

Alternative Intersections/Interchanges in Commercial Areas Applications, Misconceptions and Benefits

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ABSTRACT

Salt Lake City, Utah, USA has been at the forefront of implementing alternative intersections/interchanges (AII) to address transportation capacity concerns instead of expanding by adding additional lanes. Access management, particularly around an AII often involves restricting or eliminating movements to the nearby land uses. The result has been that an AII can be viewed negatively by commercial developers and property owners in the immediate vicinity. While an AII is typically viewed as being more access restrictive, if designed with access in mind, they can be mutually beneficial to the nearby properties and the operation of the roadway network/intersection. Early Utah projects are compared to more recent projects where continuous flow intersections (CFI) and ThrU Turns have been implemented. In addition, before and after examples of Utah CFI and ThrU Turn projects are presented in this paper and explore the lessons learned through successive implementations of the various AII projects. The result is a summary on how access management can be approached and discussed with developers and property owners to minimize the negative perception while still maintaining the goals of access management for capacity preservation and crash reduction.

INTRODUCTION

Alternative Intersection/Interchange (AII) designs are being implemented throughout the Salt Lake City metropolitan area to address congestion issues in urban areas. There is always a need to either expand traditional capacity or be more efficient in providing the capacity.

Because AII projects use non-traditional movements to improve intersection operations, they do not necessarily meet a driver's expectation when approaching the intersection. This makes access to adjacent properties a critical issue when designing a safe and functional intersection.

This paper examines implementation and design of accesses in the vicinity of two different types of AII: the Continuous Flow Intersection (CFI) and the median U-turn crossover, branded in Utah as a "ThrU Turn" intersection.

Utah looked to transfer AII concepts in order to address the congestion concerns at critical intersections. These intersections have been built at higher speed intersections and also near freeway interchanges that were experiencing queuing from the critical intersection back onto the mainline freeway. Since 2007, the Utah Department of Transportation (UDOT) has converted 9 intersections to a CFI configuration and 4 to ThrU Turn intersections.

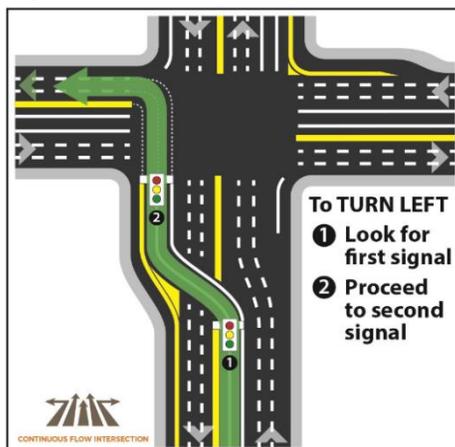
In this paper, lessons learned from early implementations as well as best practices developed in later projects will be discussed. Recommendations and considerations for both access management and public involvement are presented.

BACKGROUND

An AII is defined as an intersection treatment that minimizes the addition of traditional auxiliary lanes to increase capacity and instead looks to reduce turning movement conflicts in order to reduce signal phasing inefficiencies at critical intersections. Two and three phase signalized intersections are more efficient than higher phased intersections because the lost time is reduced and traditionally conflicting movements can occur at the same time.

Continuous Flow Intersections Defined

A CFI is an intersection that moves left turn conflicts from the primary intersection to an upstream intersection where the left turns cross-over oncoming traffic before entering the primary intersection. Figure 1 illustrates how a driver queues to make a left turn movement at the crossover. This early crossover eliminates conflict points in the primary intersection. A CFI can utilize this crossover left turn on any or all of the legs of the intersection based on traffic patterns. In Utah, most of the implementations



have been for the major street only, but one intersection discussed later in this paper has crossovers installed on all 4 legs.

As Figure 1 identifies, the CFI allows for a secondary signalized location in close

proximity to the primary intersection. The principal concern for commercial developments is ingress access. Typically, busy intersections are desirable for commercial developers. Access is a concern if driveways are too close to the main intersection as they will become difficult to use because of conflict points and congestion in the functional area of the intersection.

A two legged CFI reduces the total conflict points from a traditional signalized intersection from 32 to 30 and also changes left turn crossing conflicts to angle conflicts. This offers potential for reduction of left turn collisions and potential for an increase in angle crashes.¹

Fig. 1. Left turn diagram for a CFI¹

ThrU Turn Intersections Defined

A ThrU Turn intersection is an intersection that prohibits left turn movements at the critical intersection and provides U-turn movements at the secondary intersections where more capacity is available. This moves the critical left turn movement to a mid-block crossover point where a two-phased signalized intersection is less impactful. Figure 2 shows this U-turn movement and how a driver can make a left turn by utilizing a U-turn bulb out.

These U-turn areas can be installed on 2 legs to eliminate a protected left turn phase for one of the roads or on 3-4 legs to eliminate protected left phases for both roadways. This allows the main intersection to operate more efficiently with just two signal phases. In Utah, the two projects that this paper highlights shows both a 3 U-turn configuration and also a 4 U-turn configuration.

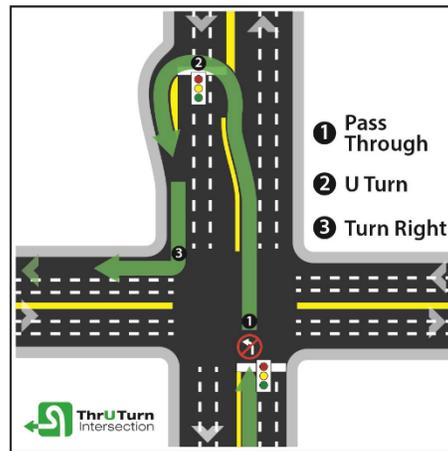


Fig. 2. Left turn diagram for a ThrU Turn.

CONTINUOUS FLOW INTERSECTION PROJECTS

The Utah test corridor for CFI projects is Bangerter Highway, a limited access, high speed highway. The signal spacing is approximately 1.6 km (1 mile) between the signals and there are no private accesses. Limited access is important because one of the major concerns for a CFI is the need to restrict access in the functional area of the intersection. The high speed corridor and its existing configuration with no private access makes this corridor an ideal candidate for retrofitting intersections with a CFI.

3500 South and Bangerter Highway CFI

At the intersection of 3500 South and Bangerter Highway was the first CFI constructed in Utah. It is a 2-legged CFI with the Bangerter Highway having the crossover. The result is the ability to increase the amount of east-west signal time because the CFI allows the north-south through and left movements to occur simultaneously. In addition, the east-west right turn movements are channelized into free right



Fig. 3. Bangerter Highway and 3500 South, North Approach

turn movements. The expanded CFI did require more ROW than the traditional intersection but no existing accesses were closed. This represented Utah's first and most conservative CFI regarding access. Figure 3 shows the north leg of the 3500 South and Bangerter Highway crossover left and free right turn bypass lane.

4100 South and Bangerter Highway CFI



Fig. 2. Bangerter Highway and 4100 S, East Approach

With the success of 3500 South, other intersections were investigated along the Bangerter Highway corridor. The 4100 South and Bangerter Highway intersection is the first location for a 4-legged CFI in Utah. This location also required that the engineer's address the existing accesses

along 4100 South that are

serving the Granger Medical Complex. Eliminating the accesses or restricting all to right-in right-out (RIRO) would have had substantial impacts to the center's traffic. The project team determined that the ingress to the medical facility was a crucial access for that facility. The logical point to allow access was at the crossover signal. This allows both ingress and egress from the site. While left turn egress could not be maintained, the site now has a signalized entrance that allows a protected left turn into the site. This opportunity exists for the crossover side of the roadway (westbound traffic). Eastbound traffic is restricted to RIRO accesses. Figure 4 shows the eastern approach of the intersection at 4100 South and Bangerter Highway.

5400 South and Redwood Road CFI

At 5400 South and Redwood Road, the CFI was installed restricting accesses at the crossover and instead providing only RIRO accesses. Since that initial design, both crossovers were converted to allow access into the commercial sites. Figure 5 shows the eastern approach. Note that that adding the access at this location allows for both right and left in and also a right out ($\frac{3}{4}$ movement) of the access making it easy for shopping center patrons to get to the site.



Fig. 5. 5400 South and Redwood Road, East Approach

CFI Lessons Learned

Allowing access to commercial areas at the crossover signal has actually led to better access for the commercial centers. In the past, they had unsignalized accesses that, due to congestion, were functioning as RIRO access points during peak periods. With the new crossover signals, the sites now benefit from a $\frac{3}{4}$ movement signalized intersection, 400-600 feet from the main intersection.

Utah started with a very conservative CFI design because of the new concept and have progressed into using the CFI as not only a capacity enhancement tool but also as an asset for access management for nearby commercial developments. It should be noted that the non-crossover side of the street is restricted to RIRO accesses for approximately 1,000 feet. Therefore, the benefits are for larger commercial development and not the pad or strip mall commercial areas.

THRU TURN INTERSECTION PROJECTS

The CFIs are successful in Utah, but not the only method that UDOT has used to eliminate left turn movements at critical intersections. The ThrU allows for the left turn movements to be placed at a secondary, less congested, intersection and requires drivers to travel out of direction and then make a U-turn at the secondary signalized intersection. The benefits to using this type of intersection include better operations, conflict point reduction, and providing enhanced access to local businesses in the vicinity.

12300 South State Street, Draper, Utah, USA



Fig. 6. Overview Draper ThrU Turn project area.

In Draper Utah, the frontage road system on either side of I-15 is very close to the 12300 South interchange. The eastern frontage road intersection is only 125 m (410 ft) from the interchange as shown in Figure 6. The ThrU Turn final design has three bulb outs and allows all left turn movements to be accommodated. Because there is no bulb out on the west leg due to a freeway interchange,

westbound left turns are required to make a right turn

and utilize the north bulb out to U-turn rather than proceeding through the intersection and making the U-turn after as is typically the design for median U-turn intersections.

Before moving to this solution, UDOT performed extensive modeling to determine whether or not this configuration would be effective in reducing congestion in the area. Because it was the first intersection of this type in the State, UDOT commissioned a before and after study. Table 1 shows before and after volumes at the main intersection and that total volumes through the intersection remain for the most part unchanged in the after condition.

Table 1. PM Peak Volumes Before and After at 12300 South and State Street².

Leg	Total Volume Before	Total Volume After
North	1051	945
South	678	577
East	1674	1902
West	1997	1933

The study also showed that even with the additional out of direction travel for several movements, overall travel time through the intersection was reduced by an average of 16 seconds per vehicle while serving approximately the same volume of vehicles. Figure 7 shows the increase or decrease in travel time per movement. Overall, the total travel time for the intersection was reduced approximately 15 seconds (about 16%).

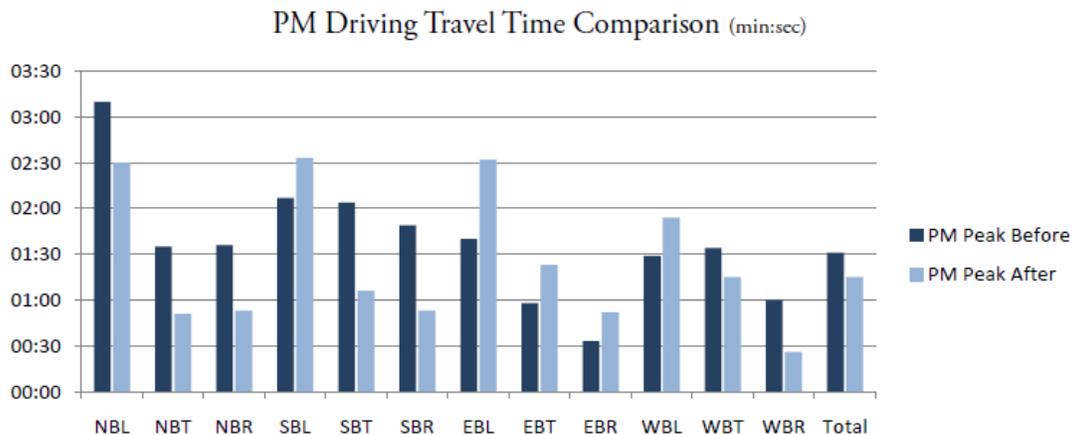


Fig. 7. Travel time comparison before and after for Draper ThrU Turn².

Vehicles from the major legs had modifications to the movements that drivers would need to make in order to access to the businesses in each quadrant. Access to the southwest and southeast quadrants from the West leg would remain largely unchanged, while access to the northeast quadrant would be enhanced by the bulb out. Lastly, for traffic going to the northwest quadrant access required going through two of the bulb-out signals to access business in this quadrant for traffic coming from the West.

For traffic coming from the east, access to the northeast and southeast quadrants is largely unchanged, while access to the northwest and southwest quadrants requires traveling through the bulb-out on the north leg of the intersection. Most volume for the area is coming from one of these two directions, it is clear that there are some major impacts to the northwest quadrant with this reconfiguration as any access except access from the north must use at least one bulb out to access businesses in this quadrant.

This change is seen as very significant to business in the area. A before and after study was conducted to observe the economic impact to the area. Table 2 shows that the southeast quadrant had a positive change and was largely unaffected by the reconfiguration. The northeast and southwest quadrants remained somewhat flat and there was a decrease to the northwest quadrant. The decrease in the northwest quadrant may be related to a gas station and convenience store located in this quadrant in the before condition that closed shortly after the project was complete. Since the project, several commercial developers have considered redeveloping the property to a use that relies on destination traffic rather than pass by traffic.

Table 2. January - June Sales Tax Revenue Totals by Quadrant (in USD)².

	2009	2010	2011	2012
NW Quadrant	\$17,972	\$16,402	\$16,073	\$14,106
NE Quadrant	\$179,875	\$176,851	\$185,004	\$178,525
SE Quadrant	\$146,434	\$155,213	\$166,268	\$175,070
SW Quadrant	\$58,454	\$52,675	\$56,418	\$57,141

This project reconfigured access to a large commercial area that surrounded a single intersection and accomplished an overall minimal impact to business while improving travel time through the intersection and significantly reducing delay. However, the project did not impact all adjacent landowners positively as some properties require redevelopment to be successful under the new configuration of access.

Hill Field Road, Layton, Utah, USA

This project in Layton Utah is an example of Utah’s latest efforts to relieve congestion and at the same time provide access to the many businesses in the corridor. The project is eliminating all left turns at a very busy intersection west of an interchange with Interstate 15 (I-15). The project also eliminated left turns and through movements from the minor road on an intersection just east of the same interchange. A diagram of the changes made during the project can be seen from Figure 8. In addition to the intersection improvements, non-traversable median islands were installed to help reduce conflict points throughout the corridor.

To help with access, a bulb out signalized intersections were built in strategic locations to accommodate movements into businesses including an indoor shopping mall located at the northeast corner of the I-15 and Hill Field Road. Other

improvements included in the project, but not discussed in this paper, include converting the interchange type from a diamond configuration to a single point urban interchange (SPUI) and an intersection improvement on a nearby intersection. This combination of treatments was the preferred alternative at a January 2014 open house after studying and evaluating 24 options to reduce congestion in the area.

These improvements include reducing conflict points throughout the project area by adding a non-traversable median curb, but still allowing reasonable access to businesses because of the increased opportunities for U-turns at the newly installed bulb outs. Seven accesses along Hill Field Road and 3

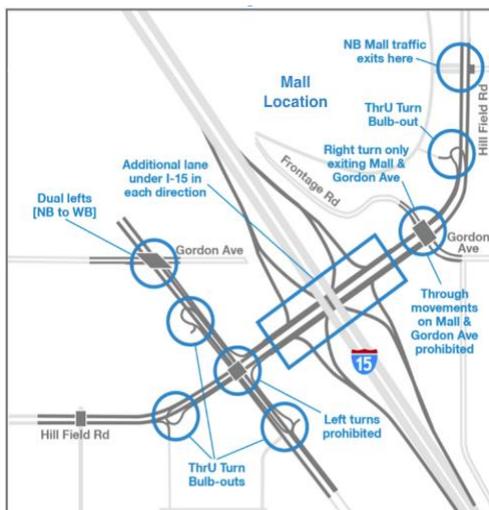


Fig. 8. Overview Layton interchange project area.

additional accesses along Main Street (SR-126) were restricted to RIRO movements which further reduces the conflict points throughout the corridor. In total, the project reduced conflict points by approximately 50 percent.

Unlike the first ThrU Turn project in Draper, this project incorporates an additional bulb out so that all four primary directions of the arterials in the vicinity have a nearby opportunity to make the U-turn movement.

The bulb outs in this project were also located at key locations to allow separation for the operations of the primary intersection, but to also match with key entry points into commercial shopping centers in the immediate vicinity of the project area. These bulb outs have both a U-turn movement as well as an ingress and egress to the adjacent businesses. This type of bulb out can enhance the access to existing businesses compared to the no build option. This is because this area was often congested to the point where left turn movements into the developments within the project were not easily made.

ThrU Turn Lessons Learned

When comparing the Draper and Layton projects, several best practices have emerged with implementing this type of AII. In both projects, UDOT invested significant resources and spent time on public education and involvement. With the Draper project, the approach was to educate drivers and business owners on the benefits of the project and how to navigate this AII that was new to the State of Utah. In Layton, the public involvement efforts were focused on building a strong partnership with Layton City officials to jointly message that something had to be done in the area to help with traffic. As UDOT worked with the City, they were presented with the choice of trying something new and innovative or doing nothing because traditional alternatives for the area were cost prohibitive. The City was able to take this message to leaders who all agreed that something had to be done. This collaborative approach with the City was critical to ensure that both UDOT and the City were both able to communicate a unified message. Patrick Cowley, UDOT project manager explained the message in an interview: “We can’t leave it the way it is, and the ThrU Turns are the best alternative.” This choice proved to be very effective and helped significantly with public acceptance of the project.

Another key difference between both projects is the addition of the 4th leg bulb out on the opposite side of the freeway on the Layton project. This provided additional mobility and access to businesses in all quadrants to allow for less out of direction travel so that impacts to a single quadrant of the area would be minimized.

CONCLUSION

These projects in Utah were completed to address congestion concerns of the primary intersections and they have improved mobility in the areas where the intersections have been improved. Additionally, each of the projects have reduced or moved conflict points so that each of the major intersections have less conflict points. UDOT is hopeful that the projects will show an improvement to safety in the new configurations.

The authors recommend analyzing conflict points when designing the configurations of an AII to best balance mobility through the area, access to surrounding land areas, and safety. Modeling can help project teams to analyze alternatives to come up with solutions that improve congestion while also fitting into the project specific land uses and needs of the project area. Working closely with landowners and other stakeholders can yield solutions such as those found in the Layton example project that are better than a typical AII design.

Conflict points can be moved to auxiliary signals and having turning movements restricted at the main intersection can potentially improve safety while also improving operations in the area. In some cases, UDOT purposely increased conflicts on later generation CFI projects to save on capital construction costs because traffic modeling showed only minimal operational improvement. Taking these best practices can improve the chances of a successful AII project and can help an authority build on the experience of UDOT.

Best Practices and Lessons Learned

- Moving conflict points to intersections improves operations and helps control conflict points
- Installing an AII needs to match the access and development traffic patterns in the area.
- Once an AII is being considered, the intersection is likely operating beyond capacity in the peak periods and therefore, the nearby accesses are already functioning as RIRO access points.
- Lots of public outreach and education can improve success and public acceptance of these projects
- Being located on a busy street is desired by many commercial developments, however this gives nice visibility but not necessarily unlimited access. Once these intersections become congested, then either through the congestion queueing or the use of raised islands, the accesses are restricted to a RIRO during peak times. These AII offer opportunities to improve access to large commercial developments.
- Realize that AII projects can create access benefits for one side of the street but restrict the other side to RIRO only operations.

Key Message: Take our lessons learned and implement our best practices and build on them.

¹U.S. Department of Transportation, Federal Highway Administration (FHWA). (2004). *Signalized Intersections: Informational Guide Publication No. FHWA-HRT-04-091*, Washington, DC, USA.

²Utah Department of Transportation. (2012). *12300 South & Minuteman Drive / State Street Before & After ThrU Turn Intersection Evaluation*, Salt Lake City, Utah, USA.