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### Technical Memorandum for Iowa DOT District 1 – Expressway Intersection Safety

This technical memorandum serves to document CTRE’s input specific to the Iowa DOT District 1 request for state of practice information on addressing expressway intersection crash. This work is in context to plans for addressing safety concerns at the Jasper County intersections noted below (image source: Iowa DOT).



Figure 1. Existing Volumes, Geometrics, and Levels of Service

## Introduction

This document summarizes CTRE’s comments specific to addressing safety at expressway intersections in context to the DOT efforts underway for the planning area noted in Figure 1. These safety centered comments are intended to support effective decision making and do not reflect or replace an engineering study. This effort notes the safety performance of the planning area and provides commentary specific to addressing this problem via several different intersection control types (Interchange, Restricted Crossing Intersection or “J-Turn”, and Traffic Signal Control).

## Safety

### Safety Performance

#### *Iowa 330 and US Highway 65*

Crash data between 2008 and 2012 was used to summarize the crash history at the intersection of Iowa 330 and US Highway 65. During this time, there were a total of 28 crashes with 2 crashes resulting in fatalities and 1 with major injuries. In total, this resulted in 2 fatalities and 3 people with major injuries. Two thirds of the accidents had a major cause from either failure to yield right of way from a stop sign or yield sign. A majority of the crashes resulted in a broadside collision and the primary vehicle action was essentially straight.

#### *Iowa 330 and County Road F17*

Crash data between 2008 and 2012 was used to summarize the crash history at the intersection of Iowa 330 and County Road F17. During this time there was a total of 13 crashes with 2 crashes resulting in fatalities and 1 crash resulting in major injuries. In total, this resulted in 2 fatalities and 2 people with major injuries. The major cause in most of the crashes were a result from failing to yield the right of way from a yield sign resulting in a broadside type of collision. The primary vehicle action was while the vehicle was essentially moving straight.

#### *Statewide Expressway Crash Comparison*

Of the 1,002 expressway intersections statewide, a system wide analysis of crashes was conducted for the years 2003 to 2012. This analysis shows that 110 intersections had one or more fatalities, 24 intersections had two or more fatalities and 7 intersections had three or more fatalities. The intersections of Iowa 330@County Road F17 and Iowa 330@US Highway 65 are included within the 7 intersections which experienced three or more fatalities over the 10 year period.

### Challenge

State DOT's have faced the challenges of balancing traffic safety, operations and investments associated with intersection design for rural, high-speed expressway intersections for many years. In fact, this very issue (in Iowa) almost ten years ago resulted in Tom Welch securing funding for staff at CTRE and CH2MHILL to investigate the problems and identify a variety of potential roadway, traffic control and technology solutions – all of which are documented in NCHRP 650 – Median Intersection Design for Rural High-Speed Divided Highways.

### Intersection Control

The primary safety concerns at intersections along divided roadways is that they appear to operate somewhat differently than similar Thru/Stop controlled intersections along conventional 2-lane roadways. The intersections along the divided roadways have about the same frequency of crashes as the intersections on 2-lane roads but a far higher fraction of the crashes involve right angle collisions and because of the higher speeds and crash angle, these crashes tend to have severe outcomes. Prior to the preparation of the NCHRP Report 650, most DOT's faced with the task of developing a project to mitigate the problem were limited in the number of alternative strategies available. The most common solutions involved either replacing the at-grade intersection with a grade-separated interchange or replace the Thru/Stop control with a traffic signal. The primary advantage of the interchange option is that it proved to be very successful at

eliminating the severe right angle crashes but because of the very high construction costs (in the range of \$15 - \$30 million), the actual number of installations was limited. As a result of the high costs associated with interchanges, most DOT's defaulted to installing traffic signals (typical project costs are under \$1 million). The safety effects associated with the installation of traffic signals though were often hard to determine because the actual number of crashes at individual locations was often too low to provide statistically credible before versus after results. However, over time, efforts to accumulate results across many installations and to use the results of cross-sectional studies that compared crash data at Thru/Stop controlled intersections versus similar signal controlled intersections found that, the signal controlled intersections had higher crash rates than the Thru/Stop intersections and did NOT eliminate the right angle collisions. In fact right angle collisions are the most common type of crash resulting in fatalities and serious injuries at the signalized intersections.

The concerns about the very few options for improving expressway intersections and the further concerns about the safety effects of one of those options was the primary impetus behind the NCHRP 650 report. This report focused on documenting the current state of the practice and, if possible, identifying the most promising geometric, traffic control and technology based alternatives. In fact, Report 650 identified ten of the most promising alternatives based on documented safety benefits and one of the potential improvement strategies identified as being highly effective involved a technique developed in Maryland – the J-Turn. This concept directly addressed what appears to be the primary cause of most right angle collisions at Thru-Stop intersections – drivers on the minor road approach attempting to cross the major road. In the vast majority of these crashes the vehicles on the minor road stopped and then proceeded to select too small of a gap in the traffic stream on the major road. The J-Turn positively addresses this issue by providing channelization in the median that physically prevents a driver on the minor road from either crossing or making the left turn onto the major road. The research showed that the crossing and left turn maneuvers represented a minority of the possible vehicle conflicts at these intersections but were involved in a majority of the severe right angle crashes. The J-Turn concept prevents these high risk maneuvers and substitutes low risk right turn and U-turn maneuvers. The experience across states that have tried this concept is very positive – 60% to 80% reductions in total crashes and a near 100% reduction in the severe right angle collisions. Another advantage of this concept is that the installation costs are similar to those for installing traffic signals with a full complement of left and right turn lanes – in the range of \$0.5 \$0.75 million. It appears that the only challenges to implementation reported by the states involve concerns expressed by nearby businesses about losing access and the fact that the concept is new which makes local agencies and residents skeptical about actually addressing their concerns.

Two stories about this last point, the skepticism of locals about the J-Turn and the fact that it is a new concept. First, Iowa DOT previously had CTRE staff go to Maryland to interview the mayor and city council where the first J-Turn was installed. The elected officials shared their initial concerns, voiced their skepticism but finished the interview by saying that “they had to eat crow” because in the year following the project all of the crashes went away. This interview was videotaped and should be available. The second story involves Minnesota's initial attempts to install the J-Turn at a handful of locations and in every case they met local resistance, which is a major roadblock to implementation because of State law requiring municipal consent. In each case, this consent was requested and denied and lower cost strategies involving flashing lights,

bigger stops signs and transverse rumble strips were tried. In each case, these techniques failed to eliminate the crashes and the J-Turns were ultimately approved and installed. The crash reduction in each of these cases resulted in the elimination of ALL of the severe right angle collisions. In a follow-up on one of the projects, a local newspaper interviewed elected officials that had initially denied their consent and one of the officials used the phrase “eating crow” because the J-Turn had proven to be a complete success.

### Implementation

It is clear, from a review of the literature and safety experience in Iowa, Minnesota, and across the country, that implementation of either the interchange or J-Turn option at the Iowa 330 and County Road F17 intersection could be expected to produce a substantial and significant reduction in crashes. In contrast, these types of results are not expected with the third option where the present Thru/Stop control is replaced with traffic signal control. This option is more traditional given that traffic signals have been installed at many similar locations around the country. It should be noted that research has found that on average traffic signals at high speed, rural intersections actually have an inferior safety performance compared to Thru/Stop control. However, given that the frequency of crashes at this intersection is higher than expected, it is likely that the traffic signal would initially result in a small reduction in the total number of crashes, including severe right angle collisions, but the research also suggests these severe right angle crashes would not be eliminated. Approximately 25% to 35% of crashes at signalized intersections involve a right angle collision, most of these are associated with one of the vehicles running a red light and the consequences of this action at high speeds is often severe. This emerging acknowledgment by state DOT's that traffic signals are rarely safety devices has led a number of states, including Iowa, to NOT include the installation of traffic signals as one of their identified high priority safety strategies in their Strategic Highway Safety Plans.

## Summary

These summary comments are based on a safety perspective without consideration of other critical project criteria such as geometric limitations, environmental considerations, traffic capacity and operations, etc. These findings are based on a mix of experience, opinion, and research findings and are presented within this limited review as input for district considerations. The findings were produced by CTRE staff in cooperation with Mr. Howard Preston of CH2MHill.

Consideration of control scenarios from a safety impact perspective:

- Interchange – An interchange effectively eliminates the severe crash issues along the expressway.
- J-Turn - The J-Turn positively addresses the crash issues faced by providing channelization in the median (physically prevents all drivers on the minor road from either crossing or making the left turn onto the major road). Crossing and left turn maneuvers represent a minority of the possible vehicle conflicts at an at-grade expressway intersections but are involved in a majority of the severe right angle crashes. The J-Turn concept prevents these high risk maneuvers and substitutes these with low risk right turn and U-turn maneuvers.
- Traffic Signal – Traffic signal control along the expressway does not have the same crash reduction potential as the above two alternatives. Approximately 25% to 35% of crashes at signalized intersections involve a right angle collision, most of these are associated with one of the vehicles running a red light and the consequences of this action at high speeds is often severe.
- Do Nothing – The safety performance at the existing Thru/Stop controlled intersections is severe in that both intersections have experienced multiple fatalities/major injuries in recent years and when compared statewide both intersections are within the top seven expressway intersections with multiple fatalities within the State of Iowa.

Respectfully,

Neal Hawkins  
CTRE Director