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# MEMORANDUM

**Date**: November 15, 2019

**To**: Tom Nikunen, ICMA-MN, Jordan City Administrator

**From**: Jacob Bongard, P.E., PTOE
Mike Larson, EIT

**CC**: Mike Waltman, P.E., Jordan City Engineer

**Subject**: Pedestrian Safety at Roundabout Intersections
City of Jordan, MN

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## Introduction

Roundabout intersections can be a topic of much debate during the development of public projects. Communities often find themselves conflicted in whether or not to implement this intersection treatment in their communities due to the relative newness of these intersections compared to traditional traffic control measures. New and innovative strategies can face resistance from the greater public, most often stemming from unfamiliarity of these intersection treatments. Attempts can be made to selectively critique partial statistics from safety studies of roundabouts, with the goal of supporting a predetermined opposition to roundabouts.

Critique and careful consideration of safety statistics is a valuable step in the scientific method used to select appropriate intersection traffic controls, however when doing so it is important to objectively consider all statistics and associated benefits/detriments without a predetermined conclusion. This memorandum will serve to highlight the benefits of roundabout intersections. We understand concerns regarding safety at the planned TH 282 / Creek Lane roundabout has been expressed in Jordan. Specific concern over the impact on pedestrian safety has also been heard and therefore documented consideration of the impact of roundabouts on pedestrian users is also provided herein.

## Driver Safety

Based on the findings of a Minnesota Statewide Roundabout Study[1], the following could be expected when converting a thru-stop condition to a Single Lane Roundabout:

- 43% increase in overall crash rate when converting a thru-stop to a single lane roundabout
- 6% reduction in injury and fatal crash rate when converting a thru-stop to a single lane roundabout

While in general thru-stop conditions are safer than roundabout intersection across the state, as reflected in the study, engineers must consider the crash history of the individual intersection to gain a better understanding of the benefits and drawback of installing a roundabout.

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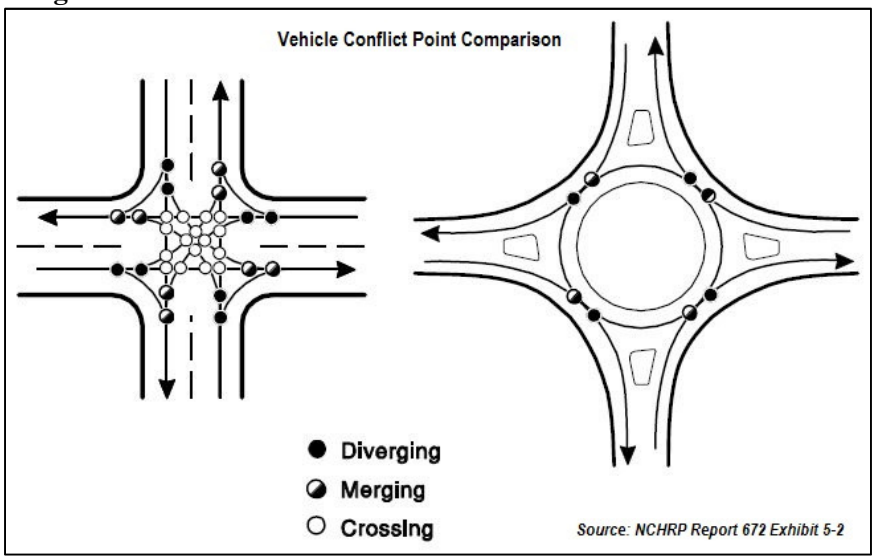
[1] Leuer, P.E., Derek. "A Study of the Traffic Safety at Roundabouts in Minnesota." *MnDOT Traffic Engineering*, Office of Traffic, Safety, and Technology Minnesota Department of Transportation, 30 Oct. 2017, www.dot.state.mn.us/trafficeng/safety/docs/roundaboutstudy.pdf.

Examining the intersection of Creek Lane and TH 282 tells a different story:

- Crash analysis shows that the intersection is currently operating above the expected safety threshold (i.e. has a greater number of crashes than a typical two-way stop-controlled intersection) for intersections of similar characteristics and can therefore be identified as **"statistically unsafe."**
- The intersection currently has an **overall crash rate nearly six times higher** than similar thru-stop controlled intersection. Crash rate is defined as the ratio of crashes occurring versus the amount of traffic entering the intersection, this rate can include all crashes observed (overall crash rate) or capture only severe and fatal crashes (injury crash rate).
- A high number of right-angle crashes have been observed in a short period (11 in a three-year period).
- The implementation of a roundabout at this specific intersection can expect a **71% reduction in overall crash rate**, based on a comparison of average crash rates for a single-lane roundabout versus the documented crash rate at Creek Lane at TH 282.

Critics of roundabouts often do not understand the importance of the reduction of severe and fatal crashes benefitted by roundabout intersections. Roundabouts may see more minor crashes than traditional intersections, but these crashes are almost always minor in severity due to vehicle orientations at locations called 'conflict points' within and approaching the roundabout. Conflict points are locations at which vehicle paths might cross within an intersection, in other words, where there is potential for collisions.

**Figure 1: Traditional Intersection vs. Roundabout Conflict Points**

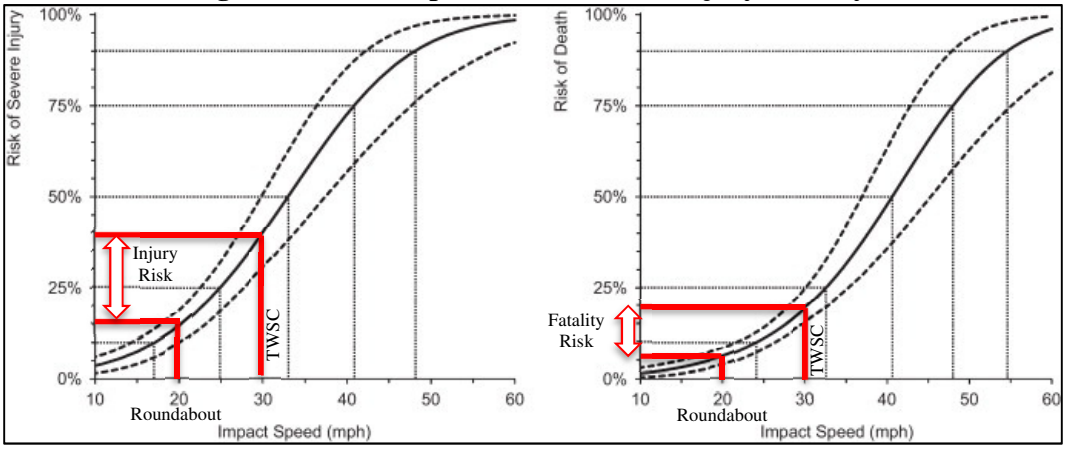



Head-on collisions and right-angle (t-bone) crashes, the most severe crash types, have very little chance of occurring within a roundabout due to the elimination of crossing conflict points. Conversely, a signalized intersection has a higher potential for more severe crashes due to the number of head-on and perpendicular conflict points and is generally expected to also increase minor crashes due to the introduced potential for rear end collisions. The safety benefits of reducing the potential for severe crashes typically outweighs the increase in overall crashes.

## Pedestrian Safety

- FHWA identified roundabouts as a Proven Safety Countermeasure[2] because of their ability to substantially reduce the types of crashes that result in injury or loss of life. Roundabouts are designed to improve safety for all users, including pedestrians and bicycles.
    - ***Less Conflict*** – Roundabouts have fewer conflict points. A single lane roundabout has 50% fewer pedestrian-vehicle conflict points than a comparable stop or signal controlled intersection.
    - ***Lower Speed*** - Traffic speed at any road or intersection is vitally important to the safety of everyone, and especially non-motorized users. Lower speed is associated with better vehicle yielding rates, reduced vehicle stopping distance, and lower risk of collision injury or fatality compared to signal or stop-controlled intersections as higher speeds result in more severe injuries. Also, the speed of traffic through a roundabout is more consistent with comfortable bicycle riding speed.

**Figure 2: Vehicle Speed vs. Pedestrian Injury Severity**




Source: Tefft, Brian C. "Impact Speed and a Pedestrian's Risk of Severe Injury or Death." *Accident Analysis & Prevention*, vol. 50, 2013, pp. 871–878., doi:10.1016/j.aap.2012.07.022.

- ***Shorter, Setback Crossings*** - Pedestrians cross a shorter distance of only one direction of traffic at a time since the entering and exiting flows are separated. While pedestrians may have a longer total route length navigate around a roundabout, the amount of time exposed to traffic within a driving lane is greatly reduced from a traditional intersection. Drivers focus on pedestrians apart from entering, circulating and exiting maneuvers, eliminating complex decision-making points.

[2] United States Department of Transportation: Federal Highway Administration. *Roundabouts with Pedestrians and Bicycles*. *Roundabouts with Pedestrians and Bicycles*, Federal Highway Administration, 2014.

**Figure 3: Typical One Stage Crossing Distance**


**Figure 4: Typical Two Stage Crossing Distances**


- ***Level-of-Service*** – A common misconception with roundabouts is that it will take longer to cross the intersection as pedestrians must wait to find gaps in traffic to make part of the crossing. In comparison to signalized intersections, roundabouts can offer delay reductions of up to 90%[3] from traditional signals, and pedestrians crossing a signalized intersection typically must wait to receive the walk sign.

## Other Notes

- *Myth: Roundabouts increase pedestrian and bike related crashes*
  - Various anti-roundabout individuals in Minnesota often reference the Minnesota Statewide Roundabout Study to support this claim. At first glance of the study, the data presented gives the impression that this is the case, showing that the total number of recorded pedestrian and bike crashes increased after the studied roundabouts were installed.

    However, the summarized findings of the report do not factor the number of years of data considered and do not account for differences in pre vs post roundabout construction

[3] "Safety and Risk in Modern Urban Roundabouts." Center of Transportation Studies, University of Minnesota, Center for Transportation Studies, Jan. 2014, www.cts.umn.edu/sites/default/files/files/roundabouts.pdf.

datasets. Limitations existed in available, reliable crash data prior to 2004, and as a result there was less reliable crash data available for pre-roundabout construction included in the study. Conversely, post-roundabout construction, there was plentiful amounts of data that could be collected. More specifically, the study noted 19 bike/ped crashes prior to roundabout installation at various sites over 463 years of site data. Conversely, the study identified 23 bike/ped crashes after roundabout installation at the various sites over 771 years of site data. Those with a predetermined opposition to roundabouts point to the increase from 19 to 23 bike/ped crashes, but neglect to 'do the math' to understand the rate of crashes has actually decreased, and the only reason more crashes were noted was because more data was collected after installation.

The study later performs a crash rate (i.e. crashes per 1 million vehicles entering) calculation based on traffic volumes across the various roundabouts. The study reports the change in reported crash types for single-lane, unbalanced, and multi-lane roundabout geometries for these crash rates. This study found the crash rate increased by 0.001 crashes per 1 million vehicles entering. To a person with a predetermined opposition to roundabout installation, this result can be interpreted to conclude roundabouts are unsafe for pedestrians because 'there was an increase, and any increase is unacceptable'. Three aspects of this statistic should be better understood however, to recognize the flaws of this conclusion:

1. The result showing an increase of 0.001 crashes per 1 million (equal to 1 additional crash per 1 billion vehicles entering) vehicles is statistically insignificant. As one example, such as the Creek Lane / Highway 282 roundabout planned in Jordan, each day an estimated 13,250 vehicles are planned to enter the intersection each day. This equates to about 4.8 million vehicles per year. On average, this increase in crash rate would therefore be anticipated to be observable at this intersection once every 206 years. There are assuredly numerous other driver decision making, weather, or other external factors which will have a much greater influence on the results at this location over those 206 years. This timescale is also about 4 times that of the life of any traffic control measure (signal or roundabout).
2. While referencing scientific studies is a reasonable and reliable way to make good traffic engineering decisions, the results from this single study do not yield a statistically significant result regarding pedestrian safety to draw firm conclusions from. Relying on the 771 years of data in this study to conclude decreased pedestrian safety over 206 years is not statistically appropriate. This would be akin to flipping a coin three times, having land on 'heads' each time, and concluding all future coin flips will assuredly result in 'heads'. For purposes of decision making from this study, the difference of 0.001 crashes per 1 million vehicles should be considered effectively equal, as the result is statistically insignificant.
3. The intersection of Creek Lane / Highway 282 does not meet warrants for a traffic signal. Warrants are thresholds by which traffic volumes or safety conditions demand a more significant traffic control treatment, such as a 4-way stop, traffic signal, or roundabout. The Creek Lane / Highway 282 intersection has not met warrants for a 4-way stop or a traffic signal, but MnDOT has agreed a roundabout would be safety and mobility improvement. This study did not account for any statistics related to the existence or installation of unwarranted traffic control improvements. Where unwarranted improvements are installed, safety issues typically arise in much greater numbers.

- *Myth: All roundabout intersections are created equal*
    - Studies of roundabouts and pedestrian safety often make the claim that roundabouts are unsafe for pedestrian use. In fact, these studies are typically performed at high volume, complex, and densely urban intersections with high numbers of pedestrian and bicycle traffic where there is an existing safety concern, inflating the opportunity for pedestrian related collisions. To validate the predetermined opposition to roundabouts, these results are then selectively compared to potential roundabout locations that do not have the same amount of pedestrian traffic, traffic volumes and driver aggression found in the studied dense urban environments. The Creek Lane intersection should not be considered a dense urban intersection in terms of pedestrian and bicycle traffic in this context.
- *Creek Lane at TH 282 Design Considerations*
    - The proposed roundabout at the Creek Lane intersection was designed to efficiently accommodate the current traffic levels upon opening day with a single-lane geometry. As traffic levels in the area increase and improvements to TH 169 are made, the roundabout may be expanded to two lanes on TH 282 to serve this growth in traffic. Single-lane roundabouts are shown to be less confusing to drivers and pedestrians and in turn show the lowest crash rates of all roundabouts. Delaying this expansion until warranted will benefit pedestrian service and safety for years to come.

*Figure 6: A graphical representation of crash rates, by traffic control device*

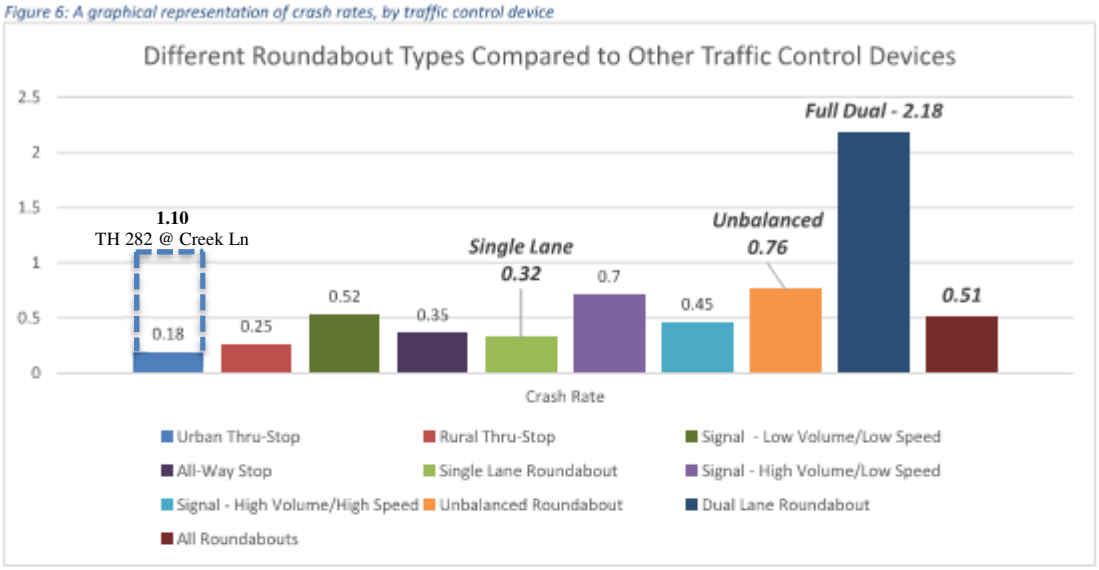
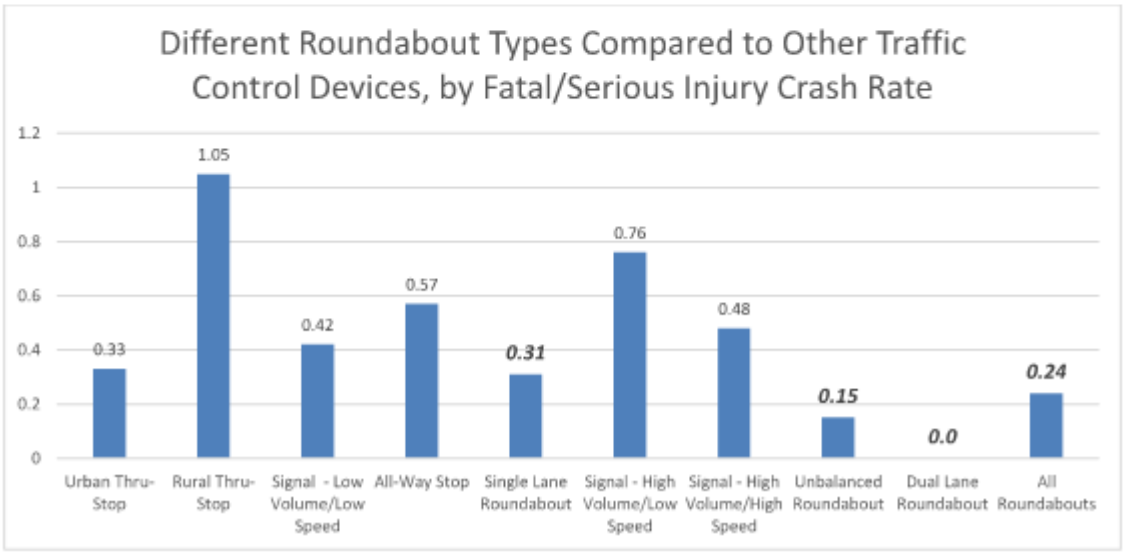



*Figure 7: A graphical representation of fatal/serious injury crash rates, by traffic control device*




Source: Leuer, P.E., Derek. "A Study of the Traffic Safety at Roundabouts in Minnesota." *MnDOT Traffic Engineering*, Office of Traffic, Safety, and Technology Minnesota Department of Transportation, 30 Oct. 2017, www.dot.state.mn.us/trafficeng/safety/docs/roundaboutstudy.pdf.