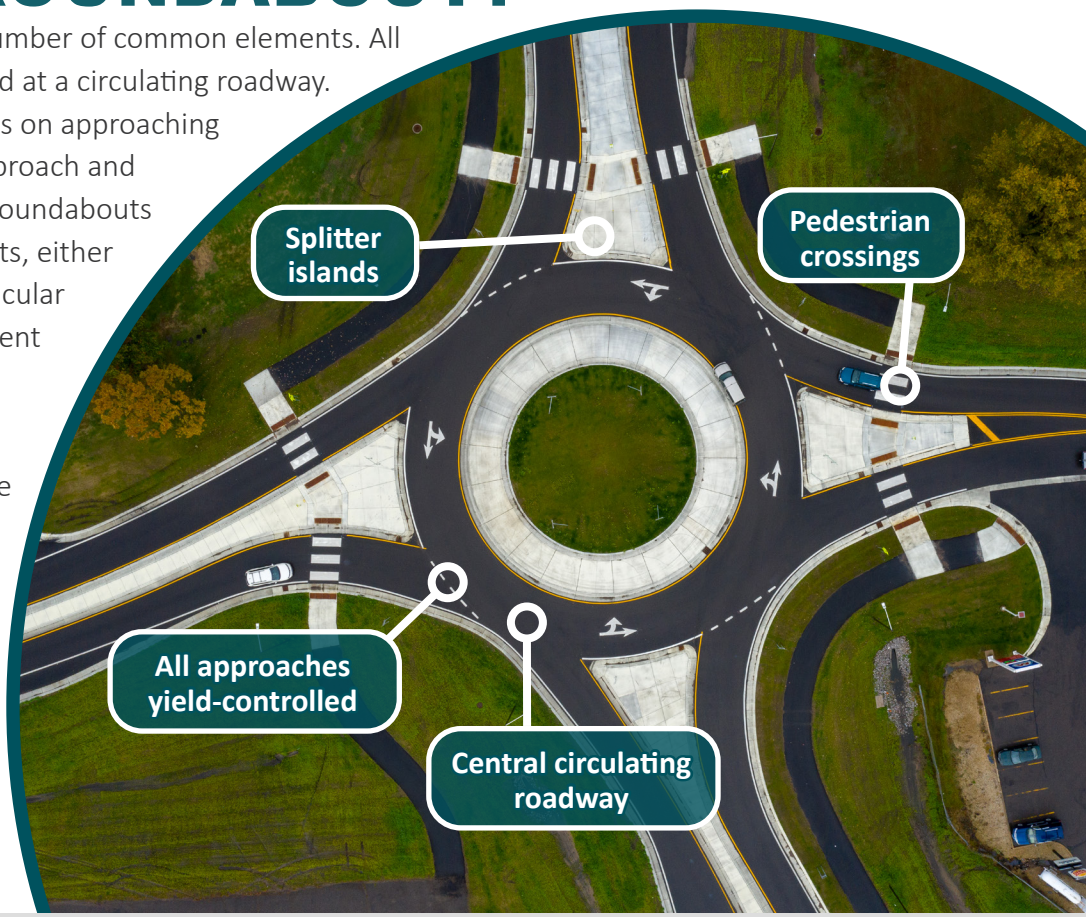
MODULAR ROUNDABOUTS
AN INTRODUCTION

RTA REGIONAL BUSINESS LEADERSHIP

In the last twenty years roundabouts have been increasingly constructed as an intersection control measure because of their benefits in safety and mobility. Modular roundabouts offer a novel way to construct these intersection improvements with significantly lower costs and impacts than other, more traditional intersection treatments. These configurations offer the same benefits of roundabouts but take less time and money to implement. While still new, Georgia, Virigina, and now North Carolina have implemented this innovative construction technique. Each example was applied in different contexts and these experiences can be used to inform future decisions about where modular roundabouts might be a good solution.

WHAT IS A ROUNDABOUT?

All modern roundabouts share a number of common elements. All intersecting legs are yield-controlled at a circulating roadway. The circular roadway and the curves on approaching roads help to slow drivers upon approach and while navigating the roundabout. Roundabouts can be built to accommodate cyclists, either by merging them in with other vehicular traffic or through ramps onto adjacent paths where they can navigate the roundabout with pedestrians.



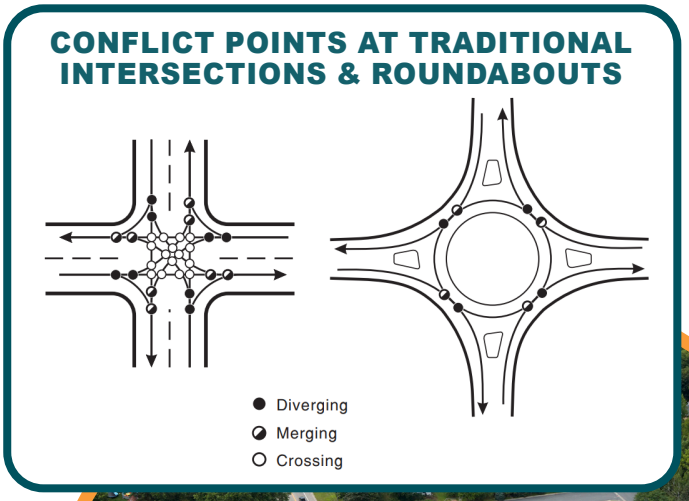
Slower travel speeds directly reduce the severity of crashes and can contribute to a safer experience for vulnerable roadway users, like pedestrians and bicyclists. A roundabout configuration also reduces the number of potential conflict points by 75% as compared to a traditional intersection. Thanks to the slower

speeds they promote, and the reduced number of conflict points present, roundabouts have been found to reduce the overall number of crashes by 35%[1], the number of injuries by 76%[1], and fatalities by over 90%[2].

VARIETIES OF ROUNDABOUTS

Roundabouts come in many shapes and sizes. While many are traditional, circular roundabouts, sometimes existing roadway configurations, physical constraints, and traffic needs warrant different configurations. Some roundabouts may not allow full movement around the circulating roadway, such as a teardrop roundabout. Sometimes, a pair of teardrop roundabouts is used in an interchange to simplify intersection operations at each ramp terminus, in what's called a dogbone roundabout interchange.

Physical constraints can limit the possible size of a roundabout as well. In some settings, a mini roundabout may be able to bring the benefits of a roundabout within the space available. A mini roundabout is a smaller roundabout with an island that can be driven over when necessary.



1. NCHRP 572
2. TRB 1751, Safety Effect of Roundabout Conversions in the United States

MODULAR ROUNDABOUTS

Modular roundabouts include the same key elements as all modern roundabouts, but are constructed on top of existing intersections, repurposing existing pavement. In some instances, these roundabouts are built using small, custom-made blocks to form the roundabout's central and splitter islands along with new striping and flexible posts to reinforce the new configuration. These central blocks can be formed using recycled pavement. In other situations, these roundabouts may be built using more conventional construction materials like concrete and asphalt, but generally do not amount to a full reconstruction of the intersection. Thanks to the limited work needed to install these improvements, construction may take place in a matter of weeks or days, rather than the months or even years more traditional improvements might require.

CASE STUDIES

While modular roundabouts are currently uncommon, a handful have been installed across the United States and Canada. Experience from some specific sites in Virginia and North Carolina shows some advantages and obstacles with this novel implementation approach.

CHESTERFIELD COUNTY, VIRGINIA

As part of a broader pilot project, the Richmond District of the Virginia Department of Transportation (VDOT) implemented modular roundabouts at two intersections along Otterdale Road, at Hampton Park Drive and at Harpers Mill Parkway, and another at the intersection of Spring Run Road with Baily Bridge Road/Springford Parkway.

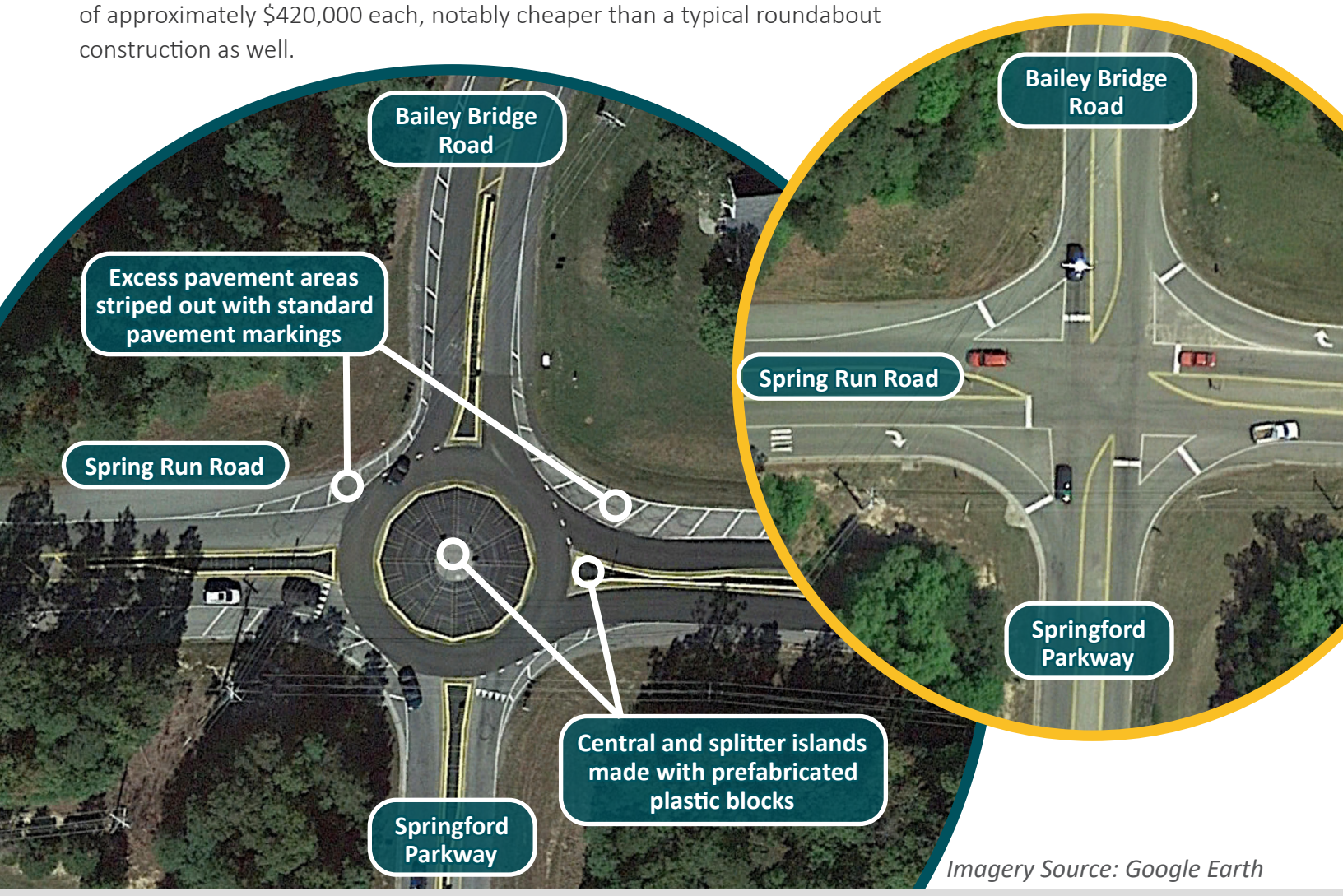
Otterdale Road is a circumferential road southwest of Richmond, Virginia, in Chesterfield County. Otterdale Road south of US 601 serves as a collector and hosts a number of subdivisions and an elementary school on the urban periphery. The two selected intersections on Otterdale road were both previously side-street stop-controlled with auxiliary lanes on both Otterdale Road and the cross-streets, contributing to very large intersection areas.

Both Spring Run Road and Baily Bridge Road/Springford Parkway are two-lane roads. Their intersection was previously all-way stop-controlled, with generous, yield-controlled right turn lanes on each approach.

While future traffic demands are expected to increase significantly with future development along Otterdale Road and expansion of the roadway network, the four-lane, median-divided roadway promoted high speeds and created safety concerns. At the third location, nearby Spring Run Elementary School created periods of substantial traffic.

These three intersections were selected for this pilot by VDOT based on their existing size as well as potential safety and traffic benefits. At both locations on Otterdale Road, approach lanes on Otterdale Road now merge into a single lane before approaching the roundabout. All three intersections have been reconfigured as single-lane roundabouts with a single-lane approach on each of the four legs. On Otterdale road, high-visibility crosswalks have been extended from the sidewalks across these travel lanes. Pavement area that is no longer needed has been striped out with pavement markings.

For all three of these roundabouts, VDOT used internal teams to do both layout design and installation, with pavement markings provided by contractors. VDOT purchased the modular roundabout components from a third-party vendor. The roundabouts were constructed in approximately one month each, much faster than a typical intersection reconstruction. VDOT reported an average construction cost across these three roundabouts of approximately $420,000 each, notably cheaper than a typical roundabout construction as well.



Imagery Source: Google Earth

FRANKLIN, NORTH CAROLINA

The North Carolina Department of Transportation (NCDOT) constructed a modular roundabout at the intersection of Wells Grove Road and Bellview Road/Clarks Chapel Road in Franklin, NC in August 2021. The intersection is located between Mountain View Intermediate School and Macon County Middle School, both two-lane roads that previously operated with stop control on Bellview Road/Clarks Chapel Road. Due to school-related congestion, traffic at the intersection was previously being directed by law enforcement during school pickup and drop-off periods. While a signal was requested, traffic volumes did not warrant a signal outside of peak hours. However, analysis suggested that a roundabout could improve performance during these peak periods.

Previously, the intersection had large turning radii and a single eastbound right turn lane. Even without the additional lanes seen in the Virginia examples, the existing pavement area was sufficient for a roundabout with a 75' outer diameter. Due to the prevalence of school buses, a 15' width was chosen for the circulating roadway to ensure that buses could navigate the roundabout in the road, though the center island was also built with mountable curve to accommodate even larger vehicles. The local NCDOT division got trial approval to use rubberized curb for a roundabout island, which they filled with aggregate and topped with asphalt. Splitter islands on all four approaches were created with flexible posts and updated pavement markings.

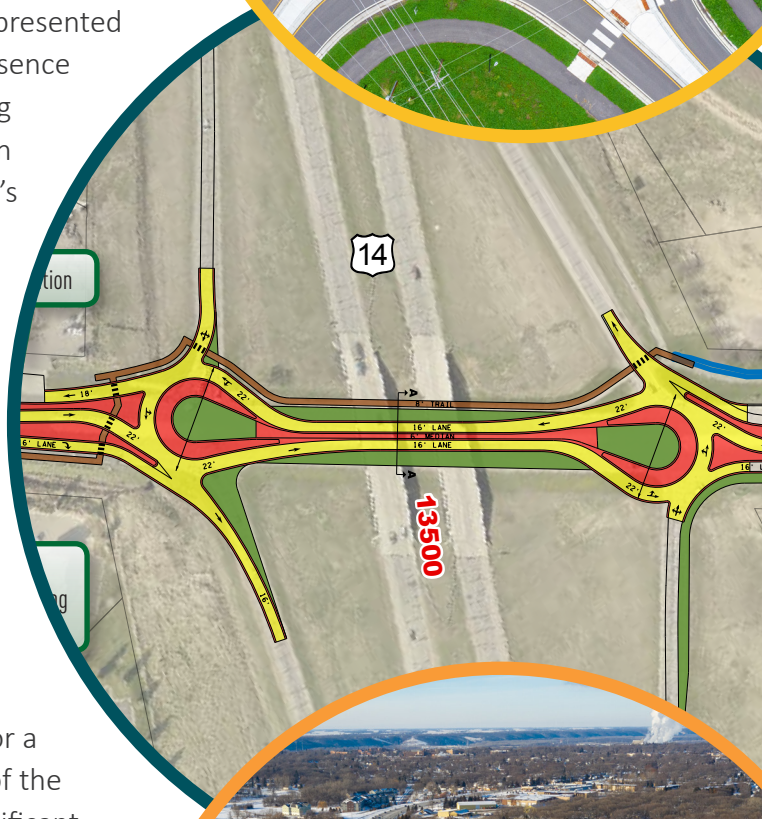
Installation of this modular roundabout was similarly completed by NCDOT crews, using approximately $10,000 in materials and $20,000 in labor over three days. This kind of cost and speed is a massive improvement over traditional construction methods. NCDOT constructed this roundabout during the summer holidays and conducted specific coordination with the nearby schools and let bus drivers use the roundabout before school started. This roundabout has relieved the need for law enforcement to direct traffic during peak school periods.

MODULAR ROUNDABOUT CONSIDERATIONS

Based on the experiences of both VDOT and NCDOT, the following should be considered when evaluating an intersection for potential installation of a modular roundabout.

INTERSECTION SIZE

The case studies depict the ability for modular roundabouts to be applied in a variety of intersection sizes. Examples in Virginia were slightly larger with diameters between 100 and 112 feet than the North Carolina example of 75 feet. It is important to note that roundabouts typically require more intersection surface area than a traditional intersection of two two-lane roadways. While the examples presented herein did not need expanded areas due to the previous presence of auxiliary turn lanes, a roundabout may not fit at all existing sites. According to NCDOT Division 14 Traffic Engineer, Steven Buchanan, who helped with the implementation of the state's first modular roundabout, any location that experiences heavy vehicle traffic should be able to support an outer diameter of at least seventy feet. At locations with smaller footprints, minimal widenings may be possible to expand the intersection, or a mini roundabout configuration may be more appropriate. In a mini roundabout, the overall diameter is smaller and the center island is largely or completely mountable, so that larger vehicles can navigate the roundabout.



DRAINAGE

When a center island is installed, roadway drainage may be disrupted. At some locations, especially when on an incline or a curve, existing roadway slopes may drain water to one side of the roadway, which may be obstructed by a central island. If significant drainage improvements are needed to accommodate the center island, a full intersection reconstruction may be more appropriate than a modular roundabout.

OTHER DESIGN CONSIDERATIONS

When implementing a modular roundabout, it will be best to use materials and design criteria that create an intersection as similar to a traditionally-constructed roundabout as possible. This may include using rubberized curb, filling in island spaces with asphalt or blocks, and ensuring adequate signage is included. In some situations, ideal

materials may not be available or practical. In these situations, low cost and easy install tools like flexible posts, reflective delineators, roadway striping, and others may prove useful. When bicycle and pedestrian facilities are present, design should incorporate crossings and facilities as a typical roundabout installation would.

TRAFFIC OPERATIONS

As with all intersection improvements, traffic operations and visibility must be considered. Traffic operations of a modular roundabout are identical to those of a traditional roundabout with a similar size. Operations can be analyzed using a number of different software packages including Trafficware's Synchro, Sidra, and ARCADY. ARCADY and Sidra provide flexibility that allows to more accurately examine roundabouts with differing geometries.

COMMUNITY CONSIDERATIONS

In regions where drivers have less familiarity with roundabouts, directed outreach prior to implementation may improve safety and operations once the roundabout opens to traffic. Specific driving populations, like school bus drivers and other heavy vehicle operators, may have concerns about navigating the roundabout and require targeted communication.

POTENTIAL FUNDING SOURCES

While modular roundabouts are still an innovative intersection improvement strategy, they provide benefits that may make them eligible for funding from a number of sources. Roundabouts have been shown to provide substantial safety improvements over more traditional intersections, and modular roundabouts can be constructed at a fraction of the cost of a traditional roundabout. This combination of benefits could make a modular roundabout a good candidate for safety-focused funds that take costs into consideration, including NCDOT's Highway Safety Improvement Program, and similar funds.

CONCLUSION

Modular construction of roundabouts presents a novel and innovative way to construct key safety improvements at relatively low cost. At existing intersections with large pavement areas, components such as plastic blocks, rubberized curbs, flexible posts, and deliniators can create a roundabout with low expense in a short time frame, compared to traditional roundabout construction. These character-istics- potential improvements to safety and operations, low cost and quick construction - make modular roundabouts an exciting and competitive tool for improving our transportation network in many different contexts.