Rail Roundabouts: The Valley Metro Experience

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VALLEY METRO

Table of Contents

1.0 INTRODUCTION 1
2.0 SAFETY AND ROUNDABOUTS 1
3.0 RESEARCH OF EXISTING RAIL ROUNDABOUTS 2
4.0 COMPLIANCE OF RAIL ROUNDABOUTS AND ICCS 4
5.0 VALLEY METRO ROUNDABOUTS 4
6.0 CONCLUSIONS 6

List of Figures

Figure 1: Primary Causes of Automobile Collisions with Valley Metro Light Rail 1
Figure 2: Blind Spots at Conventional Intersections Compared to Roundabouts 2
Figure 3: Traffic Control Types at Rail Roundabouts 3
Figure 4: Red Bouncing Ball ICCs in Nantes, France 3
Figure 5: Blank Out ICCs in Melbourne, Australia 4
Figure 6: Gilbert Road Extension Roundabout 5
Figure 7: Tempe Streetcar Roundabout 5
Figure 8: South Central Extension Roundabouts 6

1.0 INTRODUCTION

Valley Metro has operated light rail in the Phoenix metro area since 2008, and continues to improve its services to connect communities and enhance lives. The current 26-mile system is positioned to grow with several expansions planned through 2034. In concert with this growth, Valley Metro continues to pursue innovative and efficient technologies to create a more safe and reliable system. The Agency will soon have four roundabouts, with light rail or streetcar running through them. This paper identifies the safety benefits that roundabouts provide, discusses international examples of rail roundabouts and shares Valley Metro's plans to integrate rail roundabouts. It is important to note that, although Valley Metro's light rail system will include several roundabouts, the decision to install them must be evaluated on a site specific basis.

2.0 SAFETY AND ROUNDABOUTS

The existing 26-mile light rail system primarily operates in a semi-exclusive guideway usually at-grade with surface streets. Since the first full year of light rail operations in 2009 through 2017, there were 265 automobile collisions with a light rail vehicle. Figure 1 charts the primary causes of those collisions.. The most frequent cause (63%) was motorists making improper left-turns.

Recent studies have consistently concluded that roundabouts, when compared to traditional four-way intersections, create more safe and efficient environments for vehicular traffic. Studies looking at the safety impacts of converting conventional intersections to roundabouts have found that roundabouts reduce the number of overall collisions by 37% and, moreover, substantially reduces their severity. Collisions with injuries decrease by 75% and those with fatalities decrease by 90%. These numbers are based on data from the Federal Highway Administration (FHWA) and Insurance Institute for Highway Safety (Washington State Department of Transportation, 2018). Similar research by Arizona State University (Souliman, 2018) found that by converting conventional intersections to single-lane roundabout there was an 18 percent reduction in overall collisions, and a 44 percent reduction in injuries.

The geometric design of roundabouts with rail provides additional safety benefits because it reduces the blind spot areas for left-turning motorists. Figure 2 compares the blind spot area for a left-turning motorist in a conventional intersection to that of a left-turning motorist in a light rail roundabout. The motorist in the roundabout has a smaller blind spot and better visibility to see trains approaching from behind. This will decrease the likelihood of improper left-turning motorists.

Figure 1: Primary Causes of Automobile Collisions with Valley Metro Light Rail

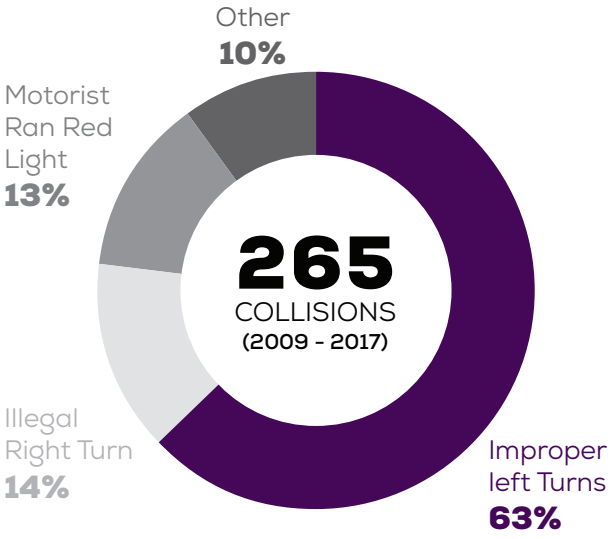
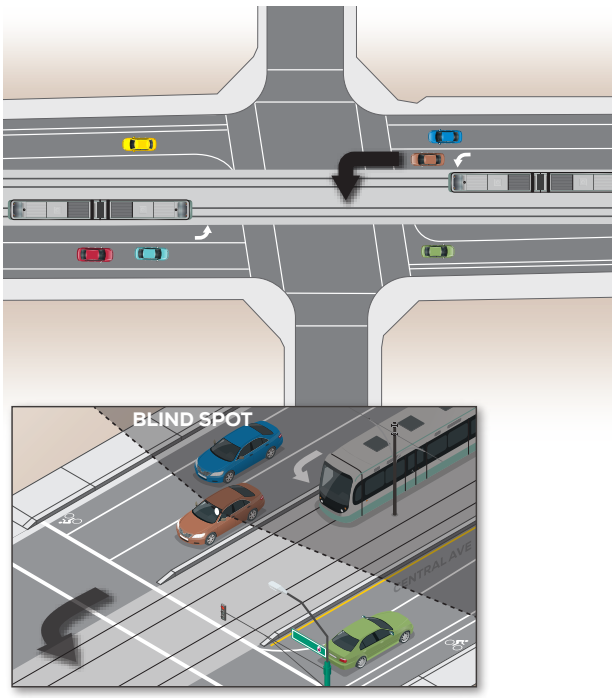
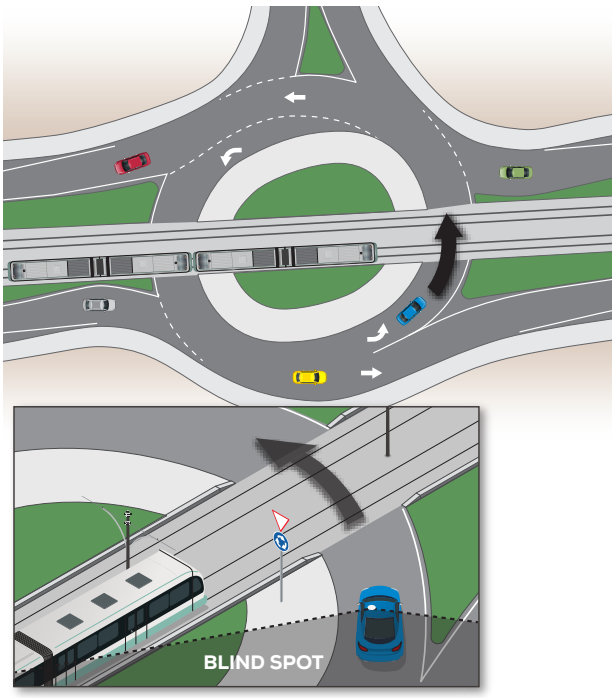


Figure 2: Blind Spots at Conventional Intersections Compared to Roundabouts



Conventional Intersection with Rail



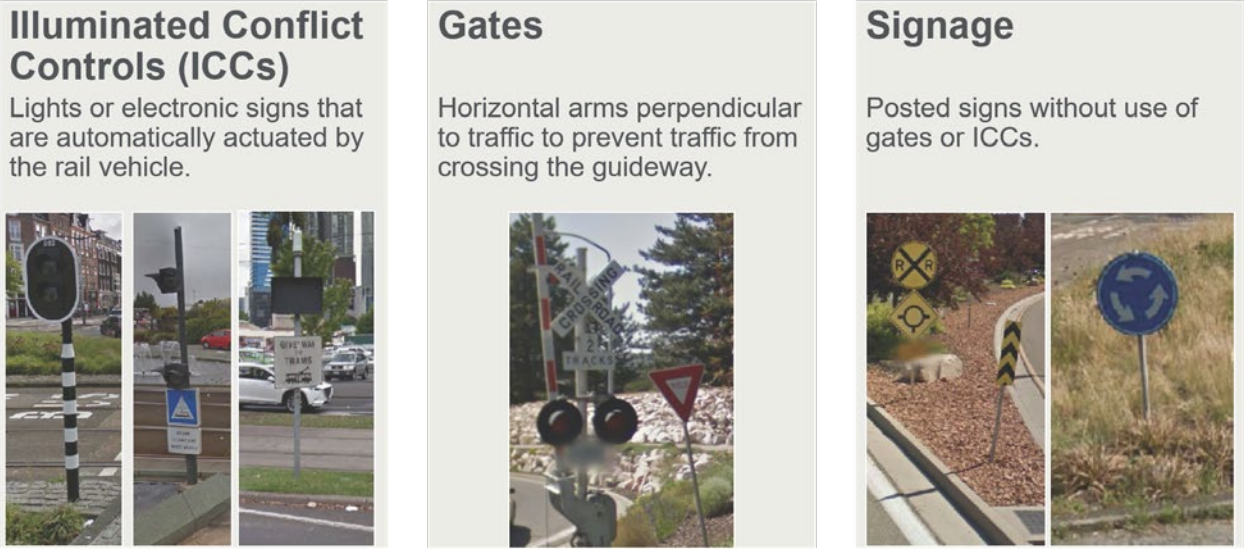
Rail Roundabout

3.0 RESEARCH OF EXISTING RAIL ROUNDABOUTS

Given the context of the new roundabouts being constructed in the Valley Metro system, this research provides a survey of international examples where roundabouts have light rail running through them. Roundabouts were discovered using extensive internet searches and exploring Google Earth aerial imagery. After excluding non-passenger and/or heavy rail examples, a sample size of 60 rail roundabouts were recorded. For each roundabout, the location, transit mode, traffic control type, number of approaches, lanes per approach, inscribed circle diameter and posted speed limit were documented. A large majority of the sample roundabouts were found in the Nantes, France metro region (36) and the greater Melbourne, Australia area (15). Only one light rail roundabout was found in the United States. Itis located in Salt Lake City, Utah.

The sample of 60 rail roundabouts have varying traffic control types. Three types of traffic control devices were identified to control automobiles, bicycles and pedestrians as a light rail vehicle is approaching, in or exiting the roundabout. Figure 3 illustrates samples of each traffic control type and its definition.

Figure 3: Traffic Control Types at Rail Roundabouts



The distribution of traffic control types among the 60 rail roundabouts are as follows: one uses gates, 10 use signage, and 49 use ICCs. The one rail roundabout controlled by gates is in Salt Lake City. The decision to use gates at the Salt Lake City roundabout was largely based on the land uses and traffic in the area. The South Campus Drive roundabout helps facilitate vehicles entering and exiting the University of Utah, including events being held at the basketball arena to the east and football stadium to the west.

The largest group of light rail roundabouts observed in this study were found in the Nantes, France metro area. Thirty-five (35) of the 36 roundabouts in Nantes, France control traffic using ICCs, with the only exception using posted signs. The types of the ICCs in the sample set predominantly included red bouncing balls (Figure 4) and blank out signs (Figure 5) that are actuated by the train or streetcar.

Figure 4: Red Bouncing Ball ICCs in Nantes, France

4.0 COMPLIANCE OF RAIL ROUNDABOUTS AND ICCS

Three sections in the Manual on Uniform Traffic Control Devices (MUTCD) are applicable to rail roundabouts, and give guidance on the use of ICCs in those roundabouts. Section 8C.03 (Flashing-Light Signals at Highway-Light Rail Grade Crossings) states that flashing-light signals shall be installed where light rail speeds exceed 35 miles per hour (mph). If speeds are less than 35 mph these flashing-light signals are optional. This is the case for Valley Metro's roundabouts where the operational speeds are at or below 35 mph for light rail and streetcar.

Section 8C.05 (Use of Automatic Gates at Light Rail Grade Crossings) states that at highway-light rail grade crossings at semi-exclusive alignments where light rail speeds exceed 35 mph, automatic gates and flashing-light signals should be installed. Again, light rail and streetcar in Valley Metro roundabouts will not operate at speeds above 35 mph.

Figure 5: Blank Out ICCs in Melbourne, Australia

Section 8C.12 (Grade Crossings Within or in Close Proximity to Circular Intersections) states that at circular intersections, where they include or are within 200 feet of a grade crossing, an engineering study shall be made to determine if queuing could impact the grade crossing. If traffic queues impact the grade crossing, provisions shall be made to clear highway traffic from the grade crossing prior to the arrival of rail traffic. This section further provides several actions that can be taken to clear traffic from the grade crossing prior to the arrival of rail traffic, including:

A. Elimination of the circular intersection,
B. Geometric design revisions,
C. Grade crossing regulatory and warning devices,
D. Highway traffic signals (ICCs),
E. Traffic metering devices (ICCs),
F. Activated signs (ICCs), or
G. A combination of these or other actions.

In the context of Valley Metro's roundabouts, activated signals and signs (ICCs) are applicable based on the standards of the MUTCD.

5.0 VALLEY METRO ROUNDABOUTS

Valley Metro is currently integrating four new roundabouts into the regional rail system. The first roundabout completed became operational in spring 2019 as part of the Gilbert Road Light Rail Extension in the city of Mesa. Given that only one through lane exists in each direction, a roundabout was recommended at this location to facilitate U-turns by large vehicles and to slow down traffic. Figure 6 shows an aerial image of the roundabout with a test train travelling east through the intersection.

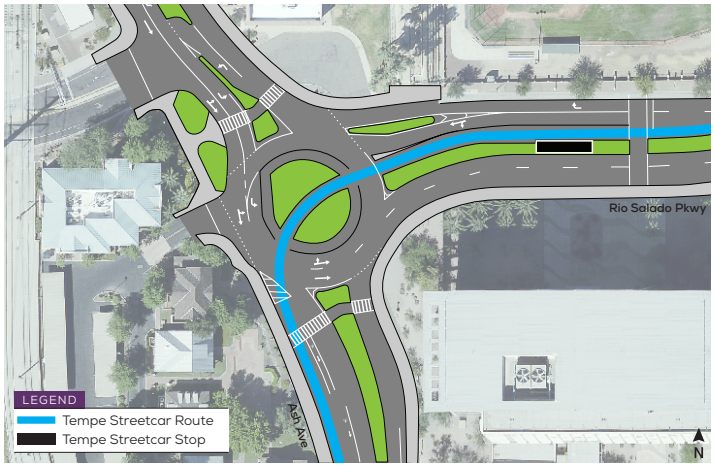
The Gilbert Road Light Rail Extension roundabout uses gates at the light rail crossing, however it was constructed so that it can be retrofitted with ICCs. Each of the four approaches has one lane of traffic. Some notable design elements include embedded pedestrian flashers at crossings, chicanes to slow traffic, bike lanes/shared paths and a truck apron.

The next roundabout will be constructed as part of the Tempe Streetcar in the city of Tempe. Figure 7 shows the design of the roundabout.

ICCs are proposed for the Tempe Streetcar roundabout crossing, but the design includes potential for future gates, if needed. Two of the three existing approaches have one lane of traffic, with the third having two lanes. Additional designs features are still being finalized.

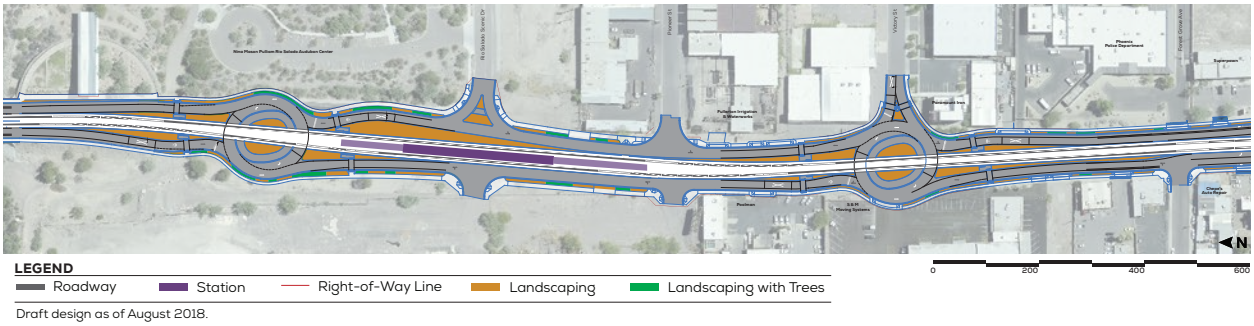
Figure 6: Gilbert Road Extension Roundabout

Figure 7: Tempe Streetcar Roundabout



In Phoenix, the South Central Light Rail Extension project will feature two new roundabouts intersecting the light rail line. Figure 8 shows the proposed concept for the roundabouts. These roundabouts are needed because this is an industrial area, where circulation of large trucks need to be accommodated. Conventional intersections at these locations cannot handle the radius needed for truck turning.

Figure 8: South Central Extension Roundabouts



Draft design as of August 2018.

ICCs are also proposed at these light rail roundabouts, but the design can easily accommodate gates, if needed in the future. Each roundabout's approaches will have one lane of traffic. Design of these roundabouts is still in process, and they will include several notable design features, including chicanes to slow traffic.

6.0 CONCLUSIONS

Valley Metro has determined that the inclusion of rail roundabouts at selected locations is appropriate, but they are not universally applicable. A sight specific analysis must be completed prior to recommending that a roundabout be used.

Where roundabouts are proposed, Valley Metro recommends use of ICCs to control rail crossing. Based on the research conducted on rail roundabouts, ICCs provide operational benefits and will not make roundabouts less safe or less efficient than those with gates. ICCs offer several benefits, including:

- **Reliability:** ICCs have a lower likelihood of malfunctioning compared to gates
- **Traffic delay:** Gates take more time to lower and raise, increasing the length of traffic delay
- **Cost:** ICCs require lower capital costs to install and operate/maintain over time than gates
- **Noise:** Bells required with gates, are not required for ICCs, reducing the impact to the surrounding community
- **Safety:** Given that roundabouts are proven to reduce intersection collision severity, the presence of ICCs will not sacrifice safety benefits
- **Compatible:** Rail roundabouts with ICCs are permissible according to the MUTCD guidelines