Chapter 1 - Introduction

One of the crucial elements to installing a successful roundabout is determining how such a design would best fit into a given context. Using a method adapted from the Institute of Transportation Engineer’s *Context Sensitive Solutions in Designing Major Urban thoroughfares for Walkable Communities* (2006), this report will determine the elements of a context appropriate roundabout concept for the Princess, Bath, and Concession (PBC) intersection. The overarching goal of this report is to present a roundabout that would be an alternative to the existing intersection, a roundabout design that would improve upon existing conditions for all road users. In addition, a secondary goal of this report is to produce a study that could be used as a reference by other municipal planners when assessing the feasibility of installing roundabouts at other intersections.

This report focuses solely on the redesign of the Princess, Bath and Concession Streets intersection, hereafter referred to as the PBC intersection. Although ideas for roundabouts have been previously proposed for intersections elsewhere in Kingston; the PBC intersection merits special attention because it once was a notable traffic circle. The “old traffic circle” still lives on in the memory of many Kingston residents and still commands significant public attention (Schliesmann, 2009).

This report builds upon previous research and design work conducted by the author, previous public presentations about a roundabout at the PBC intersection conducted by Queen’s University, and a newspaper article published by the Kingston Whig-Standard regarding the author’s proposed design for the intersection. These public presentations and the newspaper article sparked a renewed interest in the site of Kingston’s “old traffic circle.” However, public reaction to the proposed roundabout design was mixed.

Although many Kingston residents embraced the idea of a roundabout, others were sceptical about its safety and some were concerned that it was no longer an appropriate design for the current context. As mentioned previously, the goal of this report is to present a roundabout design that would be an alternative to the existing intersection. In response to public scepticism about a roundabout for the PBC intersection, this report will outline a design which fully encompasses safety concerns and is driven by context sensitivity. This introductory chapter contains a brief history of the “old traffic circle,” the rationale for its removal, and a section on design principles to provide the reader with some context on the basics of roundabout design and performance.
The Old Traffic Circle

The removal of the traffic circle from the intersection of Princess, Bath, and Concession Streets in the 1970’s was a decision that reflected the prevalent planning theory of the time. During this period, in cities across North America, municipal officials were opting to expand the traffic capacities of urban roadways without much thought put towards other road users, such as pedestrians or cyclists. At the time, planning was heavily influenced by personalities such as Robert Moses, who believed in the power of suburbia, the automobile, and the expressway commute. It was this line of thought that led to the conversion of Kingston’s most notable traffic circle into a five-way signalized intersection (Schliesmann, 2009).

Although colloquially referred to as “Kingston’s old traffic circle,” the intersection as designed was actually a roundabout. The design differences between a roundabout and a traffic circle will be discussed in detail in the following section. Former Kingston Mayor, Val Swain, campaigned vigorously in the 1970’s to have the traffic circle removed so that Bath Road could be upgraded to an expressway; which would have extended to a third crossing over the Cataraqui River. Although that third crossing was never constructed and the plans for the Bath expressway were scrapped, Mayor Swain was nonetheless successful in removing the traffic circle.

Today, however, planning theory has moved away from the practices established by Moses and his followers. Planners are more influenced by the theories and principles of Jane Jacobs, who stressed the importance of neighbourhood design and walkable streets. Similarly, street design has also been influenced by urban designers who embraced Jacobs’ principles; including Andres Duany, Plater Zyberg, and Peter Calthorpe. These influences have resulted in a renaissance of the roundabout in the United States, which has now been coded by the Institute of Transportation Engineers as the “modern roundabout” (ITE, 2008).

However, despite the ubiquity of roundabouts in Europe and its resurgence in the United States, this type of intersection design remains rare in Canada. In general, public attitudes remain sceptical about the safety and the complexity of the design, especially when compared to a conventional signalized intersection. Although at first glance a roundabout may appear daunting for anyone who has never experienced using one before, empirical studies have shown they repeatedly outperform conventional intersections in terms of vehicular and pedestrian safety (Persaud et al., 2002; Jacquemart, 1998; Robinson, 2000; Schoon and Minnen, 1993). The following design principles section will expand on the safety performance of roundabouts, outline the design elements of a roundabout, and examine some of its advantages and disadvantages when compared to a conventional intersection.
Figure 1. Aerial Photograph of former Kingston Traffic Circle, circa 1965.
Source: Kingston Whig-Standard Article May 18, 2009
Roundabout Design Principles

Baseline facts and current research results concerning roundabouts are examined in this section of the chapter. Although this section will reveal important details about roundabout design, its primary objective is to provide context. The majority of this literature stems from references given in the Institute of Transportation Engineer’s (ITE) report on *Enhancing Intersection Safety through Roundabouts* (2008).

The identified strengths and weaknesses of a roundabout’s design will provide a basis for the evaluation of the proposed design in the Analysis Chapter. The creation of the proposed design stems solely from the methodology described in the Method Chapter. Topics such as the design differences between traffic circles and roundabouts, and the advantages/disadvantages of roundabouts compared to conventional intersections will be discussed here.

**Traffic Circle vs. “Modern Roundabout”**

A modern roundabout is not the same facility as a traffic circle. Traffic circles are small raised islands, placed in intersections, around which traffic circulates. They are good for calming intersections, especially within neighbourhoods, where large vehicle traffic is not a major concern but speeds, volumes, and safety are problems.

Roundabouts require traffic to circulate counter-clockwise around a center island. Unlike traffic circles, roundabouts are used on higher volume streets to allocate right-of-way between competing movements. The term 'modern roundabout' is used in the United States to differentiate modern roundabouts from nonconforming traffic circles or rotaries that have been in use for many years. Modern roundabouts have two basic operational and design principles: Yield at entry, and Deflection of Entering Traffic. The design specifics for roundabouts vary greatly across the United States and Europe. Modern Roundabouts can have multiple entry or circulating lanes. They can be placed in many different types of road junctions, ranging from three to six intersecting routes. They can also vary in geometry, from the traditional circular layout to oval shaped layouts, (see Figure 4). Therefore, no formal or universal design standards exist for roundabouts; although some municipalities and counties, such as the State Highway Administration of Maryland, have set design guidelines to ensure design consistency across their own jurisdictions (State of Maryland, 1995). Figure 3 provides an illustration of the basic design features of a modern roundabout and the following table provides an overview of the different facets between modern roundabouts and traffic circles.

![Figure 2. Example of Traffic Circle located on Napier Street, Kingston, ON. Source: Adrian Brett](image1)

![Figure 3. Basic Design Features of a Modern Roundabout Source: Maryland State Highway Administration](image2)
Table 1. Design facets of Traffic Circles and Roundabouts

Traffic Circle Features
- Small raised island placed in middle of intersection around which traffic circulates in a counter-clockwise direction
- No deflection or splitter islands at entry

Appropriate for:
- Traffic calming on local streets in residential areas

Modern Roundabout Features
- Large central island around which traffic circulates in a counter-clockwise direction
- Deflection and splitter islands at entry
- Can vary in number of entry/circulating lanes and geometric layout

Appropriate for:
- Local or arterial roads
- Intersections with irregular approach geometry

Although they are alike in several ways, traffic circles and modern roundabouts do indeed have design differences, as can be seen above. This report examines and builds upon the design of ‘modern roundabouts,’ but will hereafter refer to them simply as roundabouts for the sake of brevity. The following section focuses on the performance of roundabouts and their comparison to conventional intersections.
Safety Performance for Vehicles, Pedestrians, and Cyclists

When compared to conventional intersections, roundabouts have shown a reduction in both the severity and overall number of automobile collisions (Persaud et al., 2002; Jacquemart, 1998; Robinson, 2000; Schoon and Minnen, 1993). This can be largely attributed to the design of a roundabout which necessitates entering traffic to yield to circulating vehicles (Persaud et al., 2002). Also the deflection of traffic at entry, and the curvature of the travel path through the intersection assist in reducing travel speeds. Furthermore, counter-clockwise circulation around the centre island reduces conflict points, largely eliminating certain types of collisions such as right angle and left turn head-on crashes, (see Figure 5). Collisions caused by a vehicle running a red light, which have the highest potential to be fatal, are completely eliminated by a roundabout’s design. A relevant study conducted by Persaud et al. (2002) evaluated the change in crash rates following the conversion of twenty-four conventional intersections to roundabouts in the United States. After the conventional intersections were converted to roundabouts, there was a statistically significant reduction of 39 percent in crash rates; for crash rates involving injuries, the reduction was 76 percent and crashes involving deaths or incapacitating injuries fell by about 90 percent (Persaud et al., 2002).

![Figure 5. Illustration of reduced Traffic Conflict Points at a Roundabout](source: Journal of Planning Literature, May, 2009.)

Pedestrian safety in roundabouts fares as well or even better than in conventional intersections. Single-lane roundabouts, in particular, have been reported to produce substantially lower pedestrian crash rates than comparable intersections with traffic signals (Brude and Larsson, 2000). The mitigating factor for pedestrian safety is vehicular travel speed. The risk of a fatal pedestrian-vehicle collision climbs exponentially from 5 percent at travel speeds of twenty miles per hour to an 85 percent chance of being killed at travel speeds of forty miles per hour (Zegeer et al., 2002). Thus, the lower the operational speed of the roundabout the safer it will be for all road users.

One additional safety concern, especially for high traffic roundabouts, is accessibility for pedestrians with vision impairments. With virtually uninterrupted traffic flow through roundabouts, the crossing task for blind pedestrians becomes difficult. A study conducted by Schroeder et al. (2008) recommends installing audio signals at roundabouts to remedy this situation.
Unfortunately, cyclists do not enjoy the same level of safety as vehicles or pedestrians at roundabouts, and are sometimes regarded as an annoyance by motorists (Brilon and Vandehay, 1998). A study conducted in Denmark by Møller and Hels (2008) found that 81 percent of killed or injured road-users in roundabouts were cyclists or moped riders. The reasons for such high accident rates among cyclists in roundabouts is still unknown, although results from a few studies focusing on the behaviour of the driver indicate that the phenomenon ‘looked-but-failed-to-see’ is involved (Rääsänen and Summala, 1998; Herslund and Jørgensen, 2003). ‘Looked-but-failed-to-see’ regards the behaviour of the driver just before the accident and refers to situations where the driver, although looking in the direction of the cyclist, fails to perceive it. Although small roundabouts with low traffic capacity may be relatively safe for cyclists, several studies recommend separate cycling facilities for moderate to large roundabouts (Brilon and Vandehay, 1998; Dabbour and Easa, 2008). Such facilities should also cross vehicular lanes adjacent to the pedestrian crossings, see Figure 6 (Dabbour and Easa, 2008; ITE, 2008). The following four subsections provide context on roundabout traffic capacity, environmental impacts, social impacts, and financial costs.

**Roundabout Sizes and Traffic Capacities**

The number of entry and circulating lanes determines the vehicular capacity of a roundabout. Small single-lane roundabouts, similar to the former Kingston “traffic circle,” can accommodate a range of 10,000-15,000 vehicles per day, whereas larger multi-lane roundabouts can accommodate up to 25,000 vehicles per day (Nambisan and Parimi, 2007; Brilon and Vandehay, 1998). Figure 7 illustrates the relationship between additional lanes in a roundabout and vehicular capacity, in passenger car units per hour (pcu/h). It should be noted from Figure 7 that the addition of a second or third entry lane provides only a limited increase in capacity. This is most likely explained by the fact that drivers are usually reluctant to use left-hand entry lanes because they are concerned it will be difficult to exit the roundabout from the inside lane (Brilon and Vandehay, 1998). In the case of the PBC intersection, which is already a high volume intersection, a roundabout with a high traffic capacity would likely be considered the best candidate to replace the existing design.
Environmental Impact of Roundabouts

When compared to conventional intersections, one of the main environmental advantages of roundabouts is a reduction in necessary impermeable surface area. The centre island of a roundabout is usually grass covered and, in general, roundabouts require 20 to 30 percent less impermeable surface coverage than conventional intersections (Brilon and Vandehey, 1998). This helps to reduce the adverse effects of storm water run-off. Vehicles in a roundabout also usually experience less delay than vehicles travelling through a signalized intersection. Reducing idling times at intersections also helps to reduce vehicular emissions. Mandavilli et al. (2008) found a reduction of 16 to 59 percent of carbon dioxide (CO₂) emissions for vehicles in roundabouts compared to vehicles in conventional intersections. The study also found statistically significant reductions in carbon monoxide (CO), Nitrogen Oxides (NOₓ) and hydrocarbon (HC) emissions (Mandavilli et al., 2008).

Aesthetic Impacts of Roundabouts

Roundabouts are generally regarded by the public, especially in Europe, as more aesthetically pleasing than conventional intersections (Brilon and Vandehey, 1998; Retting et al., 2002). The centre island provides the opportunity for landscape treatments, monuments, or a piece of significant architecture. Prior to its removal, Kingston’s ‘old traffic circle’ had flowers regularly planted in its centre island by Alcan Inc. However, whatever is built or planted in the centre island must be either maintained or constructed so that it does not obscure drivers’ sight lines. When designed correctly, a roundabout can serve as a signature element of a city and may sometimes be popular enough to become a tourist attraction.

Public Opinion of Roundabouts

In North America, public opinion regarding the benefits of roundabouts is generally sceptical (ITE, 2008). When municipalities announce the creation or instalment of a new roundabout, community members will likely raise concerns about the safety and complexity of the design. This mostly stems from the fact that roundabouts are still a relatively new type of intersection design, especially in Canada, and most drivers are not accustomed to using them. However, a study covering several intersections that were converted to roundabouts found that the majority of sceptical users soon shifted to liking them after they were built (Retting et al., 2002). The results from the study suggest that the best way to obtain public acceptance of roundabouts is to construct more of them so that more people have the chance to experience using a roundabout.

Cost Effectiveness of Roundabouts

Roundabouts are not controlled by traffic signals like most conventional intersections. Therefore they do not require the instalment or maintenance of traffic lights, which saves the municipality some money. Also, since roundabouts require less asphalt than most conventional intersections, the municipality can again save here on road maintenance costs.

Design Principles Summary

This section has revealed both the advantages and disadvantages of the roundabout’s design. Although some traffic studies have shown that the roundabout may have an advantage in terms of automobile and pedestrian safety over conventional intersections, it does have some safety deficits when it comes to cyclist accessibility. This will be an important factor when developing a roundabout design for the PBC intersection, especially if there is a high volume of pedestrians and cyclists currently using the intersection. Table 2 provides an overview of some of the advantages and disadvantages of the roundabout design.
Table 2. Advantages and Disadvantages of a Roundabout

Advantages

- Roundabouts can moderate traffic speeds on all classes of roads
- They are generally aesthetically pleasing if well landscaped
- They enhance safety for drivers and pedestrians compared to traffic signals
- They can minimize queuing at the approaches to the intersection
- They are less expensive to operate than traffic signals

Disadvantages

- Landscaping must be maintained, either by the residents or by the municipality
- They can be hazardous for cyclists if separate bicycle facilities are not provided
- Large Roundabouts can be difficult to cross for pedestrians and cyclists if pedestrian signals are not installed
- They can be hazardous for persons with vision impairments, especially if audio pedestrian signals are not installed

Now that the basic design features, operational elements, and advantages/disadvantages of a roundabout have been identified, the report will focus on how to best insert such a design into the PBC intersection. The following chapter outlines the method by which the context of the PBC is identified and how a context sensitive roundabout design is developed.
Method
This chapter outlines the method used to develop a context sensitive roundabout design for the PBC intersection. Data sources are identified including technical data and planning documents used to inform the study.

Objective
The objective of the report is to evaluate both the existing intersection and the proposed design from a circulation speed and comfort standpoint. The overall goal of this approach is to present a context sensitive roundabout design that would be an alternative to the existing intersection; a design that would improve upon existing conditions for all road users.

Study Approach
The method uses an adapted version of John Henderson’s methodology from his report on the Application of a Context Sensitive Design Approach to the Redevelopment of Upper Princess Street in Kingston (2008), see Appendix A. This methodology was selected for two reasons. First, Henderson’s study examines the design of Princess Street, but does not include any analysis of the PBC intersection - a high traffic intersection and arguably an integral part of Princess Street. This report will hopefully complement Henderson’s research and thus provide a cohesive strategy for directing the City’s approach to both the PBC intersection and Princess Street itself.

Secondly, Henderson’s approach is based on the street design method prescribed by the Institute of Transportation Engineers’ report on Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities (2006). According to the ITE, one of the central tenants of Context Sensitive Design (CSD) is that “CSD is flexible in the application of design controls and standards to design a facility that is safe and useful for all users regardless of the mode of travel they choose” (ITE, 2006: 2). A method based on CSD is thus helpful in creating a design that addresses the needs of all road users, which is the main objective of this report.

However, it should be noted that the ITE’s report on CSD is not specific to roundabout design. The document prescribes only a step-by-step method for identifying the context of a particular site and how to design an element that is sensitive to that context. Given that this method helps meet the objective of the report and that a similar method had already been used by Henderson for Princess Street, the method was again adapted for use on the nearby PBC intersection. A conceptual diagram of the report’s methodology can be seen in Table 3, which outlines the method in five main steps.
Chapter 2 - Method

Table 3. Conceptual Diagram of Report Methodology

Step One: Identifying the Current Context of the PBC Intersection
  - Documentation of Existing Conditions

Step Two: Identifying the City’s Future Goals for the PBC Intersection
  - Review of City Planning Documents

Step Three: Development of Evaluation Criteria
  - Creation of Evaluation Matrix

Step Four: Evaluation of Context Sensitive Roundabout Design
  - Comparative evaluation between existing design and proposed design

Step Five: Conclusion and Policy Recommendations
Step One: Identifying the Current Context of the PBC Intersection

This stage in the CSD approach seeks to examine the existing context and the usage of the PBC intersection. In order to establish a baseline, the existing intersection was documented using photographs, CAD drawings, and traffic statistics from the City. Traffic statistics were supplied by the City of Kingston’s Transportation Planning Department and provided a day’s worth of vehicle, pedestrian, and cyclist counts, see Appendix B. Observations in regards to the intersection’s usability were also made by the author through frequent site visits by foot, bicycle, and by vehicle.

The identification of the current context of the PBC intersection lays the foundation from which to judge the existing design’s ability to meet users’ needs and the City’s future goals. The actual judging criteria upon which the existing design is measured against the proposed design is developed later in Step 3.

Step Two: Identifying the City’s Future Goals for the PBC Intersection

A review of various City planning documents was completed in order to identify City policies relevant to the future context of the PBC intersection. The following list identifies the planning documents that were consulted in order to understand the City’s future vision for the intersection:

1) City of Kingston Official Plan (2009)
2) Former City of Kingston Official Plan (1995)
5) Cycling and Pathways Study (2003)

It should be noted that none of the planning documents reviewed have specific design or policy goals directed specifically at the PBC intersection. The primary goal of the policy review is to identify how the PBC intersection would fit into the broad context of the City’s future transportation network for pedestrians, cyclists, and motor vehicles. These particular City documents were also selected in Henderson’s (2008) report and provide the best possible overview of policies that could potentially shape the future of the PBC intersection.

These relevant policies also assisted in determining the City’s future goals for the intersection. These goals were then paired alongside the current context and desired future context of the PBC intersection in order to discern what differences exist between the two. Table 4 illustrates how the existing context was compared to the City’s desired context.

Table 4. Comparison of Existing Context to City’s Desired Future Context for PBC Intersection

<table>
<thead>
<tr>
<th>City Future Policy Goal</th>
<th>City Desired Future Context</th>
<th>Existing Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian traffic related goal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyclist traffic related goal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motorist traffic related goal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The comparison between the existing and desired future context of the PBC intersection helped to reveal areas for design improvements. In addition the comparison also provided some insight on the ability of the existing design to meet all road users’ needs and meet the City’s future goals. Information gathered in this step was then used to inform the evaluation criteria developed in **Step 3**.

**Step Three: Development of Evaluation Criteria**

In order to determine if a context sensitive roundabout design would be a feasible alternative to the existing intersection, two questions must be posed. First, would the proposed roundabout better meet the needs of all road users? Secondly, would the proposed roundabout better meet the City’s planning goals for the future? Using design features common to both a conventional intersection and a roundabout, this stage of the method provides a comparative evaluation between the existing and proposed design for the PBC intersection. Table 5 identifies the design criteria used to evaluate the two designs.

**Table 5. Evaluation Matrix**

<table>
<thead>
<tr>
<th>Road Users</th>
<th>Intersection Design Feature(s)</th>
<th>Ability to Meet User Needs</th>
<th>Ability to Meet City Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Existing Design</td>
<td>Proposed Design</td>
</tr>
<tr>
<td>Pedestrian Accommodation</td>
<td>Crosswalk Length</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyclist Accommodation</td>
<td>Cycling Lane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motorist Accommodation</td>
<td>Quantity of Vehicle Lanes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legend: 0 = **Inadequate**, 1 = **Somewhat Adequate**, 2 = **Adequate**

0 = design feature is absent, it cannot meet current road user needs nor the City’s future goals, therefore it is **Inadequate**.

1 = design feature is present but could be improved upon, it does not fully meet current road user needs nor the City’s future goals, therefore it is **Somewhat Adequate**.

2 = design feature is present, it can meet current road user needs and the City’s future goals, therefore it is **Adequate**.
The design evaluation criteria were chosen on the basis of commonality between the two designs. Conventional intersections, such as the PBC intersection, operate very differently from roundabouts; however, there are design features (as seen above) that both share. In order for this method to conduct a fair assessment of each design, the judging must be based on common traits.

The judging of each design is based upon the information gathered from **Steps 1 and 2**, the identification of the existing context and future goals from the City’s planning documents. Each design is scored according to the legend provided with Table 5. The qualitative justification for each design’s score is given in the following section, **Step 4**.

**Step Four: Evaluation of Context Sensitive Roundabout Design**

Using the Evaluation Matrix (Table 5) developed in **Step 3**, the existing and proposed designs are scored and evaluated. This stage in the method provides a justification for each design’s score and a qualitative argument in support of the purposed design. Implementation guidelines for the proposed design are given in the following section, **Step 5**.

**Step Five: Conclusion and Policy Recommendations**

In this section implementation guidelines, such as public consultation and education, are discussed. Recommendations for further studies pertinent to the successful installation of a roundabout are also discussed. Lastly, comments on the utility of this report and how it could be utilized by other municipalities considering roundabout installations will also be addressed.
Chapter 3 – Analysis

The following analysis is split into five steps, as described previously. The analysis chapter follows the logic as presented in the methods chapter. The existing context of the intersection is identified, goals pertaining to the future context are identified, and the proposed alternative design is evaluated on the basis of its ability to improve upon the existing situation and meet future goals. The first section presented in this chapter seeks to identify the existing context of the PBC intersection through the documentation of the existing built form, land uses surrounding the intersection site, and existing traffic levels for all road users. This description of baseline conditions is followed by a review of relevant land use planning and transportation planning documents in order to develop an understanding of the policy goals for the intersection and the area as a whole.

**Step One: Identifying the Current Context of the PBC Intersection**

The boundary of the analysis area is a 45 metre radius extending from the centre of the intersection, see Figure 11. This is the limit that a potential roundabout could extend before encroaching upon private property. However, the surrounding context at the fringe of this boundary is also examined in this report as identifying the current context of the intersection is a crucial part of the CSD methodology.

There are a diverse range of land uses and amenities surrounding the PBC intersection. Within a five minute walking radius there are medical services, banks, apartment buildings, restaurants, and the Kingston Centre commercial site, see Figure 8. The following graphics, Figures 9 and 10, illustrate the diverse range of land uses along Princess Street and illustrate the built form surrounding the intersection.

As it currently exists, the PBC intersection already performs a dual role. It is a mixed-use hub that attracts residents from both nearby and suburban neighbourhoods and it is also a major intersection used by many daily commuters. Based upon the observations made by the author during frequent site visits, the following interactions between users of the intersection and its surroundings were noted. First, the LCBO located at the southeast corner of the intersection garners a noticeable amount of vehicular and pedestrian traffic during business hours. This illustrates the fact that the current intersection already has to cope with the demands of multiple types of road users. However, the existing design heavily favours the flow of vehicular traffic over other road users.

Secondly, although the PBC is frequently used by commuters heading to work in the downtown, the intersection also attracts a great deal of localized vehicular traffic. Kingston residents drive frequently back and forth between the banks, the Loblaws supermarket located at the Kingston Centre, the pharmacies, and the medical service centres. Also commuters will typically stop at several of these amenities on their way home from work. However, it should be noted that most of these amenities are within a five minute walking distance of each other. Perhaps if the existing intersection were more pedestrian-friendly it would encourage more people to park and walk, than drive back and forth.

Lastly, the existing intersection is an overwhelmingly automobile dominated space, as the gathered traffic statistics will confirm. Despite the variety of nearby amenities, it is not the type of place that a pedestrian or cyclists would feel comfortable staying in for an extended period of time. The
constant noise of vehicle motors and flow of traffic would discourage most pedestrians/cyclists from frequently using the intersection. Based on observations of the author, pedestrians with young children, elderly people, and/or people with mobility problems did not use the intersection.

The following two sections focus on the physical layout of the intersection and its traffic levels. Table 6 provides an overview of the specific design details of the existing PBC intersection.

Figure 8. Five minute walking radius from PBC Intersection
Photo Source: Google Earth
Figure 9. Existing Urban Built Form North of Bath Road.
Figure 10. Existing Urban Built Form South of Bath Road
Since the intersection was once designed as a roundabout, there is more than adequate right-of-way available for the installation of a future roundabout. Since the geometry of a roundabout can vary, as shown earlier in the introductory chapter, there are no conventional standards for roundabout sizes. Currently, enough right-of-way is available for a roundabout with a maximum diameter of 90 metres (see Figure 11).

![Figure 11. Maximum Right-of-way available for future roundabout and boundary of analysis area](image)

Table 6. Existing Intersection Design Specifications

**Princess Street**
- 4 Traffic lanes
- Lane width: 4.5 metres
- Intersection Crosswalk Length, South of Bath: 42 metres, North of Bath: 32 metres
- Sidewalk width: 3 metres (separated from road by grass median)

**Bath Road**
- 4 Traffic lanes
- Lane width: 4.5 metres
- Intersection Crosswalk Length: 30 metres
- Sidewalk width: 3 metres (separated from road by grass median)

**Concession Street**
- 4 Traffic lanes (split into two one-way streets)
- Lane width: 4.5 metres
- Intersection Crosswalk Length, South Branch: 13 metres, North Branch 11 metres
- Sidewalk width: 3 metres (separated from road by grass median)

**Permitted Vehicular Travel Speed Through Intersection:** 50km/h

**Transit Routes Through Intersection:** #1 and #4 Bus Routes
The following figure and corresponding photographs illustrate the intersection from the perspective of a pedestrian or cyclist user. Figure 12 specifically illustrates the approximate field of view of each photograph.

Figure 12. Fields of view for Photographs A, B, and C

Photograph A
As mentioned previously, the intersection is primarily designed to meet the needs of motorists. Although the surrounding area has a rich mix of amenities, the intersection is not the type of environment where shoppers can easily shift from one sidewalk to another. As illustrated in photographs B and C, the crosswalks spanning Princess and Bath Streets are quite extensive and would be a daunting task for an elderly person or small children. Pedestrians and cyclists also have to keep an eye out for left turning traffic that may conflict with their path across the street. The PBC intersection has the awkward juxtaposition of being an arterial intersection placed at the mouth of a mixed-use pedestrian corridor, i.e., Princess Street south of Bath. The following section examines the traffic flow of the PBC intersection in terms of all types of road users.

Existing Traffic Conditions

Traffic statistics collected by the City of Kingston indicate that the intersection is currently a very automobile dominated space. Traffic counts taken in July of 2006, from the hour of 7:00 AM to 5:00 PM; show a total traffic count of 23,450 vehicles per day (City of Kingston, 2006). This level of traffic indicates that an alternative roundabout design would have to be a high traffic capacity design. With a traffic rate of approximately 23,500 vehicles this would require a roundabout with at least one-two entry lanes and two circulating lanes, see Figure 7.

During the day this intersection sees most of its vehicular traffic during the afternoon rush hours. From 3:00 PM to 5:00 PM, automobile traffic peaks at around 3400-3600 vehicles per hour (City of Kingston 2006). Most of its pedestrian traffic occurs during lunch hour when office, retail, and medical employees cross the intersection for their lunch break. From noon to 1:00 PM, exactly 100 pedestrians crossed the intersection; over the course of a day a total of 586 pedestrians used the intersection (City of Kingston, 2006). The intersection also receives a healthy number of cyclist users, although they are the lowest user group. During the counting period, 338 cyclists passed through the intersection (City of Kingston, 2006). This cyclist count is actually higher than the city-wide average, as will be shown later in the review of planning documents. For a full breakdown of hourly traffic counts for all road users, please see Appendix B.

It should also be noted that the current PBC intersection is a relatively safe intersection. According to the City, from 1998 to 2008, there were 207 accidents reported at the intersection; six pedestrians were injured, but none fatally (City of Kingston, 2009). However, given that roundabouts have been shown to reduce accidents, these accident numbers could be further reduced if the intersection was converted into a roundabout (Persaud et al., 2002).

The results of the City’s traffic study indicate that although the intersection’s primary users may be motorists, other road users, such as pedestrians and cyclists, are also regularly present. These existing traffic conditions will also help set a baseline from which to judge the City’s planning goals in the following section.
Step Two: Identifying the City’s Future Goals for the PBC Intersection

The following is a review of relevant City land use and planning documents that were used to identify the City’s future goals for the PBC intersection and its surrounding context. As stated in the Methods chapter, the identified goals in this section mirror the goals identified by Henderson’s (2008) study of Upper Princess Street. In addition, it should be noted that none of the reviewed planning documents explicitly recommend a roundabout for the PBC intersection nor do they contain any guidelines for roundabout installation in general; however, they do contain directives relevant to the future of the intersection.

Identification of future Vision for PBC Intersection

Background research for this report began in 2008 when the current Official Plan was still in draft form. Policy information was thus included from both the former and current Official Plan to provide a cohesive picture of the City’s goals.

The purpose of the Official Plan (OP) for the former City of Kingston was to establish policies and land use designations to pursue the development, redevelopment and protection of land to create an efficient and healthy urban environment (City of Kingston, 1995). General urban design policies within the former OP identified the need to use design as a means to develop urban environments that are functional as well as aesthetically pleasing. The creation of aesthetically pleasing environments can improve user satisfaction and the quality of life for the general citizenry. Roundabouts, which are generally considered more aesthetically pleasing than conventional intersections, would bode well under this policy. The former OP also recognized the importance of including walking facilities in all street designs in order to encourage more pedestrian activity.

The former OP also identified the PBC intersection as an important connection point between the West Princess Street Commercial District (also the site of the Kingston Centre) and the Upper Princess Street Commercial District (see Figure 13). The document outlined the City’s intent to encourage mixed-use development along Princess Street and to create a full-time resident population by utilizing residential above commercial grade-level development. Princess Street itself is identified as a former arterial by the former OP, but is also deemed to be in the transition stages of becoming of a pedestrian and transit friendly commercial corridor (City of Kingston, 1995). Princess Street is no longer just an access route to Toronto anymore, it has taken on more of a “main street” feel and is a popular destination now for many Kingston residents.
Another planning document relevant to the future of the PBC intersection is the *Urban Growth Strategy* (UGS), which was completed by the City of Kingston in 2006. According to the UGS, the PBC intersection lies in the path of an integral component of Kingston’s growth over the next 20 years: the Princess Street Corridor. The UGS identifies Princess Street as the most important corridor linking Kingston’s downtown with the commercial and residential areas surrounding the Cataraqui Town Centre in the west. It stipulates that Princess Street should be designed to support mixed-use development along with high-frequency transit and high pedestrian volumes. It also states that Princess Street should be the model for displaying the benefits of this type of development to the rest of Kingston. This implicitly means that the PBC intersection of the future will have to handle a much higher volume of pedestrian traffic than it does today. Hence, a roundabout may be a potential design solution to providing a more pedestrian-friendly environment.
The final relevant planning document is the current OP, adopted by the City of Kingston in 2009. In regards to its vision for the future of the PBC intersection, the current OP is generally in line with the policies of the former OP. The current OP formally designates Princess Street as a “Main Street Commercial” corridor. This designation gives more details on the desired design of the street including improved pedestrian access, cycling lanes, and transit facilities. In sum, the current OP envisions a future PBC intersection that will better accommodate the needs of pedestrians, cyclists, and transit users.

**Review of Transportation Planning Documents**

The first transportation planning document relevant to the PBC intersection is the *Kingston Transportation Master Plan* (KTMP). The KTMP identifies programs and priorities to guide transportation planning within the City for the next 25 years (City of Kingston, 2004). Similar to the planning documents previously discussed, the UGS and OP, the KTMP encourages the development of a high frequency transit corridor along Princess Street. In addition the KTMP stresses the importance of multi-modal trips whereby a person can easily transfer from public transit to foot and/or bicycle. The goals of the KTMP again stress the importance of having streets designed for multiple types of road users.

The second relevant document is the *Kingston Cycling and Pathways Study* (CPS), completed by the City in 2003. The goals of the CPS are very much in line with KTMP as both documents identify cycling and walking as the preferred mode of transportation within the city and seek to increase the quantity of trips made by these road users (City of Kingston, 2003). The CPS explicitly states “...the assumption that motorists have first priority in the public transportation system should be challenged” (CPS, 2003: 4). The CPS recommends the creation of designated cycling routes throughout the city. It identifies the PBC intersection as part of the future cycling network, linking the western cycling path along Bath Road to the Downtown via a utilitarian cycling route on Princess Street (see Figure 14).

Cyclists counts conducted by the Study also revealed that the PBC intersection already has a high rate of cyclist users when compared to the rest of the city. If the City legitimately plans to follow the plans of the CPS, any future design changes to the PBC intersection will have to include some sort of cycling facilities. Any future roundabout design would also certainly have to include cycling facilities to ensure cyclist safety (Brilon and Vandehey, 1998; Dabbour and Easa, 2008).
Although the reviewed transportation documents prioritize pedestrians and cyclists over motorists, the future design of the PBC intersection must keep the needs of motorists in perspective. Bath Road and Princess Street are both well high traffic thoroughfares, as is illustrated by the City’s traffic counts, and they are both important routes leading to Kingston’s downtown. Any realistic future design of the PBC intersection will have to balance the desired pedestrian and cyclist goals with motorist demands as well. In order to be truly context sensitive the proposed roundabout design will have to accommodate the needs of all three of these road users.

Table 2 is a compilation of the policy goals identified in the reviewed land use and transportation planning documents.
Table 2. City Policy Goals Identified from the Planning Documents

Pedestrian related goals
- Enhanced pedestrian environment
- Enhance quality of life through urban design
- Encourage pedestrian oriented retail at grade

Cyclists related goals
- Support cycling (and walking) as an alternative to driving
- Develop cycling routes along Princess Street and Bath Road
- Priority to cyclists (and pedestrians) over automobile users

Motorist related goals
- Reduce car trips by providing better walking and cycling facilities
- Keep motorists needs in perspective

These policy goals help to paint a picture of the City’s desired future conditions of the PBC intersection. In terms of developing an alternative roundabout design, a comparison of the existing conditions and desired conditions would help to identify areas for design improvement. In the following section, these discrepancies are examined and assist in determining how a roundabout could improve upon the existing conditions.
Step Three: Development of Evaluation Criteria

Comparison of Existing Context to Desired Future Context of PBC Intersection

The following three tables, 7, 8, and 9, illustrate some of the discrepancies between existing conditions and desired conditions at the PBC intersection. These discrepancies help to highlight design issues that a future roundabout could ameliorate.

Table 7. Comparison of Existing Context to City’s Desired Future Context for Pedestrians

<table>
<thead>
<tr>
<th>City Future Policy Goal</th>
<th>City Desired Future Context for PBC</th>
<th>Existing Context of PBC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhanced pedestrian environment</td>
<td>Safe and accessible intersection for all types of pedestrians</td>
<td>Safe, but a daunting crossing for persons with mobility problems</td>
</tr>
<tr>
<td>Enhance quality of life through urban design</td>
<td>Functional intersection that is also aesthetically pleasing</td>
<td>Functional, but with little aesthetic appeal</td>
</tr>
<tr>
<td>Encourage pedestrian oriented retail at grade</td>
<td>Intersection easily traversed by shoppers on foot</td>
<td>All foot traffic is controlled by traffic signals</td>
</tr>
</tbody>
</table>

In terms of improving the context for pedestrians, a future roundabout could help in several ways. First, roundabout designs utilize pedestrian splitter islands which split the crossing in half and reduce the amount of time pedestrians are in the path of vehicles, see Figure 3 and Figure 4 for examples. Also, as mentioned previously, installing a roundabout at the PBC intersection could potentially further reduce accident rates, which would make the intersection safer for all road users. In addition, in order to ensure maximum safety and comfort for pedestrians, the installation of pedestrian signals, especially audio signals for blind pedestrians, should be considered.

Secondly, roundabouts are generally regarded as being more aesthetically pleasing than conventional intersections. Although the current design functions well, it promotes the flow of vehicles over other types of travel. A roundabout would calm traffic, reduce travel speeds, and produce a more hospitable intersection for pedestrians. Such an environment would promote more people to walk and take advantage of the nearby amenities by foot; thus improving pedestrians’ quality of life.

Lastly, by reducing travel speeds and improving pedestrian accessibility, a roundabout could potentially improve the flow of shoppers to nearby shops and other amenities. If people feel safe to cross the street and are not barred by lanes of fast moving traffic then they may be more likely to park their vehicle and walk from shop to shop. A roundabout design would help balance the flow of pedestrian traffic with vehicular traffic, ultimately making the pedestrian’s trip quicker and easier.

The following section examines the City’s future goals for cyclists and how a roundabout design could improve upon the existing conditions.
Table 8. Comparison of Existing Context to City’s Desired Future Context for Cyclists

<table>
<thead>
<tr>
<th>City Future Policy Goal</th>
<th>City Desired Future Context for PBC</th>
<th>Existing Context of PBC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support cycling as an alternative to driving</td>
<td>Increase cyclist count for intersection</td>
<td>Cyclist count high relative to rest of city, but nowhere near vehicle count</td>
</tr>
<tr>
<td>Develop cycling routes on Bath Road and Princess Street</td>
<td>Designated cycling lanes on Princess and Bath</td>
<td>No cycling lanes currently exist on Princess or Bath</td>
</tr>
<tr>
<td>Priority to cyclists (and pedestrians) over motorists</td>
<td>Motorists must yield to pedestrian/cyclist signals</td>
<td>All road users controlled by same traffic signals</td>
</tr>
</tbody>
</table>

Despite having a cyclist count above the citywide average, the existing intersection design has no cycling facilities, not even a painted bicycle lane (City of Kingston, 2003). A future roundabout would make the PBC intersection even more appealing to cyclists by reducing vehicular traveling speeds. However, as mentioned previously in the design principles section there are several safety concerns when integrating cyclist facilities with roundabouts. In order to ensure adequate cyclist safety, any future roundabout design would need cycling facilities separate from vehicular traffic (Dabbour and Easa, 2008). Such facilities should also cross vehicular lanes adjacent to the pedestrian crossings (Dabbour and Easa, 2008). Therefore, in order to adequately meet the City’s cycling related goals, the proposed roundabout must include separate cycling facilities.

Table 9. Comparison of Existing Context to City’s Desired Future Context for Motorists

<table>
<thead>
<tr>
<th>City Future Policy Goal</th>
<th>City Desired Future Context for PBC</th>
<th>Existing Context of PBC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce car trips by providing better walking and cycling facilities</td>
<td>Increase pedestrian and cyclist counts for intersection, reduce vehicle count</td>
<td>Vehicle count dominates intersection, pedestrian and cyclist count small in comparison</td>
</tr>
<tr>
<td>Keep motorists needs in perspective</td>
<td>Maintain a reasonable vehicular capacity for the intersection</td>
<td>Vehicular capacity currently sits at approximately 23,500 vehicles per day</td>
</tr>
</tbody>
</table>

The design of a roundabout has two advantageous features that could help improve existing traffic conditions. First, a roundabout has a variable level of service. During rush hour when the roundabout is reaching its maximum capacity traffic will move much slower through the intersection. In such a case, regular commuters may eventually opt to take other routes, thus reducing the intersection’s vehicle count. In addition, if the City hopes to reduce car trips and promote more pedestrian/cyclist trips it will eventually have to put a limit on road capacity. The “old traffic circle” was originally removed from PBC to accommodate a higher vehicle traffic capacity. However, the vehicular capacity of the intersection cannot grow indefinitely. The installation of a roundabout at the PBC...
intersection will effectively cap vehicular capacity at approximately 25,000 vehicles a day. This limit will help to focus future transportation policies on pedestrian, cyclist, and transit accommodation, instead of continuing road expansion unabated.

Secondly, as mentioned in the previous sections, a more pedestrian-friendly intersection would promote more walking within the local area. Instead of driving back and forth between amenities, residents may choose to park and walk, thus reducing the amount of local traffic. Table 10 provides a compilation of the identified areas of improvement that could be addressed by a roundabout’s design.

Table 10. Desired Roundabout Design Features

**Pedestrian Accommodation**
- Reduced crossing distance/time with splitter islands
- Reduced vehicular travel speeds

**Cyclist Accommodation**
- Cycling facilities separate from vehicular traffic
- Cyclist crossing facilities

**Motorist Accommodation**
- Sufficient vehicular capacity to meet current traffic loads

The above design features, as derived from the City’s goals and desired future context, will shape the proposed roundabout design for the PBC intersection. The proposed design and existing design will then be evaluated against each other using the following evaluation matrix (Table 11).

Table 11. Evaluation Matrix

<table>
<thead>
<tr>
<th>Road Users</th>
<th>Intersection Design Feature(s)</th>
<th>Ability to Meet User Needs</th>
<th>Ability to Meet City Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Existing Design</td>
<td>Proposed Design</td>
</tr>
<tr>
<td>Pedestrian Accommodation</td>
<td>Crosswalk Length</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyclist Accommodation</td>
<td>Cycling Lane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motorist Accommodation</td>
<td>Quantity of Vehicle Lanes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legend: 0 = Inadequate, 1 = Somewhat Adequate, 2 = Adequate
Step Four: Evaluation of Context Sensitive Roundabout Design

The following section presents the proposed roundabout design and evaluates its merits against the existing design of the PBC intersection. Using the evaluation matrix, each design is scored based on its ability to meet the needs of the three user types (pedestrians, cyclists, and motorists) and its ability to meet the City’s future goals. Tables 12 and 13 provide a descriptive summary of the evaluated design features and figures 15 and 16 provide a plan view of each design.

![Diagram of existing intersection design](image)

Figure 15. Existing intersection design with location and lengths of crosswalks indicated

Table 12. Evaluated Design Features of the Existing Design

**Crosswalk Length**
- Princess Street South: 42m
- Princess Street North: 32m
- Concession Street South: 13m
- Concession Street North: 11m
- Bath Road: 30m

**Cycling Lane**
- No cycling facilities currently exist

**Quantity of Vehicle Lanes**
- Princess: 4 Lanes, 2 entry and 2 exit
- Concession: 4 Lanes, 2 one-way streets
- Bath: 4 Lanes, 2 entry and 2 exit
Table 13. Evaluated Design Features of the Proposed Design

**Crosswalk Length** (for both sides of each splitter island)
- **Princess Street South**: 6.5m
- **Princess Street North**: 7.5m
- **Concession Street South**: 4.5m
- **Concession Street North**: 3.5m
- **Bath Road**: 7m

**Cycling Lane**
- Dedicated Bike Lane separated from traffic by grass median

**Quantity of Vehicle Lanes**
- **Princess**: 4 Lanes, 2 entry and 2 exit
- **Concession**: 4 Lanes, now as two dual-way streets
- **Bath**: 4 Lanes, 2 entry and 2 exit
As can be seen from the evaluation matrix, the proposed roundabout design does a better job of meeting all road users’ needs and meeting the City’s goals. In terms of pedestrian accommodation, it provides a more foot-traffic friendly environment by reducing vehicular travel speeds and reduced crosswalk lengths. The roundabout will also encourage more local residents to visit nearby amenities by foot in two ways. First, slower vehicular speeds reduce the incentive for residents to drive back and forth between amenities. Residents would likely save more time by walking to their destinations. Secondly, the shorter crosswalks, divided by splitter islands, reduce the time pedestrians spend in the vehicular lanes of traffic. This, in conjunction with the reduced travel speeds, enhances the safety of the intersection and would likely encourage more elderly and young people to walk across the intersection. In sum, the roundabout enhances the pedestrian safety of the intersection, it enhances pedestrian access to nearby amenities, and better balances the mobility of pedestrian traffic with vehicular traffic; all of which are centrally important to the City goals identified in this analysis.

The proposed roundabout design also improves upon the existing design in terms of cyclist accommodation. The current PBC intersection provides no cycling facilities. By providing a cycling lane, separated from traffic by a grassy median, the proposed design would improve cyclist safety and encourage more cyclists to use the intersection. In addition, the creation of an intersection with dedicated cycling facilities would provide an impetus for further creation of cycling facilities on Bath Road and Princess Street. By improving the cyclist traffic count and helping to expand dedicated cycling paths, the roundabout would be fulfilling some of the directives identified in the City’s Cycling and Pathways Study (2003).

Lastly, the proposed roundabout is designed with double entry lanes and two circulating lanes. This design should be more than sufficient to handle the current traffic of 23,500 vehicles per day and cap vehicular traffic at 25,000 vehicles per day. It is likely that during rush hours the roundabout may become congested with very slow moving traffic. Over time, however, this may dissipate as regular commuters opt for different routes, thus eventually reducing the vehicle count for the PBC intersection. Improving the balance between, pedestrian, cyclist, and vehicular traffic is one of the City goals identified in this analysis; a goal that would be assisted by the installation of the proposed roundabout.
Step Five: Conclusion and Policy Recommendations

Conclusion

The proposed roundabout would improve upon the existing context and would outperform the existing design in terms of achieving the future context desired by the City. The proposed roundabout also meets the main objective of this study: a design that would improve upon existing conditions for all road users. Although the roundabout is not a flawless design, the analysis has shown that it would be an improvement compared to the existing design. For these reasons, this report concludes that a roundabout design would be a feasible alternative to the existing PBC intersection. The following outlines some concrete policy recommendations for guiding the City’s development of a roundabout at the PBC intersection and roundabouts at other sites elsewhere in Kingston. Also included in this section are important implementation guidelines and future studies necessary for the successful instalment of a roundabout at the PBC intersection.

Policy Recommendations

1. Include Roundabout Design Guidelines in Planning Documents, such as the Kingston Transportation Master Plan (KTMP).

   There is an absence of information about roundabouts within the City’s planning documents. None of the reviewed planning documents contain recommendations for a roundabout at the PBC intersection nor do they contain any guidelines for roundabout installation in general. Although traffic circles are mentioned as potential traffic calming tools by the KTMP, there is no discussion of roundabout design. This report recommends an inclusion of roundabout design guidelines in the KTMP and provided as an appendix to the Official Plan.

2. Identify other intersections within Kingston which would be good candidates for roundabout installation.

   In conjunction with the inclusion of roundabout design guidelines, the City should also conduct a study of intersections within Kingston that could benefit from the installation of a roundabout. Publicly identifying such intersections will help to raise awareness about roundabout design and incite the conversion of additional intersections. Ultimately, the more roundabouts constructed within the city, the more likely local drivers, pedestrians, and cyclists will become accustomed to them.
Implementation Guidelines for Conversion of PBC Intersection

As demonstrated by the surveys conducted by Retting et al. (2002), the City can expect general scepticism from the public concerning the benefits of installing a roundabout. The key to minimizing public backlash against a new roundabout is to begin public consultation and education about the project well in advance of the actual installation. In order to ensure community acceptance of the project, the City should identify key stakeholders who would be directly affected. In the case of the PBC intersection, the City should implement a task force consisting of local residents, business owners from Princess and Bath Road, employees who work near the intersection, and municipal officials. The task force can act as a conduit of information from the City to their respective interest groups. Several other municipalities, including Towson, Maryland (see Figure 2), have found this structure of public engagement to be very successful (City of Towson, 2004). In addition, it is also important to educate Kingston residents from outside the local neighbourhood about the operational conditions of a roundabout. Princess and Bath are both major thoroughfares used by daily commuters from all parts of the city. The City should invest in distributing educational literature, and announcements in the local media, e.g., the Kingston Whig-Standard, about how to use a roundabout. Investments in signage are also important for informing visitors to the area that they are approaching a roundabout, see Figure 17.

Figure 17. Example of Roundabout Signage

Recommendations for Further Studies

1. **Ensure sufficient right-of-way for emergency vehicles, transit buses, and trucks**

   Although this report has helped to assess the features of a roundabout that would meet the City’s desired future context; further engineering studies should be conducted to ensure the roundabouts entries and exits are sufficiently wide to handle emergency vehicles and transit. This study will be equally crucial in determining the feasibility of a roundabout at the PBC intersection especially given the City’s emphasis on creating a high frequency transit corridor on Princess Street.

2. **Conduct Accessibility Study for Persons with Disabilities and Vision Impairments**

   Roundabouts can be especially difficult to navigate for persons with vision impairments. One of the overarching goals of the City’s OP is to make streets more accessible to all users. Therefore the City should also conduct a study to assess the accessibility of the PBC intersection as it exists today and how it might exist in the future. Depending on how the City weighs accessibility in comparison to traffic flow, it may even consider installing traffic signals and pedestrian audio signals to ensure the safe passage of
disabled persons. Although traffic signals at a roundabout would reduce the rate of traffic flow at a roundabout, it has been done before in other cities to ensure pedestrian safety (City of Towson, 2004).

3. **Conduct a Cost-Benefit Analysis and Project Financing Assessment**

   The conversion of the PBC intersection to a roundabout will cost the City money. In order to keep public costs low the City should consider consulting the local Business Improvement Association (BIA) about contributing to the project. The city should also conduct a cost-benefit analysis that will take into account not only the monetary costs of construction, but also the benefits of reduced vehicle emissions, improved flow of traffic, increased pedestrian traffic, and reduced maintenance costs. The cost-benefit analysis will be helpful in illustrating the potential benefit of installing a roundabout to local businesses and help entice them to contribute to the project.

4. **Conduct a Traffic Study for a Two-way Conversion of Concession Street**

   Concession Street currently exists as two one-way streets. However, the proposed roundabout design would require Concession to be converted into dual-way streets. Before implementation of the roundabout, the City should conduct a traffic study to determine the effects of converting Concession into two single lane dual-way streets.

**Generalizability and Utility of Method**

   The methodology of this study focused mainly on comparing the existing context of the PBC intersection to the goals and desired future context from the City’s planning documents. This method revealed that the PBC was actually an intersection in transition. Critical routes leading to the PBC intersection, Bath Road and especially Princess Street, have been the subject of several previous planning studies. This made the task of discerning the City’s vision for the PBC intersection relatively easier. Had the report selected to assess an intersection elsewhere, the process would have been more difficult.

   The method of this report could be useful for other municipalities in Canada, provided they have the planning resources and similar previous studies prepared as the City of Kingston. However, the method constructed was very Kingston-focused and it may not provide similar conclusions in other municipalities. Although the report revealed some important information on how to identify a given site’s context and then how to create a design sensitive to that context, the steps necessary to finding that information may be quite different in other municipalities. Therefore, although the method of this report could be used as a reference by other planners studying potential roundabout sites, its utility as a broad planning tool that could be used at any intersection, is quite limited.
Limitations of the Study

The objective of this report was to evaluate both the existing intersection and the proposed design from a circulation speed and comfort standpoint. Although the report utilized a Context Sensitive Design framework to evaluate the designs, the report is by no means a full urban design study. This report focused on only a single design variable for each road user type (pedestrians, cyclists, and motorists) and compared that variable between each intersection design. In order to be considered a full urban design study, this report would have to include numerous other design variables including surrounding building facades, crosswalk treatments, landscaping features, etcetera. This report has a scope limited to design features relating solely to the operational speed and comfort level of pedestrian and cyclist users. Although these design features are a part of urban design considerations, they form only a piece of the many design options that could be included within an urban design strategy for the PBC intersection. Hopefully this report will lay the foundation for an urban design study that would integrate a future roundabout into the PBC intersection site with full consideration of its aesthetic and functional demands.
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Appendix A
Context Sensitive Methodology

Appendix B
Traffic Counts for PBC Intersection

Source: City of Kingston (2006) Traffic Count for Princess Street at Bath Road and Concession Street, July 31. (Abridged Version)