



DRCOG Transportation Improvement Program (TIP)
FY 2024-2027 TIP Subregional Share (Call #4) –
Douglas County Subregion
Surface Transportation Block Grant (STBG) Project Application

OPTIONAL ADDENDUM OF SUPPLEMENTAL MATERIALS FOR CASTLE PINES I-25/HAPPY CANYON ROAD INTERCHANGE DESIGN

In the application from for this project, the answers to two questions indicated that supplemental information was being provided:

- PROJECT INFORMATION QUESTION 6. What planning document(s) identifies this project? Provide link to document(s) and referenced page number if possible, or provide documentation in the supplement **PROVIDED ON THIS PAGE**
- PART B, MVRTP PRIORITIES. SAFETY SECTION. CRASH REDUCTION TABLE. Provide the methodology below. **SEE CRASH ANALYSIS WHICH FOLLOWS**

Planning Documents

1. The application provided information regarding the *Castle Pines 2021 Comprehensive Plan Update*, including its public review/engagement process.

This document can be found online at: [COMPREHENSIVE PLAN - City of Castle Pines \(castlepinesco.gov\)](https://www.castlepinesco.gov/COMPREHENSIVE%20PLAN)

Please see discussion of the Happy Canyon interchange on pages 43, 48, 51, 67, B-6 and B-18.

2. The application mentioned the *2040 Douglas County Transportation Master Plan* as a relevant planning document. This plan was adopted by the Douglas County Board of County Commissioners in September 2019. Public engagement included public comment period of June 17 through July 22, which included a July 10 public open house meeting.

This document can be found online at: [https://www.douglas.co.us/documents/2040-transportation-master-plan.pdf/](https://www.douglas.co.us/documents/2040-transportation-master-plan.pdf)

Please see pages 43 and 45 which specify I-25/Happy Canyon interchange improvements (interim and ultimate).

Crash Analysis – Please see attachment.

CRASH REDUCTION PREDICTION APPROACH FOR I-25/HAPPY CANYON INTERCHANGE

Predicting crash reduction resulting from proposed improvements at the I-25/Happy Canyon interchange is challenging because the surrounding area will experience considerable growth and the entire interchange will be converted from an outdated diamond interchange to a Diverging Diamond Interchange. Thus, the goal is to estimate the crash reduction for a future baseline condition where interchange safety performance will decline significantly if no improvements are made, to a build condition with the planned DDI.

Castle Pines reached out to DRCOG staff for technical direction on how to address this challenge, because this Happy canyon Road project is not a good fit for the crash reduction methodologies that are specified for use in the funding application form. Castle Pines was advised that this situation does not lend itself well to a standard safety analysis, but the important point was to tell the story” (explain the situation) in the narrative and attempt a quantification of impacts with an explanation of why the resulting numbers might be reasonable.

The instructions on the DRCOG Funding Application State that “if constructing a new facility, report crashes along closest existing alternative route.” Replacing the existing Happy Canyon diamond interchange with a DDI is effectively the same as constructing a new facility. The closest existing alternative route is Castle Pines Parkway (I-25 Exit 188), just one mile away. Exit 188 carries more traffic than Happy canyon, which would tend to increase crashes, but it is also a more modern and safer interchange. It is not a standard diamond but has a loop ramp in its southeastern quadrant.

In addition to using data from I-25 Exit 188, another approach was tried. A search of the DRCOG Regional Traffic Counts database found surprisingly few diamond interchanges with more volume than Happy Canyon Road but less traffic than Castle Pines Parkway. The best fit was found to be I-25 Exit 243 in Weld County. Although the crossroad is a State Highway (66), this is a diamond interchange with crossroad volume (approximately 20,000 vehicles per day) that is greater than Happy Canyon Road and less than Castle Pines Parkway. Exit 243 is presumably much safer than Happy Canyon Road, in terms of physical configuration, but it was the best diamond interchange with appropriate traffic volumes that could be found to represent a future traffic baseline for this exercise.

A comparison of the DRCOG crash data (within 0.2 miles of the project) for the various interchange configurations is provided in the table that follows.

DRCOG database crashes, 2015-2019, within 0.2 mile of project, for three interchanges

Crash Type	I-25 Exit 187 Happy Canyon Not representative as a baseline due to imminent growth	I-25 Exit 188 Castle Pines Parkway Closest existing alternative route (non-standard diamond)	I-25 Exit 243 SH 66 in Weld County Diamond interchange with more traffic than Exit 187 but less than Exit 188
Fatal	0	1	1
Serious Injury	4	3	4
Other injury	38	35	61
Property damage only	88	108	133

Based on this comparison, it seems likely that the imminent growth around the Happy Canyon interchange is likely to result in increase crashes for the baseline, ‘no-action” scenario, where the traffic increases but the outdated interchange remains unimproved. In particular, fatalities and serious injuries may remain fairly stable, but other injury accidents and property damage. Use of the existing Exit 187 data therefore would be a very conservative approach.

Beyond the question of what the appropriate baseline crash data should be, based on imminent growth, there is the question of what amount of crash reduction can be expected from replacing the existing diamond interchange with a DDI. There are relatively few DDIs in Colorado, although the number is growing. A University of Missouri study was found (in the Journal of the Transportation Research Board, Volume 2486 Issue 1, January 2015) that intensively analyzed crash reduction (before-and-after) at six DDIs using three different analysis methods. See attached research summary: “**Safety Evaluation of the Diverging Diamond Interchanges in Missouri**”.

Here are the study’s key findings:

- A DDI replacing a conventional diamond decreased crash frequency for all severities.
- Total crash frequency also decreased by 40.8% to 47.9%, depending on the analysis method used.
- Crashes involving property damage only were reduced by 33.9% to 44.8%.

Based on these findings, a crash reduction factor of 40% has been applied to the Happy canyon Road 2015-2019 crash history for the purposes of completing the DRCOG funding application form:

- 0 * .4 = 0 fatal crashes reduced
- 4 * .4 = 1.6 serious injury crashes reduced; round it to 2
- 38 * .4 = 15 other injury crashes reduced
- 88 * .4 = 35 PDO crashes reduced

Research Summary

Safety Evaluation of the Diverging Diamond Interchanges in Missouri

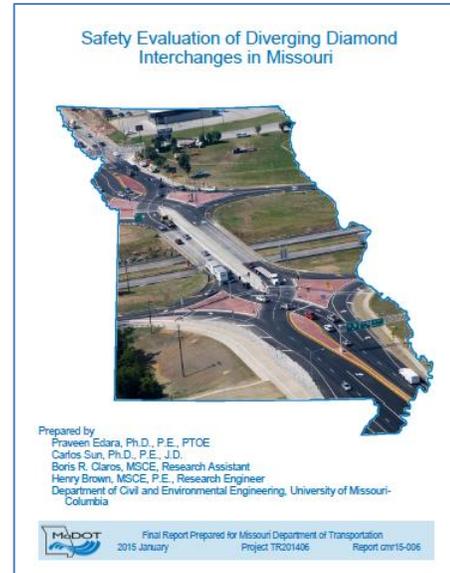
The Diverging Diamond Interchange (DDI) has gained in popularity in the United States during the last decade. The operational benefits and lower costs of retrofitting a conventional diamond with a DDI have contributed to its increased use. Existing research on DDIs has focused primarily on the assessment of operational benefits. Unfortunately, formal safety evaluations of DDIs have been lacking.

This study filled the knowledge gap by examining data from six DDI sites in Missouri to conduct a before-after safety evaluation at the project level (interchange) and the site-specific level (ramp terminals) of the DDIs using three methods: Naïve, Empirical Bayes (EB), and Comparison Group (CG).

The three evaluation methods that were used involved different trade-offs, such as data requirements, complexity, and regression-to-the-mean.

The safety evaluation at the project level accounts for the influence of the DDI treatment in the entire footprint of the interchange. On the other hand, the site-specific approach focused on the influence at the ramp terminals only.

All three methods showed that a DDI replacing a conventional diamond decreased crash frequency for all severities.



At the project level, the highest crash reduction was observed for fatal and injury (FI) crashes: 63.2% (Naïve), 62.6% (EB), and 60.6% (CG). Property damage only crashes were reduced by 33.9% (Naïve), 35.1% (EB), and 49.0% (CG). Total crash frequency also decreased by 41.7% (Naïve), 40.8% (EB), and 52.9% (CG).

Similarly, in the site-specific analysis, the highest crash reduction was observed for fatal and injury (FI) crashes: 64.3% (Naïve), 67.8% (EB), and 67.7% (CG). Property damage only crashes were reduced by 35.6% (Naïve), 53.4% (EB), and 47.0% (CG). Total crash frequency also decreased by 43.2% (Naïve), 56.6% (EB), and 53.3% (CG).

A collision type analysis revealed that the DDI, when compared to a diamond, traded high severity for lower severity crashes. While 34.3% of ramp terminal-related FI crashes in a diamond occurred due to the left turn angle crashes with oncoming traffic, the DDI eliminated this crash type.

In summary, the DDI offers significant crash reduction benefits over conventional diamond interchanges.

The safety effectiveness results for the individual sites also demonstrated that fatal and injury (FI), property damage only (PDO), and total (TOT) crashes decreased at most sites after DDI implementation.



Aerial view of DDI at RT-13 and I-44, Springfield, MO



Aerial view of DDI at US 65 and MO 248, Branson, MO



Aerial view of DDI at I-435 and Front Street, Kansas City, MO

Project Information

PROJECT NAME: Safety Evaluation of the Diverging Diamond Interchanges in Missouri

PROJECT START/END DATE: July 2013 through January 2015

PROJECT COST: \$60,001

LEAD CONTRACTOR: University of Missouri-Columbia

PRINCIPAL INVESTIGATOR: Dr. Praveen Edara

REPORT NUMBER: [cmr 15-006](#)

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