Continuous Green T-Intersections

This case study is one in a series documenting successful intersection safety treatments and the crash reductions that were experienced. Traffic engineers and other transportation professionals can use the information contained in this case study to answer the following questions:

- What is an innovative treatment option to reduce injury and angle crashes at T-intersections in rural areas?
- How many crashes did this treatment reduce?
- Are there any implementation issues associated with this treatment and, if so, how can they be overcome?

Photo by Zane Znamenacek, CDOT (used with permission).

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Safe Roads for a Safer Future
Investment in roadway safety saves lives

Introduction

Angle crashes are among the most severe crashes that occur in intersections, including T-intersections. In some cases, substandard sight distance can contribute to this problem. Several States including Colorado, Florida, Maryland, North Carolina, and South Carolina have converted from fully-signalized to continuous green T-intersections (CGT) to improve safety.

Objective

The following case study showcases two rural intersections in Colorado where the signal-controlled through lane on the flat side (top) of a T-intersection was converted to a CGT. The treatment was implemented to reduce angle crashes due to left-turning traffic on the stem, turning in front of the though movement on the top of the T (Figure 1 provides a photograph of one of the intersections).

Treatment Summary

Both of the intersections complied with minimum Manual on Uniform Traffic Control Devices (MUTCD) requirements before improvements. The CDOT converted both of these fully-signalized intersections to CGTs.

The CGT design allows main line through traffic to pass through a signalized intersection without stopping (the top side of the "T"), while also eliminating conflicting vehicular movement. With a CGT, the through movement on the main line approach to the intersection is denoted by a steady green arrow traffic signal as well as by pavement markings or other lane delineation devices, so left-turning traffic stays in its respective lane (CDOT implemented advance warning signs to inform drivers of the special lane configuration). Engineers should only consider the CGT at intersections with three approaches, moderate-to-low left-turn volumes from the cross-street, and high arterial through volumes.

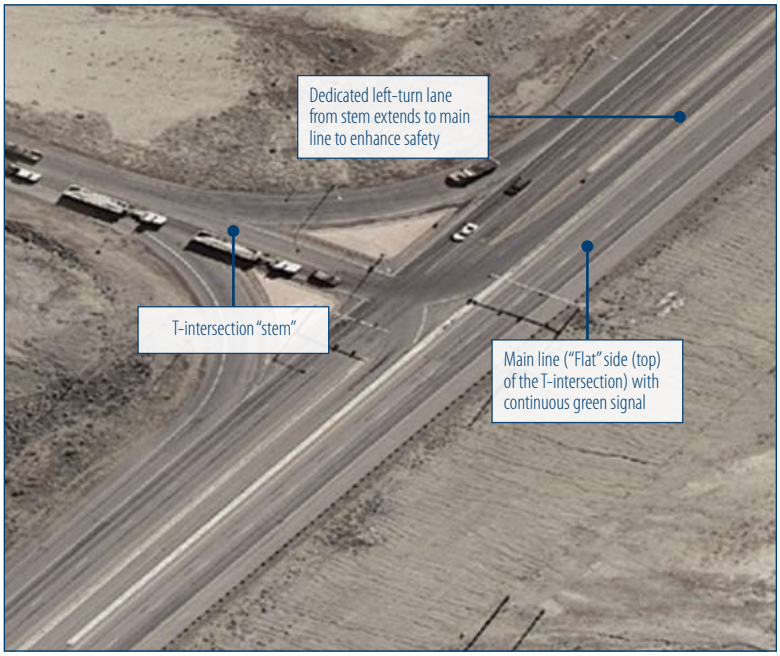
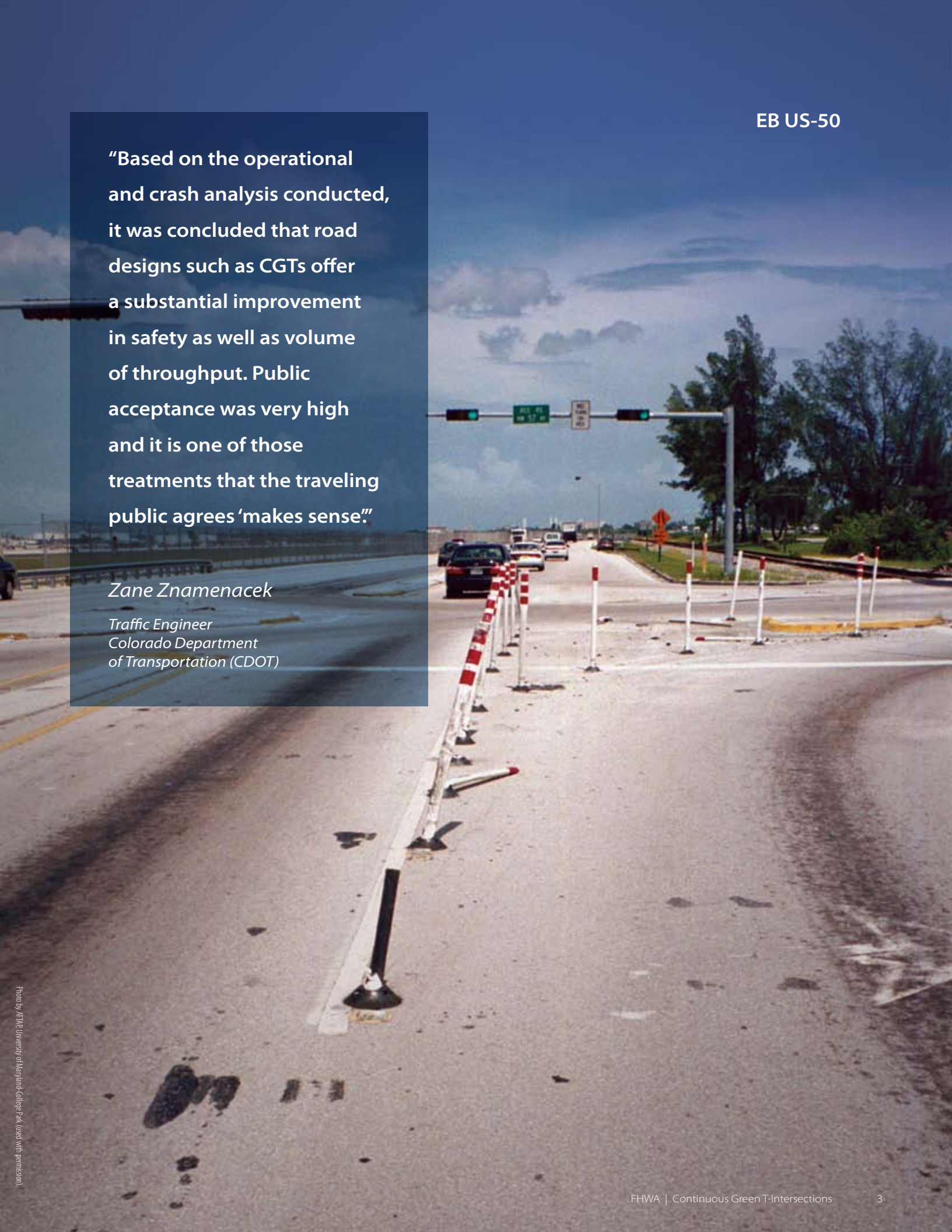


Photo from Zane Znamenacek, CDOT (used with permission).

Figure 1: Aerial view of the CGT in Grand Junction, Colorado
Source: CDOT



"Based on the operational and crash analysis conducted, it was concluded that road designs such as CGTs offer a substantial improvement in safety as well as volume of throughput. Public acceptance was very high and it is one of those treatments that the traveling public agrees 'makes sense'."

Zane Znamenacek

Traffic Engineer
Colorado Department of Transportation (CDOT)

Photo by ATAP, University of Maryland-College Park (used with permission).

The safety enhancements discussed in this case study were added to reduce angle, injury and total crashes. Implementation of the CGT cumulatively reduced angle crashes at the treated intersections by 96.8 percent, injury crashes by 70 percent, and total crashes by 60 percent.

Photo by Zane Znamenacek, CDOT (used with permission).

Evaluation Methodology

This case study examines two rural T-intersections in Colorado, with a high incidence of injury and angle crashes. Crash reduction results were based on a review of "before and after" data from these intersections during a period of four years, which occurred during the period between 1994 – 2006[1]. (The "before" and "after" observation periods were 24 months at both intersections).

Results

Problem: Two T-intersections in Grand Junction and Durango, CO were experiencing a high incidence of crashes, particularly angle crashes and many with injuries, due to limited stopping sight distance.

Solution: CDOT sought an intersection design treatment that would eliminate the stopping sight distance problem and to reduce the number of angle crashes, while also improving the efficiency of these intersections:

- **US-50 and SH 141, Grand Junction, CO**
  This rural intersection serves an annual daily traffic (ADT) of approximately 16,800. Prior to conversion, the east-west highway (US-50) had two lanes in each direction and a posted speed limit of 45 miles per hour (mph). The north-south highway (SH-141) had one lane in each direction and a speed limit of 35 mph.

  In 2004, the traffic control on eastbound (EB) US-50 was converted from a fully-signalized intersection to a CGT to eliminate the substandard sight distance problem and thus reduce the number of injury and angle crashes. The two right lanes were designed to carry continuous through traffic while a separate left-turn deceleration lane was provided for exclusive left-turning movement onto SH-141 (the mainline). Similarly an acceleration lane was provided from SH-141 onto EB US-50 (the stem of the T-intersection). The acceleration and deceleration lanes were channelized, and pavement markings and a 4-foot-wide concrete median separated the continuous through lanes. Appendix A provides plan details for this intersection.

  After the conversion of this intersection to a CGT, angle crashes decreased from 16 to 0 (a 100 percent reduction); injury crashes decreased from 12 to 2 (an 83.3 percent reduction); total crashes decreased from 16 to 7 (a 56.3 percent reduction).

- **US-160 and US-550, Durango, CO[2]**
  This rural intersection serves an ADT count of approximately 30,000. Both the east-west highway (US-160) and the north-south highway (US-550) had a posted speed limit of 50 mph. The traffic control at the intersection of westbound (WB) US-160 and US-550 was converted to a CGT in 1996 (see Figure 2) to reduce the number of injury and angle crashes.

  After conversion, US-160 (the main line) had a single through lane running WB with a separate deceleration lane; and two lanes running EB. US-550 (the stem of the T-intersection) had one acceleration lane for WB movement. Pavement markings and a 4-ft-wide median separated the continuous through lane and the adjacent left turning lane.

  After the CGT conversion, angle crashes decreased from 15 (including 1 fatality) to 1 (an average crash reduction of 93.3 percent); injury crashes decreased from 8 to 4 (an average crash reduction of 50 percent); and total crashes decreased from 19 to 7 (an average crash reduction of 63.2 percent).

Photo from David Pickten, CDOT (used with permission).

Figure 2: WB on US-160

[1] Note that reduction averages in this report reflect the percent reduction per year based on the difference between the total number of "before" and "after" crashes.

[2] Plan details for this intersection were not available.

Table 1 summarizes the results of the "before" and "after" crash analysis at the treated intersections.

Location	Implementation Date	Before				After				Reduction In Crashes/Year		
		Months	Total Crashes	Injury Crashes	Angle Crashes	Months	Total Crashes	Injury Crashes	Angle Crashes	Total Crashes	Injury Crashes	Angle Crashes
US-50 and SH-141	Apr-02	24	16	12	16	24	7	2	0	56.3%	83.3%	100%
US-160 and US-550	Aug-96	24	19	8	15 (1 fatality)	24	7	4	1	63.2%	50%	93.3%
Total		48	35	20	31	48	14	6	1	60%	70%	96.8%

Table 1: Summary of crash reductions after conversion to CGT.
Data Source: CDOT

Discussion

Implementation Issues

CDOT experienced no implementation issues converting these intersections to CGTs. However, the major movement of the side streets (the minor routes on the "stems" of the T-intersections) was affected by the lane closures required for maintenance of these CGTs, as there were no reasonable alternate routes. Also, the geometric changes (i.e., lane construction) required more time and approvals than operational changes (i.e., traffic signal timing adjustments).

Cost

The construction cost of the CGT, which included the new signal as well as the raised median work, was approximately $300,000 for each intersection.

Time Frame

The CGT was implemented within three months at each intersection.

Effectiveness

The CGTs were effective in substantially reducing angle, injury and total crashes at these intersections.

Summary of Results

The safety enhancements discussed in this case study were added to reduce angle, injury and total crashes. **Implementation of the CGT cumulatively reduced angle crashes at the treated intersections by 96.8 percent, injury crashes by 70 percent, and total crashes by 60 percent.**

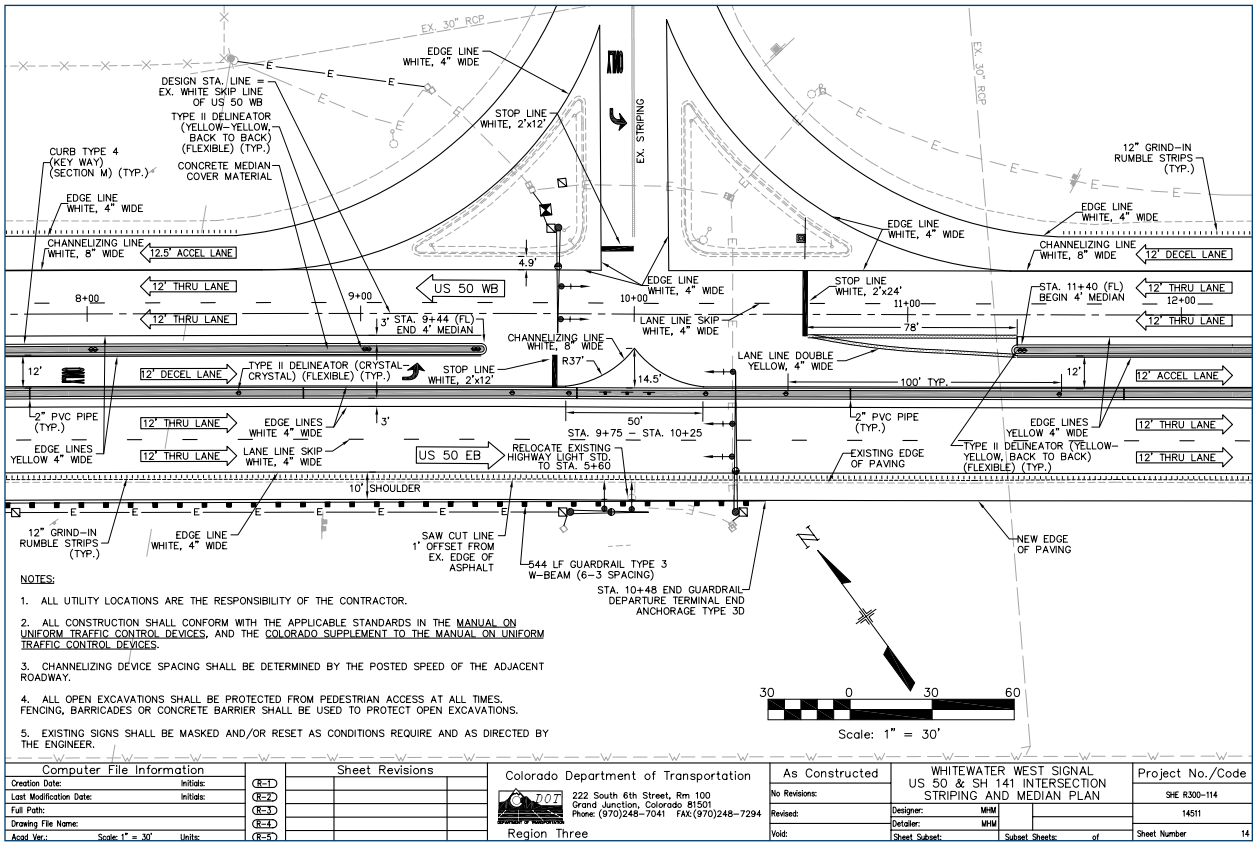
References

1) Jarem, E.S., "Safety and Operational Characteristics of Continuous Green Through Lanes at Signalized Intersections in Florida," Presented at the 2004 Institute of Transportation Engineers (ITE) Annual Meeting and Exhibit.

2) Boone, J.L., and Hummer, J.E., Unconventional Design and Operation Strategies for Oversaturated major Suburban arterials: Final Report, Project 23241-93-9, North Carolina State University, Department of Civil Engineering, Center for Transportation Engineering Studies, April 1995.

3) Reid, Jonathan, "Unconventional arterial intersection design, management and operations strategies," Parsons Brinckerhoff, July 2004.

Appendix A: US-50 and SH-141 Plan Details



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