



FINAL REPORT [DRAFT]

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

2/12/2018



DRAFT

PREPARED FOR:
BURLINGTON VERMONT DEPARTMENT OF PUBLIC WORKS

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EXECUTIVE SUMMARY

Why this intersection?

The intersection of St Paul Street, Howard Street, and South Winooski Avenue is a gateway to several neighborhoods, and it is an emerging neighborhood hotspot of its own. The five-legged intersection operates reasonably well for motor vehicles, which are guided by traffic lights. However, it is a challenging environment for pedestrian, wheel chair, bicyclist, vision impaired and other non-motorized travelers. Most notably, there are no pedestrian signals or push buttons for people to safely cross the intersection on foot. Nearby residents that travel through or observe the intersection daily were the first to call request safety and accessibility improvements several years ago, and have been engaged throughout this study.

The study has been conducted to be consistent with the City's past planning efforts, including planBTV Walk-Bike and planBTV South End. The results will inform future planning along Winooski Avenue.

Multimodal Perspective

This study placed an emphasis on pedestrian and bicycle safety and improved accessibility. The steering committee and members of the public recognized and supported a reduced efficiency for motor vehicles within reason, as long as safety is not jeopardized and volumes are not redirected elsewhere.

Pop-Up Demonstration (August 2017)

A pop-up demonstration project (based on Alternative 1) was in place over the course of 5 days, which allowed intersection users and the project team to better understand the look and feel and impacts and benefits of curb extensions at the intersection. Feedback received was largely positive.

Study Findings

Of the 5 alternatives presented to the public, there was overwhelming support for preserving the 5-legged intersection geometry (as opposed to splitting the intersection into two separate intersections) and the use of a signal (as opposed to a roundabout), but including the following major features: pedestrian signals and ADA upgrades, an accessible crosswalk of South Winooski Ave, and curb extensions that create plaza space and reduce curb radii. RSG recommends conducting a semi-permanent demonstration project with curb extensions during the summer of 2018, with the long-term goal of refining the design to address vehicle turning maneuvers, and implementing Alternative 2 of this study, with these minor design modifications.

EXISTING CONDITIONS

1.0 BURLINGTON'S FIVE CORNERS

The intersection of St Paul Street, Howard Street, and South Winooski Avenue is a defining intersection in Burlington's South End. It is a gateway to several neighborhoods, including the Five Sisters, the Hill Section, and the South End Arts and Business District, and it is an emerging neighborhood hotspot of its own. It is along a primary vehicle route between downtown Burlington and points south, and it is a major pedestrian crossing point for nearby destinations like Calahan Park, the Pine Street corridor, and Christ the King and Edmunds School Campuses, as well as the four businesses located at the intersection.

Above all, the intersection is hub of activity where pedestrians, vehicles, bicycles and transit meet and interact. Residential neighborhoods surround the commercial intersection very near to the burgeoning Pine Street corridor. The goal of this scoping study is to evaluate various ways to improve the safety for people walking, bicycling, driving and taking transit, to meet accessibility standards, and to foster the emerging neighborhood by supporting enhancements to pedestrian, bicyclist, and motorist travel.

The acronym "WHSP" will be used to describe the Winooski – Howard – St Paul intersection study area throughout this document.

The character of this intersection is defined by the roadway and the adjacent land use. The paved width consists of motor vehicle lanes, crosswalks, on-street parking spaces, and areas where buses stop

FIGURE 1-1: STUDY AREA WITHIN BURLINGTON.

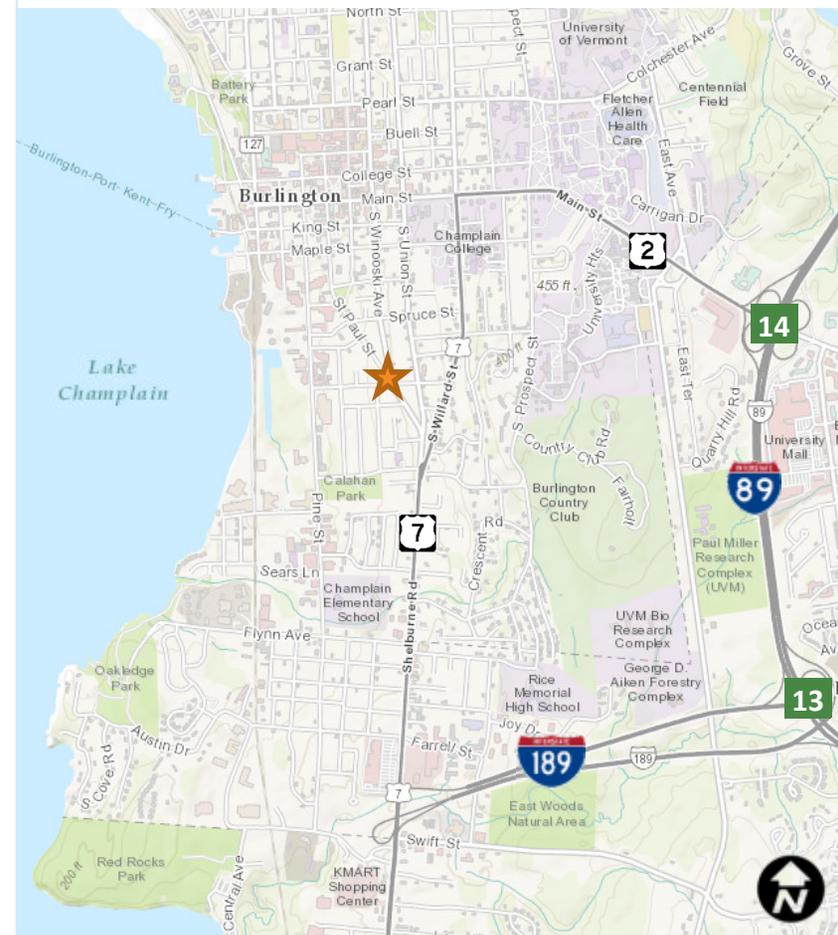


FIGURE 1-2: CENSUS TRACTS WITHIN BURLINGTON.

WHSP Intersection Scoping Study Final Report - DRAFT
Existing Conditions

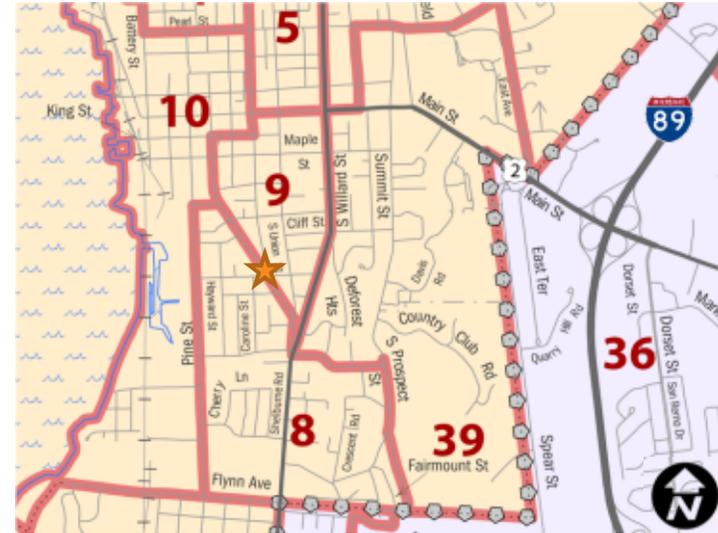
for passengers. South Winooski Avenue is one-way southbound, with bike lanes in both directions. Off the pavement are businesses, houses, sidewalks, parking areas, driveways, a park, and bus stops. A traffic signal controls the movement of vehicles. The landscape generally slopes east to west.

1.1 | STUDY AREA DEMOGRAPHICS

The WHSP study area straddles two census tracts within Burlington:

1. Chittenden Tract 8, roughly bounded by Pine Street, St Paul Street, Ledge Street, South Prospect Street, and Flynn Ave; and
2. Chittenden Tract 9, roughly bounded by St Paul Street, Main Street, and Willard Street.

Several key demographics of the surrounding census tracts include:



American Community Survey Demographic and Housing Estimates, 2011-2015	Tract 8	Tract 9
Population	2,723	2,627
Non-White Population, Percentage	9.5%	6.9%
Under age of 15, Percentage	17.7%	7.1%
Over age of 65, Percent	9.4%	13.0%
Commute Share, Percentage	Drive Alone – 50.8% Drive, Carpool – 8.0% Transit – 8.3% Walk – 18.8% Other – 4.7%	Drive Alone – 40.6% Drive, Carpool – 6.7% Transit – 1.8% Walk – 29.5% Other – 8.2%
Percentage of Families whose income in the past 12 months is below the poverty level	17.4%	21.4%

1.2 | ADJACENT LAND USE

Immediately adjacent to the WHSP intersection are four commercial spaces straddling Howard on the west side of St Paul, with the remaining land use as residential. The four businesses include:

- The **Neighborhood Market** sells groceries, wine, and beer, and is open between 10 am and 9 pm.
- **Shy Guy Gelato** sells servings of gelato at their storefront Fridays through Sundays from 11 am to 9 pm, with no indoor seating.
- **Tomgirl Juice** sells juice, coffee and tea, and prepared foods. The shop has a seating area and is open Mondays through Saturdays during the day.
- **South End Style** is a hair and beauty salon.

There is head-in perpendicular parking outside of the Neighborhood Market with room for approximately five cars; two spaces reserved to the house immediately to the north of the market, leaving three for public use.



FIGURE 1-3: DESTINATIONS AT THE WHSP INTERSECTION



FIGURE 1-5: OUTDOOR SEATING FOR AT THE WHSP INTERSECTION.

Potvin Park is a small park owned and managed by the City of Burlington, located between St. Paul Street and South Winooski Ave. The park is located on the slope between the streets and is defined by this difference in elevation. It contains a stepped seating area with a platform near the St Paul Street bus stop and is spotted with trees and shrubs. A stairway running through it connects the two streets. Much of the treated lumber defining the park is deteriorated; concrete sidewalks, metal railings and other park features are similarly worn and showing age.



FIGURE 1-4: POTVIN PARK.

1.3 | MOTOR VEHICLE MOBILITY

Each leg of the intersection has one motor vehicle lane in each direction except for S. Winooski Ave, which is one-way in the southbound direction (into the intersection) adjacent to a contraflow northbound bicycle lane. Thus, for vehicles, there are five approach routes and four exit routes. There are no dedicated turn lanes or turn signal phases. Hard right turns from South Winooski Avenue onto St. Paul Street are legal movements. Right turns on red lights are permitted.

St. Paul Street is a designated truck route; trucks are prohibited on S. Winooski Ave. South Winooski Avenue and St. Paul Street south of the intersections are proposed minor arterials and Class 1 Town Highways designated as Alternate US-7.

Surrounding the intersection, on-street parallel parking is located on the west side of South Winooski Ave, the north side of Howard Street (both east and west legs), and the west side of St. Paul Street (both north and south legs).



FIGURE 1-7: BUS STOP ON ST PAUL STREET



FIGURE 1-6: PARKING AND BUS STOPS.

1.4 | TRANSIT MOBILITY

The Route 5 (Pine Street) Green Mountain Transit bus makes two stops at the Study intersection: on the eastbound side of Howard Street west of the intersection, and on the northbound side of St. Paul Street north of the intersection. School Tripper buses also stop on St. Paul Street; these buses help students and other passengers travel to school, and they are also open to the general public. There are no bus shelters or designated waiting areas for passengers waiting for the bus.

1.5 | PEDESTRIAN MOBILITY

All five legs of the intersection are lined by a sidewalk on both sides.

Close to the center of the intersection, red crosswalks provide a guided connection from corner to corner. Where St. Paul Street and South Winooski Avenue first meet at the tip of Potvin Park, a crosswalk connects the southwest tip of the park across St. Paul Street to the sidewalk in front of 457 St. Paul Street (the building containing the Neighborhood Market and Shy Guy Gelato). There is no crosswalk between the park and the opposite side of S. Winooski Ave, and the skew angle of the intersection leads to long crossing distances across St. Paul Street. The Manual on Uniform Traffic Control Devices (MUTCD) guidelines encourage short perpendicular crossings, spaced at least 200 feet.

The intersection does not have pedestrian signals. Pedestrians must pay attention to which directions have a green light and be aware of turning vehicles to safely cross the street.

1.6 | BICYCLE MOBILITY

Bike lanes are striped and signed on South Winooski Ave in both directions; double yellow striping allows bicyclists to ride northbound on this street that is one-way southbound for motor vehicles. The other streets approaching the WHSP intersection do not have bicycle facilities. The northbound lane of St Paul Street has a striped shoulder, but not a marked bicycle lane.

Although identified as a Bike Route in various planning documents and the Burlington Bike Map, Howard Street does not have any designated bicycle infrastructure or amenities.

The steep grades, particularly along eastbound Howard Street and southbound St Paul Street, create challenges for many bicyclists to build momentum and traverse the expanse of pavement.



2.0 STUDY AREA MAPS

Zoning districts, historic districts, and natural resource boundaries have been reviewed in the vicinity of the Study intersection to understand the context of the Study intersection and features that will need to be considered when designing and comparing potential alternatives.

2.1 | ZONING

The Study intersection is at the convergence of two residential zoning districts: Medium Density Residential (northwest of the intersection) and Low Density Residential (surrounding the remainder of the intersection). To the west, along Pine Street, is an Enterprise - Light Manufacturing district. The Main Street boundary of downtown Burlington is approximately 0.6 miles north of the Study intersection along S. Winooski Avenue.

According to Walk Score (walkscore.com), the intersection has a Walk Score of 67 - “Somewhat Walkable”; this means that “some errands can be accomplished on foot.” Walk Score rates locations with a score of 1 (least walkable) to 100 (most walkable) by the destinations within walking distance.

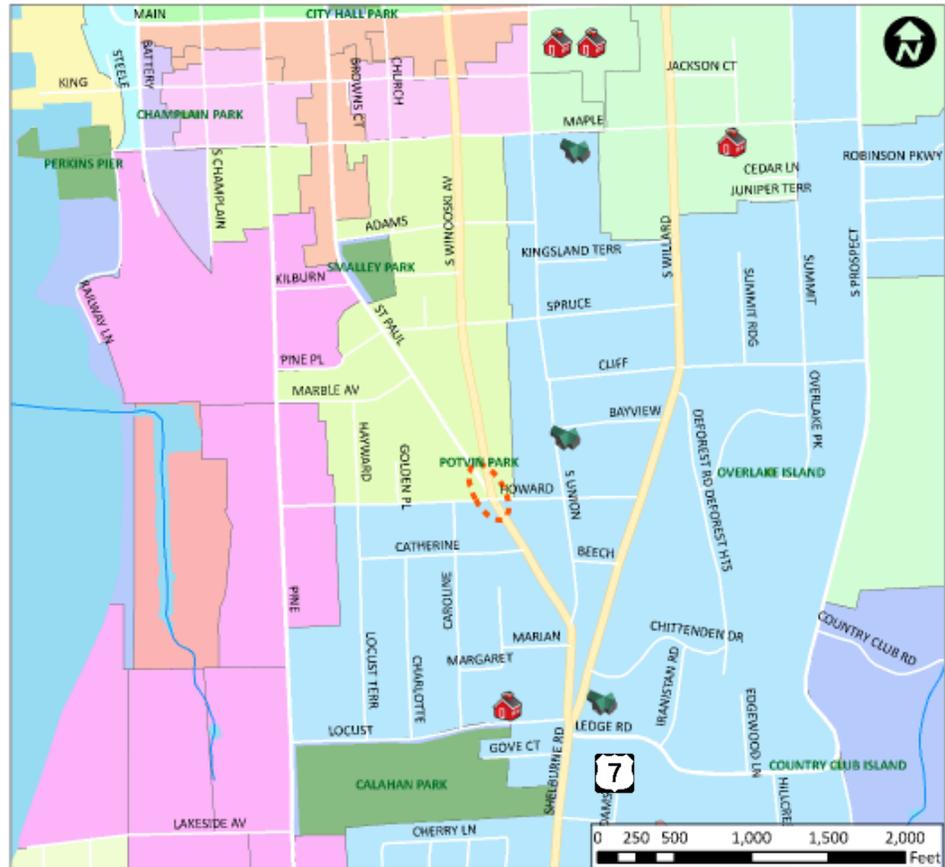
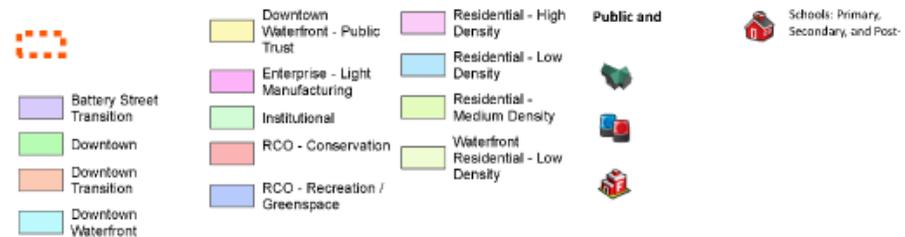


FIGURE 2-1: BURLINGTON ZONING DISTRICTS



2.2 | NEARBY DESTINATIONS

The WHSP study intersection is within one mile of many different community destinations, giving them potential to be both walkable and bikeable.

To the north is downtown Burlington and the shared campus of Edmunds Elementary and Middle Schools. Smalley Park has a basketball court, baseball field, and natural playground.

To the west is the Pine Street corridor, home to art and music venues, shops, cafes, and breweries. Along Pine Street is Dealer.com, one of the largest employers in Burlington.

To the south is Christ the King School, Calahan Park, and Champlain Elementary School (not pictured). Calahan Park, approximately 16 acres in size, has baseball diamonds, soccer fields, tennis courts, a basketball court, an outdoor ice rink and sledding hill in the winter, and a community garden managed by Burlington Parks and Recreation.

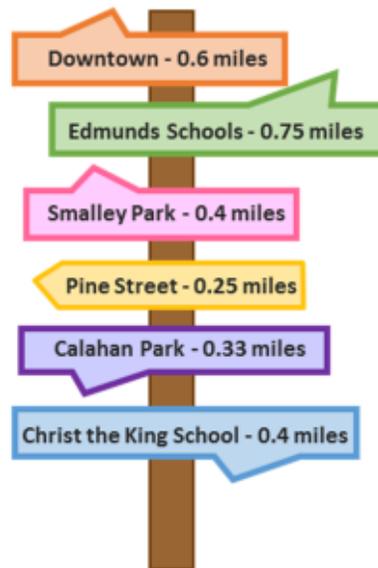


FIGURE 2-2: NEARBY DESTINATIONS

2.4 | NATURAL RESOURCES

The WHSP study intersection is not within any wetlands buffer zones, endangered/sensitive species' habitats, or Special Flood Hazard Areas (lands that are at high risk of flooding). Thus, future changes to the intersection will not impact or be impacted by these things. The nearest sensitive areas are located in and near the Barge Canal, including wetlands and a rare-to-Vermont plant species. A flood hazard zone runs along the shore of Lake Champlain and surrounds the Barge Canal.

Stormwater is currently directed into the Main Plant Combined Sewer System. "Green Streets" concepts to slow and reduce peak stormwater flow volumes are recommended.

2.5 | SITE SPECIFIC CONSTRAINTS

The WHSP study intersection is a gateway into downtown Burlington and a more pedestrianized environment. Proposed intersection improvements should reflect the higher volumes of non-motorized traffic and pedestrian activity. The intersection should be designed for slower speeds, which may include roundabouts, mini-roundabouts, or traffic signal pedestals (as opposed to mast arms), as appropriate.

The urban environment indicates that many utilities should be expected underground, including water, sewer, and natural gas.

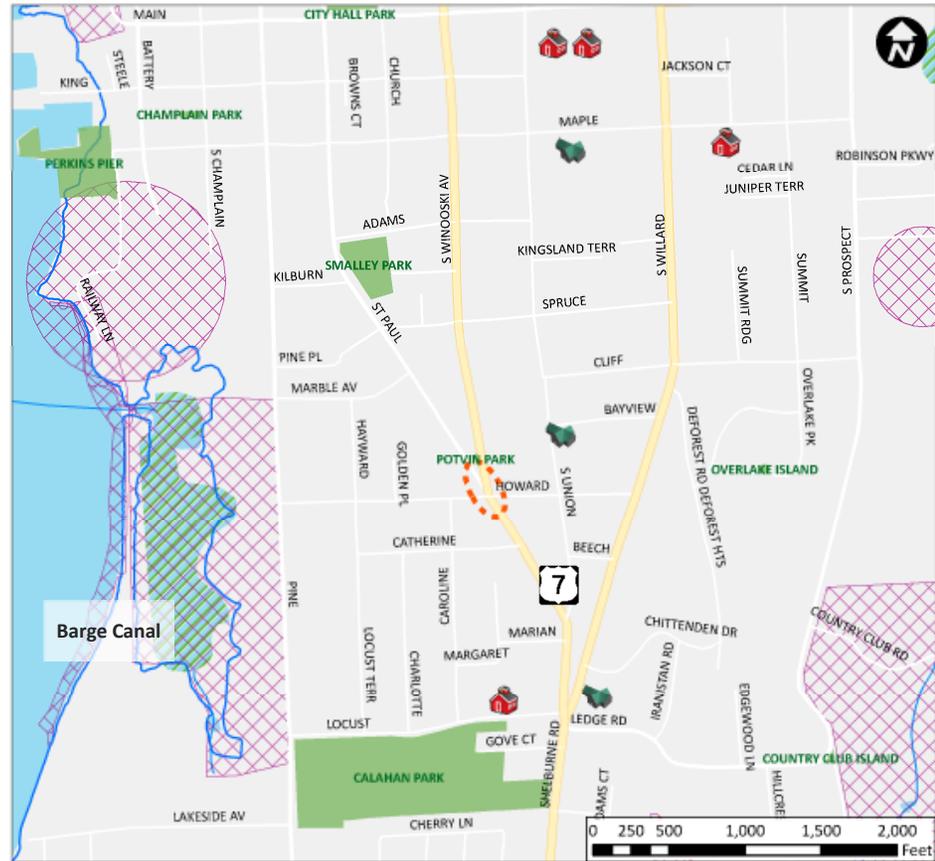


FIGURE 2-4: NEARBY NATURAL RESOURCES



3.0 PAST STUDIES

In recent years, the WHSP intersection has been considered for improvement twice. These studies included a VTrans reconstruction project and a neighborhood study to explore accessibility challenges. Several recent and ongoing planning studies managed by the City also provide insight to the greater neighborhood and various elements of the intersection, including planBTV South End, planBTV Walk Bike, the Open Space Protection Plan, and the Winooski Avenue Corridor Study.

3.1 | 2009 VTRANS RECONSTRUCTION

As of 2009, Potvin Park did not extend as far south into the intersection as it currently does; it ended approximately 40 feet north of its current tip. At that time, the crosswalk across the north leg of St. Paul Street connected the park to the current crossing point in front of the Neighborhood Market, resulting in a significantly longer pedestrian crossing than the existing crosswalk. The southbound bicycle lane, installed in 2006, ended further north on S. Winooski Ave as a southbound right turn lane opened.

In 2009, VTrans initiated a construction project (STP 2722) along US Alternate Route 7, which includes S. Winooski Ave to the north of the Study intersection and St. Paul Street to the south of the Study intersection. Results of this project at the Study intersection included:

- Removal of the southbound right turn lane and extension of bicycle lanes on South Winooski Avenue to the stop bar;
- Extension of Potvin Park further south into the intersection;
- Revised striping to align with the extended park; and
- Reconstruction of sidewalk ramps.

The final construction did not include a crosswalk across S. Winooski Avenue, presumably due to no existing sidewalk landings and steep slopes creating a challenge for construction of an ADA-compliant landing area.



FIGURE 3-1: WHSP STUDY AREA INTERSECTION IN 2004.

3.2 | AARP LIVABLE COMMUNITIES GRANT STUDY

In 2012, a group of residents living near the Study intersection applied for and secured an AARP Livable Communities Grant to better understand accessibility challenges for all users at the intersection. AARP's Livable Communities "supports the efforts of neighborhoods, towns, cities and rural areas to become great places for people of all ages." Safe, walkable streets and access to community life and important services are key to the mission of this program.

The study considered a number of concerns from neighbors, and a safe crossing of S Winooski Ave emerged as a priority. A crosswalk at this location is challenging due to the steep grade of Potvin Park with respect to an ADA-compliant landing space and connection to the existing sidewalk network.

The City of Burlington Department of Public Works reviewed several crosswalk options, one of which was developed into a proposed construction improvement, shown below. The proposed plan would involve a diagonal crossing of South Winooski Avenue, from the east side of Potvin Park southeast across South Winooski Avenue. Further development of the crosswalk installation was postponed for a more comprehensive study of the intersection.

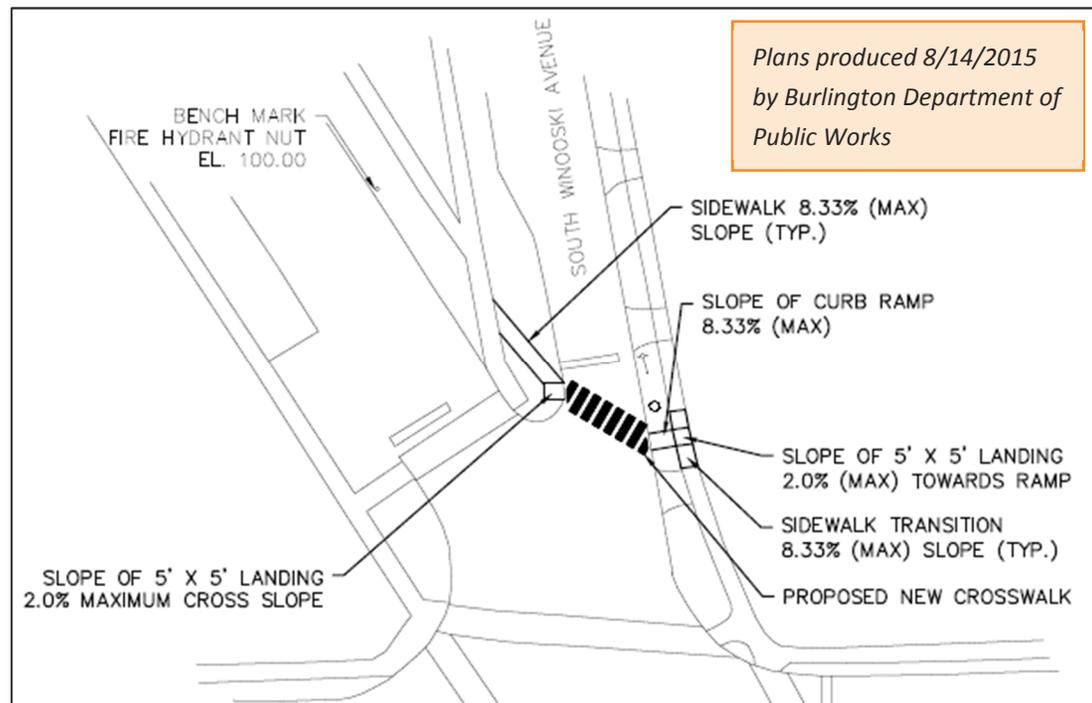


FIGURE 3-2: S. WINOOSKI AVE CROSSWALK PLANS

3.3 | PLAN BTV SOUTH END

planBTV South End is a master plan for the southwestern quarter of Burlington. The WHSP Study Intersection is located within the planBTV South End “Broader Study Area”. The latest version is a draft plan from June 2015.

planBTV South End focuses on the South End Enterprise Zone - a zoning district encompassing the arts and business district along Pine Street, but many of its goals apply to the South End as a whole. Overarching goals in planBTV relevant to the Study intersection relate to **mobility** (also a focus of Walk Bike planBTV), **parks**, and **stormwater management**.

MOBILITY

Overarching goal: Increase walkability and bikeability and improve transit service in the South End. Goals and strategies relevant to the Study intersection include:

Goal: Design for Lower Speeds and Many Modes

- Reinforce the target speed of 25 mph, and incorporate traffic calming principles into every project.
- Consider expanded use of roundabouts and mini roundabouts.

Goal: Serve the full range of cyclists

- Continue to expand and enhance bike infrastructure within the South End

Goal: Improve transit service.

- Provide amenity-rich / artful bus stop areas.



PARKS AND POCKET PARKS

Overarching goal: Increase green spaces and accessibility to them in the South End. Goals and strategies relevant to the Study intersection include:

Goal: Create new parks within the South End; make existing parks more accessible.

- Incorporate pocket parks and plazas into new development in the Lakeside Ave area. (The Study intersection is not in the Lakeside Ave area, but it presents a potential opportunity for a pocket park or plaza.)

STORMWATER MANAGEMENT

Overarching goal: Reduce the City's impact on Lake Champlain through stormwater management. Strategies relevant to the Study intersection include:

- Minimize paved areas;
- Slow the flow of stormwater by dispersing runoff; and
- Treat the water before it heads to the lake through infrastructure such as bioretention cells and bioswales.

REFERENCE TO WHSP INTERSECTION

The planBTV South End study specifically references the Winooski / Howard / St Paul intersection in the Connectivity and Mobility element of the study:

Address key intersections to improve safety and alleviate traffic congestion.

Consider appropriate locations for new traffic signals, roundabouts or mini-roundabouts to address traffic congestion, and reinforce lower, safer speeds at intersections.

Explore potential for a redesigned intersection at Howard/St.

Paul/Winooski, where improvements could help foster an emerging neighborhood activity center.



Watersheds by receiving water

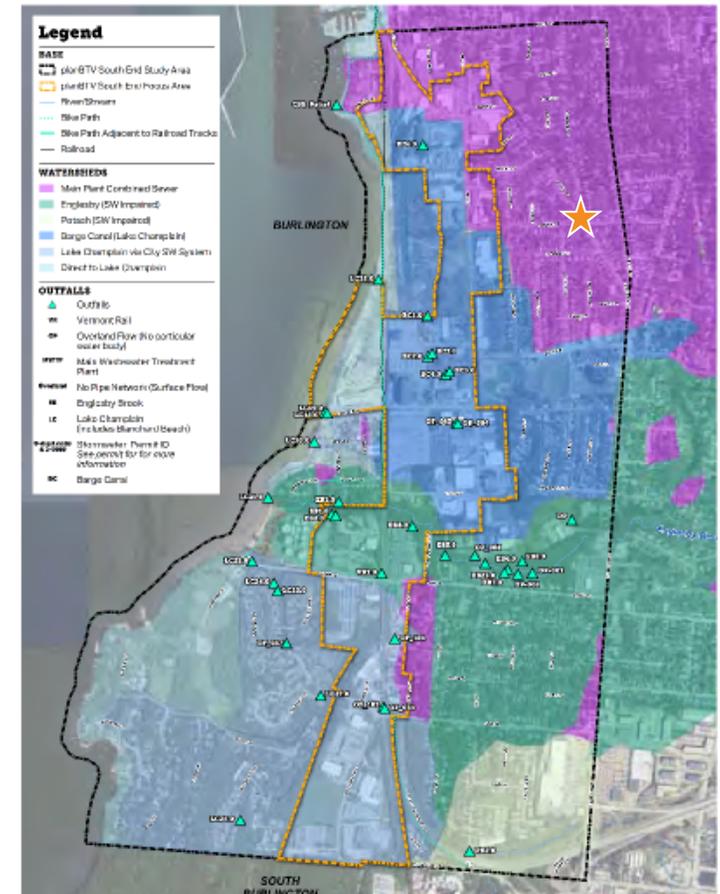


FIGURE 3-4: STORMWATER WATERSHED MAP FROM THE PLANBTV SOUTH END STUDY

3.4 | PLAN BTV WALK BIKE

Plan BTV Walk Bike, approved in April 2017, summarizes existing conditions of walking and bicycling conditions in Burlington, and it offers design recommendations for intersections, street segments, and amenities (such as bike parking). It has two overarching goals:

1. Create safer streets for everyone.
2. Make walking and biking a viable (and enjoyable) way to get around town.

The plan identifies the S. Winooski-Howard-St. Paul intersection as **one of 20 priority intersections**. Specific recommendations to consider for this intersection within the next 2 to 5 years include a mini-roundabout or signal phasing changes, high visibility crosswalks, and curb extensions with creative materials.

The plan also recommends **nine city-wide actions** as part of its Action Plan. The following five actions are particularly relevant to the S. Winooski-Howard-St. Paul intersection:

1. Engineer and design city streets to self-enforce appropriate target speeds.
2. Improve safety at all 20 priority intersections. (The S. Winooski-Howard-St. Paul intersection is one of the 20 priority intersections.)
3. Provide a connected network of sidewalks and safe intersections.
4. Create a dense, interconnected bicycle network that serves the needs of people of all ages and abilities.
5. Leverage walk/bike projects to add green infrastructure to Burlington's streets.

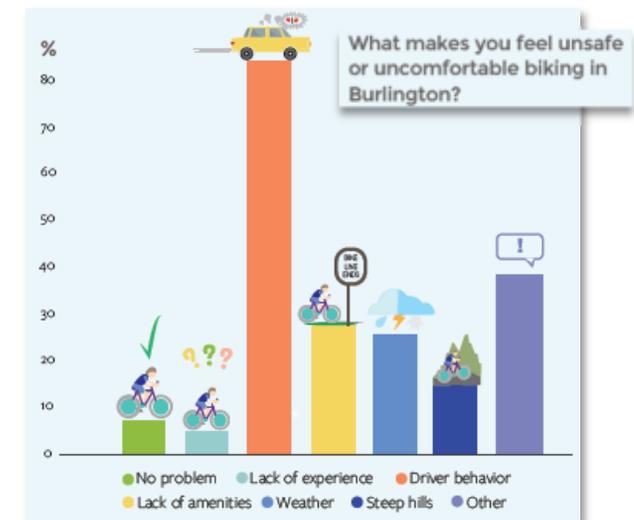
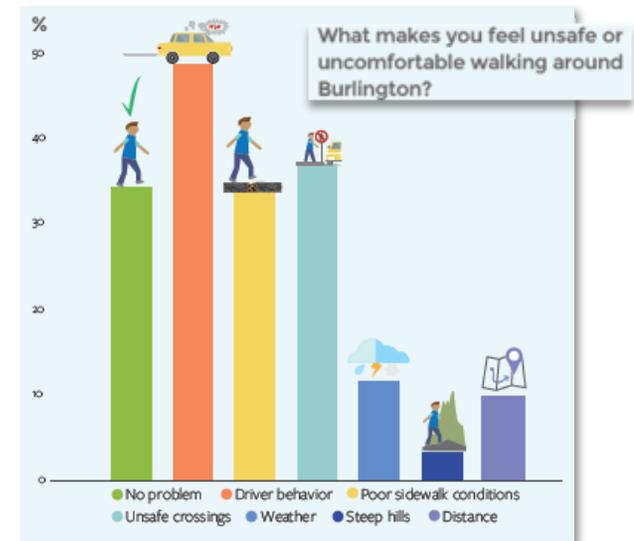


FIGURE 3-5: WALK BIKE SURVEY RESULTS; 540 PARTICIPANTS

3.5 | OPEN SPACE PROTECTION PLAN

The 2014 Open Space Protection Plan (OSPP) is an update of the first OSPP completed in 2000. The OSPP includes an inventory of open spaces within the City, summarizes comments from the public, and recommends actions. The overarching goals of the OSPP are to:

1. Protect and preserve natural areas and open spaces of local, regional, and statewide significance for the benefit of future generations.
2. Maintain and improve the integrity of natural and recreational systems within the City.
3. Ensure long-term stewardship and appropriate public access to natural areas and open space, including improved opportunities for pedestrian access and interaction throughout the City.

The OSPP focuses on four types of open space and sets a goal for each of them: natural areas, urban agriculture, parklands, and green infrastructure/stormwater management. The latter two open spaces types are particularly relevant to the S. Winooski-Howard-St. Paul intersection due to the presence of Potvin Park at the intersection, the proximity to other open spaces, and the potential for significant stormwater runoff mitigation.

FIGURE 3-6: COMMUNITY GARDEN AT CALAHAN PARK, A HALF-MILE WALK OR BIKE RIDE FROM THE WHSP INTERSECTION



Photo: Vermont Community Garden Network

3.6 | WINOOSKI AVENUE CIRCULATION STUDY

The Winooski Avenue Circulation Study, completed in December 2016, evaluated five alternative traffic patterns along Winooski Avenue between Howard Street and N. Union Street in Burlington. All alternatives reviewed would fit within the existing paved width of the roadway. The purpose of the study was to find a connection between the Old North End and the South End that improves safety and the flow of traffic for both bicycles and vehicles. Currently, both Winooski Ave and S. Union Street have segments of one-way vehicle traffic. When present, bicycle facilities are also limited to one direction except along S. Winooski Ave between Howard Street and Maple Street.

The following alternatives were modeled in a microsimulation model:

1. Complete Street on Winooski Avenue; Winooski Avenue as primary bicycle corridor
2. Two-Way Flow on North Winooski Avenue
3. Two-Way Flow on all of Winooski Avenue; Union Street as primary bicycle corridor
4. One-Way Pair: Counter-Clockwise Flow
5. One-Way Pair: Clockwise Flow

The Complete Street on Winooski Ave was found to have the least amount of impact on traffic compared to the other four alternatives. This alternative would include bike lanes on both sides of Winooski Avenue from Union Street (to the north) to the S. Winooski-Howard-St. Paul intersection. The existing vehicular traffic directions would remain the same, but a conversion from four lanes to three lanes would be required between Pearl Street and Main Street. Some on-street parking would need to be removed.



4.0 ROADWAY CHARACTERISTICS AND TRAFFIC VOLUMES

The average annual daily traffic (AADT) of the St Paul Street and South Winooski Avenue approach legs of the Study intersection are shown to the right.

Roadway classifications for each approach leg include:

St Paul Street South – FAU A007 (Alt US Route 7) – Class 1 Town Highway (TH-4) – Functional Class: Urban Principal Arterial (Proposed Change to Minor Arterial)

St Paul Street North – FAU S5046 – Class 2 Town Highway (TH-15) – Functional Class: Urban Collector (Proposed Change to Minor Arterial)

South Winooski Avenue – FAU A007 (Alt US Route 7) Class 1 Town Highway (TH-4) – Functional Class: Urban Principal Arterial (Proposed Change to Minor Arterial)

Howard Street – not on the Federal Aid system – Functional Class: Urban Local

The speed limit for all roads is 25 mph.

ROADWAY RIGHT OF WAY

Given the urban and developed context of the intersection, the roadway right of way is assumed to extend 1-foot beyond the existing sidewalk. Any proposed impacts beyond the existing sidewalks would likely constitute impacts to private property.

UTILITY INFRASTRUCTURE

A number of utilities are located within and directly adjacent to the existing roadway and sidewalk network, including aerial electric and communications lines, with lighting on the utility poles, underground gas, sewer, water, and stormwater pipes and conduits, including valves and manholes; utilities are illustrated in the existing conditions basemap in Attachment 4. While the entire project area is within an urban soil background area, no underground storage tanks, well heads, or other environmentally hazardous or sensitive sites have been identified nearby.



FIGURE 4-1: AVERAGE ANNUAL DAILY TRAFFIC ALONG THE PRIMARY APPROACH LEGS TO THE WHSP INTERSECTION

PAST COUNTS

VTrans conducted a twelve-hour count from 6 AM to 6 PM on August 4, 2016 (PM hours) and August 5, 2016 (AM hours). The raw turning movement traffic volumes from this count are presented in Figure 4-2.

Notably in this count, only 18 pedestrians were tallied throughout the day. Much higher pedestrian volumes should be expected. Bicycles were not differentiated from vehicles, if they were counted at all. Beyond confirming traffic volumes and heavy vehicle percentages, the count appears to offer minimal value to a Bicycle and Pedestrian study.

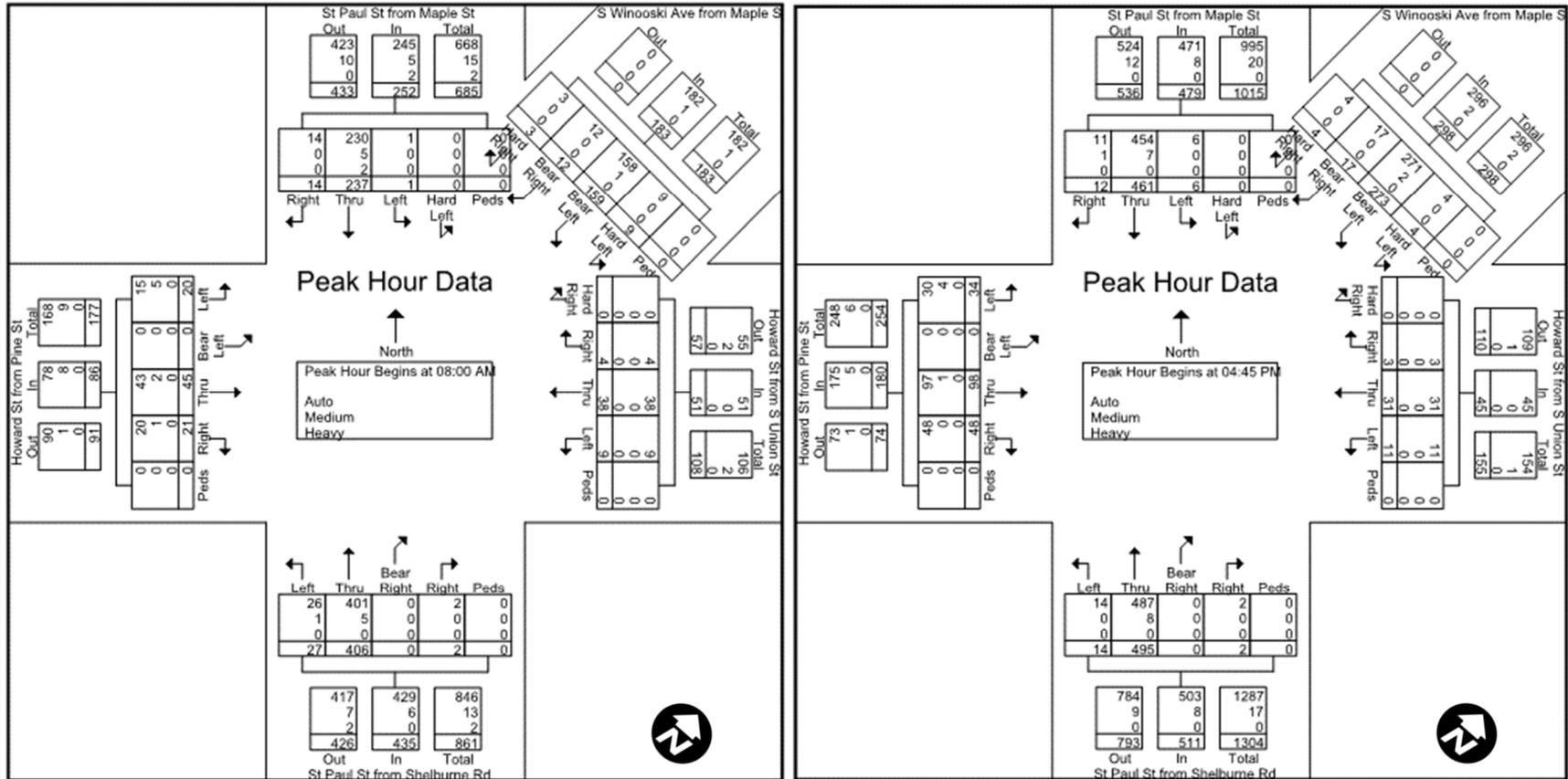


FIGURE 4-2: AM (LEFT) AND PM (RIGHT) PEAK HOUR VOLUMES FROM 2016 VTRANS TURNING MOVEMENT COUNT.

SUPPLEMENTAL 2016 COUNT

RSG performed a 12-hour turning movement count on October 26, 2016 (6AM to 6PM) at the Study intersection using digital video equipment. The movements of motorized vehicles, bicycles, and pedestrians were counted. The weather was noted to be overcast and cool, with a maximum temperature of 39-degrees. Light snowfall was noted.

MOTORIZED VEHICLES

The observed morning and evening peak hours of motorized traffic were determined to be 7:45-8:45 am and 4:45-5:45 pm, respectively.

Following VTrans traffic study guidelines, observed peak hour traffic volumes were adjusted to represent the design hour volume (DHV)¹. Design hour adjustment factors are based on VTrans automatic traffic recorder (ATR) **D157**, located on St. Paul Street approximately 750 feet north of the Study intersection. The calculations to adjust observed traffic volumes to the DHV are as follows:

1. The most recently observed AADT at ATR D157 was 9,472 vehicles in 2002. This AADT was adjusted to 2016 based on observed growth at ATR D163, located 0.4 miles north of the Study intersection. ATR D163 had counts in 2005 and 2016. An assumption was made that volumes in 2005 were similar to volumes in 2002. ATR D163 saw no growth between 2005 and 2016, so a growth factor of 1.00 was applied to ATR D157. Thus, ATR D157 is assumed to have a **2016 volume of 9,472**.
2. The k factor of VT-15 is 0.1061 (the VTrans k factor for urban areas). Plugging this k factor and the 2016 AADT into the equation $DHV = AADT * k$ leads to a **DHV of $9,472 * 0.1061 = 1,000$ vehicles**.
3. Because ATR D157 is north of the Study intersection along St. Paul Street, vehicles in the 2016 RSG traffic count that entered the intersection from the north along St. Paul Street or exited the intersection heading north were added together. The total number of **vehicles from the peak hour of this count that likely passed ATR D121 are 985 vehicles**.
4. The adjustment factor between 985 and 1,000 is 1.02. Therefore, the observed traffic volumes at the Study intersection in the morning and evening peak hours were **increased by 2%** to adjust to the DHV.

The raw and adjusted volumes are shown in the following figures.



FIGURE 4-3: TRAFFIC COUNTING CAMERA ON SIGN SOUTH OF THE WHSP INTERSECTION

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

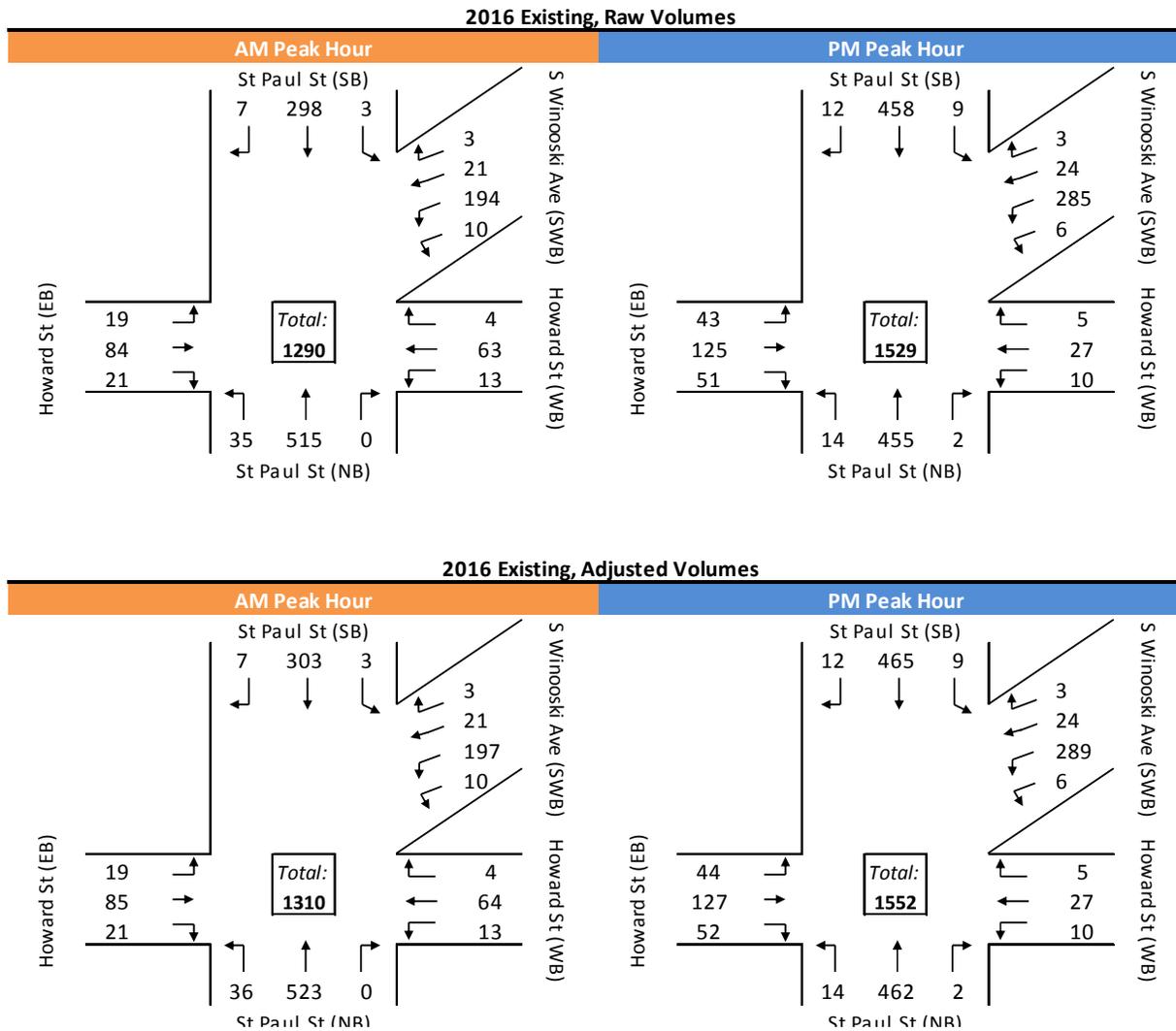


FIGURE 4-4: RAW AND ADJUSTED PEAK HOUR VOLUMES FROM 2016 TURNING MOVEMENT COUNT

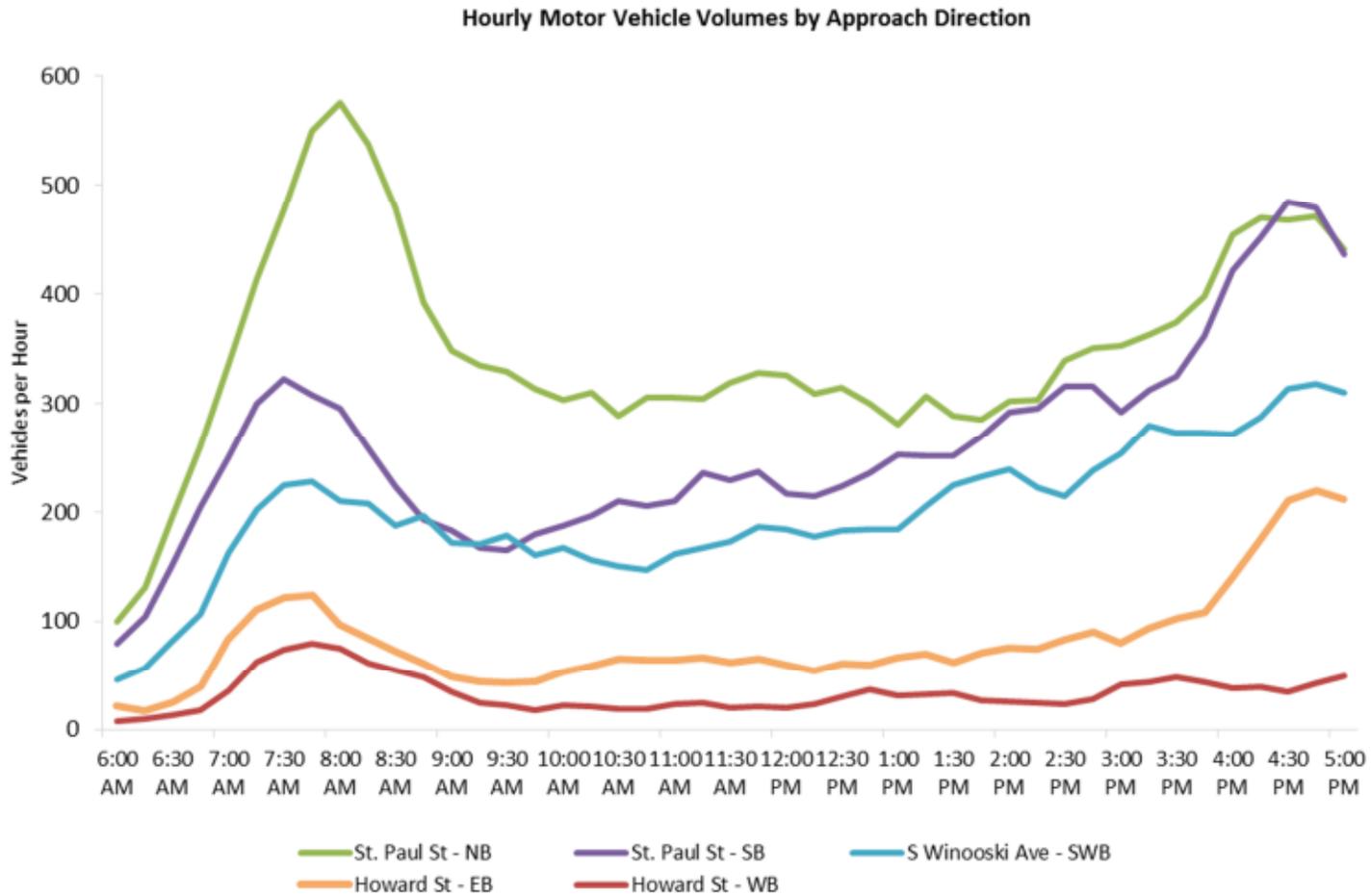


FIGURE 4-5: HOURLY MOTOR VEHICLE VOLUMES BY APPROACH DIRECTION

PEDESTRIANS

Pedestrian movements were recorded in the same videos as the traffic movements. Pedestrian crossings occurred at the intersection in several peaks over the course of the day rather than experiencing distinct peak times. During the AM and PM vehicle peak hours, there were 12 and 26 pedestrian crossings at the Study intersection, respectively. In the entire 12-hour period, there were 263 pedestrians. The day of the count was in the mid-thirties and there were light snow flurries in the morning. Schools were in session.

Total pedestrians observed: 263

(Warmer months would likely record a greater number of pedestrians)

Pedestrian Crossings by Intersection Leg

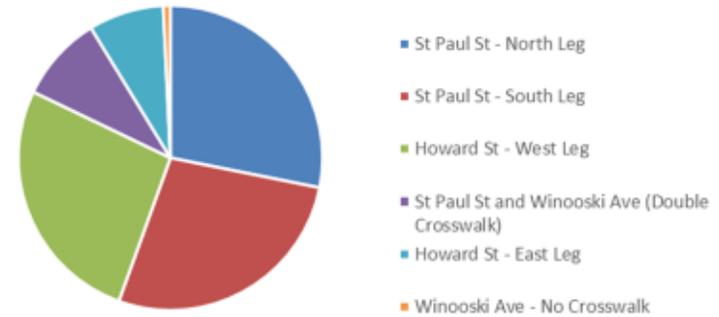


FIGURE 4-6: PEDESTRIAN CROSSINGS BY INTERSECTION LEG

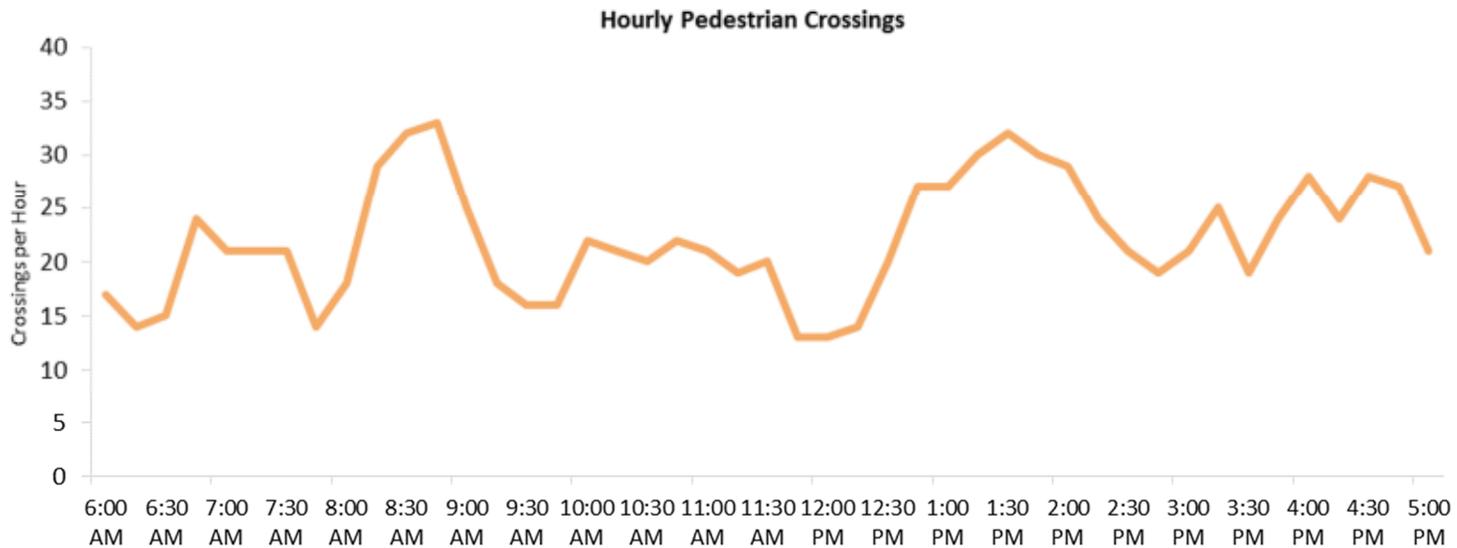


FIGURE 4-7: HOURLY PEDESTRIAN CROSSINGS

BICYCLES

Bicycle movements were recorded in the same videos as the traffic movements. 61 people on bicycles passed through the Study intersection during the 12-hour count. This number does not include bicyclists riding on the sidewalk. No bicyclists were observed on the north leg of St. Paul Street, except for those using the sidewalk.

Bicyclists riding in the street were all adults. Several elementary school-age kids were on bicycles, but did not ride through the intersection, instead using sidewalks and crosswalks.

Total bicyclists observed: 61

(Warmer months would likely record a greater number of cyclists)

Bicyclist Volume by Approach Direction

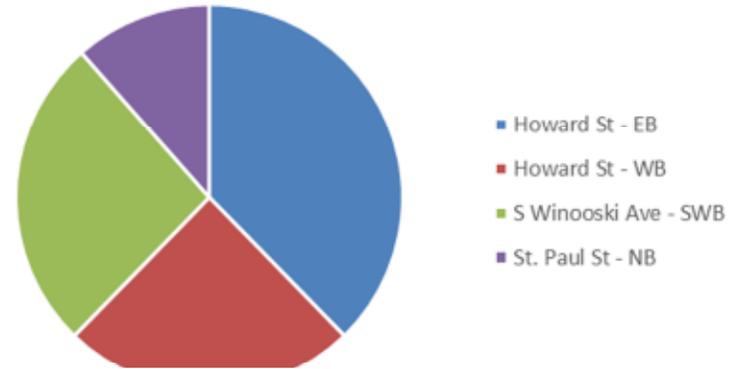


FIGURE 4-8: BICYCLIST VOLUME BY APPROACH DIRECTION

Hourly Bicycle Volumes



FIGURE 4-9: HOURLY BICYCLE VOLUMES

5.0 CRASH ANALYSIS

Crashes at the Study intersection were compiled using the VTrans Public Crash Data Query Tool and by contacting VTrans directly. Crashes were reviewed in the five-year period between October 15, 2011 and October 15, 2016. During this time, there were 33 crashes, two of which resulted in injury with the remaining crashes causing property damage only. One crash involved a bicycle with no injury resulting. There have been no reported crashes involving pedestrians.

Rear end crashes and sideswipes were markedly the most common type of crash.

Most crashes occurred during daylight hours, between 6:00 AM and 6:00 PM; this is unsurprising given that most traffic occurs during this time period.

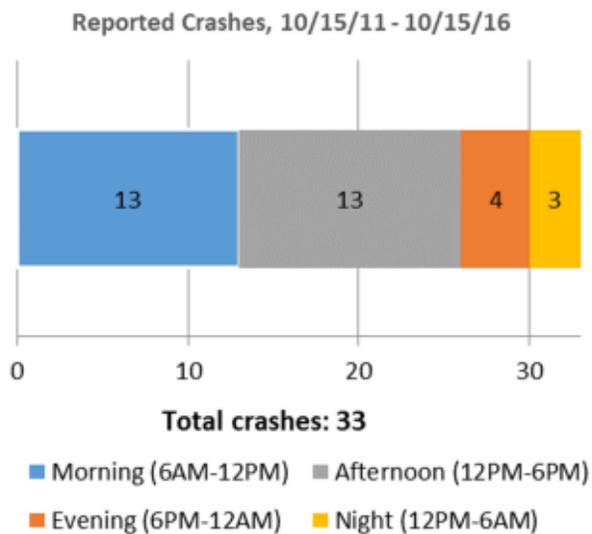


FIGURE 5-2: CRASHES BY TIME OF DAY

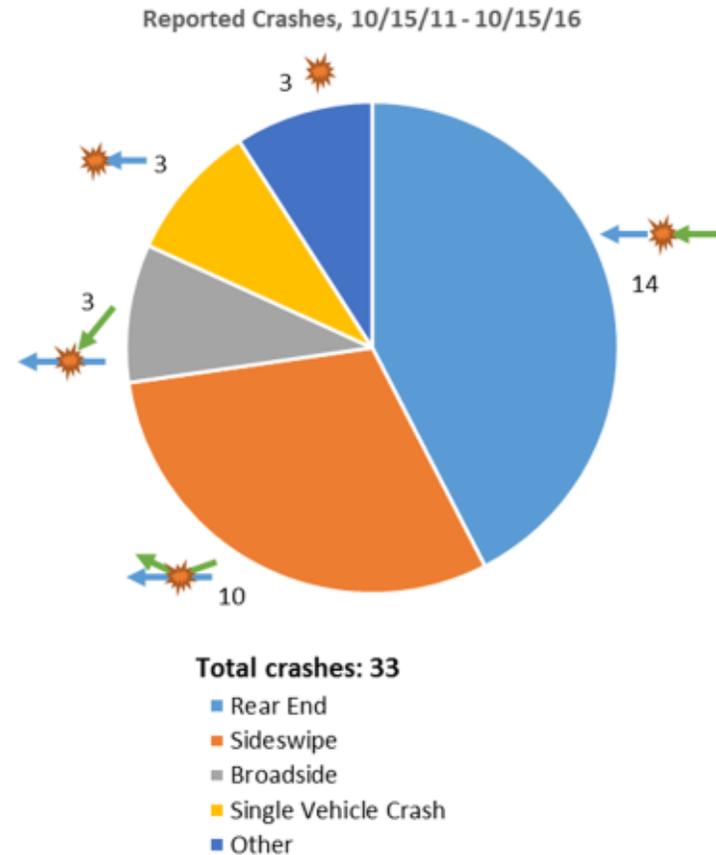


FIGURE 5-1: CRASHES BY TYPE OF CRASH

6.0 PUBLIC MEETING – LOCAL CONCERNS

A public meeting was held on Saturday, November 12, 2016. This meeting was held to gather local residents and experience the intersection as a group. The City’s Public Works Staff, RSG consultant team, and 25 residents walked to all five corners, discussed their concerns from their perspective as pedestrians, bicyclists, and motorists, and proposed solutions to improve travel. Notes and the results from this meeting are available as an attachment to this report.



FIGURE 6-1: LOCAL CONCERNS MEETING

ALTERNATIVES ANALYSIS

7.0 PURPOSE AND NEED

The following Purpose and Need statement was developed based on a preliminary review of the study area, concerns articulated at the neighborhood meeting held on November 12, 2016, and comments from the public sent to the project email address.

PURPOSE

Make the intersection easy and safe to cross for all modes of transportation, including pedestrians, bicycles, transit, and vehicles, while minimizing impacts to vehicle capacity, encouraging an inviting and welcoming environment, and supporting the neighborhood center.

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. Reports from neighbors that vehicles run red lights. This issue was confirmed by watching a video recording of the intersection.
- h. Reports from a neighbor that motorists do not observe the “Do Not Enter” sign for S. Winooski Ave and attempt to drive north on the street.
- i. Right-turn on red rules of the intersection are unclear. Right turns on red from Howard Street westbound and S. Winooski southbound are particularly challenging.
- j. Potvin Park is underutilized as a public space; pedestrians do not have space to interact, limiting the possibility of fostering a sense of community.
- k. 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.

8.0 ALTERNATIVES FOR CONSIDERATION

RECOMMENDATIONS FROM OTHER STUDIES:

planBTV South End: Consider appropriate locations for new traffic signals, roundabouts or mini-roundabouts.

planBTV Walk Bike: Explore mini-roundabout or signal phasing changes, high visibility crosswalks, and curb extensions with creative materials.

OSPP: Incorporate storm water runoff mitigation into open space

The following list of preliminary alternatives is intended to build upon the proposed concepts of past studies and address the needs articulated in the Purpose and Need Statement.

IMMEDIATE TERM

- a. Quick Build or Demonstration project with paint and flexible posts
- b. Neighborhood art in remaining asphalt area
- c. Bike infrastructure to start from flat area in front of Howard Street eastbound crosswalk

SHORT TERM

- d. Curb extensions
- e. Accessible crossing of S. Winooski Ave
- f. New signal system – existing geometry

LONG TERM

- g. Roundabout – existing geometry
- h. Realigned roadway – traffic signal
- i. Realigned roadway – roundabout
(traditional / mini / multiple / oblong)



9.0 DESIGN CRITERIA

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

GEOMETRY

Design Speed = 25 MPH (all streets and approaches)

Minimum Proposed 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

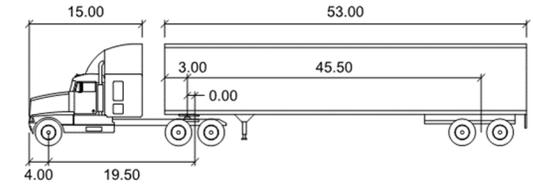
Minimum Vertical Curve Length, L = 100 feet

- 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

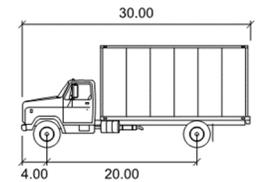
The WB-67 represents the largest interstate tractor-semitrailer that



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

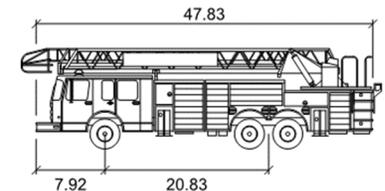
The SU-30 single unit truck represents a typical local delivery truck. The SU-30 should be able to turn into and out of each street, but may need to encroach into opposing lanes.



All Streets: City of Burlington

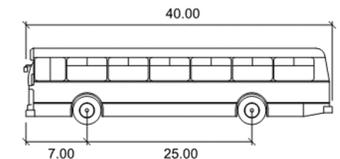
Ladder Fire Truck

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 9-1 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 10.1**. 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 primary 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."² The City of Burlington targets a LOS of "D".

² VTrans Highway Design "Level of Service Policy (2007)" <http://vtrans.vermont.gov/sites/aot/files/highway/documents/publications/LevelOfServicePolicy2007.pdf>

FIGURE 9-1 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.

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.

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.

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 an accessible bicycle network.

See [Cycle Tracks](#)

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.

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.

10.0 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 purpose and need. Table 10.1 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 qualitatively evaluated based on these criteria - whether they will improve, worsen, or have no effect on each issue.

In addition to the qualitative criteria summarized below, more quantifiable impacts to resources will also be documented. These resources include **parking options, traffic operations, stormwater management, utility impacts, Right-of-Way impacts, historic / archaeological, and estimated costs** and are key elements of this study.

TABLE 10.1 QUALITATIVE EVALUATION CRITERIA

Issues to Address	Study Goals		
	Improve safety for people walking, bicycling, driving, and taking transit	Meet (and exceed) accessibility standards	Foster the emerging neighborhood
1 Crossing length for all modes	x	x	
2 Pedestrian crossing guidance	x	x	
3 Pedestrian crossing of S. Winooski Ave	x	x	
4 Crash rate	x		
5 Comfortable transit facilities		x	
6 Visibility of traffic signals to motorists	x	x	
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		
11 Right turns on red	x		
12 Use of Potvin Park			x
13 Public gathering space			x
14 Bicycle infrastructure	x	x	
15 Stormwater management			
16 Support relationship between residents and businesses			x

11.0 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. Quick Build 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: A planning level cost estimate range is given for each alternative, including design, construction, and inspection. The cost estimate does not include costs associated with Right of Way acquisition.

RIGHT OF WAY (ROW) IMPACT: The square footage and number of impacted private parcels is quantified; impacts to Potvin Park is not included.

UTILITY IMPACTS: The number of impacted utility poles is quantified. While some underground utility infrastructure is expected to be modified by each alternative, no alternative proposes to relocate existing underground infrastructure.

HISTORIC / ARCHAEOLOGIC IMPACTS: The square footage of disturbed area outside the existing sidewalk limits and the number of directly impacted structures is quantified.

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

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in Table 10.1. The number of “+” are subtracted by the number of “-”, for each category, with a resulting score.

These ratings are shown collectively in Figure 13-1.

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

RIGHT OF WAY (ROW) IMPACT: 0 SF / 0 Properties

UTILITY IMPACTS: 0 Poles

HISTORIC / ARCHAEOLOGIC IMPACTS: 0 SF / 0 Structures

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
- No change in maintenance requirements

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.

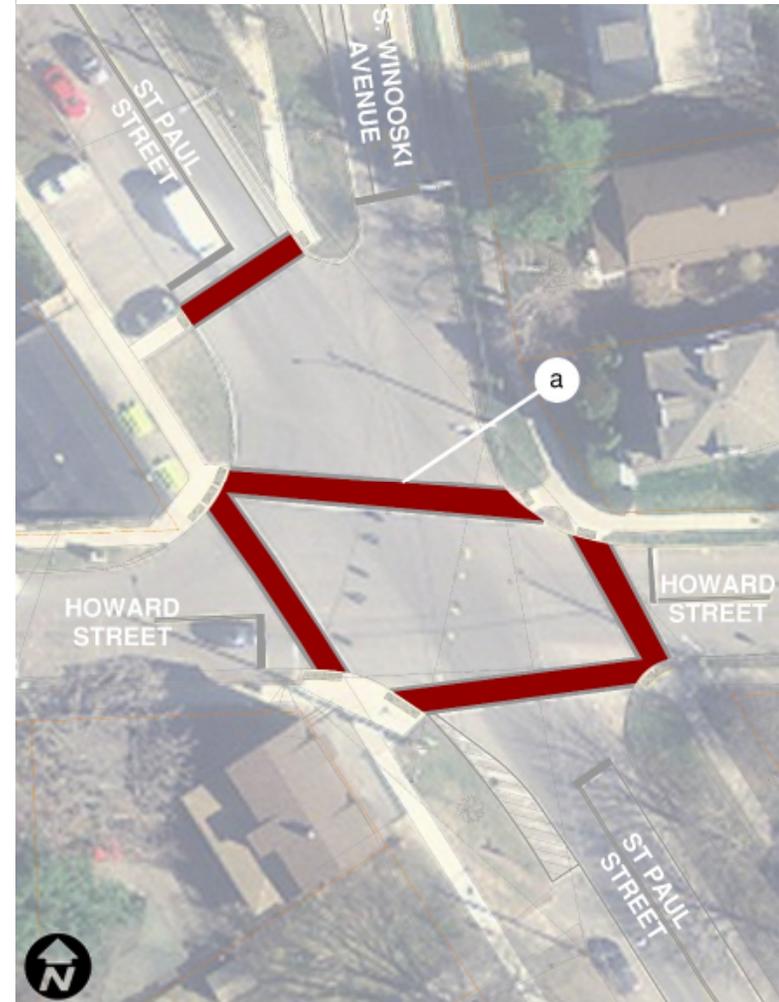
GOALS MET:

- Safety: 0 of 10
- Accessibility: 0 of 6
- Neighborhood: 0 of 3

OPPORTUNITIES FOR ENHANCEMENT:

- No Build Alternative proposes no changes to the existing features

FIGURE 11-1: NO BUILD ALTERNATIVE



ALTERNATIVE 1: Quick Build Alternative Project

TIMEFRAME: Immediate

COST ESTIMATE: \$5,000 – \$25,000

RIGHT OF WAY (ROW) IMPACT: 0 SF / 0 Properties

UTILITY IMPACTS: 0 Poles

HISTORIC / ARCHAEOLOGIC IMPACTS: 0 SF / 0 Structures

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 11-2: QUICK BUILD ALTERNATIVE



CONSIDERATIONS:

- A person walking from the temporary bulb-outs may have reduced visibility to the traffic signals. 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 may make it more difficult for pedestrians to see the traffic signals and know when to walk.
- Demonstration project would require regular inspection and replacement of bollards.

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 11-3, the design vehicle encroaches only on the minor leg approach to the intersection.

GOALS MET:

- Safety: 4 of 10
- Accessibility: 2 of 6
- Neighborhood: 2 of 3

ADDITIONAL CRITERIA:

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

OPPORTUNITIES FOR ENHANCEMENT:

- A one-day demonstration project of similar concept occurred on July 26, 2017. This weekend installation is detailed in Section 15.
- A neighborhood art project may be planned in conjunction with this quick build project.
- The extension of the South Winooski / St Paul curb radius is intended to be refined to inform the placement of permanent curb, sidewalk, and a crosswalk across South Winooski Avenue.

FIGURE 11-3: SOUTHBOUND SU-30 VEHICLE TURNING RIGHT ONTO WESTBOUND HOWARD STREET



ALTERNATIVE 2: New Signal System, Existing Geometry

TIMEFRAME: Short Term

COST ESTIMATE: \$1.0 – 1.5 million

RIGHT OF WAY (ROW) IMPACT: 0 SF / 0 Properties

UTILITY IMPACTS: 0 Poles

HISTORIC / ARCHAEOLOGIC IMPACTS: 0 SF / 0 Structures

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, 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 11-4: 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 **(f)** in front of 457 St. Paul Street (Neighborhood Market, Shy Guy Gelato)

CONSIDERATIONS:

- The driveway of the house at the northeast corner; vehicles must enter from S. Winooski Ave and exit to the south (St. Paul Street would no longer be accessible to this driveway)
- Burlington DPW has received reports of shallow ledge in area making signal system potentially expensive
- Plowing is potentially more complicated with tighter curb radii and bulb-outs
- The additional striping would require more regular maintenance
- Drainage enhancements (bioswales, infiltration areas) would require more regular maintenance
- New green spaces and plaza may require city resources to mow and maintain

LONGEST CROSSWALK LENGTH: 43 feet

VEHICLE TRACKING: The curb layouts of Alternative 2 are the same as the quick build project temporary “curbs”, with the same operating characteristics of turning vehicles. Figure 11-5 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 3

ADDITIONAL CRITERIA:

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

OPPORTUNITIES FOR ENHANCEMENT:

- Improved transit shelter(s)
- Potential phased construction allowing crosswalk across South Winooski Ave. prior to full build out.
- Potential stormwater best management practices (BMP) at plaza: permeable pavers or infiltration area

FIGURE 11-5: WESTBOUND HOWARD STREET CITY BUS TURNS LEFT ONTO NORTHBOUND ST PAUL STREET



- New green space between S. Winooski Ave and the four-way intersection **(a)**, intersected by driveways
- 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
- The curve for the realigned South Winooski Avenue approach to St Paul Street is less than design criteria minimum (designed at 100-feet, min. is 180-ft); maximum grade is 4%; may require advanced warning sign for 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
- Plowing is potentially more complicated with tighter curb radii and bulb-outs
- The additional striping would require more regular maintenance
- Drainage enhancements (bioswales, infiltration areas) would require more regular maintenance
- Large new green spaces may require city resources to mow and maintain

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 11-7 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 3

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 11-7: SOUTHBOUND S. WINOOSKI AVE. BURLINGTON
LADDER TRUCK MANEUVERING TO WESTBOUND HOWARD ST.**



ALTERNATIVE 4: Dual Roundabout, Realigned Roadway

TIMEFRAME: Long Term

COST ESTIMATE: \$1.9 – 2.4 million

RIGHT OF WAY (ROW) IMPACT: 7 SF / 1 Property

UTILITY IMPACTS: 1 Pole

HISTORIC / ARCHAEOLOGIC IMPACTS: 7 SF / 0 Structures

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 dual mini-roundabouts
 - 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.
- New green space along east side of roundabout (d)
- Marked pedestrian crossings of all five approaches
- Sidewalk around perimeter for pedestrians or people walking bicycles; not wide enough to ride bicycles on walk

FIGURE 11-8: DUAL ROUNDABOUT, REALIGNED ROADWAY



- Shared lane markings **(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
- Plowing is potentially more complicated with raised island features and roundabout geometry
- The additional striping would require more regular maintenance
- Drainage enhancements (bioswales, infiltration areas) would require more regular maintenance
- New mountable areas and central planting islands may require city resources to maintain

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 11-9 and Figure 11-10.

GOALS MET:

- Safety: 8 of 10
- Accessibility: 4 of 6
- Neighborhood: -1 of 3

ADDITIONAL CRITERIA:

- Net change in permeable area: + 1,100 SF
- Parking impacts:
 - Loss of 5 off-street parking spaces 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 11-9: SOUTHBOUND WB-67 AT THE ST PAUL STREET ENTRANCE



FIGURE 11-10: EASTBOUND CITY BUS ENTERING AT THE HOWARD STREET ENTRANCE



ALTERNATIVE 5: Modern Roundabout, Existing Geometry

TIMEFRAME: Long Term

COST ESTIMATE: \$1.6 – 2.1 million

RIGHT OF WAY (ROW) IMPACT: 3,300 SF / 2 Properties

UTILITY IMPACTS: 1 Pole

HISTORIC / ARCHAEOLOGIC IMPACTS: 950 SF / 1 Structure

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 11-11: MODERN ROUNDABOUT, EXISTING GEOMETRY



CONSIDERATIONS:

- Full take of building and property at 457 St. Paul Street **(g)** requiring Uniform Relocation Assistance
- Difficult vehicle access to two houses along S. Winooski Ave **(h)**
- Grade of sidewalk approaches may be higher than permitted by ADA standards
- Plowing is potentially more complicated with raised island features and roundabout geometry
- The additional striping would require more regular maintenance
- Drainage enhancements (bioswales, infiltration areas) would require more regular maintenance
- New mountable areas and central planting islands may require city resources to maintain

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 11-12.

GOALS MET:

- Safety: 8/10
- Accessibility: 4/6
- Neighborhood: -2/3

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

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 11-12: A SU-40 TRUCK NAVIGATING THE ROUNDABOUT



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

In general, mini-roundabouts are not recommended at locations with high truck volumes and with five entrance approaches. The FHWA Technical Report³ “Mini-Roundabouts” states “mini-roundabouts are generally not recommended for intersections with more than four legs” and “high volumes of trucks will significantly reduce the capacity of a mini-roundabout”. Discussion with Dr. Wei Zhang from the FHWA Office of Safety Research and Development indicated that while “it is very rare to use a mini-roundabout at a 5-leg intersection”, a 5-leg mini-roundabout is in design in Anoka MN. The geographic location is different, located in a more residential neighborhood, off the primary road network on generally level ground, with the minimum approach angle between adjacent entrances at approximately 45-degrees

A single mini-roundabout was sketched, and is illustrated in Figure 11-13. The South Winooski Avenue approach intersects St Paul Street at a 24-degree acute angle. Three geometric issues arise from designing a small-radius roundabout with this acute angle:

3

<https://safety.fhwa.dot.gov/intersection/innovative/roundabouts/fhwas10007/>

FIGURE 11-13: 5-APPROACH MINI-ROUNABOUT.



- a. Rather than merging into the roundabout circulating aisle, southbound S. Winooski Avenue entering vehicles must cross the northbound St Paul Street exiting path, creating a high-risk head-on collision conflict point.
- b. Southbound drivers approaching from St Paul Street would need to focus their attention sharply

to the left for oncoming traffic from South Winooski Avenue, distracting from events directly in front of their vehicle, such as bicyclists in the travel lane or congestion within the roundabout.

- c. The yield bar for the South Winooski Avenue entrance to the roundabout would cross the northbound exiting lane (see a. above) and placed 40-feet from the circulating lane (typically 4-feet); vehicles on this approach will have trouble safely entering the roundabout.

A single mini-roundabout is too small to accommodate all five legs of the intersection given the acute angle of the approaching roadway.

4. Dual Roundabout Centered on S. Winooski Axis

This alternative would have proposed a second mini roundabout, similar to Alternative 4, but instead of centered on St Paul Street the second roundabout would be more easterly centered on South Winooski. This alignment would have forced the heavier traffic volume on St Paul Street to turn left to approach the roundabout, ascend a steep grade to the roundabout, and turn right to enter the roundabout. With a large volume of heavy vehicles, through the St Paul approaches, this alternative would require significant trailer tracking pads, resulting in extensive hardscape improvements. Additionally the uphill approach grade would be difficult in winter conditions.

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.

12.0 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.

12.1 | VEHICLE LOS 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.⁴ 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 12-1 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-

⁴ 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

FIGURE 12-1: LEVEL-OF-SERVICE CRITERIA FOR SIGNALIZED AND UNSIGNALIZED INTERSECTIONS

LOS	UNSIGNALIZED	SIGNALIZED
	AVERAGE DELAY (SEC)	AVERAGE DELAY (SEC)
A	≤ 10.0	≤ 10.0
B	10.1-15.0	10.1-20.0
C	15.1-25.0	20.1-35.0
D	25.1-35.0	35.1-55.0
E	35.1-50.0	55.1-80.0
F	> 50.0	> 80.0

controlled intersections, all movements experience delay and an overall LOS can be calculated.

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 considers LOS D to be acceptable in the urban environment, and may choose to accept even greater vehicle delay in the peak hour to address non-motorized travel priorities.

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. 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).

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 12-2 and Figure 12-3 and discussed in Section 5.3.

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.

Additionally, 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.

FIGURE 12-2 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

12.2 | 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,⁵ 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 12-3 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

⁵ As each run is different, a difference of less than 50 feet (or three vehicles) should not be seen as significant.

12.3 | 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 12-2. 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.

13.0 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.

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 13-1 ALTERNATIVES EVALUATION MATRIX

Issues to Address	Study Goals			Alternatives					
	Improve safety for people walking, bicycling, driving, and taking transit	Meet (and exceed) accessibility standards	Foster the emerging neighborhood	0 No Build	1 Quick Build 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		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	improvement	improvement	improvement	improvement
8 Running of red lights	x			no change	no change	improvement	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			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 management				no change	no change	improvement	improvement	improvement	improvement
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	Level of Service			C	C	E (possible C)	C+C	B+B	B
Traffic Operations: Total Average Queue Length	Total Average Queue Length (sum of all five approaches)			730 ft	760 ft	1220 ft	1100 ft	690 ft	310 ft
Reduction in Asphalt Area	Change in Impermeable Area			n/a	0 sf	-1270 sf	-5300 sf	-7720 sf	-3760 sf
Parking Options: Change in Parking Spaces	Change in Parking Spaces			n/a	0	0	-7 on-street spaces	-8 on-street, -5 off-street	-1 on-street
Right of Way Impacts	Square Feet / Number of Properties			0 / 0	0 / 0	0 / 0	0 / 0	7 / 1	3300 / 2
Utility Impacts	Number of Impacted Poles			0	0	0	1	1	1
Historic / Archaeologic Impacts	Area of Potential Impact (SF) / Number of Historic Structures			0 / 0	0 / 0	0 / 0	0 / 0	7 / 0	950 / 1
Timeframe	Immediate (1 year) / Short (2-5 years) / Long (5+ years)			Immediate	Immediate	Short - Long	Long	Long	Long
Planning Level Cost Estimate	2018 Dollars			\$0	\$5,000 - 25,000	\$1.0 - 1.5 million	\$1.7 - 2.2 million	\$1.9 - 2.4 million	\$1.6 - 2.1 million

14.0 PUBLIC MEETING – ALTERNATIVES PRESENTATION



A second public meeting was held on Tuesday, June 27, 2017 in the ArtsRiot Event Space near the Winooski – Howard – St Paul intersection. This meeting was held to review the alternatives developed and get feedback from residents, neighbors, commuters, travelers, and other interested parties. The City’s Public Works Staff, the RSG consultant team, members of the Project Advisory Committee, and at least 25 residents, discussed the alternatives following a brief presentation. Members of the public were invited to comment on the alternatives and vote on their preferred alternative.

The top three Issues to Address as voted by the attendees included the missing pedestrian crossing of South Winooski Avenue (13 votes), supporting relationships between residents and business (9 votes), and vehicle speed (8 votes). Many participants expressed a preference for Alternative 2, maintaining the existing traffic pattern with a smaller intersection, shorter pedestrian crossing distances, enhanced pedestrian environment at the corners, a crosswalk across South Winooski, and pedestrian signals. Some members of the public expressed a preference for a roundabout at the intersection, noting that a mini-roundabout should be considered by a qualified professional; the mini roundabout was considered and rejected as discussed earlier in this document.

Notes, presentation materials and the additional results from this meeting are available as an attachment to this report.



FIGURE 14-1: PHOTOS FROM THE ALTERNATIVES PRESENTATION MEETING ON JUNE 27, 2017



15.0 DEMONSTRATION PROJECT IMPLEMENTATION

Local Motion, with AARP and the Burlington Department of Public Works, coordinated pop-up installation of Alternative 1 - the demonstration project meant to showcase aspects of Alternative 2. RSG assisted in the installation, helping layout the temporary striping and bollards, and Local Motion held community events to create temporary park infrastructure, such as benches, planters, and bike racks. The Demonstration Project was installed in the early morning hours of Wednesday, July 26 and continued through the weekend until Sunday July 30.

Throughout the demonstration project and after it was removed, feedback was collected by Local Motion and by the Winooski-Howard-St Paul Intersection Scoping Study project email. Of the 38 comments tallied to date, 31 were positive. Many respondents requested pedestrian signals, while others suggested modifications to the layout to improve walking, biking and driving conditions.

Not all responses to the demonstration were supportive, and many of the overall positive responses had suggestions for improvement. Some residents were not content with the difficulty turning right in a motor vehicle from southbound South Winooski Avenue to northbound St Paul Street, while others believed that there was no reason to improve the intersection at all.

RSG compiled the most common questions and pieces of feedback and responded to them in an online presentation, located here: <https://sway.com/e5vfJ7tbFEkiVxO1>

Local Motion responded to the pop-up with a recommendation to install a “semi-permanent” pilot project using paint and bolted-down bollards, in place for six months to a year and with a plan for detailed data collection and analysis.

RSG incorporated the public feedback as well as recommendations from Local Motion into its final recommendations.

“I came across this last weekend and LOVE IT... It calmed an otherwise difficult intersection and made it much more pedestrian friendly.

I think that it’s a great idea to implement here and elsewhere in the city where edges of intersections could be taken back for people.”

- Survey Response

“Please leave well enough alone.”

- Survey Response

"I love the pop-up demo at Winooski, Howard, and St. Paul St. I like the calming impact on traffic, the shorter crossing distances for pedestrians, and the additional public space available in front of Shy Guy."

- Survey Response



RECOMMENDATIONS AND NEXT STEPS

16.0 RECOMMENDATION AND NEXT STEPS

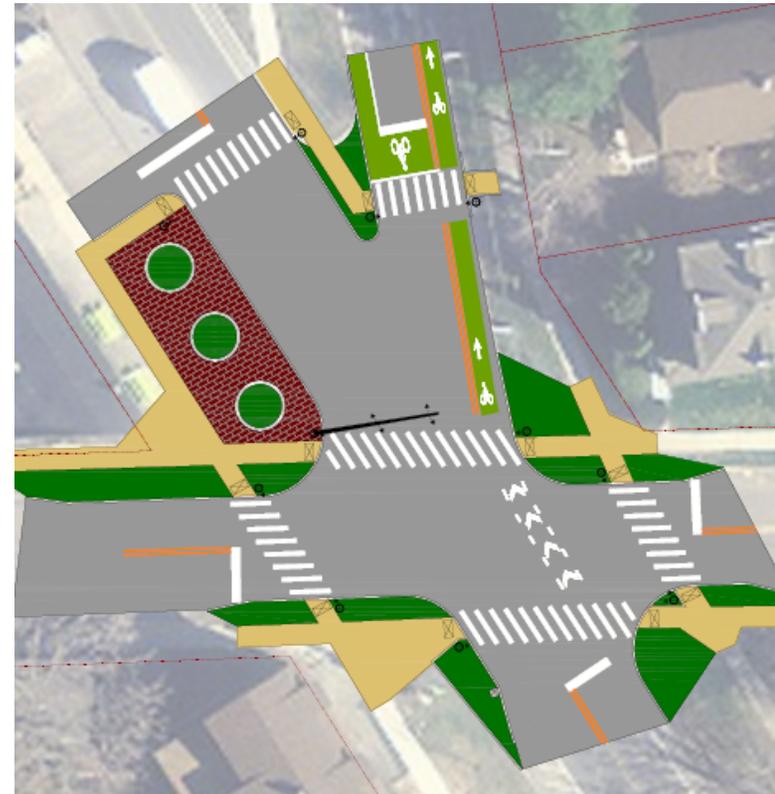
It is clear the community not only supports modification to the intersection that prioritizes safe pedestrian and bicycle travel through the intersection, but also one that increases public gathering space in front of the businesses at the intersection and reduces unnecessary space for vehicles. When curb extensions were first proposed at the Local Concerns Meeting in October 2016, residents were excited about this possibility, and this excitement turned into approval at the Alternatives meeting and from the pop-up demonstration's feedback.

RECOMMENDATION

In the short term, RSG recommends implementation of a semi-permanent quick build project based on the pop-up demonstration with minor design modifications, described below. The project should include a data collection component to assist with an objective evaluation. This would be a step toward a long-term goal of reconstructing the intersection with narrower lanes, reduced curb radii, pedestrian signals, and an accessible marked crossing of South Winooski Ave.

During the medium term (2-5 years), Potvin Park curb should be extended as far as possible as determined in the semi-permanent demonstration project. This curb extension should include associated sidewalks and landings on either side of South Winooski Avenue to install a pedestrian crosswalk across the missing leg. Associated bike lane extension striping, green markings, and bike box striping may be installed at this time to enhance the bike lanes.

FIGURE 16-1: ALTERNATIVE 2 (AS PRESENTED IN THE ALTERNATIVES ANALYSIS REPORT)



The long-term reconstruction would be based on Alternative 2, including design modifications where determined appropriate based on the semi-permanent demonstration project and public feedback.

CONSIDERATIONS IN RECOMMENDATION

Public Support was greatest for the enhancement to the intersection in its current configuration, maintaining Potvin Park as a useable public space and enhancing the commercial potential of the western corners.

Roundabouts were infeasible in this location; the five approach legs precluded a mini-roundabout; a large, modern roundabout impacted the potentially historic and commercial resource; and the dual mini-roundabout required non-standard driveway access directly into the travel lane.

The maintenance demands for the recommended alternative is expected to be the least of the alternatives analyzed. The recommended configuration, and associated maintenance, is very similar to the existing intersection. Additional maintenance concerns as a result of the recommended features include:

- The immediate term quick build project recommends installation of flexible post bollards; these bollards are likely to be struck by vehicles and will need to be monitored regularly. The installation may be maintained over winter similar to the protected bike lane installation in other locations on Winooski Avenue around the city.
- Shorter crossing distances will result in less crosswalk striping, but additional paint will be required for the bike lane markings on an annual basis.
- Reduced curb radii and bulb outs may make plowing more difficult, but this is not unlike other bulb-out crossing designs throughout the city.
- New stormwater BMPs may require seasonal maintenance to ensure proper functioning.

- The extended nose between South Winooski Avenue and St Paul Street may result in increased mowing as part of Potvin Park maintenance
- The plaza space and associated plantable areas are expected to be maintained by the adjacent commercial properties. If not, low maintenance materials may be selected to minimize maintenance responsibilities.

VIABILITY OF THE RECOMMENDED ALTERNATIVE

The phased implementation of the recommended alternative is both feasible and reasonable. The recommended alternative addresses all of the criteria identified by the community with improvements over the existing conditions and directly meets the documented purpose and need. The recommended alternative is consistent with the existing development pattern and is the least expensive long term solution. As documented in the public outreach process, the community is united in the need for improvement and the recommended alternative as the solution.

The investment in bulbouts, shorter pedestrian crossing distances, crosswalks at each leg, and pedestrian signals, with associated drainage and bicycle travel enhancements, is responsive to the community need, serves the public good, and is viable.

FUNDING

The semi-permanent quick build project and the long-term reconstruction may be eligible for a number of grant and funding opportunities. Below is a list of various funding sources that could be used to help with their implementation, with funding ratios based on data available as of August 2017.

- **Transportation Alternatives Program (TAP Funds):** TAP funds are a federally-funded, VTrans-administered, and locally-managed grant program that have been used to increase bicycle and pedestrian mobility in the past, although the funds are specifically dedicated towards stormwater improvement projects over the next funding cycles. The funding source should be monitored as a potential supplement for the stormwater enhancement features.
- **Bicycle and Pedestrian Program:** Similar to TAP funds, the Bicycle and Pedestrian Program is a federally-funded, VTrans-administered, and locally-managed grant program dedicated to bicycle and pedestrian improvement projects specifically, and are provided via a competitive application process. This scoping study was funded through this program. These funds may cover a maximum of 80% of the project, with the remaining portion likely coming from the project-sponsoring organization. A state-funded, 50% match grant for small scale projects is also available through this program, which may be helpful for implementing the phased Potvin Park Curb Extension medium term recommendation. The grant program is typically announced in the spring.
- **FHWA Accelerated Innovation Deployment (AID) Demonstration:** The Safe Transportation for Every Pedestrian (STEP) Program is part of the FHWA Every Day Counts fourth round of innovations. The recommended improvements may be eligible for federal funding as an AID Demonstration project. Innovative project delivery, such as consultant management and refinement through the long-term demonstration project, may strengthen the project funding application.

- **Community Sponsorship or Private Fundraising:** The City could work to raise private funds for the new plaza/seating area, at least in part, possibly with some memorial that acknowledges the contributions.

DETAILS AND DESIGN MODIFICATIONS

The semi-permanent quick build project should be installed through the 2018 summer season - when weather allows for a high amount of pedestrian and bicycle use - to gain a full understanding of how the revisions would work for all road users. The demonstration project is intended to be installed with DPW or volunteer labor at minimal investment; federal grant funding is not anticipated for the immediate demonstration project.

Data collection to document the success of the demonstration is recommended may include: traffic counts (all modes), in-person observations during peak hours, and crash data to ensure crashes are not increasing. The operating characteristics and turning radii of vehicles should be documented to inform the permanent installation of curbs in future phases.

At minimum, design modifications for the semi-permanent quick build project should include the following:

- **Move the stop bar of South Winooski Ave up to the end of the park extension.**
- **The white line should be placed at the edge of traveled way, typically marking an 11-foot lane.** Bollards should be placed at the edge of the desired roadway, 14-feet offset from the centerline along St Paul Street and South Winooski Avenue, and 12-feet along Howard Street.

- **Marked crosswalk of South Winooski Ave.** This was included in Alternative 2 but was not included in Alternative 1 or the pop-up since there would not be an ADA compliant connection to the existing sidewalks (curb cuts would be necessary). If the funding for the associated curb ramps and sidewalk approaches can be acquired, the marked crossing of South Winooski Avenue may be included. It would still be recommended to revise the curb radius to best suit the southbound hard right turn from South Winooski Avenue to northbound St Paul Street.
- **Include “No right turn on red” signs.** (This was also included in Alternative 1 but resources were not available at the time of the pop-up to put them in place.)
- **Install a “Stop Here on Red” (MUTCD R10-6) at the stop bar of southbound St. Paul Street, and cross stripe the area beyond the stop bar to discourage encroachment.** With the extension of Potvin Park, drivers may assume that the stopping point should be extended as well. During the pop-up, a business owner at the intersection noted that he observed cars pulling past the stop bar; this space is needed for vehicles making the southbound South Winooski Avenue hard right to northbound St Paul Street.
- **Increase the curb radius for right turns from southbound St. Paul Street onto Howard Street.** The curb extension in front of 457 St. Paul Street during the pop-up made this turn more difficult for trucks. Modeling an SU-30 making this turn shows that the turn is possible, but only if the truck encroaches on northbound St. Paul Street traffic and/or the eastbound Howard Street approach lane (depending on the exact movements of the truck). To avoid encroaching on other lanes,

the curb radius would need to be wider and the curb on the north side of Howard Street would need to be pulled back from the pavement by up to two feet. These changes would result in longer crossing distances than the current design shows.

- **Increase the curb radius for hard right turns from southbound South Winooski Avenue onto St. Paul Street for motor vehicles.** The dimensions of the Potvin Park extension in the alternative designs allow for a passenger car to make the turn, but a larger radius would assist the turn. Modifications to the curb extension may alter the access to driveways on S. Winooski Ave, particularly 426 South Winooski Avenue.

ADDITIONAL CONSIDERATIONS FOR LONG-TERM DESIGN

The following summary circles back to the elements of the recommended design beyond the pedestrian- and bicycle- centered improvements. These were touched upon in the Alternatives Analysis report and are important aspects to the future of the intersection.

Cost: Alternative 2 is the least expensive of the long-term options studied in the Alternatives Analysis. The conceptual cost estimate of the total project cost, including consultant fees, inspection, project management, and construction, is approximately \$1,100,000.

Parking Options: This alternative does not require removal of parking.

Traffic Operations: Two signal timing options were offered in the Alternatives Analysis, one which had two leading pedestrian intervals (LPI) per cycle throughout the day, and one that had LPIs in effect all day except during the peak hours, to alleviate stress on traffic operations. RSG recommends to program the signal with a LPI throughout the day, while also regularly monitoring traffic operations. If congestion is observed to worsen significantly, the LPI may be removed during peak hours, as vehicle volumes but not pedestrian volumes are higher during these times.

Stormwater Management: This alternative will increase permeable space by approximately 1,300 square feet. The new plaza space may also be constructed with permeable pavers to maximize stormwater management.

Transit: There are two transit stops near the WHSP intersection: on the west side of Potvin Park (northbound on St. Paul Street) and on the south side of the eastbound Howard Street approach. Transit stops will not need to be relocated, but as observed early in the study, the transit stops could be improved to make them more accessible and friendly to bus riders. They could include a platform that is plowed in the winter, a curb-cut, seating, and/or a shelter. It is recommended that the stops are improved as part of the long-term reconstruction of the intersection.

