternatives and the No Build alternative were modeled in a traffic analysis software package from Trafficware to determine the average delay, level-of-service, and average queue length for each approach and each intersection as a whole.

5.1 | VEHICLE LEVEL OF SERVICE ANALYSIS

LEVEL OF SERVICE DEFINITION

Level of service (LOS) is a performance metric describing the delay experienced by motorists at an intersection. LOS is calculated using the procedures outlined in the 2000 and 2010 Highway Capacity Manuals.[2] In addition to traffic volumes, key inputs include the number of lanes at each intersection, traffic control type (signalized or unsignalized), and the traffic signal timing plans.

The 2010 Highway Capacity Manual defines six qualitative grades to describe the level of service at an intersection, based on the average delay experienced. Figure 5-1 shows the various LOS grades and delay ranges for signalized and unsignalized intersections.

The delay thresholds for LOS at signalized and unsignalized intersections differ because of the driver's expectations of the operating efficiency for the respective traffic control conditions. According to HCM procedures, an overall LOS cannot be calculated for two-way stop-controlled intersections because not all movements experience delay. In signalized and all-way stop-controlled intersections, all movements experience delay and an overall LOS can be calculated.

FIGURE 5-1: LEVEL-OF-SERVICE CRITERIA FOR SIGNALIZED AND UNSIGNALIZED INTERSECTIONS

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

The VTrans policy on level of service for Signalized and All-Way Stop Intersections is:

- Overall LOS C should be maintained for state-maintained highways and other streets accessing the state's facilities
- Reduced LOS may be acceptable on a case-by-case basis when considering, at minimum, current and future traffic volumes, delays, volume to capacity ratios, crash rates, and negative impacts (cultural, environmental, etc.) as a result of improvement necessary to achieve LOS C.

The City of Burlington may choose to accept greater vehicle delay and a lower LOS to address non-motorized travel priorities.

[2] The HCM 2010 does not provide methodologies for calculating intersection delays at certain intersection types including signalized intersections with exclusive pedestrian phases and signalized intersections with non NEMA-standard phasing. Because of these limitations, HCM 2000 methodologies are employed where necessary.

VOLUME TO CAPACITY RATIO DEFINITION

In addition to LOS, a key performance measure is the volume-to-capacity ratio (v/c ratio) of an intersection, also known as the degree of saturation. A v/c ratio less than 0.85 generally indicates that adequate capacity is available and vehicles are not expected to experience significant queues and delays. As the v/c ratio approaches 1.0, traffic flow may become unstable, and delay and queuing conditions may occur. Once the demand exceeds the capacity (a v/c ratio greater than 1.0), traffic flow is unstable and excessive delay and queuing is expected. Under these conditions, vehicles may require more than one signal cycle to pass through the intersection (known as a cycle failure). For design purposes, a v/c ratio between 0.85 and 0.95 generally is used for the peak hour of the horizon year (generally 20 years out). Overdesigning for an intersection should be avoided due to negative impacts to pedestrians associated with wider street crossings, the potential for speeding, land use impacts, and cost.[3]

LIMITATIONS TO LOS AND V/C

Level-Of-Service and Volume-to-Capacity are both measures of vehicular travel during the peak hour of the day. It is a valuable tool to assess traffic congestion, but as noted earlier, there are often competing perspectives on acceptable traffic operations based on multi-modal accessibility or neighborhood characteristic considerations. For a specific location, it may be more important to provide certain features, such as pedestrian crossing enhancements, that will be present throughout the day, rather than planning an intersection for one particular hour.

LEVEL OF SERVICE RESULTS

The Highway Capacity Manual congestion reports within Synchro (version 9), a traffic analysis software package from Trafficware that is routinely relied upon by transportation engineering professionals, were used to assess traffic congestion at the study intersection with the existing volumes for each alternative, including the No Build alternative.

Preliminary results in the PM peak hour are shown in Figure 5-2 and Figure 5-3 and discussed in Section 5.3.

[3] FHWA. Signalized Intersections: Informational Guide. 2004. https://www.fhwa.dot.gov/publications/research/safety/04091/07.cfm

FIGURE 5-2 LEVEL OF SERVICE RESULTS

A0 - No Build	LOS	Delay	v/c
Overall	**C**	**29**	**0.72**
EB, Howard St	C	34	0.66
WB, Howard St	C	25	0.12
NB, St Paul St	C	24	0.64
SB, St Paul St	C	28	0.75
SWB, Winooski Ave	D	36	0.73

A1 - Demonstration	LOS	Delay	v/c
Overall	**C**	**33**	**0.75**
EB, Howard St	D	39	0.71
WB, Howard St	C	27	0.12
NB, St Paul St	C	27	0.71
SB, St Paul St	C	30	0.76
SWB, Winooski Ave	D	41	0.79

A2 - Signal	LOS	Delay	v/c
Overall	**E**	**74**	**0.74**
EB, Howard St	F	>100	0.94
WB, Howard St	D	36	0.18
NB, St Paul St	D	39	0.77
SB, St Paul St	E	78	0.95
SWB, Winooski Ave	F	99	0.96

A3 - Dual Signal: Winooski Ave	LOS	Delay	v/c
Overall	**C**	**27**	**0.60**
WB, Winooski Ave	D	44	0.80
NB, St Paul St	C	26	0.57
SB, St Paul St	B	16	0.56

A3 - Dual Signal: Howard St	LOS	Delay	v/c
Overall	**C**	**21**	**0.78**
EB, Howard St	D	55	0.82
WB, Howard St	C	30	0.13
NB, St Paul St	B	13	0.49
SB, St Paul St	B	16	0.85

A4 - Dual Roundabout: Winooski Ave	LOS	Delay	v/c
Overall	**B**	**13**	**n/a**
WB, Winooski Ave	B	14	0.51
NB, St Paul St	A	9	0.51
SB, St Paul St	B	16	0.63

A4 - Dual Roundabout: Howard St	LOS	Delay	v/c
Overall	**B**	**15**	**n/a**
EB, Howard St	B	16	0.46
WB, Howard St	A	7	0.07
NB, St Paul St	B	11	0.52
SB, St Paul St	B	17	0.76

A5 - Roundabout	LOS	Delay	v/c
Overall	**B**	**14**	**n/a**
EB, Howard St	B	16	0.46
WB, Howard St	A	7	0.07
NB, St Paul St	B	11	0.52
SB, St Paul St	B	16	0.63
SWB, Winooski Ave	B	14	0.51

5.2 | QUEUING ANALYSIS

In addition to the congestion analysis, estimated average queues were evaluated using SimTraffic microsimulation software. Five one-hour-long simulations were averaged together to estimate queue lengths,[4] shown in the table to the right.

The queuing analysis is a valuable tool to evaluate complex intersections, such as the closely spaced signals of Alternative A3 or Dual Roundabouts of A4. Abbreviations:

EB	eastbound Howard Street
WB	westbound Howard Street
NB	northbound St Paul Street
SB	southbound St Paul Street
SWB	southbound S. Winooski Avenue

FIGURE 5-3 ESTIMATED QUEUE LENGTHS

Queue Lengths by Number of Vehicles (assume 20 ft per vehicle)

	A0 - No Build				
	EB	WB	NB	SB	SWB
Maximum Queue	12	6	13	25	17
Average Queue	7	2	11	12	9
95th Queue	11	4	15	23	15
	A1 - Demonstration				
	EB	WB	NB	SB	SWB
Maximum Queue	15	5	14	23	17
Average Queue	8	2	10	11	9
95th Queue	13	4	15	20	14
	A2 - Signal				
	EB	WB	NB	SB	SWB
Maximum Queue	19	4	24	36	19
Average Queue	10	2	21	28	12
95th Queue	22	4	28	43	19
	A3 - Dual Signal				
	EB	WB	NB	SB	SWB
Maximum Queue	13	4	20	19	16
Average Queue	6	1	8	8	8
95th Queue	11	3	15	15	13
	A4 - Dual Roundabout				
	EB	WB	NB	SB	SWB
Maximum Queue	15	12	11	17	17
Average Queue	8	5	6	9	9
95th Queue	21	16	15	19	22
	A5 - Roundabout				
	EB	WB	NB	SB	SWB
Maximum Queue	11	4	9	13	11
Average Queue	4	1	3	5	5
95th Queue	8	3	7	10	8

[4] As each run is different, a difference of less than 50 feet (or three vehicles) should not be seen as significant.

5.3 | TRAFFIC CONGESTION DISCUSSION

ALTERNATIVE 0 (NO BUILD)

- No changes to signal timing or geometry

The traffic evaluation indicates that the study intersection currently operates at an LOS of C. The existing signal has no pedestrian phases, and right turns on red are permitted for all approaches.

ALTERNATIVE 1 (DEMONSTRATION PROJECT)

- Restricts right turns on red for all approaches

The one difference between the No Build scenario and Alternative 1 (demonstration project) and is that the demonstration project restricts right turns on red using signage. This change increases average delay by less than 4 seconds. The purpose of this signage is to better protect pedestrians, who will hopefully be traveling through the intersection in higher than average numbers on the day of the demonstration.

ALTERNATIVE 2 (SIGNAL)

- Two 3-second leading pedestrian intervals
- Assumes 5 pedestrian calls per hour conflicting with each approach
- Right turns on red restricted for the westbound Howard Street approach and the southwest-bound Winooski Ave approach

Alternative 2 has the least efficient traffic operations of all the alternatives, due to the above changes that reduce the signal capacity. These changes, however, make the intersection safer for pedestrians and will eliminate right turns on red for approaches with the highest potential for conflict. The average delay is 74 seconds and the LOS is E.

Time-of-day modifications to the signal programming would improve the LOS of Alternative 2. A leading pedestrian phase is modeled in the results for Alternative 2 illustrated in Figure 5-2. This signal timing allows pedestrians to enter the intersection during an all-red phase for vehicles, but reduces the overall vehicular capacity of the intersection. During the peak hours, it may be possible to eliminate the leading pedestrian phase, increasing the intersection capacity during the highest traffic volume periods. (Pedestrians would still have a pedestrian phase concurrent with the vehicle phases during these peak hours.) This modification would improve the LOS to a C, and the average delay to 27 seconds. The 12-hour count conducted at the study intersection in October 2016 showed that pedestrian volumes fluctuate throughout the day but do not peak at the same time as the vehicle volumes.

A2 - Signal - No LPI	LOS	Delay	v/c
Overall	**C**	**27**	**0.74**
EB, Howard St	C	33	0.69
WB, Howard St	C	23	0.13
NB, St Paul St	C	23	0.69
SB, St Paul St	C	27	0.78
SWB, Winooski Ave	C	31	0.73

ALTERNATIVE 3 (DUAL SIGNAL)

- Two separate intersections, coordinated with each other
- Three 3-second leading pedestrian intervals

Both intersections in Alternative 3 have an LOS of C. The alternative has similar delays as the No Build alternative but shorter average queue lengths than the No Build alternative.

ALTERNATIVES 4 AND 5 (DUAL AND SINGLE ROUNDABOUTS)

From an operational perspective, the roundabout alternatives perform with the greatest efficiency (on par with the dual signal), both operating at an LOS of B. Delays are approximately 15 seconds. The single roundabout has smaller queues than the dual roundabout.

6.0 ALTERNATIVES COMPARISON

In this section of the report, the alternatives are evaluated based on how they meet the 16 issues to address and how they impact traffic circulation. In both cases, the five alternatives are compared to the existing conditions, referred to as a **No Build** alternative.

A full-size version of the alternatives matrix below is presented as an attachment to the document.

6.1 | ALTERNATIVES MATRIX

The matrix below shows how each alternative improves, worsens, does not change, or provides an opportunity for the 16 issues to address. It also relates each alternative to the additional key study elements and their metrics.

FIGURE 6-1 ALTERNATIVES EVALUATION MATRIX

		Study Goals			Alternatives					
	Issues to Address	Improve **safety** for people walking, bicycling, driving, and taking transit	Meet (and exceed) **accessibility** standards	Foster the emerging **neighborhood**	0 **No Build**	1 **Demonstration Project** Existing Geometry	2 **New Signal System** Existing Geometry	3 **Dual Signal System** Realigned Roadway	4 **Dual Roundabout** Realigned Roadway	5 **Modern Roundabout** Existing Geometry
1	Crossing length for all modes	x	x		no change	improvement	improvement	improvement	improvement	improvement
2	Pedestrian crossing guidance	x	x		no change	no change	improvement	improvement	improvement	improvement
3	Pedestrian crossing of S. Winooski Ave	x	x		no change	no change	improvement	improvement	improvement	improvement
4	Crash rate	x			no change	no change	improvement	improvement	improvement	improvement
5	Comfortable transit facilities		x	x	no change	no change	opportunity	opportunity	opportunity	opportunity
6	Visibility of traffic signals to motorists	x	x		no change	no change	improvement	improvement	improvement	improvement
7	Vehicle speeds	x			no change	improvement	no change	improvement	improvement	improvement
8	Running of red lights	x			no change	no change	no change	improvement	improvement	improvement
9	Wrong-way driving on S. Winooski Ave	x			no change	no change	improvement	improvement	improvement	improvement
10	Trucks on S. Winooski Ave	x		x	no change	no change	no change	no change	no change	no change
11	Right turns on red	x			no change	improvement	improvement	improvement	improvement	improvement
12	Use of Potvin Park			x	no change	no change	improvement	worse	worse	no change
13	Public gathering space			x	no change	improvement	improvement	improvement	no change	worse
14	Bicycle infrastructure	x	x		no change	improvement	improvement	improvement	opportunity	opportunity
15	Stormwater retention				no change	no change	opportunity	opportunity	opportunity	opportunity
16	Support relationship between residents and businesses			x	no change	improvement	improvement	improvement	no change	worse
Additional key study elements		**Metric**								
Traffic Operations		Level of Service			C	C	E (possible C)	C+C	B+B	B
Traffic Operations		Total Average Queue Length (sum of all five approaches)			730 ft	760 ft	1220 ft	1100 ft	690 ft	310 ft
Stormwater Management		Change in Permeable Area			n/a	0 sf	1270 sf	5300 sf	7720 sf	3760 sf
Parking Options		Change in Parking Options			n/a	0	0	-7 on-street spaces	-8 on-street, -5 off-street	-1 on-street
Cost		Relative Cost			$$$$$	**$**$$$$	**$$$**$$	**$$$$**$	**$$$$**$	**$$$$$**

7.0 ALTERNATIVES PRESENTATION MEETING

This section to be completed following the Alternatives Presentation Meeting.

8.0 RECOMMENDATIONS

This section to be completed following the Alternatives Presentation Meeting.

Q:\Projects\VT\Burlington VT\16264 - WHSP Winooski Howard St Paul\8_Site Plans\16264-nu1.dwg

LEGEND

TEMP. PLAZA / ART SPACE
AREA = 2,000 SF

TEMP. GREEN BIKE MARKINGS
LANES: 100 FT
BIKE BOXES: 1 EACH

CONES
EACH = 50

HAY BALES / PLANTERS
EACH = 26

TEMP.BIKE SYMBOLS
EACH = 1

TEMP. BIKE CROSSING MARKINGS
LENGTH = 38 FT

TEMP. STRIPING
4" WHITE: 150 FT
4" DOUBLE YELLOW: 75 FT

TEMP. SIGNS:
EACH: 4

NO TURN ON RED

SCALE 1"=10'

10 5 0 10 20

28'

24'

24'

28'

SHEET: 1 of XXX	DATE: 03/15/17	CITY OF BURLINGTON, VERMONT DEPARTMENT OF PUBLIC WORKS
DRAWING No. A1		WINOOSKI - HOWARD - ST PAUL INTERSECTION SCOPING STUDY
		ALTERNATIVE 1 - IMMEDIATE TERM DEMONSTRATION PROJECT

BURLINGTON, VT PUBLIC WORKS

RSG

PROJECT No.	16264
DESIGNED BY:	CDM
CHECKED BY:	CDM
SCALE:	AS SHOWN

no.	revision	revision	date	by

Q:\Projects\VT\Burlington VT\16264 - WHSP Winooski Howard St Paul\8_Site Plans\16264-nu1.dwg

LEGEND

NEW / REDEV. ASPHALT
AREA = 11,030 SF

NEW / REDEV. GREEN SPACE
AREA = 1,760 SF
NET INCREASE: +490 SF

NEW / REDEV. SIDEWALK
AREA = 2,290 SF

NEW PLAZA SPACE
AREA = 970 SF

NEW GREEN BIKE LANES
LENGTH = 105 FT

NEW BIKE BOXES
NUMBER = 1

NEW BIKE CROSSING MARKINGS
LENGTH = 26 FT

NEW SHARED LANE MARKINGS
NUMBER = 0

NEW YIELD MARKINGS
NUMBER = 0

NEW PEDESTAL SIGNALS
NUMBER = 10

NEW MAST ARM SIGNALS
NUMBER = 1

SCALE 1"=10'

10 5 0 10 20

CITY OF BURLINGTON, VERMONT
DEPARTMENT OF PUBLIC WORKS

WINOOSKI - HOWARD - ST PAUL
INTERSECTION SCOPING STUDY

ALTERNATIVE 2 - SHORT TERM
NEW SIGNAL SYSTEM - EXISTING GEOMETRY

SHEET: 1 of XXX

DRAWING No.: A1

DATE: 03/15/17

BURLINGTON, VT PUBLIC WORKS

RSG

PROJECT No. 16264

DESIGNED BY: CDM

CHECKED BY: CDM

SCALE: AS SHOWN

no.	revision	revision	date	by

Q:\Projects\VT\Burlington VT\16264 - WHSP Winooski Howard St Paul\8_Site Plans\16264-nu1.dwg

LEGEND

NEW / REDEV. ASPHALT
AREA = 18,700 SF

NEW / REDEV. GREEN SPACE
AREA = 6,840 SF
NET CHANGE: +1,530

NEW / REDEV. SIDEWALK
AREA = 3,550 SF

NEW PLAZA SPACE
AREA = 750 SF

NEW GREEN BIKE LANES
LENGTH = 450 FT

NEW BIKE BOXES
NUMBER = 0

NEW BIKE CROSSING MARKINGS
LENGTH = 65 FT

NEW SHARED LANE MARKINGS
NUMBER = 0

NEW YIELD MARKINGS
NUMBER = 0

NEW PEDESTAL SIGNALS
NUMBER = 14

NEW MAST ARM SIGNALS
NUMBER = 0

SCALE 1"=10'

10 5 0 10 20

CITY OF BURLINGTON, VERMONT
DEPARTMENT OF PUBLIC WORKS

WINOOSKI - HOWARD - ST PAUL
INTERSECTION SCOPING STUDY

ALTERNATIVE 3 - LONG TERM
DUAL SIGNAL SYSTEM - REALIGNED ROADWAY

SHEET: 1 of XXX

DRAWING No. A1

DATE: 03/15/17

PROJECT No. 16264

DESIGNED BY: CDM

CHECKED BY: CDM

SCALE: AS SHOWN

no.	revision	revision	date	by

Q:\Projects\VT\Burlington VT\16264 - WHSP Winooski Howard St Paul\8_Site Plans\16264-nu1.dwg

LEGEND

NEW / REDEV. ASPHALT
AREA = 20,320 SF

NEW / REDEV. GREEN SPACE
AREA = 8,830 SF
NET CHANGE: +1,100

NEW / REDEV. SIDEWALK
AREA = 4,840 SF

NEW PLAZA SPACE
AREA = 0 SF

NEW MOUNTABLE CURB
AREA = 4,420 SF

NEW GREEN BIKE LANES
LENGTH = 100 FT

NEW BIKE BOXES
NUMBER = 0

NEW BIKE CROSSING MARKINGS
LENGTH = 0 FT

NEW SHARED LANE MARKINGS
NUMBER = 12

NEW YIELD MARKINGS
NUMBER = 5

NEW PEDESTAL SIGNALS
NUMBER = 0

NEW MAST ARM SIGNALS
NUMBER = 0

SCALE 1"=10'

10 5 0 10 20

SHEET: 1 of XXX

DRAWING No. A1

DATE: 03/15/17

CITY OF BURLINGTON, VERMONT
DEPARTMENT OF PUBLIC WORKS

WINOOSKI - HOWARD - ST PAUL
INTERSECTION SCOPING STUDY

ALTERNATIVE 4 - LONG TERM
DUAL ROUNDABOUT - REALIGNED ROADWAY

BURLINGTON, VT PUBLIC WORKS

RSG

PROJECT No. 16264

DESIGNED BY: CDM

CHECKED BY: CDM

SCALE: AS SHOWN

no.	revision	revision	date	by

Q:\Projects\VT\Burlington VT\16264 - WHSP Winooski Howard St Paul\8_Site Plans\16264-nu1.dwg

SHEET: 1 of XXX

DRAWING No.: A1

DATE: 03/15/17

CITY OF BURLINGTON, VERMONT
DEPARTMENT OF PUBLIC WORKS

WINOOSKI - HOWARD - ST PAUL
INTERSECTION SCOPING STUDY

ALTERNATIVE 5 - LONG TERM
MODERN ROUNDABOUT - EXISTING GEOMETRY

BURLINGTON, VT PUBLIC WORKS

RSG

PROJECT No. 16264

DESIGNED BY: CDM

CHECKED BY: CDM

SCALE: AS SHOWN

no.	revision	revision	date	by

Winooski - Howard - St Paul Intersection Scoping Study
Draft Alternatives Evaluation Summary

6/21/2017

	Study Goals			Alternatives					
Issues to Address	Improve **safety** for people walking, bicycling, driving, and taking transit	Meet (and exceed) **accessibility** standards	Foster the emerging **neighborhood**	0 **No Build**	1 **Demonstration Project** Existing Geometry	2 **New Signal System** Existing Geometry	3 **Dual Signal System** Realigned Roadway	4 **Dual Roundabout** Realigned Roadway	5 **Modern Roundabout** Existing Geometry
1 Crossing length for all modes	x	x		no change	improvement	improvement	improvement	improvement	improvement
2 Pedestrian crossing guidance	x	x		no change	no change	improvement	improvement	improvement	improvement
3 Pedestrian crossing of S. Winooski Ave	x	x		no change	no change	improvement	improvement	improvement	improvement
4 Crash rate	x			no change	no change	improvement	improvement	improvement	improvement
5 Comfortable transit facilities		x	x	no change	no change	opportunity	opportunity	opportunity	opportunity
6 Visibility of traffic signals to motorists	x	x		no change	no change	improvement	improvement	improvement	improvement
7 Vehicle speeds	x			no change	improvement	no change	improvement	improvement	improvement
8 Running of red lights	x			no change	no change	no change	improvement	improvement	improvement
9 Wrong-way driving on S. Winooski Ave	x			no change	no change	improvement	improvement	improvement	improvement
10 Trucks on S. Winooski Ave	x		x	no change	no change	no change	no change	no change	no change
11 Right turns on red	x			no change	improvement	improvement	improvement	improvement	improvement
12 Use of Potvin Park			x	no change	no change	improvement	worse	worse	no change
13 Public gathering space			x	no change	improvement	improvement	improvement	no change	worse
14 Bicycle infrastructure	x	x		no change	improvement	improvement	improvement	opportunity	opportunity
15 Stormwater retention				no change	no change	opportunity	opportunity	opportunity	opportunity
16 Support relationship between residents and businesses			x	no change	improvement	improvement	improvement	no change	worse
Additional key study elements	**Metric**								
Traffic Operations	Level of Service			C	C	E (possible C)	C+C	B+B	B
Traffic Operations	Total Average Queue Length (sum of all five approaches)			730 ft	760 ft	1220 ft	1100 ft	690 ft	310 ft
Stormwater Management	Change in Permeable Area			n/a	0 sf	1270 sf	5300 sf	7720 sf	3760 sf
Parking Options	Change in Parking Options			n/a	0	0	-7 on-street spaces	-8 on-street, -5 off-street	-1 on-street
Cost	Relative Cost			$$$$$	**$**$$$$	**$$$**$$	**$$$$**$	**$$$$**$	**$$$$$**