City of Thunder Bay

TRANSPORTATION MASTER PLAN

Background Report E:

ROUNDABOUTS

April 2019

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1 Background

1.1 Roundabouts in Thunder Bay

At present, only one roundabout exists in Thunder Bay. Constructed in 2014, the Pearl Street / Sleeping Giant Parkway roundabout is a single-lane roundabout with a 40 metre inscribed circle diameter with three legs. Currently one leg leads to Pearl Street to the west, another to Sleeping Giant Parkway to the north, while the third leg leads south to a surface parking lot. It is expected that Sleeping Giant Parkway will continue further south in Phase 2 of the Waterfront Master Plan. The roundabout replaced an all-way stop intersection.

As the roundabout is approximately 60 metres east of an at-grade rail crossing, the roundabout provides the advantage of continuous traffic flow, which should ensure that traffic entering the waterfront area does not back up and block the rail crossing.

Exhibit 1.1: Roundabout at Sleeping Giant Pkwy and Pearl St, Thunder Bay, ON

Imagery: Google, Map data: Google

Based on discussions with City staff and feedback during the first two rounds of public engagement for the Transportation Master Plan, there appears to be a public appetite for the implementation of roundabouts within the City. Commonly cited reasons include improving traffic flow, reducing fuel consumption and energy costs, and improving environmental outcomes. Thunder Bay appears to be in an advantageous situation to begin implementing roundabouts as the political will exists and public opinion on roundabouts is positive.

2 What is a Roundabout?

The modern roundabout is distinguished from a traffic circle by its operational and design characteristics. The key operational feature of a roundabout is that traffic must yield at entry to traffic already within the roundabout.

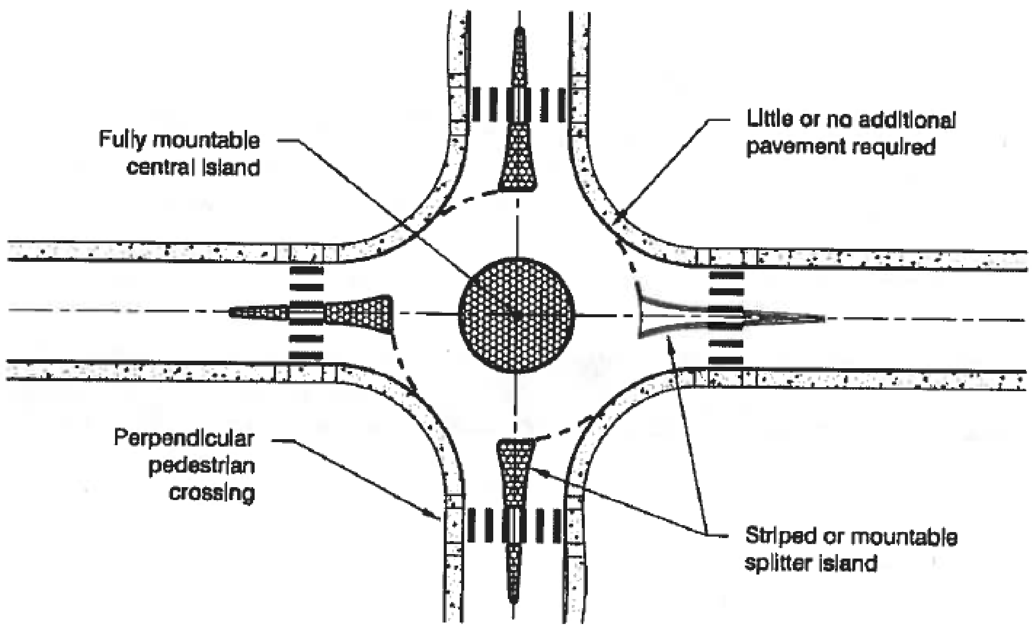
Other important design characteristics include:

- Circular central island
- Splitter islands which act to reduce speed and provide pedestrian refuge areas
- Circulatory roadway
- Truck apron surrounding the central island to ensure larger vehicles can safely traverse
- Crosswalks upstream of the yield line at each approach

Modern roundabouts can vary in size, speed, and context. The *Canadian Roundabout Design Guide* (CRDG) released in 2017 by the Transportation Association of Canada (TAC) identifies three categories of roundabouts:

Mini-roundabout – A small, low-speed roundabout characterized by a fully traversable centre island and a typical diameter of less than 27 metres.

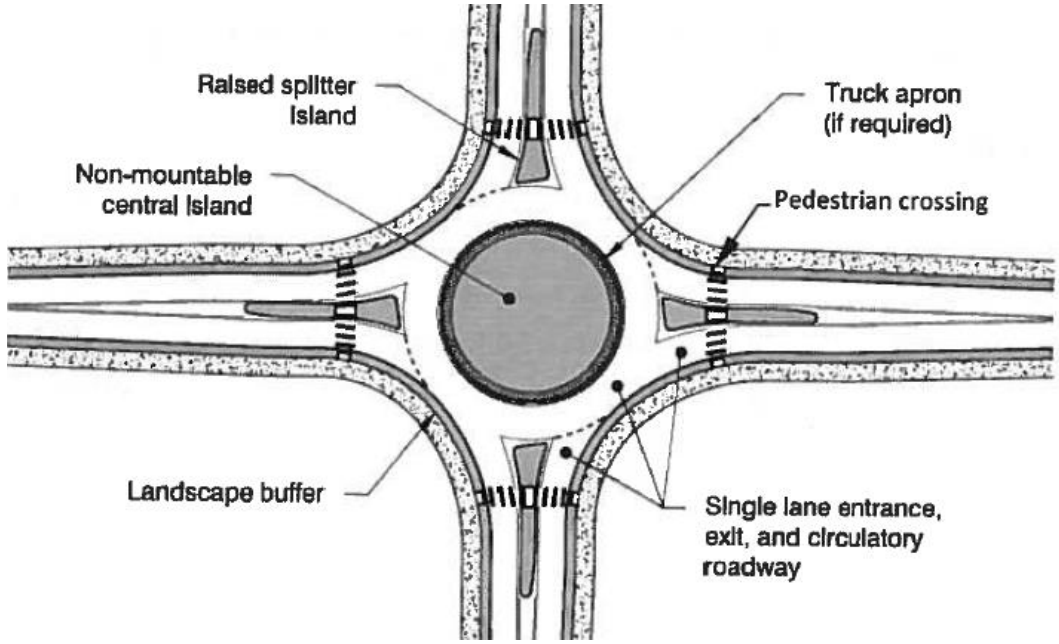
Exhibit 2.1: Typical Mini-Roundabout Layout



Source: TAC Canadian Roundabout Design Guide

Single-lane roundabout – A mid-sized roundabout with single-lane approaches and a single circulatory lane.

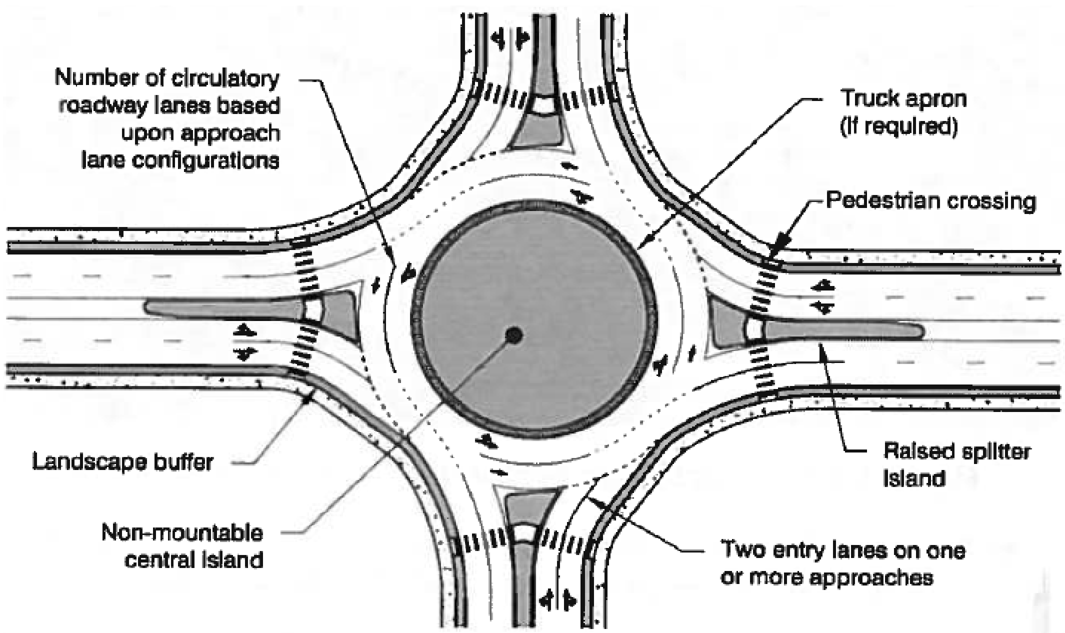
Exhibit 2.2: Typical Single-Lane Roundabout Layout



Source: TAC Canadian Roundabout Design Guide

Multi-lane roundabout – A roundabout with at least one leg having multiple approach lanes, with a wider circulatory roadway, usually of 2 lanes or more. A variation of the multi-lane roundabout that is increasing in use is the turbo roundabout, which has stricter lane controls, often with the use of raised curbs.

Exhibit 2.3: Typical Two-Lane Roundabout Layout



Source: TAC Canadian Roundabout Design Guide

Note that modern roundabouts should be distinguished from other types of circular intersections. These are:

- Neighbourhood traffic circles – a traffic calming feature consisting typically of just a circular island within a low volume intersection, lacking the rest of the design characteristics of modern roundabouts.
- Traffic circles – an older version of the modern roundabout, but often larger and equipped with traffic signals.
- Rotaries – large diameter central islands designed for higher speeds and often giving right-of-way to those entering the intersection, as opposed to entering traffic having to yield in a modern roundabout.

2.1 Advantages of Roundabouts

2.1.1 Reduced Collision Frequency

The frequency of collisions is typically lower in a roundabout intersection when compared to one with similar traffic volumes and traffic signals. There are two main reasons for reduced collisions. First, speeds are reduced through the intersection because of the care needed to yield and make the turns. Drivers are not entering the intersection at high speeds. Secondly, the design of the roundabout has significantly fewer potential collision points.

In addition, the severity of collisions is decreased at roundabouts compared to intersections with traditional traffic control devices. Serious injury and death are less likely to occur due to the lower travel speeds and the geometry involved. Collisions in roundabouts tend to be angle collisions which are typically less severe than the head-on collisions which are more likely in traditional intersections.

2.1.2 Pedestrian Safety

Research has shown that pedestrians are at least as safe at roundabouts as they are at traditional intersections. Typically, pedestrians only need to cross one or two lanes at a time and have access to a refuge island between the entry and exit lanes on each leg.

It should be noted, however, that roundabouts force pedestrians to detour around the circle, resulting in longer walk distances and walk times to cross the intersection.

2.1.3 Reduced Delay, Improved Traffic Flow, and Increased Capacity

Research has shown that average delays are reduced at intersections after being converted to roundabouts. Roundabouts allow for continuous traffic flow and increase capacity compared to traditional intersections.

2.1.4 Reduced Environmental Impacts

Roundabouts reduce pollution by minimizing instances of idling and stopping delay compared to traditional intersections. Additionally, at roundabouts, as drivers can proceed through the intersection without coming to a full stop, fuel consumption decreases.

2.1.5 Reduced Operations Costs

Long-term operation and maintenance costs are lower at roundabouts than at traffic signals due to the lack of traffic control equipment to maintain. Society cost savings are also gained through fewer and less severe collisions, and through decreased upstream capacity impacts due to better traffic flow at the roundabout.

2.1.6 May Require Less Space

In some applications, replacing a signalized intersection with a roundabout may reduce the amount of land required. Particularly, this can happen at larger intersections where turning lanes will no longer be needed.

Because roundabouts can achieve a higher capacity and continuous traffic flow, they may also provide for an opportunity to decrease the width of the roads approaching the roundabout, allowing for excess road space to be reallocated to other uses.

2.2 Disadvantages of Roundabouts

2.2.1 Protection of Cyclists

Many international jurisdictions have documented an increase in collisions involving cyclists after roundabouts were installed. Typically, where bike lanes exist, cyclists are either forced to merge into the traffic lane prior to entering the roundabout, or in some cases, are directed to ride on the sidewalk and use the crosswalks to traverse a roundabout. Cyclists are at the greatest risk within the circulating traffic where drivers may fail to yield the right of way.

2.2.2 Pedestrian Navigation

Pedestrians are forced to detour around the perimeter of the roundabout increasing the walking distance. Roundabouts are also more difficult for visually-impaired users as, without traffic signals, there are no audible indicators for crossing and it is also more difficult to judge traffic audibly.

2.2.3 Increased Capital Costs

Construction of a roundabout may have higher initial capital costs, particularly in retrofit projects. The complexity of retrofit projects may require longer planning and design timelines and more complicated staging and traffic management programs.

2.2.4 May Require More Space

In some applications, roundabouts may require a larger area than their traditional counterparts. This is particularly true at smaller intersections such as at the intersection of two 2-lane roads without additional turning lanes.

Additionally, pedestrian crosswalks are typically set back at least one car length from the inscribed circle which may further extend the land requirements of the roundabout to accommodate pedestrian facilities.

3 Best Practices

The City of Calgary and the Regional Municipality of Waterloo have the most comprehensive policies and planning processes in Canada to date and are heavily drawn upon to inform the development of the best practices in this report.

The most important document, however, is the *Canadian Roundabout Design Guide* (CRDG) released in 2017 by the Transportation Association of Canada. As the Calgary and Waterloo work pre-dates the CRDG, they both factor heavily into its recommendations. The Guide also references similar guides in both the United States and Britain, thus, the best practice summarized below are largely adapted from the *Canadian Roundabout Design Guide*.

3.1 Appropriate Use

While individual projects should be evaluated within their own local context, roundabouts are typically more suitable to certain contexts. The CRDG lists the following intersection characteristics which are most likely to benefit from the implementation of a roundabout:

- Historic safety concerns and/or a high frequency of collisions, particularly head-on, right angle, and left-turn collisions;
- Heavy left turn volumes, especially where no left turn lanes are present;
- T- and Y-shaped intersections;
- High collision severity due to excessive speed;
- Frequent U-turn movements;
- Significant delays, especially on the minor road approach;
- A desire for traffic calming measures or as an element to deter cut-through traffic in residential areas;
- As part of an access management strategy;
- An increase in traffic volumes is anticipated;
- Higher-order traffic controls (i.e. signalization) are not warranted and would result in a greater overall delay;
- Unusual geometry or complexity, including limited storage capacity or limited potential to expand storage capacity;
- Higher speed roadways;
- Interchange ramp terminals;

- A change in roadway configuration occurs, such as from four to two lanes or a transition from a rural to an urban environment;
- A community gateway;
- Closely spaced intersections that require short queue lengths; and
- Commercial corridors where a two-way centre left-turn lane creates operational and/or safety problems, and restrictions to right in/right out movements would be preferable.

By contrast, the CRDG advises that caution should be exercised if the following conditions are present:

- Large amounts of heavy vehicle traffic, particularly if left-turns are frequently required;
- Heavy pedestrian or cyclists traffic;
- Large populations of vulnerable road users such as children, the elderly, or persons with disabilities or other accessibility challenges;
- Where geometric design criteria cannot be satisfied;
- Corridors with insufficient gaps in the major flow to accommodate the minor flow;
- Where queuing causes traffic to spill back into the roundabout or adjacent intersections;
- Corridors with closely spaced intersections;
- Corridors with coordinated traffic signals or where traffic control devices require pre-emption;
- Corridors with peak period reversible traffic lanes or one-way streets;
- Steep approach grades or other factors limiting visibility;
- Where there is a large gap between the functionality of the two roads intersection, such as a highway and a local road;
- Significantly unbalanced traffic volumes on the approach roads; and
- Where pedestrians would need to be re-routed.

It is worth re-emphasizing that while the above is generally true, each individual location must be analyzed on its own merits to determine the applicability of a roundabout.

3.2 Policy

Many jurisdictions in Canada have adopted policies that require the consideration of a roundabout when a new intersection is being constructed, when a traffic control signal or all-way stop control becomes warranted or capital improvements are planned to alleviate capacity or safety concerns.

A policy such as this ensures that roundabouts are given proper consideration as a traffic control option and not dismissed due to unfamiliarity or other reasons. It also provides the opportunity to assess the various intersection control methods against one another. This process is discussed in Section 3.3.

3.3 Planning

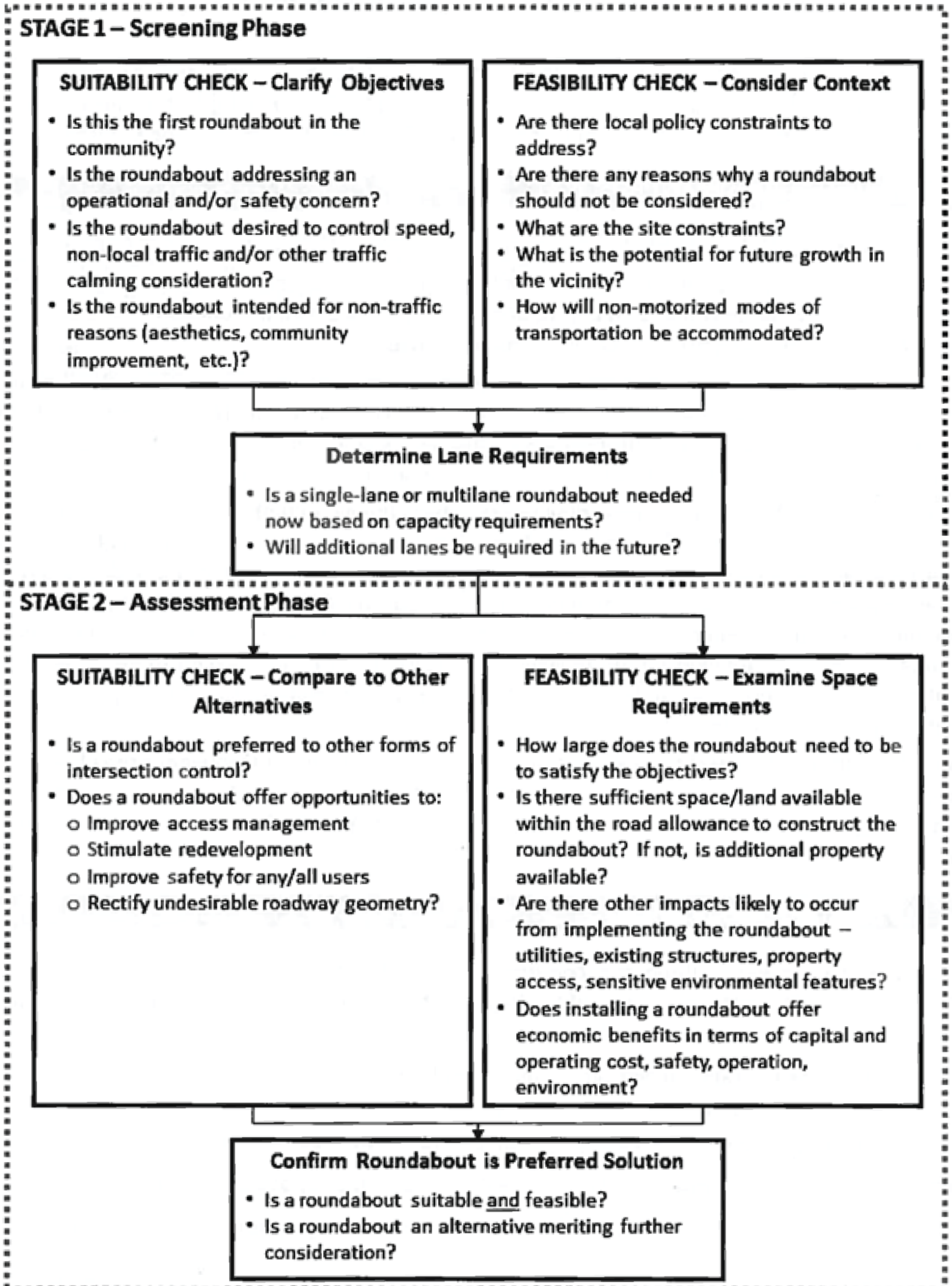
The CRDG provides a planning framework to assess roundabout suitability and feasibility which is divided into two phases. The preliminary screening phase is followed by a more detailed and comparative assessment phase. The framework diagram is shown in Exhibit 3.1.

3.3.1 Screening Phase

The first phase recommended in the CRDG is mostly qualitative in nature. It involves clarifying the objectives and considering the context. A basic quantitative analysis should also be undertaken to determine whether the existing and projected traffic volumes are within the capacity of a roundabout. This also allows designers to assess the lane requirements that may be required.

The Region of Waterloo utilizes a comprehensive 5-page questionnaire as an initial screening tool (attached as Appendix A), designed to be completed in 3-5 hours per candidate intersection. The questionnaire seeks to organize relevant information such as the location, existing configuration and traffic control, collision history, and forecasted traffic volumes. Further, the initial screening tool requires the provision of proposed configurations for both the roundabout and alternative solutions, and a 20-year life-cycle cost estimate.

Exhibit 3.1: Early Stage Planning Framework Recommended in *Canadian Roundabout Design Guide*



Source: Figure 3.1 of Canadian Roundabout Design Guide

3.3.2 Assessment Phase

Upon completion of the screening phase, and if not screened out, a more rigorous assessment is administered. At this point, it is important to assess the potential for a roundabout against other traffic control methods.

The feasibility check includes examining in detail the impacts to the built environment, utilities, natural environment, and how much property acquisition may be required.

This is also the stage to quantify the added benefits and extra costs of the roundabout. This includes safety benefits, delay benefits, environmental benefits, and operations and maintenance costs over the life-cycle of the intersection, and the initial capital costs. A comparison of all potential intersection control options should be undertaken at this stage using a Benefit-Cost Analysis or a Life-Cycle Cost Analysis.

Some considerations in the initial screening phase and the assessment phase may be suitable in either phase, providing individual cities the flexibility in how rigorous they wish the screening phase to be. For example, the Region of Waterloo considers traffic volumes, initial designs, and life-cycle costs in the initial screening phase, while CRDG recommends this be done in the secondary assessment phase. There is no one-size fits all solution, but it is important to find a balance between the two phases to ensure that clearly unsuitable intersections are not being carried forward to the more rigorous assessment stage. The initial screening phase should have enough rigor to eliminate these intersections, as well as providing the basis for the planning rationale and objectives, and the other qualitative aspects that are important towards feasibility.

3.3.3 Stakeholder Involvement and Public Awareness

Involving stakeholders and the general public is critical for cities or regions where roundabouts are not yet common design elements. It is important to engage with stakeholders early and often, and to educate both stakeholders and the public in general on the benefits and costs associated with transitioning to roundabouts and how the community will benefit. It is important to dispel some commonly held yet inaccurate beliefs in regards to the relative safety and costs of implementing roundabouts.

The stakeholders on each project may include nearby residents, including persons with disabilities and the elderly; businesses and business associations; emergency and maintenance services; schools; places of worship; community facilities; pedestrian, bicycle, and transit users and advocacy groups; oversized and overweight vehicle operators; and trucking, logging, and farming industry representatives as appropriate.

A general city-wide educational campaign is also typically required for areas where roundabouts are unfamiliar to residents in order to ensure drivers, cyclists, and pedestrians know how to navigate a roundabout confidently and safely.

3.4 Design

The *Canadian Roundabout Design Guide* contains a comprehensive guide to all aspects of designing roundabouts. The Guide contains more than 100 pages dedicated to the design of the intersection, with chapters dedicated to geometric design, traffic control devices, illumination, landscaping, pavement design, and construction, maintenance, and rehabilitation.

It is recommended that the City of Thunder Bay utilize the CRDG for its roundabout designs, or as a starting point for a more robust adaptation of a customized design guide.

Five topics that would be of particular interest to the City of Thunder Bay are sizing considerations, pedestrian crossings, cycling facilities, proximity to other driveways, and winter maintenance. These are described in the subsections that follow.

3.4.1 Sizing Considerations

The size of each roundabout is highly flexible and depends on a number of different inputs: number of entering lanes per approach, projected traffic volume, site constraints, design vehicle chosen, and the stated objectives of the design. Roundabouts can range from as small as a 14 metre inscribed circle diameter to more than 100 metres.

The CRDG provides geometric design guidelines in terms of ranges that specific measurements should fall in to, it is the designer's job to create a working design that falls within the various range. Because of this, roundabouts can vary considerably in size, as required by the different constraints at each location.

Another important consideration in the sizing is selecting an appropriate design vehicle. The chosen design vehicle depends on the expected usage and objective of the street. Intersections of two local roads, for example, may be designed with only a passenger car as the design vehicle, while the intersections of two arterial roads would typically consider the requirements of at least a semitrailer truck.

The chosen design vehicle will have an impact on the size of the inscribed circle within the roundabout, including the truck apron. The CRDG provides a reference table for the typical design vehicles for various sizes and configurations of roundabouts, as seen in Exhibit 3.3.

Due to the ability of roundabouts to be adaptable to a wide range of conditions, the designer has a considerable amount of leeway in what the ultimate design will look like. It is up to the designer to take all of the above factors into consideration when designing the roundabout, as well as all other geometric design guidelines included in the CRDG.

Exhibit 3.2: Roundabout categories and characteristics

DESIGN ELEMENT	MINI-ROUNDABOUT	SINGLE-LANE ROUNDABOUT	MULTI-LANE ROUNDABOUT
Maximum Number of Entering Lanes per Approach	1	1	2 or more
Typical Inscribed Circle Diameter	14 to 27 m	28 to 60 m	46 to 100 m
Central Island Treatment	Fully traversable	Raised (may have traversable truck apron)	Raised (may have traversable truck apron)
Typical Daily Service Volumes on Four-Leg Roundabout	Up to approximately 15,000 vehicles per day	Up to approximately 25,000 vehicles per day	Up to approximately 45,000 vehicles per day (for two-lane roundabout)

Source: Table 1.2 of Canadian Roundabout Design Guide

Exhibit 3.3: Typical inscribed circle diameters based on typical design vehicle selected

ROUNDABOUT CONFIGURATION	TYPICAL DESIGN VEHICLE	COMMON INSCRIBED CIRCLE DIAMETER RANGE (m)
Mini-roundabout	MSU (Medium single unit truck)	14 – 27
Single-lane roundabout	B-12 (Single unit bus)	28 – 46
	WB-15 (Intermediate semitrailer)	32 – 46
	WB-20 (Large semitrailer)	40 – 60
Two-lane roundabout	WB-15 (Intermediate semitrailer)	46 – 67
	WB-20 (Large semitrailer)	50 – 67
Three-lane roundabout	WB-15 (Intermediate semitrailer)	61 – 76
	WB-20 (Large semitrailer)	67 – 100

Source: Table 6.1 of Canadian Roundabout Design Guide

3.4.2 Pedestrian Crossings

OTM Book 15 explains that in Ontario pedestrians do not have the right-of-way at roundabouts unless a traffic control measure has also been installed. Based on international best practice, however, it is recommended that a traffic control measure be included in all roundabout installations in order to give the right-of-way to pedestrians within or about to enter the crosswalks.

This approach has been implemented in most Ontario jurisdictions, and roundabouts within the Region of Waterloo have been accompanied by signage indicating that drivers must yield to pedestrians who are in, waiting at, or about to arrive at the crosswalks. These signs are similar to the “Yield here to bicycles” sign discussed below.

More recently, however, the Region of Waterloo has been upgrading these crossings to Level 2 Pedestrian Crossovers to reinforce that pedestrians have priority.

Cities in Ontario have the option to proceed with two types of traffic control devices in order to give pedestrians the right-of-way at roundabouts.

The first option is to install a yield sign before the crosswalk. The Highway Traffic Act states that drivers approaching the yield sign shall slow down to a reasonable speed or stop if necessary and shall yield the right-of-way to traffic in the intersection, including pedestrians. This approach requires that appropriate traffic controls also be used to communicate to drivers entering the roundabout that they must still yield to traffic in the circulatory roadway, after yielding to crossing pedestrians, particularly if the crosswalks are set back from the yield line, as is typically the case.

The second option is the installation of Level 2 Pedestrian Crossovers, including the appropriate signage, as seen in Exhibit 3.4, which may or may not include flashing beacons. The level of traffic control required for pedestrians should be determined using the process as described in OTM Book 15, Section 5. Pedestrian crossover signage is detailed in the Highway Traffic Act Regulation 402/15: Pedestrian Crossover Signs.

Exhibit 3.4: Level 2

Source: City of Ottawa

Regardless of the approach selected, roundabouts, especially single-lane roundabouts, have shown to be very accommodating to pedestrians, and their safety performance, particularly with respect to fatal and injury collisions, is often better than that of signalized intersections serving similar volumes of traffic.

In terms of accessibility, research presented in National Cooperative Highway Research Program

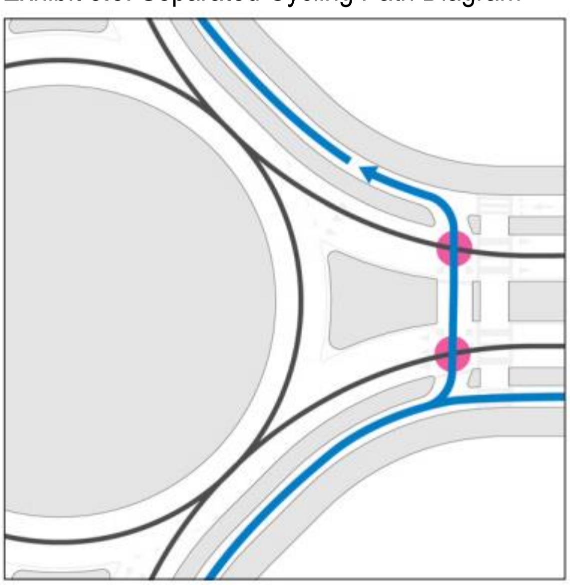
(NCHRP) Report 674 concluded that "while some blind research participants had difficulties crossing single-lane roundabouts in a safe manner, these sites appear not to pose crossing difficulties that are beyond those experienced by many blind travelers at similar signalized intersections." The same research concluded that accessibility of single-lane roundabouts seems to be critically linked to:

- Low vehicle speeds at the crosswalk, where reduced vehicle speeds are the result of good geometric design as opposed to driver willingness to reduce speeds due to the possibility of encountering a pedestrian;
- The willingness of a majority of drivers to yield to pedestrians;
- Properly installed detectable warning surfaces at all transition points between sidewalk and the street, including the pedestrian splitter island; and
- Availability of O&M instruction customized to roundabout crossings to explain to pedestrians the intersection geometry and the expected traffic patterns at the crossing.

3.4.3 Cycling Facilities

The MTO recommends that on-street bike lanes taper to an end just before entering a roundabout, and that designers provide cyclists with two options. The first is to have cyclists merge with general traffic to proceed through the roundabout, while the second is to provide a ramp from the bike lane to the sidewalk and have cyclists walk their bikes through the intersection using the sidewalk.

Exhibit 3.5: Separated Cycling Path Diagram



Source: MassDOT Separated Bike Lane Planning & Design Guide

However, an alternate practice is utilized in areas of Europe such as the Netherlands and Denmark where cycling has a high mode share and has also been introduced by the Massachusetts Department of Transportation in their Separated Bike Lane Planning and Design Guide as shown in Exhibit 3.5.

Typically the treatment would apply to separated bicycle lanes or multi-use paths, but could just as easily apply to bicycle lanes that are on-street for the rest of the corridor.

Instead of requiring cyclists to merge into general traffic, the design treats the bicycle paths in the same way as the sidewalks. In the case of separated lanes or parallel off-street trails, the routes follow the perimeter of the roundabout and cross next to the sidewalk in the form of a cross-ride at the splitter islands. It is important that the crossings are set back at least one vehicle-length from the circulatory roadway, the same as is recommended with sidewalks alone. To provide cyclists and pedestrians with the right of way in this design, proper signage and pavement markings must be included to ensure drivers look out for and yield to cyclists and pedestrians waiting to cross. For example, MassDOT uses a "Yield here to bicycles" sign in conjunction with its roundabout design (see Exhibit 3.6).

Exhibit 3.6: Yield here to bicycles sign

Source: MassDOT Separated Bike Lane Planning & Design Guide

In cases where on-street bicycle lanes are present, the solution is to utilize a ramp from street-level, as is already recommended in the CRDG, but to connect it with an off-street path adjacent to the sidewalk around the perimeter of the roundabout. The CRDG provides an alternate example of the sidewalk becoming a shared use path, which would also be acceptable where pedestrian volumes are low. Beyond the roundabout, another ramp would be provided to reconnect to the on-street bicycle lanes.

This type of treatment for cyclists may require more space, but has been shown to be safer for cyclists compared to requiring cyclists to merge with general traffic.

Pavement marking at cyclist crossings should adhere to OTM Book 18, with the implementation of either separate, combined, or mixed crossrides.

This roundabout design should be considered whenever there is a cycling facility in or adjacent to the roadway.

3.4.4 Proximity to other driveways

Low volume driveways, such as those for single-family houses, may be positioned anywhere beyond the splitter islands. Higher volume driveways, such as those for commercial developments or multi-family residential buildings, should be located far enough away from the roundabout so that enough space can be allocated for left turn queuing.

The biggest consideration with driveway placement is to avoid or severely limit the potential for traffic to get backed up into the circulatory roadway. If possible, it may be preferred to incorporate higher volume driveways into the roundabout itself, as this would eliminate the possibility of queuing drivers blocking the circulatory roadway. These driveways should be treated as another leg in the roundabout and given full roundabout treatment including pedestrian facilities and splitter islands.

There are some examples of driveway entrances being placed between the splitter islands and the circulatory roadway, and though this may be acceptable with very low volumes, it is not recommended.

3.4.5 Winter Maintenance

Of particular interest to a winter city such as Thunder Bay is the aspect of snow clearing and storage. The CRDB provides discussion on how these impact the design of the roundabout.

The recommended process for removing snow is for the plow enter the roundabout and proceed around the circulatory roadway, including the truck apron, from the centre to the outermost lane in a spiral pattern until the circulatory roadway is cleared. The next step is to remove the snow from the entries and exits by making right hand turns to and from each approach.

Snow storage must also be taken into consideration in the design, particularly with potential for snow piles obstructing sightlines, encroaching on the circular roadway, and impeding pedestrian access.

Snow banks tend to accumulate over the course of the winter, so it is recommended that snow clearing contracts include the removal of snow banks along the perimeter of the circular roadway, the centre island, and the splitter islands.

4 Proposed Policy

4.1 Policy Statement

Roundabouts shall be considered and evaluated as standard practice in the event that an intersection control study is triggered due to the proposed construction of a new intersection, a warrant has been reached for traffic control signals or all-way stop control, or capital improvements are planned for the intersection.

4.2 Actions

Policy

1. Adopt the above roundabout policy.

Planning

2. Adapt a screening and assessment process based on the Canadian Roundabout Design Guide, the best practices outlined in this report, and the examples referenced.
3. Update existing intersection control study protocols to include roundabouts as an option in all cases.
4. Develop a Life-Cycle Cost Analysis process to compare roundabouts, all-way stop control, and traffic control signals.

Design Guidelines

5. Adopt Canadian Roundabout Design Guide (2017), TAC as the City's design manual for roundabouts.
6. Adopt separated cycling path design (per MassDOT Separated Bike Lane Planning & Design Guide) as the preferred cycle path design through roundabouts.
7. Adopt upgraded pedestrian best practices as outlined in this report.

Operations and Maintenance

8. Update winter maintenance procedures to include procedures for roundabout snow removal.

5 Screening of Candidate Locations

5.1 Identified Candidate Locations

The City has identified nine candidate locations for roundabout implementation as shown in Exhibit 5.1:

Exhibit 5.1: Candidate Locations for Potential Roundabout

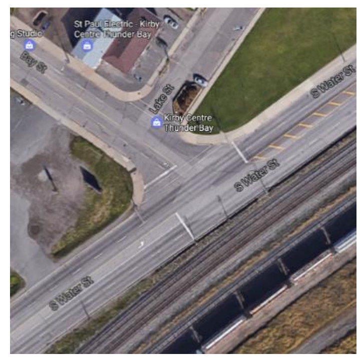
Memorial Ave & High St

Beverly St & Winnipeg Ave

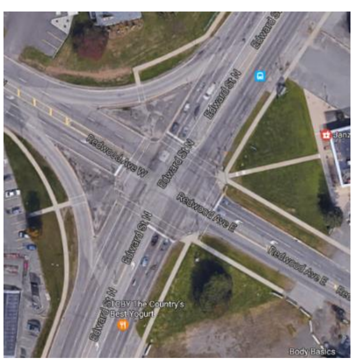
John St & Water St

John St Rd & Mapleward Rd

Court St & Clavet St

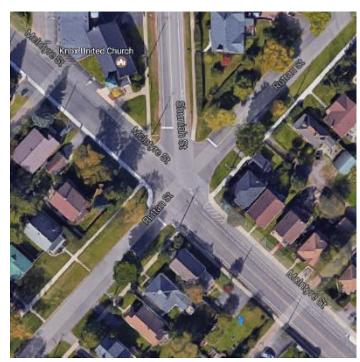


Bay St & Water St



Redwood Ave & Edward St

Algoma St & Lyon Blvd-Gibson St



McIntyre St, Shuniah St & Ruttan St

Imagery: Google. Map data: Google

5.2 Initial Screening

The initial screening phase is the first step in the analysis to determine whether a roundabout is both suitable and feasible at the candidate location. For the purposes of this report, a desktop review of available data and information was undertaken. This process differs from the planning best practices outlines in Section 3.3 due to the limited scope and immediate availability of required information.

A more robust analysis will need to be performed by the City on the intersections it desires to carry forward.

5.2.1 Suitability and Feasibility Check

For each intersection under review, the major objective of the potential improvement has been defined, along with a review of the existing conditions and potential constraints. Appendix B details the following items for each location:

- Existing configuration;
- Road classification;
- Property requirements;
- Site constraints;
- Non-motorized user accommodations required; and
- Additional comments.

Preliminary analysis for each intersection can be found in Appendix B.

5.2.2 Determine Lane Requirements

As a second step, each of the nine candidate intersections was evaluated using a traffic flow worksheet, which calculated the volume-to-capacity (v/c) ratios for various roundabout sizes and designs based on the traffic data that was available. Turning movement counts were used for the AM peak hour for the most recent count available.

Two intersections did not have any turning movement counts available. These are the John Street Road / Mapleward Road and McIntyre Street / Shuniah Street / Ruttan Street intersections.

The volumes John Street Road / Mapleward Road were estimated using nearby intersection turning movement counts to approximate total volumes and the proportion of turning movement volumes. The 5-legged intersection at Shuniah Street has been omitted from this step due to the lack of traffic counts and its unique design.

The initial screening tool returned the v/c ratios for each leg of the roundabout for four different configurations:

- Single-Lane
  - 1 entry lane, 1 circulating lane
  - 1 entry lane, 2 circulating lanes
- Double-Lane
  - 2 entry lanes, 1 circulating lane
  - 2 entry lanes, 2 circulating lanes

Based on this information, and the existing configuration of the intersecting streets, a configuration has been proposed for each identified location.

Traffic flow output for each intersection can be found in Appendix B.

5.2.3 Preliminary Recommendations

Given the inherent flexibility provided by roundabouts, each of the assessed intersections has the potential to be converted to a roundabout, with varying levels of complexity and cost. Detailed design and increase spending may be able to solve the issues identified but confirming that would require a more in depth analysis than is possible at this time.

Further, the recommendations provided herein take into account the ease of implementation and the consideration that these are likely to be among the first roundabouts built in the City. The most favorable circumstances were sought to help familiarize City staff with the design and installation process and the general public with the function of roundabouts.

Appendix B details the preliminary analysis undertaken for each candidate intersection. The following recommendations are the result of that analysis.

Intersection	Recommendation
Memorial Avenue / High Street	Rejected at this time. This is a complex and busy intersection. Reconfiguration to introduce a 5-legged roundabout may be feasible with further detailed analysis and design, which could help simplify the intersection and improve safety for all road users, but is not recommended at this time.
Beverly Street / Winnipeg Avenue	Rejected at this time due to a lack of demonstrated need to upgrade the intersection to a roundabout. However, this location does present an opportunity to implement a roundabout if desired, as a demonstration project.
John Street / Water Street	Rejected at this time due to site constraints and this segment of Water Street being part of a signal coordination corridor.

Intersection	Recommendation
John Street Road / Mapleward Road	Carry forward.
Court Street / Clavet Street	Rejected at this time due to potential issues with approach grades, as well as the presence of the Court Street bicycle lanes.
Bay Street / Water Street	Rejected at this time due to site constraints and this segment of Water Street being of a signal coordination corridor.
Redwood Avenue / Edward Street	Carry forward with caution. All initial analysis is favourable, however, as this is a proposed to be a 2-lane roundabout, it is recommended that implementation be held off until the general public becomes more familiar with single-lane roundabouts.
Algoma Street / Lyon Boulevard-Gibson Street	Carry forward.
McIntyre Street / Shuniah Street / Ruttan Street	Rejected at this time due to potential issues with approach grades, and the complexity of a 5-leg roundabout with constrained physical dimensions.

Following the results of the initial screening phase, a more rigorous feasibility analysis should be performed on the intersections recommended to be carried forward, including comparing the roundabout to alternative intersection configurations. This process is described in Section 3.3.

Appendix A
Region of Waterloo Roundabout Feasibility Initial Screening Tool

Region of Waterloo

REGION OF WATERLOO
ROUNDABOUT FEASIBILITY
INITIAL SCREENING TOOL VERSION 1.0

The intent of this screening tool is to provide a relatively quick assessment of the feasibility of a modern roundabout at a particular intersection in comparison to other appropriate forms of traffic control or road improvements including auxiliary lanes, traffic control signals, four-way stop, etc. The intended outcome of this tool is to provide enough information to assist staff in deciding whether or not to proceed to an Intersection Control Study to further investigate in more detail the feasibility of a roundabout.

1) Project Name/File No.:

____

____

2) Intersection Location
(Street/Road Names, distance from major intersection, etc.):

____

____

3) Brief Description of Intersection
(Number of Legs, Lanes on each leg, total AADT, AADT on each road, etc. Attach or sketch diagram showing existing and horizon-year turning movements.):

____

____

____

____

4) What operational problems are being experienced at this location?

____

____

____

5) Is it a new intersection or is it a retrofit of an existing intersection? If existing, what is the existing traffic control?

____

____

6) Is the intersection in the vicinity of a railroad crossing *or another intersection?* If so, how close and what type of traffic control exists at the adjacent intersection(s)? Will queues be a problem?

____

____

7) Would the intersection be located within a coordinated signal system?

____

____

8) Would the intersection be located on a Preferred Roundabout Corridor?

____

____

9) Is the intersection located within a corridor that is scheduled for improvements in the 10 Year Transportation Capital Program? What is the ultimate cross-section of the approach roads?

____

____

____

____

10) What is the collision history of the intersection over the past five years? Is there a collision problem that needs to be addressed?

____

____

____

____

11) Are persons with disabilities or horse and buggies frequent users of this intersection?

____

____

____

12) What traditional road improvements are proposed for this intersection? (eg. traffic signals, all-way stop, auxiliary lanes, etc.) Please attach a sketch of the traditional road improvements. A sample sketch is attached (DOCS #529440).

____

____

____

13) If traffic control signals are being considered, are the traffic signal warrants met for the horizon year?

____

____

____

14) What size of roundabout is being considered for this intersection? (eg. Single-lane, two-lane entry or three-lane entry?) Please attach a Traffic Flow Worksheet and lane configuration diagram. Please attach a sketch showing how a roundabout would "fit" into the right-of-way. A sample sketch is attached (DOCS #529433).

____

____

____

15) 20-Year Life Cycle Cost Estimate

10-Year AADT: ______________________

Injury Collision Cost (ICC): ______________________

Discount Rate: (i): ______________________

20 YEAR LIFE-CYCLE COST COMPARISON		
Cost Item	**Other Traffic Control**	**Roundabout**
Implementation Cost	$	$
Injury Collision Cost (Present Value)	$	$
Total Life Cycle Cost	**X**	**Y**

Notes:

- Implementation Cost
  = sum of costs for construction, property utility relocations, illumination, engineering (20%), contingency (20%) and maintenance (5%);
- Present Value of 20 Year Injury Collision Cost
  = expected annual collision frequency x ICC $((1 + i)^{20}-1) / i(1+i)^{20}$

- Monte Carlo Analysis may be required. If so, a range for the implementation cost (i.e. 10%, 50%, 90% probability) is required

Conclusions and Recommendation

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____

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____

____

Appendix B
Initial Screening Analysis

Memorial Ave & High St

Step 1: Suitability and Feasibility Check

CRITERIA	ANALYSIS
Clarify Objectives	Improve safety and operations. Improve environmental outcomes. Remove dangerous ramp from High St.
Existing Configuration	High St (2 lanes) meets Memorial Ave (5 lanes) at a signalized T-intersection. A ramp exists for southbound to south-westbound movements from High to Memorial. Memorial Ave is a transit road.
Road Classifications	Memorial Ave – Major arterial High St – Minor arterial
Property Requirements	City owns required land
Site Constraints	Complex existing configuration with a connection to Beverly immediately off of High St. Nearby commercial driveways need to be considered.
Accommodating Non-motorized Users	There is potential to introduce high quality cycling facilities on Memorial in the future. The roundabout would have to be designed with this in mind, requiring additional space for protected crossings. Pedestrian safety would be improved.
Additional Comments	Nearby Beverly/Winnipeg intersection being considered for a roundabout as well. Opportunity to re-align Beverly and High, but design needs further work.

Step 2: Determine Lane Requirements

See attached Traffic Flow Worksheet

Proposed Configuration: Single-lane roundabout (1 entry lane, 1 circulation lane)

Step 3: Recommendation

Rejected at this time. This is a complex and busy intersection. Reconfiguration to introduce a 5-legged roundabout may be feasible with further detailed analysis and design, which could help simplify the intersection and improve safety for all road users, but is not recommended at this time.

Project No.:	103442	**Horizon Year:**	2013
Intersecrtion:	High St at Memorial Ave	**Time Period:**	AM

Entering+Circulating 829

Memorial Ave N

Entering PCEs 655

42 | 600 | 0 | 0

Exiting PCEs 491

Southbound Approach

Single-Lane (1E,1C) V/C	0.69
Single-Lane (1E,2C) V/C	0.65
Double-Lane (2E,1C) V/C	0.34
Double-Lane (2E,2C) Left V/C	0.33
Double-Lane (2E,2C) Right V/C	0.33
% Trucks	2%

Westbound Approach

Single-Lane (1E,1C) V/C	0.00
Single-Lane (1E,2C) V/C	0.00
Double-Lane (2E,1C) V/C	0.00
Double-Lane (2E,2C) Left V/C	0.00
Double-Lane (2E,2C) Right V/C	0.00
% Trucks	0%

Exiting PCEs 217

Entering+Circulating 1067

High St W

0

Entering PCEs 455

40
0
412

174

612

665

40

0
0
0

0

Entering PCEs 0

High St E

665 **Entering+Circulating**

0 **Exiting PCEs**

% Trucks 1%

Single-Lane (1E,1C) V/C	0.74
Single-Lane (1E,2C) V/C	0.62
Double-Lane (2E,1C) V/C	0.37
Double-Lane (2E,2C) Left V/C	0.32
Double-Lane (2E,2C) Right V/C	0.31

- Input Field (veh/hr, %)

- Formula Field (PCE)

Eastbound Approach

1027 **Exiting PCEs**

0 | 167 | 433 | 0

625 **Entering PCEs**

Memorial Ave S

Entering+Circulating 665

% Trucks 4%

Single-Lane (1E,1C) V/C	0.58
Single-Lane (1E,2C) V/C	0.57
Double-Lane (2E,1C) V/C	0.29
Double-Lane (2E,2C) Left V/C	0.29
Double-Lane (2E,2C) Right V/C	0.28

Northbound Approach

Beverly St & Winnipeg Ave

Step 1: Suitability and Feasibility Check

CRITERIA	ANALYSIS
Clarify Objectives	Improve safety and operations. Improve environmental outcomes.
Existing Configuration	Both streets are 2-lanes. Winnipeg Ave has bike lanes on both sides of the intersection, while Beverly St has bike lanes only to the west. Winnipeg Ave has a stop sign in both directions at Beverly. An existing transit route turns from Beverly EB to Winnipeg NB and Winnipeg SB to Beverly WB.
Road Classifications	Beverly St – Collector Winnipeg Ave – Local
Property Requirements	City owns all land to the north. Realignment may be necessary.
Site Constraints	Residential driveway on south leg of Winnipeg Ave very close to proposed location. Some grade issues may exist to the north where the Community Auditorium landscaping begins, resulting in additional grading work being required.
Accommodating Non-motorized Users	Careful consideration for cyclists should be undertaken as bike lanes are present on Beverly to the west and Winnipeg to the north and south.
Additional Comments	Nearby Memorial/High being considered for a roundabout as well. Potential for Winnipeg to be closed to traffic a block north.

Step 2: Determine Lane Requirements

See attached Traffic Flow Worksheet

Proposed Configuration: Single-lane roundabout (1 entry lane, 1 circulation lane)

Step 3: Recommendation

Rejected at this time due to a lack of demonstrated need to upgrade the intersection to a roundabout. However, this location does present an opportunity to implement a roundabout if desired, as a demonstration project.

Project No.:	103442	**Horizon Year:**	2016
Intersecrtion:	Beverly St at Winnipeg Ave	**Time Period:**	AM

Entering+Circulating 246

Winnipeg Ave N

Entering PCEs 142

71	45	24	0

Exiting PCEs 63

Southbound Approach

Single-Lane (1E,1C) V/C	0.14
Single-Lane (1E,2C) V/C	0.14
Double-Lane (2E,1C) V/C	0.07
Double-Lane (2E,2C) Left V/C	0.07
Double-Lane (2E,2C) Right V/C	0.07
% Trucks	1%

Westbound Approach

Single-Lane (1E,1C) V/C	0.10
Single-Lane (1E,2C) V/C	0.10
Double-Lane (2E,1C) V/C	0.05
Double-Lane (2E,2C) Left V/C	0.05
Double-Lane (2E,2C) Right V/C	0.05
% Trucks	1%

Exiting PCEs 175

104

Entering+Circulating 293

Beverly St W

0

Entering PCEs 222

45
131
45

71

64

201

12
89
1

Entering PCEs 103

0

Beverly St E

167 **Entering+Circulating**

158
Exiting PCEs

% Trucks 0%

Single-Lane (1E,1C) V/C	0.21
Single-Lane (1E,2C) V/C	0.21
Double-Lane (2E,1C) V/C	0.11
Double-Lane (2E,2C) Left V/C	0.10
Double-Lane (2E,2C) Right V/C	0.10

92
Exiting PCEs

0	13	6	2

21
Entering PCEs

Winnipeg Ave S

Entering+Circulating 222

% Trucks 0%

Single-Lane (1E,1C) V/C	0.02
Single-Lane (1E,2C) V/C	0.02
Double-Lane (2E,1C) V/C	0.01
Double-Lane (2E,2C) Left V/C	0.01
Double-Lane (2E,2C) Right V/C	0.01

Northbound Approach

- Input Field (veh/hr, %)

- Formula Field (PCE)

Eastbound Approach

Note: Double-lane rounabout analysis assumes even entry lane utilization.

John St & Water St

Step 1: Suitability and Feasibility Check

CRITERIA	ANALYSIS
Clarify Objectives	Improve operations. Improve environmental outcomes.
Existing Configuration	John St (4 lanes) meets Water St (4/5 lanes) at a signalized T-intersection There is no transit at this location.
Road Classifications	Water St – Major arterial John St – Minor arterial
Property Requirements	Property acquisition unlikely to be required.
Site Constraints	Parallel railway constrains any changes to the east side of the intersection, roads would need to be re-aligned to meet a roundabout, however removal of the left turn lane and painted median can help make up some of that space.
Accommodating Non-motorized Users	There are no sidewalks along Water St, pedestrian volume is likely minimal. No cycling infrastructure at this location and likely low cycling volumes.
Additional Comments	This intersection is part of a signal coordination corridor and as such, it would only make sense to convert to a roundabout if the entire corridor was being converted.

Step 2: Determine Lane Requirements

See attached Traffic Flow Worksheet

Proposed Configuration: Double-lane roundabout (2 entry lanes, 2 circulation lanes)

Step 3: Recommendation

Rejected at this time due to site constraints and this segment of Water St being part of a signal coordination corridor.

Project No.:	103442	**Horizon Year:**	2014
Intersecrtion:	John St at Water St	**Time Period:**	AM

Southbound Approach

Single-Lane (1E,1C) V/C	1.22
Single-Lane (1E,2C) V/C	1.20
Double-Lane (2E,1C) V/C	0.61
Double-Lane (2E,2C) Left V/C	0.60
Double-Lane (2E,2C) Right V/C	0.60
% Trucks	30%

Water St N

Entering+Circulating	1356
Entering PCEs	1300
Exiting PCEs	923

130	871	0	0

Westbound Approach

Single-Lane (1E,1C) V/C	0.00
Single-Lane (1E,2C) V/C	0.00
Double-Lane (2E,1C) V/C	0.00
Double-Lane (2E,2C) Left V/C	0.00
Double-Lane (2E,2C) Right V/C	0.00
% Trucks	0%

John St W

Exiting PCEs	224
Entering+Circulating	1402
Entering PCEs	271

0
125
0
80

Circulating flows

55	978
1131	165

John St E

Entering PCEs	0
Entering+Circulating	978
Exiting PCEs	0

0
0
0
0

Eastbound Approach

% Trucks	32%
Single-Lane (1E,1C) V/C	0.74
Single-Lane (1E,2C) V/C	0.53
Double-Lane (2E,1C) V/C	0.37
Double-Lane (2E,2C) Left V/C	0.28
Double-Lane (2E,2C) Right V/C	0.26

- Input Field (veh/hr, %)

- Formula Field (PCE)

Water St S

Exiting PCEs	1237
Entering PCEs	813
Entering+Circulating	978

0	43	589	0

Northbound Approach

% Trucks	29%
Single-Lane (1E,1C) V/C	0.85
Single-Lane (1E,2C) V/C	0.81
Double-Lane (2E,1C) V/C	0.42
Double-Lane (2E,2C) Left V/C	0.41
Double-Lane (2E,2C) Right V/C	0.40

John St Rd & Mapleward Rd

Step 1: Suitability and Feasibility Check

CRITERIA	ANALYSIS
Clarify Objectives	Improve operations and increase safety. Improve environmental outcomes.
Existing Configuration	John St Rd and Mapleward Rd are each 2 lane rural roads. One-way stop control is in place with John St Rd having priority. There is no transit at this location.
Road Classifications	John St Rd – Rural arterial Mapleward Rd – Rural arterial
Property Requirements	Property acquisition will be required. The City owns lands to the southwest, but any realignment would result in additional property requirements.
Site Constraints	The intersection is angled with the smallest angle between legs being roughly 60 degrees.
Accommodating Non-motorized Users	Cyclist and pedestrian volumes are minimal at this location.
Additional Comments	

Step 2: Determine Lane Requirements

See attached Traffic Flow Worksheet

Proposed Configuration: Single-lane roundabout (1 entry lane, 1 circulation lane)

Step 3: Recommendation

Carry forward.

Project No.: 103442 **Horizon Year:**

Intersecrtion: John St Rd at Mapleward Rd **Time Period:** AM

Entering+Circulating 150

Mapleward Rd N

Entering PCEs 102

7 | 40 | 50 | 0

Exiting PCEs 32

N

Southbound Approach

Single-Lane (1E,1C) V/C	0.09
Single-Lane (1E,2C) V/C	0.09
Double-Lane (2E,1C) V/C	0.05
Double-Lane (2E,2C) Left V/C	0.05
Double-Lane (2E,2C) Right V/C	0.05
% Trucks	5%

Westbound Approach

Single-Lane (1E,1C) V/C	0.04
Single-Lane (1E,2C) V/C	0.04
Double-Lane (2E,1C) V/C	0.02
Double-Lane (2E,2C) Left V/C	0.02
Double-Lane (2E,2C) Right V/C	0.02
% Trucks	10%

Exiting PCEs 51

Entering+Circulating 178

John St Rd W

0

Entering PCEs 79

4

67

4

48

99

34

127

2

36

4

Entering PCEs 46

0

John St Rd E

80 Entering+Circulating

135 Exiting PCEs

51 Exiting PCEs

0 | 4 | 25 | 12

42 Entering PCEs

Mapleward Rd S

Entering+Circulating 169

% Trucks	5%
Single-Lane (1E,1C) V/C	0.08
Single-Lane (1E,2C) V/C	0.07
Double-Lane (2E,1C) V/C	0.04
Double-Lane (2E,2C) Left V/C	0.04
Double-Lane (2E,2C) Right V/C	0.04

- Input Field (veh/hr, %)

- Formula Field (PCE)

Eastbound Approach

% Trucks	2%
Single-Lane (1E,1C) V/C	0.04
Single-Lane (1E,2C) V/C	0.04
Double-Lane (2E,1C) V/C	0.02
Double-Lane (2E,2C) Left V/C	0.02
Double-Lane (2E,2C) Right V/C	0.02

Northbound Approach

Court St & Clavet St

Step 1: Suitability and Feasibility Check

CRITERIA	ANALYSIS
Clarify Objectives	Improve operations. Improve environmental outcomes.
Existing Configuration	Both streets are 2-lanes and the intersection is controlled by stop signs only for Court St traffic. Court St has bicycle lanes in both directions. Two transit routes use this location including one route making a right hand turn from SB Court onto WB Clavet. The other route proceeds across the intersection on Clavet.
Road Classifications	Court St – Collector Clavet St – Local
Property Requirements	Property acquisition may be required
Site Constraints	Grades should be analyzed in further detail as Clavet runs downhill from the west. Grades should be limited to 3-4% in the last 20m of the approach and should not exceed 6% within the deceleration zone. Further analysis would be required to determine whether this intersection meets those criteria.
Accommodating Non-motorized Users	Court St currently has bicycle lanes, special care should be taken to accommodate these users safely.
Additional Comments	

Step 2: Determine Lane Requirements

See attached Traffic Flow Worksheet

Proposed Configuration: Single-lane roundabout (1 entry lane, 1 circulation lane)

Step 3: Recommendation

Rejected at this time due to a lack of demonstrated need to upgrade the intersection to a roundabout. However, this location does present an opportunity to implement a roundabout if desired, as a demonstration project.

Project No.: 103442 **Horizon Year:** 2013

Intersecrtion: Clavet St at Court St **Time Period:** AM

Entering+Circulating 136

Court St N

Entering PCEs 87.966

13	62	6	0

Exiting PCEs 88

Southbound Approach

Single-Lane (1E,1C) V/C	0.08
Single-Lane (1E,2C) V/C	0.08
Double-Lane (2E,1C) V/C	0.04
Double-Lane (2E,2C) Left V/C	0.04
Double-Lane (2E,2C) Right V/C	0.04
% Trucks	9%

Westbound Approach

Single-Lane (1E,1C) V/C	0.04
Single-Lane (1E,2C) V/C	0.04
Double-Lane (2E,1C) V/C	0.02
Double-Lane (2E,2C) Left V/C	0.02
Double-Lane (2E,2C) Right V/C	0.02
% Trucks	15%

Exiting PCEs 59

Entering+Circulating 177

Clavet St W

Entering PCEs 100

0
25
69
4

48

77

97

102

4
27
3
0

Entering PCEs 39

Clavet St E

136 **Entering+Circulating**

93

Exiting PCEs

% Trucks 2%

% Trucks 4%

75

Exiting PCEs

0	13	56	16

88

Entering PCEs

Single-Lane (1E,1C) V/C	0.10
Single-Lane (1E,2C) V/C	0.09
Double-Lane (2E,1C) V/C	0.05
Double-Lane (2E,2C) Left V/C	0.05
Double-Lane (2E,2C) Right V/C	0.05

Single-Lane (1E,1C) V/C	0.09
Single-Lane (1E,2C) V/C	0.08
Double-Lane (2E,1C) V/C	0.04
Double-Lane (2E,2C) Left V/C	0.04
Double-Lane (2E,2C) Right V/C	0.04

- Input Field (veh/hr, %)

- Formula Field (PCE)

Court St S

Entering+Circulating 190

Northbound Approach

Eastbound Approach

Note: Double-lane rounabout analysis assumes even entry lane utilization.

Bay St & Water St

Step 1: Suitability and Feasibility Check

CRITERIA	ANALYSIS
Clarify Objectives	Improve operations. Improve environmental outcomes.
Existing Configuration	Bay St (4 lanes) meets Water St (4/5 lanes) at a signalized T-intersection. There is an existing transit route that turns from Bay EB to Water NB and Water SB to Bay WB.
Road Classifications	Water St – Major arterial Bay St – Collector
Property Requirements	Some property acquisition may be required, depending on the size and design speed of the roundabout.
Site Constraints	Lake St meets Bay St 10 metres from Water St, would need to be considered for closure or as another leg. The rail corridor is directly against the curbline of the existing Water St. Realignment of the approaches would be necessary.
Accommodating Non-motorized Users	Cycling volumes are low, pedestrian volumes are low, but with potential for some growth with the north core to the north and west. Crossing Water St at this location would not be required for pedestrians, however.
Additional Comments	This intersection is part of a signal coordination corridor and as such, it would only make sense to convert to a roundabout if the entire corridor was being converted. If implemented, consideration should be given to reducing Bay St to 2-lanes, but greater analysis of existing and future traffic volumes would be required.

Step 2: Determine Lane Requirements

See attached Traffic Flow Worksheet

Proposed Configuration: Double-lane roundabout (2 entry lanes, 2 circulation lanes)

Step 3: Recommendation

Rejected at this time due to site constraints and this segment of Water St being of a signal coordination corridor.

Project No.: 103442 **Horizon Year:** 2012

Intersecrtion: Bay St at Water St **Time Period:** AM

Entering+Circulating 1052

Water St N

Entering PCEs 990

70 | 889 | 0 | 0

Exiting PCEs 618

Southbound Approach

Single-Lane (1E,1C) V/C	0.93
Single-Lane (1E,2C) V/C	0.91
Double-Lane (2E,1C) V/C	0.47
Double-Lane (2E,2C) Left V/C	0.46
Double-Lane (2E,2C) Right V/C	0.46
% Trucks	3%

Westbound Approach

Single-Lane (1E,1C) V/C	0.00
Single-Lane (1E,2C) V/C	0.00
Double-Lane (2E,1C) V/C	0.00
Double-Lane (2E,2C) Left V/C	0.00
Double-Lane (2E,2C) Right V/C	0.00
% Trucks	0%

Exiting PCEs 135

Entering+Circulating 985

Bay St W

0

Entering PCEs 68

18

0

46

62

917

680

19

0

0

0

Entering PCEs 0

0

Bay St E

680 Entering+Circulating

0 Exiting PCEs

Eastbound Approach

% Trucks	6%
Single-Lane (1E,1C) V/C	0.15
Single-Lane (1E,2C) V/C	0.11
Double-Lane (2E,1C) V/C	0.08
Double-Lane (2E,2C) Left V/C	0.06
Double-Lane (2E,2C) Right V/C	0.06

966 Exiting PCEs

0 | 60 | 576 | 0

661 Entering PCEs

Northbound Approach

% Trucks	4%
Single-Lane (1E,1C) V/C	0.60
Single-Lane (1E,2C) V/C	0.59
Double-Lane (2E,1C) V/C	0.30
Double-Lane (2E,2C) Left V/C	0.30
Double-Lane (2E,2C) Right V/C	0.30

Water St S

Entering+Circulating 680

- Input Field (veh/hr, %)

- Formula Field (PCE)

Note: Double-lane rounabout analysis assumes even entry lane utilization.

Redwood Ave & Edward St

Step 1: Suitability and Feasibility Check

CRITERIA	ANALYSIS
Clarify Objectives	Improve operations and safety. Improve environmental outcomes. Significant opportunity to “right-size” this intersection.
Existing Configuration	Edward is a 4/5-lane road, Redwood is 2 lanes plus turn lanes at the intersection. There are channelized right turn lanes from southbound to westbound and eastbound to southbound. Two transit lines exist here, including one turning from EB Redwood to NB Edward and SB Edward to WB Redwood. The other route proceeds across the intersection on Edward.
Road Classifications	Edward St – Major arterial Redwood Ave – Collector
Property Requirements	No property required.
Site Constraints	The existing intersection is large enough to easily accommodate a roundabout with an inscribed circle diameter of 60 metres, and likely much larger, though that would not be necessary given desired speeds and volumes.
Accommodating Non-motorized Users	Opportunity to improve pedestrian experience by eliminating existing high speed turn channels and shrinking the size of the intersection by eliminating right and left turn lanes.
Additional Comments	This location presents a terrific opportunity to implement a roundabout, but due to Edward St being a 4-lane road, it may not be the best site for the first installation, as the double-lane round about adds an extra level of complexity for drivers unaccustomed to roundabouts.

Step 2: Determine Lane Requirements

See attached Traffic Flow Worksheet

Proposed Configuration: Double-lane roundabout (2 entry lanes from Edward, 1 entry lane from Redwood, 2 circulation lanes)

Step 3: Recommendation

Carry forward with caution. All initial analysis is favourable, however, as this is a proposed to be a 2-lane roundabout, it is recommended that implementation be held off until the general public becomes more familiar with single-lane roundabouts.

Project No.: 103442 **Horizon Year:** 2015

Intersecrtion: Redwood Ave at Edward St **Time Period:** AM

Entering+Circulating 488

Edward St N

Entering PCEs 395

47	246	82	0

Exiting PCEs 475

Southbound Approach

Single-Lane (1E,1C) V/C	0.38
Single-Lane (1E,2C) V/C	0.37
Double-Lane (2E,1C) V/C	0.19
Double-Lane (2E,2C) Left V/C	0.19
Double-Lane (2E,2C) Right V/C	0.19
% Trucks	5%

Westbound Approach

Single-Lane (1E,1C) V/C	0.20
Single-Lane (1E,2C) V/C	0.17
Double-Lane (2E,1C) V/C	0.10
Double-Lane (2E,2C) Left V/C	0.09
Double-Lane (2E,2C) Right V/C	0.09
% Trucks	1%

Exiting PCEs 94

Entering+Circulating 589

Redwood Ave W

0

Entering PCEs 195

125
25
43

94

394

424

238

83
12
48

Entering PCEs 145

0

Redwood Ave E

569 Entering+Circulating

146 Exiting PCEs

351 Exiting PCEs

0	32	259	34

332 Entering PCEs

Edward St S

Entering+Circulating 570

% Trucks	1%
Single-Lane (1E,1C) V/C	0.26
Single-Lane (1E,2C) V/C	0.23
Double-Lane (2E,1C) V/C	0.13
Double-Lane (2E,2C) Left V/C	0.12
Double-Lane (2E,2C) Right V/C	0.11

- Input Field (veh/hr, %)

- Formula Field (PCE)

Eastbound Approach

% Trucks	2%
Single-Lane (1E,1C) V/C	0.37
Single-Lane (1E,2C) V/C	0.35
Double-Lane (2E,1C) V/C	0.19
Double-Lane (2E,2C) Left V/C	0.18
Double-Lane (2E,2C) Right V/C	0.17

Northbound Approach

Algoma St & Lyon Blvd-Gibson St

Step 1: Suitability and Feasibility Check

CRITERIA	ANALYSIS
Clarify Objectives	Improve operations and safety. Improve environmental outcomes.
Existing Configuration	T-intersection controlled as an all-way stop. There is no transit at this location.
Road Classifications	Algoma St – Minor arterial Gibson St – Minor arterial Lyon Blvd - Local
Property Requirements	Property is likely not required as the City owns property to the north. Re-alignment may be required to stay within existing property lines.
Site Constraints	Immediately south of the intersection is a driveway to St. Ignatius High School's bus loop, which must be taken into consideration. As buses may need to use the new roundabout, consideration should be given to ensure they can make the left hand turn north bound from Gibson, in particular.
Accommodating Non-motorized Users	A multi-use path runs parallel to Lyon/Gibson and may need to be relocated slightly. This is a popular recreational area so the roundabout should be designed with consideration to recreational users.
Additional Comments	Lyon Blvd has been considered for closure to automobiles northwest of the intersection. Through traffic would decrease, but parking lot access would still generate traffic.

Step 2: Determine Lane Requirements

See attached Traffic Flow Worksheet

Proposed Configuration: Single-lane roundabout (1 entry lane, 1 circulation lane)

Step 3: Recommendation

Carry forward.

Project No.: 103442 **Horizon Year:**

Intersecrtion: Algoma at Lyon-Gibson **Time Period:** AM

Southbound Approach

Single-Lane (1E,1C) V/C	0.05
Single-Lane (1E,2C) V/C	0.05
Double-Lane (2E,1C) V/C	0.03
Double-Lane (2E,2C) Left V/C	0.03
Double-Lane (2E,2C) Right V/C	0.03
% Trucks	0%

Entering+Circulating 129

Lyon-Gibson N

Entering PCEs 55

19	36	0	0

Exiting PCEs 50

Westbound Approach

Single-Lane (1E,1C) V/C	0.00
Single-Lane (1E,2C) V/C	0.00
Double-Lane (2E,1C) V/C	0.00
Double-Lane (2E,2C) Left V/C	0.00
Double-Lane (2E,2C) Right V/C	0.00
% Trucks	0%

Exiting PCEs 93

Entering+Circulating 259

Algoma W

Entering PCEs 223

0
29
1
193

74

36

123

30

0
1
0
0

Entering PCEs 1

Algoma E

124 Entering+Circulating

1 Exiting PCEs

Eastbound Approach

% Trucks	0%
Single-Lane (1E,1C) V/C	0.20
Single-Lane (1E,2C) V/C	0.20
Double-Lane (2E,1C) V/C	0.10
Double-Lane (2E,2C) Left V/C	0.10
Double-Lane (2E,2C) Right V/C	0.10

- Input Field (veh/hr, %)

- Formula Field (PCE)

229 Exiting PCEs

0	63	18	0

94 Entering PCEs

Lyon-Gibson S

Entering+Circulating 124

Northbound Approach

% Trucks	16%
Single-Lane (1E,1C) V/C	0.09
Single-Lane (1E,2C) V/C	0.08
Double-Lane (2E,1C) V/C	0.04
Double-Lane (2E,2C) Left V/C	0.04
Double-Lane (2E,2C) Right V/C	0.04

Note: Double-lane rounabout analysis assumes even entry lane utilization.

McIntyre St, Shuniah St & Ruttan St

Step 1: Suitability and Feasibility Check

CRITERIA	ANALYSIS
Clarify Objectives	Improve operations and safety. Improve environmental outcomes.
Existing Configuration	5-point intersection with stop signs at Shuniah and Ruttan. All are 2-lane roads. Shuniah has bike lanes which continue on McIntyre one block to Algoma St. There is no transit at this location.
Road Classifications	Shuniah St – Collector McIntyre St – Local Ruttan St – Local
Property Requirements	Property acquisition may be required.
Site Constraints	The intersection has 5-legs which presents some difficulties with a smaller scale roundabout, in terms of turn radii, etc for larger vehicles. This can be solved by having a fully mountable centre island, however. There are also homes rather close to the street along McIntyre that could constrain the design. Approaches to this intersection are on a slope and will require further investigation. Grades should be limited to 3-4% in the last 20m of the approach and should not exceed 6% within the deceleration zone.
Accommodating Non-motorized Users	Consideration should be given to how cyclists will be expected to use the roundabout. Separated facilities are preferred. Pedestrians should be accommodated in all directions.
Additional Comments	

Step 2: Determine Lane Requirements

Traffic Flow Worksheet could not be completed for this intersection as traffic volumes are not available

Proposed Configuration: Single-lane roundabout (1 entry lane, 1 circulation lane)

Step 3: Recommendation

Rejected at this time due to potential issues with approach grades, and the complexity of a 5-leg roundabout with constrained physical dimensions.

Note: Due to lack of available data, no traffic flow worksheet is available for this intersection.