RESOLUTION TO APPROVE THE ROUNDBOAUTH DESIGN GUIDELINES FOR THE CHAMPAIGN-URBANA URBANIZED AREA TRANSPORTATION STUDY (CUUATS)

WHEREAS, the Champaign-Urbana Urbanized Area Transportation Study (CUUATS) addresses transportation problems within a defined study area; and

WHEREAS, the CUUATS adopted mission is “to coordinate metropolitan transportation planning with the Illinois Department of Transportation, Champaign County, the Cities of Champaign and Urbana, Village of Savoy, University of Illinois, the Champaign-Urbana Mass Transit District, and the general public, and to coordinate the use of federal transportation funds within the Champaign-Urbana urbanized area”; and

WHEREAS, the CUUATS Long Range Transportation Plan: Choices 2035 adopted the following goals:

- **Goal 1**: Non-single occupancy vehicle travel will be a principal consideration of the transportation planning process to make the urbanized area more sustainable, efficient, and provide a higher quality of life for residents.
- **Goal 2**: Compact development and mixed-use forms should be principal considerations for new development and redevelopment in the urbanized area to create a more walkable, sustainable, and efficient development pattern.
- **Goal 3**: Transportation modes and facilities in the urbanized area will be safe for all users.
- **Goal 4**: The urbanized area transportation system will be secure from human and natural hazards.
- **Goal 5**: All transportation system users will have convenient, multi-modal access to all parts of the urbanized area and will travel with increased mobility during peak traffic hours.
- **Goal 6**: To provide facilities for non-auto modes of transportation in order to improve mobility and decrease the number of vehicles on our roadways.
- **Goal 7**: Utilize a sustainable approach to transportation planning and engineering which promotes environmental stewardship and energy conservation.
- **Goal 8**: Provide a user-friendly, integrated regional transportation system that supports accessibility and promotes desirable social impacts.
- **Goal 9**: All transportation system users in the urbanized area will have access to a network of transportation modes and infrastructure that maximizes connectivity between origins and destinations and promotes the use of both motorized and non-motorized modes to travel between them.
- **Goal 10**: To the greatest extent possible, the existing capacity of the urbanized area transportation system will be maximized through innovative transportation system management approaches.
- **Goal 11**: Interagency coordination will be emphasized in all phases of the transportation planning and implementation process.
- **Goal 12**: To the greatest extent possible, improvements will be made to the existing roadway network to preserve or improve upon its current condition and add pedestrian, bicycle and transit facilities where needed.

WHEREAS, in certain circumstances, roundabouts are considered a viable alternative to other intersection traffic controls and help support CUUATS’ mission; and
WHEREAS, roundabouts are a useful intersection control structure designed and constructed to support safe and convenient travel along and across streets for all users, including pedestrians, cyclists, motor vehicles, transit riders, regardless of age, physical abilities, income or ethnicity; and

WHEREAS, the CUUATS Technical Advisory Committee has recommended establishing roundabout policy guidelines for the Champaign-Urbana urbanized area to promote the construction of roundabouts within the regional transportation network when feasible and appropriate; and

WHEREAS, the Champaign-Urbana urbanized area includes streets and facilities falling under the jurisdiction of the Illinois Department of Transportation, Champaign County, the Cities of Urbana and Champaign, the Villages of Savoy, Tolono and Bondville, and the University of Illinois, and CUUATS members strive to coordinate transportation policies and improvements of its constituent organizations;

WHEREAS, CUUATS wishes to promote best management practices in building and maintaining transportation facilities; and

WHEREAS, CUUATS has determined it is in the best interest of its members and the population the members represent to adopt Roundabout Design Guidelines.

NOW, THEREFORE, BE IT RESOLVED BY THE CHAMPAIGN-URBANA URBANIZED AREA TRANSPORTATION STUDY (CUUATS) POLICY COMMITTEE, as follows:

Section 1. That the Roundabout Design Guidelines attached hereto as "Attachment A" are adopted.

Section 2. That the Roundabout Design Guidelines are in conformance with the current and anticipated needs of the Champaign-Urbana Urbanized Area.

Passed and approved this 12th day of December 2012.

ATTEST:

Ron Peters
Chair
CUUATS Policy Committee
RESOLUTION TO APPROVE THE ROUNDBOOTH DESIGN GUIDELINES FOR THE CHAMPAIGN-URBANA URBANIZED AREA TRANSPORTATION STUDY (CUUATS)

WHEREAS, the Champaign-Urbana Urbanized Area Transportation Study (CUUATS) addresses transportation problems within a defined study area; and

WHEREAS, the CUUATS adopted mission is “to coordinate metropolitan transportation planning with the Illinois Department of Transportation, Champaign County, the Cities of Champaign and Urbana, Village of Savoy, University of Illinois, the Champaign-Urbana Mass Transit District, and the general public, and to coordinate the use of federal transportation funds within the Champaign-Urbana urbanized area”; and

WHEREAS, the CUUATS Long Range Transportation Plan: Choices 2035 adopted the following goals:

- Goal 1: Non-single occupancy vehicle travel will be a principal consideration of the transportation planning process to make the urbanized area more sustainable, efficient, and provide a higher quality of life for residents.
- Goal 2: Compact development and mixed-use forms should be principal considerations for new development and redevelopment in the urbanized area to create a more walkable, sustainable, and efficient development pattern.
- Goal 3: Transportation modes and facilities in the urbanized area will be safe for all users.
- Goal 4: The urbanized area transportation system will be secure from human and natural hazards.
- Goal 5: All transportation system users will have convenient, multi-modal access to all parts of the urbanized area and will travel with increased mobility during peak traffic hours.
- Goal 6: To provide facilities for non-auto modes of transportation in order to improve mobility and decrease the number of vehicles on our roadways.
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WHEREAS, the Champaign-Urbana urbanized area includes streets and facilities falling under the jurisdiction of the Illinois Department of Transportation, Champaign County, the Cities of Urbana and Champaign, the Villages of Savoy, Tolono and Bondville, and the University of Illinois, and CUUATS members strive to coordinate transportation policies and improvements of its constituent organizations;

WHEREAS, CUUATS wishes to promote best management practices in building and maintaining transportation facilities; and

WHEREAS, CUUATS has determined it is in the best interest of its members and the population the members represent to adopt Roundabout Design Guidelines.

NOW, THEREFORE, BE IT RESOLVED BY THE CHAMPAIGN-URBANA URBANIZED AREA TRANSPORTATION STUDY (CUUATS) POLICY COMMITTEE, as follows:

   Section 1. That the Roundabout Design Guidelines attached hereto as “Attachment A” are adopted.

   Section 2. That the Roundabout Design Guidelines are in conformance with the current and anticipated needs of the Champaign-Urbana Urbanized Area.

Passed and approved this 5th day of December 2012.

ATTEST:  
Roland White  
Chair  
CUUATS Technical Committee
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Executive Summary

The objective of this document is to provide the Champaign Urbana Urbanized Area Transportation Study (CUUATS), the designated Metropolitan Planning Organization (MPO) for the region, with guidelines for the implementation of roundabouts as an alternative to other intersection traffic controls.

A modern roundabout is a circular intersection where traffic flows around a center island. Modern roundabouts are defined by two basic operational and design principles: yield-at-entry and deflection for entering traffic. Yield-at-entry requires that vehicles in the circulatory roadway have the right-of-way and all entering vehicles on the approaches have to wait for a gap in the circulating flow. Deflection for entering traffic requires that entering traffic points toward the central island, which deflects vehicles to the right, thus causing low entry speeds.

![Figure 1. Modern Roundabout](image1.png)

Modern roundabouts are becoming more popular in the United States and although multilane roundabouts present some challenges for visually impaired pedestrians, studies have shown that converting single lane approach to roundabout has been effective in crash reduction and speed reduction thus enhancing safety for motorists, pedestrians and bicycle users. As a result, more than 1,000 roundabouts have been implemented across the country as of 2012.\(^1\)

Many Midwestern states like Indiana, Wisconsin, and Iowa have even issued design guidelines to be used in their jurisdiction. Wisconsin’s design guidance gives strong support for roundabouts:

*If an intersection warrants a signal or a four-way stop within the design life of the proposed project, the modern roundabout shall be evaluated as an equal alternative. Where there is an existing four-way stop or signal and there are operational problems with the current control, then the roundabout shall be considered as a viable alternative. As stated above the roundabout may be a viable alternative for a two-way stop control in certain circumstances. In either case, roundabouts are a potential intersection control strategy until such time that the evaluation indicates that the roundabout alternative is not appropriate.*\(^1\)

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\(^2\) Benekohal, R. F. and Atluri, V., 2009
Iowa addressed roundabouts in their intersection design guidelines, which are similar to the Illinois Department of Transportation’s “BDE Chapter 36.” Although the Illinois Department of Transportation (IDOT) has not published any roundabout design guidelines currently, the Department advocates the use of the Federal Highway Administration’s (FHWA) Roundabout Guidelines3, the NCHRP Report 672 Roundabouts: An Informational Guide (Second Edition)4 and the NCHRP Report 572 Roundabouts in the United States5 for roundabout implementation.

This document has been mainly produced using the Federal Highway Administration document FHWA’s Roundabout: an Informational Guide and the NCHRP Report 672. The planning guidelines provided by Kittelson & Associates, Inc. for the City of Bend in Oregon, the Wisconsin Department of Transportation (WisDOT), and the Center for Transportation Research and Education (CTRE) at Iowa State University are also used as references. The CUUATS Roundabout Design Guidelines will leverage much of the research and recommendations in previously published documents to provide the Champaign-Urbana MPO member agencies with a set of regional guidelines to facilitate the inclusion of roundabouts as an option for intersection design/upgrade in the Champaign-Urbana area.

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3 Robinson B. W., et al., 2000  
4 NCHRP Report 672  
5 NCHRP Report 572
Foreword

When planning the design or upgrade of an intersection, the intersection control evaluation is an important step that leads to the choice of the appropriate traffic control to be used at the intersection. Such analysis depends on many factors such as crash data and diagrams, user delay or level of service for all traffic movements for the current and/or design year, the appropriate design vehicle, right-of-way impacts and other safety improvements for pedestrians and bicyclists. According to the Wisconsin Department of Transportation (WisDOT), there are three ways to control traffic at an intersection:

- **Stop control**
  
  This type of intersection control utilizes stop signs to control traffic at a two-way stop-controlled (TWSC) or an all-way stop-controlled (AWSC) intersection. In the TWSC intersection, stop signs are used on the minor road where vehicles must stop and yield to the vehicles on a major road. In the AWSC intersection, all four legs of the intersection have stop signs.

- **Signal Control**
  
  This type of traffic control is utilized when some traffic warrants are met.

- **Roundabout control**
  
  Roundabout control is often used as alternative to AWSC or signal control at an intersection with safety and/or geometry issues. Using a roundabout may also be appropriate to improve a TWSC intersection with safety issues.

Roundabouts are becoming more popular across the United States, due in part to their ability to improve safety at intersections. They are often recommended as a safe alternative to traffic signal and stop controls at intersections with safety issues since they process high volumes of left turns better than AWSC intersections and generally simplify traffic movements.
Section 1. Introduction to Roundabouts

1.1. History – Background

The predecessor to modern roundabouts, the rotary, was built in the United States beginning in 1905. In these traffic circles the priority was given to the entering vehicles because of the “yield-to-the-right” rule. This allowed vehicle entries at speeds often greater than 30 mph and resulted in numerous crashes and congestion inside the circle. Such results detracted from the usefulness of traffic circles and their popularity waned in the United States during the 1950s. Figure 2 shows images of a modern roundabout and an old style rotary.

![Figure 2. Modern Roundabout vs. Old Style Rotary](http://www.azdot.gov/ccpartnerships/roundabouts/history.asp)

In 1966, the rule for vehicle flow in traffic circles was altered in the United Kingdom and the modern roundabout was born. The new rule made entering vehicles yield to the circulating traffic inside a circle, which meant that any entering vehicle waited to find a gap in the traffic inside the circle or simply yielded if there was no vehicle blocking their entrance into the circle. This change improved the traffic flow of traffic circles by preventing the circulation of traffic inside the circle from being locked up, contributing to a reduction of the speed in the circle and reducing the number and severity of the crashes.

1.2. Roundabout presentation and definition

A roundabout is one of the three types of circular intersections listed by the FHWA. **Rotaries** are circular intersections implemented in the United States in the early 1900s and generally are the largest of the three intersections. **Neighborhood traffic circles** are used to calm traffic or for aesthetics purposes. **Roundabouts** are the final type of circular intersection.

The FWHA defines roundabouts as “circular intersections with specific design and traffic control features. These features include yield control of all entering traffic, channelized approaches, and appropriate geometric curvature to ensure that travel speeds on the circulatory roadway are typically less than 50 km/h (30 mph). Thus, roundabouts are a subset of a wide range of circular intersection forms.”

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6 Isebrands, H. N. and Hallmark, S., 2008

Roundabout Design Guidelines, CUUATS
Roundabouts are considered superior to their predecessors (e.g. traffic circles and rotaries) and generally are a more efficient alternative to traffic lights or stop signs for an intersection. Studies have indeed shown a reduction in injury crashes at an intersection where a roundabout has replaced traffic signals or two way stop signs. Roundabouts are also known to result in vehicular emission and energy consumption reduction in Europe.

1.3. Key parameters and geometric features of a roundabout

A roundabout is characterized by two types of elements: its key parameters and geometric features.

1.3.1. Key parameters

The Federal Highway Administration (FHWA) has listed the following key parameters:

- **Central Island**: The raised area in the center of a roundabout around which traffic circulates.
- **Splitter Island**: The raised or painted area on an approach used to separate entering from exiting traffic, deflect and slow entering traffic, and provide storage space for pedestrians crossing the road in two stages.
- **Circulatory roadway**: The curved path used by vehicles to travel in a counterclockwise fashion around the central island.
- **Apron (also refer to as truck apron)**: The mountable portion of the central island adjacent to the circulatory roadway when required on smaller roundabouts to accommodate the wheel tracking of large vehicles.
- **Yield line**: The pavement marking that shows the point of entry from an approach into the circulatory roadway. This mark is generally painted along the inscribed circle. Entering vehicles must yield to any circulating traffic coming from the left before crossing this line into the circulatory roadway.
- **Accessible pedestrian crossings (sidewalk)**: The crossing location is set back from the yield line, and the splitter island is cut to allow pedestrians, wheelchairs, strollers, and bicycles to pass through. Accessible pedestrian crossings should be provided at all roundabouts.
- **Bicycle treatments (bike ramp)**: This ramp provides bicyclists the option of traveling through the roundabout either as a vehicle or as a pedestrian, depending on the bicyclist’s level of comfort.
- **Landscaping buffer**: This buffer separates vehicular and pedestrian traffic and encourages pedestrians to cross only at the designated crossing locations.

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7 O’Laughlin, R. and Murtha, T., 2009
Landscaping buffers can also significantly improve the aesthetics of the intersection.

Two more key features can also be considered:

- **Outside curbing**: A mountable or non-mountable curb defining the outside edge of the pavement on each approach, around the circulatory roadway, and continuing outside the adjacent exit. It ideally begins at the deceleration point on each approach.

- **Lighting**: This provides illumination for all potential conflict areas, including the beginning of the splitter island, all crosswalks, and entries and exits to the circulatory roadway.

The following figures show the key parameters, as listed by the FHWA and the CTRE respectively.

![Figure 3. Key parameters of a roundabout identified by the FHWA](image)

![Figure 3a. Key parameters of a roundabout identified by the CTRE](image)
1.3.2. Geometric Features

Roundabouts can be described by the following geometric features:

- **Inscribed circle diameter (ICD):** Defines the size of the roundabout, measured between the outer edges of the circulatory roadway. Typically 100 to 130 ft. for single-lane roundabouts and 150 to 180 ft. for double-lane roundabouts, but varies based on the design vehicle turning radius and intersection layout.

- **Circulating or circulatory roadway width:** The width of the circulatory roadway between the outer edge of the curbed roadway and the curbed center island or truck apron. It does not include the width of the truck apron and is typically between 1.0 and 1.2 times the maximum entry width.

- **Approach width:** Roadway width used by the approaching traffic. Typically 12 ft. per lane. Shoulders and wide lanes can lead to undesirably high speeds.

- **Entry width:** Width at the entry to the circulating roadway (where the approach meets the inscribed circle), measured perpendicularly from the right face of the curb to the left face of the curb. Typically 14 to 18 ft. for a single-lane entry, but varies on the design vehicle turning radius.

- **Entry flare:** The widening of an approach lane from the standard lane width to a wider entry width. Flare can increase capacity and accommodate off-tracking of large trucks, but decreases path definition and increases speed variance.

- **Entry deflection:** Entry deflection helps control vehicle speeds and prevents wrong-way movements on the circulatory roadway.

- **Design speed, entry:** The recommended maximum entry design speed is 25 mph (rural) and 20 mph (urban) for single-lane roundabouts and 25 mph for multi-lane roundabouts.

- **Vehicle path radii:** The roundabout design speed is based on the fastest movement through the roundabout. However, speed consistency is important for all the movements. R1, the minimum radius on the fastest through path prior to the yield line, and R5, the minimum radius on the fastest path of a right-turning vehicle, are typically the most critical radii for design speed.

- **Fastest path:** Determines the speed of the roundabout. The fastest path of a single vehicle, excluding all other traffic and lane markings, traversing from the entry, around the circulator roadway, and through the exit. This is usually associated with through movement but can also be right-turn movement.

- **Natural path:** The path that an approaching vehicle will take through a multi-lane roundabout, assuming traffic in all lanes. The speed and orientation of the vehicle at the yield line determines the natural path.
• **Vehicle path overlap:** Path overlap occurs on multi-lane roundabouts when the natural path through the roundabout of one vehicle overlaps that of another vehicle. Occurs most commonly on the approach when a vehicle in the right lane cuts off a vehicle in the left lane as the vehicle enters the circulating lane.

Also listed as geometric features of a roundabout by the FHWA:

• **Departure width:** The departure width is the width of the roadway used by departing traffic downstream of any changes in width associated with the roundabout. The departure width is typically less than or equal to half of the total width of the roadway.

• **Exit width:** The exit width defines the width of the exit where it meets the inscribed circle. It is measured perpendicularly from the right edge of the exit to the intersection point of the left edge line and the inscribed circle.

• **Entry radius:** The entry radius is the minimum radius of curvature of the outside curb at the entry.

• **Exit radius:** The exit radius is the minimum radius of curvature of the outside curb at the exit.

![Figure 4. Geometric features of a roundabout identified by the FHWA](image)

1.4. **Roundabout classification**

There are different ways to classify the roundabouts. The key parameters described above are the components of a basic roundabout and can be modified or adjusted to the type to be used.
In the NHCRP Report 672, the size and the number of lanes are used to classify three types of roundabouts: the mini-roundabouts, the single-lane roundabouts and the multilane roundabouts. The values of the key parameters are shown in the following table:

### Table 1. NCHRP Report 672 Roundabouts classification

<table>
<thead>
<tr>
<th>Design Element</th>
<th>Mini Roundabout</th>
<th>Single-Lane Roundabout</th>
<th>Multilane Roundabout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desirable maximum entry design speed</td>
<td>25 to 30 km/h</td>
<td>30 – 40 km/h</td>
<td>40 – 50 km/h</td>
</tr>
<tr>
<td></td>
<td>(15 – 20 mph)</td>
<td>(20 – 25 mph)</td>
<td>(25 – 30 mph)</td>
</tr>
<tr>
<td>Maximum number of entering lanes per approach</td>
<td>1</td>
<td>1</td>
<td>2+</td>
</tr>
<tr>
<td>Typical inscribed circle diameter</td>
<td>13 – 27 m</td>
<td>27 – 55 m</td>
<td>46 – 91 m</td>
</tr>
<tr>
<td></td>
<td>(45 – 90 ft.)</td>
<td>(90 – 180 ft.)</td>
<td>(150 – 300 ft.)</td>
</tr>
<tr>
<td>Central Island Treatment</td>
<td>Fully traversable</td>
<td>Raised (may have traversable apron)</td>
<td>Raised (may have traversable apron)</td>
</tr>
<tr>
<td>Typical daily service volumes on 4-leg roundabout below which may be expected to operate without requiring a detailed capacity analysis (veh/day)</td>
<td>Up to approximately 15,000</td>
<td>Up to approximately 25,000</td>
<td>Up to approximately 45,000 for two-lane roundabout</td>
</tr>
</tbody>
</table>

*Operational analysis needed to verify upper limit for specific applications or for roundabouts with more than two lanes or four legs.

For the purpose of this document, the three types of roundabouts presented in the table above will be considered: the mini-roundabout, the single-lane roundabout and the multi-lane roundabout. The environment of the intersection whether it is rural, suburban or urban, will also be taken in consideration to present the existing conditions of the intersection to be analyzed.

1.5. Benefits

Roundabouts are often referred to as a safer intersection control than signalized and stop-controlled intersections. Such safety directly results from their design since all vehicles are traveling in one direction in the circle, which reduces the number of conflicts due to right or left turns. Its geometric features decrease the entry speed of vehicles to a value generally between 10 and 25 mph. For that reason, roundabouts are considered a speed control design. According to the NCHRP Report 672, the benefits of the implementation of a well-designed roundabout are as follows:

- Entering vehicles have more time to allow safer mergers
- The size of sight triangles for users to see one another are reduced
- An increase in motorists yielding to pedestrians
- A reduction in the frequency of crashes
- Safer intersections for novice users

However, the roundabouts also have some limitations. In the table below, the NCHRP 672 lists the advantages and disadvantages associated with roundabouts.
Table 2. Advantages and disadvantages of roundabouts

<table>
<thead>
<tr>
<th>Non-Motorized Users</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>• Pedestrians consider only one direction of conflicting traffic at a time.</td>
<td>• Pedestrians with vision impairments may have trouble finding crosswalks and determining when/if vehicles have yielded at crosswalks.</td>
</tr>
<tr>
<td>• Bicyclists have options for negotiating roundabouts, depending on their skill and comfort level.</td>
<td>• Bicycle ramps at roundabouts have the potential to be confused with pedestrian ramps.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>• Reduce crash severity for all users, allow safer merges into circulating traffic, and provide more time for all users to detect and correct for their mistakes or the mistakes of others due to lower vehicle speeds.</td>
<td>• Increase in single-vehicle and fixed-object crashes compared to other intersection treatments.</td>
</tr>
<tr>
<td>• Fewer overall conflict points and no left-turn conflicts.</td>
<td>• Multi-lane roundabouts present more difficulties for individuals with blindness or low vision due to challenges in detecting gaps and determining that vehicles have yielded at crosswalks.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operations</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>• May have lower delays and queues than other forms of intersection control.</td>
<td>• Equal priority for all approaches can reduce the progression for high volume approaches.</td>
</tr>
<tr>
<td>• Can reduce lane requirements between intersections, including bridges between interchange ramp terminals.</td>
<td>• Cannot provide explicit priority to specific users (e.g. trains, emergency vehicles, transit, pedestrians) unless supplemental traffic control devices are provided.</td>
</tr>
<tr>
<td>• Create possibility for adjacent signals to operate with more efficient cycle lengths where the roundabout replaces a signal that is setting the controlling cycle length.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Access Management</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>• Facilitate U-turns that can substitute for more difficult midblock left turns.</td>
<td>• May reduce the number of available gaps for mid-block unsignalized intersections and driveways.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Environmental Factors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>• Noise, air quality impacts, and fuel consumption may be reduced.</td>
<td>• Possible impacts to natural and cultural resources due to greater spatial requirements at intersections.</td>
</tr>
<tr>
<td>• Little stopping during off-peak periods.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Traffic Calming</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>• Reduce vehicular speeds.</td>
<td>• More expensive than other traffic calming treatments.</td>
</tr>
<tr>
<td>• Beneficial in transition areas by reinforcing the notion of a significant change in the driving environment.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Space</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>• Often require less queue storage space on intersection approaches—can allow for closer intersection and access spacing.</td>
<td>• Often requires more space at the intersection itself than other intersection treatments.</td>
</tr>
<tr>
<td>• Reduce the need for additional right-of-way between links of intersections.</td>
<td></td>
</tr>
<tr>
<td>• More feasibility to accommodate parking, wider sidewalks, planter strips, wider outside lanes, and/or bicycle lanes on the approaches.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operations and maintenance</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>• No signal hardware or equipment maintenance.</td>
<td>• May require landscape maintenance.</td>
</tr>
</tbody>
</table>
## Aesthetics

- Provide attractive entries or centerpieces to communities.
- Used in tourist or shopping areas to separate commercial uses from residential areas.
- Provide opportunity for landscaping and/or gateway feature to enhance the community.

| | May create a safety hazard if hard objects are placed in the central island directly facing the entries. |
Section 2. Champaign-Urbana Existing Conditions

Roundabouts are considered an alternative to other traffic controls that help reduce crashes and improve safety at intersections. Thus far, there are four roundabouts in the Champaign-Urbana-Savoy-Bondville urbanized area:

- Three located in the City of Champaign at the intersections of: English Oak Drive/Chestnut Grove Drive, English Oak Drive/Abbey Fields Drive, and Crabapple Lane/Sandcherry Drive;
- One in the City of Urbana at the intersection of Stebbins Drive/Division Avenue

Three other locations have been considered for the installation of roundabouts in the City of Urbana: Florida Avenue/Philo Road intersection, Windsor Road/Race Street intersection and Olympian Drive/Lincoln Avenue intersection. All three intersections have been studied to assess the feasibility of installing roundabouts; however, none was considered appropriate for such implementation.

For the three intersection control studies, the City of Urbana sought the expertise of Roundabout consultants since the Illinois Department of Transportation (IDOT) does not provide roundabout guidelines. States like Iowa have addressed roundabouts in their intersection design guidelines, similar to the Illinois Department of Transportation’s “BDE Chapter 36.” Illinois has not issued any guidelines on roundabouts but recommends the use of the FHWA Roundabout Guidelines and the NCHRP 672 report as references whenever the feasibility of a roundabout is questioned. These guidelines provide general information for roundabout design, but need to be adapted to the Champaign-Urbana local transportation conditions to better fit the existing conditions of the community. This document proposes guidelines for roundabouts that can be used in Champaign-Urbana when an intersection is being evaluated for installation of traffic control devices.
Section 3. Considerations and Feasibility

“Planning determines whether a roundabout is even feasible, before expending the effort required for more detailed analysis and design.” It is about addressing whether the choice of a roundabout is appropriate for the location, the size or number of lanes of the roundabout to be designed, the impact of the implementation of the roundabout and the appropriate public education approach. In these guidelines, the main focus will be on deciding when a roundabout is appropriate for an intersection.

The NHCRP 672 identifies three environmental situations where a roundabout might appear as an opportunity: a retrofit of an existing intersection, the first roundabout in the area and roundabouts in a new roadway network. Although, only the case where the roundabout is proposed as a retrofit of an existing intersection will be considered in the following, further considerations will be made for the other cases as well.

3.1. Roundabout as an alternative for an existing intersection (Retrofit intersection)

When an intersection is subject to a retrofit, the alternative analysis is generally based on improving the safety or capacity of the existing intersection. In either case, the existing conditions and future demands should be well documented to be used in the alternative analysis. Therefore, considering the roundabout as an alternative will be based on criteria such as safety and geometric factors along with the intersection operation. Such factors may include but are not limited to: the existing morning and afternoon peak-hour turning-movement counts; major traffic generators with shift changes that occur during off-peak hours; approved design-year morning and afternoon peak-hour turning-movement projections; design vehicle to be accommodated; base mapping, either aerial photograph, aerial mapping, or survey; right-of-way mapping; crash data for the most recent three-year to five-year period available; location of nearby intersections and signal timing information, if applicable; location of major constraints near the intersection, i.e., right of way, major utilities, structures, railroad crossings, bodies of water; existing and future planned bicycle and pedestrian facilities; truck percentages; and accommodation of disabled persons.

---

8 Kittelson & Associates, Inc., 2010
Table 3. Factors when considering a roundabout

<table>
<thead>
<tr>
<th>Safety factors</th>
<th>Right-angle crashes</th>
<th>Left-turn crashes</th>
<th>Red light or Stop sign running</th>
<th>Roundabout is a viable alternative</th>
<th>Roundabout is a viable alternative</th>
<th>Roundabout is a viable alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor crash history&lt;sup&gt;a&lt;/sup&gt; (with injury crashes) at two-way stop-controlled or signalized intersections with high proportion of these crash types:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>Non-motorized users&lt;sup&gt;b&lt;/sup&gt;</td>
<td>High volume of pedestrians and high volume of vehicles</td>
<td></td>
<td></td>
<td>Additional investigation needed</td>
<td>Additional investigation needed</td>
<td></td>
</tr>
</tbody>
</table>

Notes
<sup>a</sup> Four-way stop intersections and roundabouts have similar crash histories, whereas two-way stop-controlled and signalized intersections have much higher crash rates than roundabouts.
<sup>b</sup> Roundabouts provide an intersection environment for pedestrians where speeds are low and pedestrians only cross one direction of vehicular traffic at a time and find refuge in the splitter island. Active research, NCHRP 3-78/3-78A, is investigating the need to provide additional guidance for pedestrians at multi-lane roundabouts, specifically blind and sight-impaired pedestrians. The recommendation by the U.S. Access Board suggests that all multi-lane roundabout pedestrian crossings be equipped with a pedestrian-activated signal to stop traffic (e.g., a high-intensity activated crosswalk [HAWK] signal).

<table>
<thead>
<tr>
<th>Geometric factors</th>
<th>More than four legs</th>
<th>Skewed</th>
<th>Close to another intersection</th>
<th>Within 100 ft. of a driveway&lt;sup&gt;d&lt;/sup&gt;</th>
<th>Roundabout is a viable alternative</th>
<th>Roundabout is a viable alternative</th>
<th>Roundabout can be a viable alternative depending on the roadway classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intersection geometry&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Roundabout not recommended</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sight distance&lt;sup&gt;e&lt;/sup&gt;</td>
<td>Inadequate stopping sight distance</td>
<td></td>
<td></td>
<td></td>
<td>Roundabout is a viable alternative alternative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimal intersection sight distance with adequate sight lines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes
<sup>c</sup> Roundabouts provide flexibility at intersections where other intersections are in close proximity. An adjacent side road approach may be realigned such that it can be added as a leg to the roundabout.
<sup>d</sup> Driveways can be difficult to accommodate near any intersection, both geometrically and operationally. Roundabouts can provide more flexibility when driveways are within 100 ft. to 500 ft. of the intersection. Right-in-right-out turning restrictions can be implemented at driveways near roundabouts while still minimizing traffic impacts, as roundabouts allow for convenient U-turns.
<sup>e</sup> Stopping sight distance for a roundabout is critical at the entrance approach, within the circulatory roadway, and on the exit approach (crosswalk). Intersection sight distance is essentially the sight “triangle” (which may be on a curve) needed for a driver who does not have the right of way to perceive and react to a conflicting pedestrian, vehicle, or bicyclist. Roundabouts have an advantage over standard intersections in that there are fewer conflicts to check for sight distance requirements. The minimum required sight distance is actually preferred in order to keep speeds low at the intersection.
<table>
<thead>
<tr>
<th>Operation factors</th>
<th>Near traffic signals</th>
<th>Two way stop delay</th>
<th>Four way stop delay</th>
<th>Signal delay</th>
<th>Turning movements</th>
<th>Access management</th>
<th>Interchange ramps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where queuing may extend into other intersections</td>
<td>Additional investigation needed</td>
<td>Additional investigation needed</td>
<td>Additional investigation needed</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>Within a coordinated signal system</td>
<td>Additional investigation needed</td>
<td>Additional investigation needed</td>
<td>Additional investigation needed</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>Where modifications to traffic via signal timing is desired</td>
<td>Additional investigation needed</td>
<td>Additional investigation needed</td>
<td>Additional investigation needed</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>Major movement - peak hours</td>
<td>Additional investigation needed</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
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</tr>
<tr>
<td>Minor movement - peak hours</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
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<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>Major movement - off-peak hours</td>
<td>Additional investigation needed</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>Minor movement - off-peak hours</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
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</tr>
<tr>
<td>Major movement – peak hours</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>Minor movement – peak hours</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>Major movement – off-peak hours</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>Minor movement – off-peak hours</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>No left-turn lane</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>No protected left-turn phase</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>High percentage of vehicles turning left</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>Major traffic movement changes direction</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>In lieu of right turn on red</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>Need for U-turns</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>Right-in-right-out restrictions</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>Exit ramps with a high number of left turns</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>Limited storage on ramp</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
<tr>
<td>Where headway between vehicles is</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
<td>Roundabout is a viable alternative</td>
</tr>
</tbody>
</table>
important as vehicles enter a freeway/expressway alternative

Notes

1 Traffic signals and roundabouts can and do exist on the same corridor. Intersections on corridors need to be considered as part of a system and not on an individual or isolated basis. With proper signal timing, coordination, and an operations analysis to account for queuing between intersections, roundabouts and signalized intersections can be compatible.

9 Access management principles align with how roundabouts function and operate. Corridors that are hampered with numerous accesses, especially those to businesses, can benefit from roundabouts. Roundabouts facilitate the use of U-turns at intersections and allow for right turns into driveways and parking lots rather than left turns across traffic. The impacts of right-in-right-out restrictions and closed medians become reduced when roundabouts provide a natural U-turn at an adjacent intersection.

The table above identified the factors that can be used to make a preliminary recommendation when considering a roundabout. Those are general and preliminary recommendations based on non-specific numerical data. They may be used whenever preliminary analysis is required and in this case, the recommendation criteria limits are left at the discretion of the planner/designer.

There are many different approaches that can be used when the feasibility of a roundabout is being questioned. For the Champaign-Urbana area, the following process is recommended:

- **Step 1**: Identify the context of the intersection; whether it is an urban, sub-urban, rural or University District intersection.

- **Step 2**: Identify the reasons the roundabout alternative is being considered.

  The consideration of a roundabout for a retrofit intersection is generally for capacity or safety improvements. The factors described in the table above can help clarify the reason a roundabout is being recommended. The end goal for a roundabout is supported by its purpose as a safety or capacity enhancer, therefore, these reasons should be identified in the planning stages of a roundabout.

- **Step 3**: Gather the relevant crash data and traffic data for the existing intersection being considered.

  Data such as volume to capacity ratio, average delay, Level of Service (LOS), queue lengths, crash data, peak hour volume and others may be useful. The exact data to be gathered should be determined by the reason for roundabout consideration as explained in Step 2.

- **Step 4**: Future projection of existing data and conditions (20-30 years).

  Projecting the existing data and conditions into the future is important to evaluate the approximate growth of those factors and assess the capacity of the proposed alternatives to handle the volumes and conditions over the roadway design life.

- **Step 5**: Proposition of the appropriate type of roundabout.
Choosing the type of roundabout (mini, single-lane or multi-lane) is based on projected traffic volumes and design speed (See Table 2 or NCHRP 672 Exhibit 3-12).

- **Step 6**: Compute delay, LOS and queue lengths for all alternatives considered.

Whether the intersection being studied is a signalized, an AWSC or a TWSC intersection, refer to the Highway Capacity Manual 2010 for the formulas to compute the delay, LOS and queue length.

For example, the NCHRP Report 672 and Kittelson & Associates, Inc. recommended the following formulas to assist the implementation of a roundabout in the City of Bend, (OR):

- For the entry capacity at single-lane roundabouts:
  \[
  c = 1130 \exp(-0.0010v_c) \tag{1}
  \]
  With
  \( c = \text{entry capacity (passenger car units [pcu]/h)} \)
  \( v_c = \text{conflicting flow (pcu/h)} \)

- For the critical lane of a multilane entry into a two-lane circulatory roadway:
  \[
  c_{crit} = 1130 \exp(-0.0007v_c) \tag{2}
  \]
  With
  \( c_{crit} = \text{entry capacity of critical lane (pcu/h)} \)
  \( v_c = \text{conflicting flow (pcu/h)} \)

- To compute the delay for each lane:
  \[
  d = \frac{3600}{c} + \frac{900T}{c} \left( \frac{v}{c - 1} + \sqrt{\left( \frac{v}{c - 1} \right)^2 + \frac{3600}{450T} \cdot \frac{v}{c}} \right) \tag{3}
  \]
  With
  \( d = \text{average control delay (s/veh)} \)
  \( c = \text{capacity of subject lane (veh/h)} \)
  \( T = \text{time period (h: } T = 1 \text{ for 1-h analysis, } T = 0.25 \text{ for 15-min analysis)} \)
  \( v = \text{flow in subject lane (veh/h)} \)

And for the intersection:

\[
D(\text{intersection}) = \frac{\sum D_i V_i}{\sum V_i} \tag{4}
\]

With
\( D_{\text{intersection}} = \text{intersection control delay (s/veh)} \)
\( D_i = \text{control delay on approach } i \text{ (s/veh)} \)
\[ V_i = \text{volume on approach } i \text{ (veh/hr)} \]

- **Step 7:** Assess pedestrian and/or bicycle impacts

Existing and projected pedestrian and bicycle volumes need to be assessed to evaluate their impacts on the capacity and safety of all traffic alternatives being analyzed. Section 4 of this document provides more information about considerations for pedestrians and bicycles in roundabouts.

- **Step 8:** Benefit/Cost Analysis

When a roundabout is being considered as a solution, a benefit/cost analysis should also be used as an important decision guidance tool. Such analysis can be performed by comparing the benefit/cost ratio for both intersection control types. The existing intersection should be observed for at least three (3) years before the analysis period\(^9\) to evaluate the benefits, the frequency, patterns, severity and types of crashes.

Three types of benefits should be evaluated: safety benefits (crash analysis), operational benefits (reduction of delay) and environmental benefits (reduction of fuel consumption and improvement of air quality).

The cost of maintenance and construction are two cost components to be evaluated for both the existing intersection and the roundabout. For example, a roundabout does not require costs associated with traffic signals, such as energy and maintenance. However, the footprint surface needed for the roundabout is larger than the one needed for a signalized intersection.\(^3\)

To find the footprint or space requirement of the roundabout, the ADT data should be used with Table 1 to choose the type of roundabout to be constructed. The space required for the type of roundabout should be compared to the actual size of the existing intersection to ensure it is a viable option.

If more than two alternatives are being compared, the benefits/costs for all alternatives should be compared to a no-build alternative using the following equation\(^4\):

\[ \frac{B}{C}(i \rightarrow nb) = \frac{\text{Benefits}(i) - \text{Benefits}(nb)}{\text{Costs } i - \text{Costs } nb} \]  

(5)

With \(i = \text{Alternative } i\)

\(nb = \text{no-build alternative}\)

Once the not viable alternative is eliminated (\(B/C < 1\)), the B/C ratios of the viable alternatives are to be compared by pair\(^4\).

---

\(^9\) Indiana Department of Transportation, Indiana Design Manual (IDM) Chapter 51.12, 2011
• **Step 9**: Results and recommendations sheet

Draw up a result and recommendation sheet containing all the considerations made for the alternatives considered, final comments, interpretations and recommendations. This sheet may be similar to the figure below:

<table>
<thead>
<tr>
<th>Intersection Location:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factors</strong></td>
</tr>
<tr>
<td>Safety</td>
</tr>
<tr>
<td>Operational Analysis</td>
</tr>
<tr>
<td>Construction Cost</td>
</tr>
<tr>
<td>Right-of-way</td>
</tr>
<tr>
<td>...</td>
</tr>
</tbody>
</table>

Figure 6: Results and recommendations sheet

Figure 7 illustrates the steps to be followed in the roundabout analysis.
Step 1: Identify the location

Step 2: Identify the reasons the roundabout alternative is being considered

Step 3: Get the relevant crash data and traffic data for the existing intersection

Step 4: Future projection of existing data and conditions

Step 5: Proposition of the appropriate type of roundabout

Step 6: Compute delay, LOS and queue lengths for all

Step 7: Assess pedestrian and/or bicycle impacts

Step 8: Benefit/Cost Analysis

Step 9: Draw up an analysis and recommendation sheet

Conclusion: Which alternative is feasible and/or recommended?

Figure 7. Flow Chart of the Analysis Process
3.2. First roundabout in an area

When a roundabout is introduced as a retrofit for the first time, the process outlined above should be used to decide whether or not the roundabout is the appropriate intersection control. However, an education campaign is needed to promote awareness of the benefits of the roundabout for current and future users. The education campaign should focus on the safety improvement and advantages of the use of roundabouts and educate users on traffic operation in roundabouts.

Multi-lane roundabouts have been successfully constructed as the first roundabout in many communities across the U.S., although single-lane roundabouts are usually more easily understood by users without roundabout experience.4

3.3. Roundabouts in a new roadway network (new intersection)

Fewer considerations need to be made for a roundabout as part of a new roadway project when compared to a retrofit project. There are usually no field observations of site-specific problems to be addressed and it is easier to get right-of-way. In this case, a roundabout should be presented as one alternative among many others4.

Once a location is determined, the design year traffic should be chosen to help decide what type of roundabout is necessary. Other factors like the environmental conditions and future development at the site should also be taken into consideration.
Section 4: Other considerations

Aside from drivers, there are three important users to consider when determining the feasibility of roundabouts as an alternative to an existing intersection control: pedestrians, persons with disabilities and cyclists. Each group is subject to high risks when interacting with cars while crossing or cycling across or within the roundabout. Therefore, taking into account their volumes and interaction with the vehicles at the intersection under study should be an important factor of the decision-making process.

4.1. Pedestrians

Pedestrians are particularly at risk at intersections since their paths often include crossing streets at signals where they are subjected to unprotected left and right turn conflicts or at stop control intersections where they must consider two directional traffic simultaneously. While pedestrians usually look both ways when there is no median in traditional intersections, in roundabouts, the splitter island allows them to pause between the two ways. Pedestrians face more conflict points at traditional intersections than at roundabouts, where they cross one leg of traffic at a time.4

While the characteristics described above apply to both the mini and single-lane roundabouts, it is more difficult for pedestrians to cross in multi-lane roundabouts because of the longer crossing distance. The NCHRP Report 672 states that two to three times as many vehicles do not yield to pedestrians in multi-lane roundabouts as compared to single-lane roundabouts.

4.2. Pedestrians with disabilities

Accommodating pedestrians with disabilities at roundabouts represents a challenge for transportation entities. The Americans with Disabilities Act (ADA) specifically requires that “Any new or modified intersection in the United States that has pedestrian facilities must be accessible to and usable by all pedestrians.” In other words, pedestrians with disabilities should be able to use or cross a roundabout intersection without any special training. Accommodations for these roundabout users are important and below are a few of the most common difficulties for pedestrians with disabilities4:

- **Wayfinding**

  Wayfinding in a roundabout is difficult for pedestrians with visual impairment because the roundabout intersection design is circular and the crosswalks are outside the projection of approaching sidewalks.

- **Alignment**

  The blind pedestrians need audible and tactile clues to align themselves with the crosswalks and the roundabout is not generally equipped with these.

- **Gap and yield detection**

  This is the most difficult issue that blind pedestrians face in a roundabout. Pedestrians with vision impairment rely on audible clues to cross an intersection, which may be
masked by the circulating traffic inside the traffic circle. Since there may always be traffic movement in a roundabout, it is difficult for these pedestrians to distinguish a vehicle that has totally stopped from one that intends to stop or a vehicle inside the circle from one that is exiting the circle. In multi-lane roundabouts, the issue is amplified due to the increased number of lanes.

Accommodating blind pedestrians is a challenge in roundabouts. Some solutions like the use of detectable edge treatment or a landscape strip to lead those pedestrians to the crosswalks have been used. The NCHRP Report 674 also listed some other treatments that may be applicable to accommodate pedestrians with visual disabilities:

- **Flashing Beacon**
  
The installation of a continuous flashing beacon along with a static sign to make it more visible which can become ineffective if the existing pedestrian traffic cannot indicate how frequent the crosswalk is used.

- **Distal Crosswalk**
  
  Placing a crosswalk 100 ft. away from the roundabout circulation lane will have the benefit to orient the pedestrians away from the noise generated by traffic inside the roundabout circulating lane. Although this solution would facilitate the pedestrians with visual disabilities in their crossing travel, it can be less beneficial for the sighted pedestrians who can just ignore the crosswalk because of the longer crossing distance and cross in a location in between the crosswalk and the circulation lane. Having a raised distal crosswalk or combining the distal crosswalk with speed lowering measures can also be a solution to accommodate visually impaired pedestrians.

- **Offset exit crossing**
  
  Assuming that it is more difficult for a visually impaired pedestrians to cross an exit lane comparing to an entry lane, this solution would facilitate the selection of gap if the crosswalk is offset enough from the in circle traffic. The zigzag geometry obtained will also provide additional queue storage for the exit lane.

- **Pedestrian-actuated additional signal – one or two stage**
  
  This solution would be particularly beneficial for blind pedestrians since audio is also provided along with the red-yellow-green traditional which, in this case, would be used for the pedestrians. However, slow driver reaction, delay and queue spillback at roundabouts with high pedestrians and vehicular traffic might be an issue.

- **Pedestrian hybrid beacon or HAWK**
  
  This solution would be more efficient than the conventional pedestrian traffic signal because vehicles would be allowed to move after stopping when the “Don’t walk” is flashing if there is no pedestrian crossing.

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10 NCHRP Report 674
The solutions above are among many to be explored when pedestrians with disabilities are being considered in designing a roundabout. However, only few of them have been tested. While testing the HAWK on double-lane roundabouts have revealed a reduction in the vehicle delay and a lower level of risks in the roundabout, those solutions remained experimental at the moment and are the subject of many on-going researches.

4.3. Bicyclists

The speed inside a roundabout circle (10 to 15 mph) is very comparable to a cyclist’s speed in traffic (12 to 20 mph). Single-lane roundabouts are safer and simpler for bicyclists due to the low speed of circulating traffic compared to multi-lane roundabouts. Moreover, cyclists do not have to change lanes, select an appropriate circulating lane or cross a vehicle path while exiting the circle. It is for these reasons that a single-lane roundabout is more desirable for cyclists than a multi-lane roundabout, even when long-term predictions suggest that a multi-lane roundabout may be desirable.

When bicycle lanes are painted on the side of a roadway and next to vehicle traffic lanes, they should terminate before entering the circle. Bicycle lanes at the edge of a roundabout circle create conflicts between the bikes and the exiting vehicles, which can result in high crashes inside the circle. At the approach of the circle, the bike lane may be continued with bike ramps allowing the bikes to access the sidewalks. However, such measure may not be necessary in urban single lane roundabouts since the low-speed and lower-volume environment will typically facilitate comfortable navigation for the cyclists.

4.4. Pedestrian and bicycle planning considerations

The NCHRP Reports 672 and 674 provides further information for considerations to be made for pedestrians and bicyclists. For the CUUATS Roundabout Design Guidelines, the existing pedestrian and bicycle volumes and facilities should be carefully considered. A planner/designer should assess their impact on capacity and safety reduction by identifying and analyzing the crashes due to their interaction with the vehicles, any signal timing available for their process, and any other relevant data.

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11 FHWA Safety Program, FHWA SA-10-006, 2010
Section 5: Recommendations

This set of guidelines is the result of a careful synthesis of planning guidelines published and adopted by numerous states and cities across the United States. They should not be used as standards for roundabouts but can be used as guidelines for the Champaign-Urbana MPO member agencies to lead preliminary intersection analyses that include roundabout feasibility. Adequate considerations should be made to comply with all requirements of the conditions of each intersection being analyzed since each case is different.

Although each case study differs from one another, roundabout implementation across the world has revealed some trends across cases. According to NCHRP Report 672:

- A roundabout will always provide a higher capacity and lower delays than all-way stop-control (AWSC) operating with the same traffic volumes.
- A roundabout is unlikely to offer better performance in terms of lower overall delays than TWSC at intersections with minor movements (including cross-street entry and major-street left turns) that are not experiencing, nor predicted to experience, operational problems under TWSC.
- A single-lane roundabout may be assumed to operate within its capacity at any intersection that does not exceed the peak-hour volume warrant for signals.
- A roundabout that operates within its capacity will generally produce lower delays than a signalized intersection operating with the same traffic volumes.

Some cases were also reported by the Wisconsin Department of Transportation at locations where roundabouts may be ideal to other alternatives:

- Intersections with a high-crash rate or a higher severity of crashes.
- Where an existing intersection is failing, for any reason.
- Where other alternatives are expensive.
- Where aesthetics are an objective.
- Transitions in functional class or desired speed change (including rural to urban transitions).
- Where a random/continuous arrival pattern exists.
- Where a random/continuous traffic pattern is desired or platoons are especially expensive and inefficient (on-ramps, bridges).
- Freeway ramp terminals.
- High-speed rural intersections.
- Intersections of dissimilar functional class (arterial-arterial, arterial-collector, arterial-local, collector-collector, collector-access).
- 4-leg intersections with entering volumes less than 8,000 vph or approximately 80,000 ADT.
- 3-leg intersections of any volume.
- 2-way stop control intersections with a high-crash rate or a higher severity of crashes.
- Intersection of two signalized progressive corridors where turn proportions are heavy (random arrival is better than off-cycle arrival).
- Closely spaced intersections where signal progression cannot be achieved.
- Locations where future access will be added to the intersection.
- Replacement of 4-way stops.
- Intersections near schools.
- Other intersections where safety is a major concern.

These considerations should be taken into account and utilized as references during the planning process.
Section 6: References


Ourston Roundabout Engineering, Inc., Intersection Control Study Windsor Road and Race Street, Urbana, IL, June, 2011.


Transportation Research Board of the National Academy, Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities, NCHRP Report 674, Washington D.C., 2011.


Section 7: CUUATS Roundabout Sample Policy

WHEREAS, the Champaign-Urbana Urbanized Area Transportation Study (CUUATS) addresses transportation problems within a defined study area; and

WHEREAS, the CUUATS adopted mission is “to coordinate metropolitan transportation planning with the Illinois Department of Transportation, Champaign County, the Cities of Champaign and Urbana, Village of Savoy, University of Illinois, the Champaign-Urbana Mass Transit District, and the general public, and to coordinate the use of federal transportation funds within the Champaign-Urbana urbanized area”; and

WHEREAS, the CUUATS Long Range Transportation Plan: Choices 2035 adopted the following goals:

- **Goal 1:** Non-single occupancy vehicle travel will be a principal consideration of the transportation planning process to make the urbanized area more sustainable, efficient, and provide a higher quality of life for residents.
- **Goal 2:** Compact development and mixed-use forms should be principal considerations for new development and redevelopment in the urbanized area to create a more walkable, sustainable, and efficient development pattern.
- **Goal 3:** Transportation modes and facilities in the urbanized area will be safe for all users.
- **Goal 4:** The urbanized area transportation system will be secure from human and natural hazards.
- **Goal 5:** All transportation system users will have convenient, multi-modal access to all parts of the urbanized area and will travel with increased mobility during peak traffic hours.
- **Goal 6:** To provide facilities for non-auto modes of transportation in order to improve mobility and decrease the number of vehicles on our roadways.
- **Goal 7:** Utilize a sustainable approach to transportation planning and engineering which promotes environmental stewardship and energy conservation.
- **Goal 8:** Provide a user-friendly, integrated regional transportation system that supports accessibility and promotes desirable social impacts.
- **Goal 9:** All transportation system users in the urbanized area will have access to a network of transportation modes and infrastructure that maximizes connectivity between origins and destinations and promotes the use of both motorized and non-motorized modes to travel between them.
- **Goal 10:** To the greatest extent possible, the existing capacity of the urbanized area transportation system will be maximized through innovative transportation system management approaches.
- **Goal 11:** Interagency coordination will be emphasized in all phases of the transportation planning and implementation process.
- **Goal 12:** To the greatest extent possible, improvements will be made to the existing roadway network to preserve or improve upon its current condition and add pedestrian, bicycle and transit facilities where needed.

WHEREAS, in certain circumstances, roundabouts are considered a viable alternative to other intersection traffic controls and help support CUUATS’ mission; and
WHEREAS, roundabouts are a useful intersection control structure designed and constructed to support safe and convenient travel along and across streets for all users, including pedestrians, cyclists, motor vehicles, transit riders, regardless of age, physical abilities, income or ethnicity; and

WHEREAS, the CUUATS Technical Advisory Committee has recommended establishing roundabout policy guidelines for the Champaign-Urbana urbanized area to promote the construction of roundabouts within the regional transportation network when feasible and appropriate; and

WHEREAS, the Champaign-Urbana urbanized area includes streets and facilities falling under the jurisdiction of the Illinois Department of Transportation, Champaign County, the Cities of Urbana and Champaign, the Villages of Savoy, Tolono and Bondville, and the University of Illinois, and CUUATS members strive to coordinate transportation policies and improvements of its constituent organizations;

WHEREAS, CUUATS wishes to promote best management practices in building and maintaining transportation facilities; and

WHEREAS, CUUATS has determined it is in the best interest of its members and the population the members represent to adopt Roundabout Design Guidelines.

NOW, THEREFORE, BE IT RESOLVED BY THE CHAMPAIGN-URBANA URBANIZED AREA TRANSPORTATION STUDY (CUUATS) POLICY COMMITTEE, as follows:

Section 1. That the Roundabout Design Guidelines attached hereto as “Attachment A” are adopted.

Section 2. That the Roundabout Design Guidelines are in conformance with the current and anticipated needs of the Champaign-Urbana Urbanized Area.
Attachment A

Purposes
The purpose of the CUUATS Roundabout Design Guidelines is to promote the construction of roundabouts in the Champaign-Urbana Urbanized Area whenever feasible and appropriate, whether by the Illinois Department of Transportation, Champaign County, the Cities of Urbana and Champaign, the Villages of Savoy, Tolono and Bondville, or the University of Illinois.

Roundabout Principles
Roundabouts are a useful intersection control structure designed and constructed to support safe and convenient travel along and across streets for all users, including pedestrians, cyclists, motor vehicles, transit riders, regardless of age, physical abilities, income or ethnicity.

Champaign-Urbana Urbanized Area.
The Champaign-Urbana Urbanized Area Boundary is determined by the US Census Bureau in conjunction with the Decennial Census and is defined as an area of 50,000 or more population that is considered currently urban in character. The Champaign-Urbana Urbanized Area currently includes the transportation jurisdictions of the Illinois Department of Transportation, Champaign County, the Champaign-Urbana Mass Transit District, the Cities of Urbana and Champaign, and the Villages of Savoy, Bondville and Tolono.

Values
The values to incorporate within the CUUATS Roundabout Design Guidelines not only include safety, mobility, and fiscal responsibility, but also community values and qualities including: environmental, scenic, aesthetic, historic and natural resources, and social equity values. This approach demands careful analysis of the feasibility and appropriateness of roundabouts within the construction and reconstruction of intersections. The public should be consulted, when appropriate, as a factor in the transportation infrastructure decision-making process.

Adaptability
The CUUATS Roundabout Design Guidelines provides flexibility to accommodate various roadway users in roundabouts when appropriate at intersections to enhance the safety and convenience of users and the capacity of the roadway in a way that fits the context(s) of the community.

Applicability
If an intersection warrants a signal or a four-way stop within the design life of the proposed project, the modern roundabout shall be evaluated as an equal alternative. Where there is an existing four-way stop or signal and there are operational problems with the current control, then the roundabout shall be considered as a viable alternative. As stated above the roundabout may be a viable alternative for a two-way stop control in certain circumstances. In either case, roundabouts are a potential intersection control strategy until such time that the evaluation indicates that the roundabout alternative is not appropriate.

Appropriate roundabout accommodation(s) should be considered a part of all appropriate transportation intersection projects, including:
  - Project identification
  - Scoping procedures and design approvals, including design manuals and performance measures
Roundabout Design Guidelines should:
- Apply to both existing and future intersections
- Apply to transportation infrastructure projects where intersections are considered, regardless of funding source(s), and
- Not apply to streets ultimately to be privately owned and maintained, where specified users are prohibited by law, or the cost of providing accommodation are excessively disproportionate to the need or probable use.

**Existing Policies and Regulations**
To support the CUUATS Roundabout Design Guidelines, existing policies and regulations of member jurisdictions may be reviewed and modified by those jurisdictions in consultation with CUUATS where appropriate. Such policies and regulations may include:

- Comprehensive plans
- University District master plans
- Transportation plans
- Subdivision codes
- Manuals of practice
- Grant-writing practices
- Impact assessments
- Level of Service assessments
- Departmental policies and procedures
- Any other applicable procedures and standards

**Latest Standards**
In furthering the CUUATS Roundabout Design Guidelines, transportation projects should make use of the latest and best design standards, policies, and guidelines. Performance measures should also be utilized to measure the effectiveness of roundabout practices that align with concurrent transportation planning efforts, particularly the Champaign-Urbana Long Range Transportation Plan.