



CDOT INTERSECTION CONTROL ASSESSMENT TOOL (ICAT)

Version 1.0 Users Guide

The CDOT Intersection Control Assessment Tool (ICAT) is an open-source Excel workbook that includes 7 worksheets, each containing data inputs needed to complete an intersection control assessment. Computations rely on input from multiple worksheets, and the assessment results are continually updated as the worksheets are completed. Therefore, no results should be considered final until all worksheets are fully complete.

INTRODUCTION WORKSHEET

The **Introduction** worksheet provides information on the purpose and goals of the intersection control assessment, a description of the tool processes and responsibilities, answers to frequently asked questions, and documentation of ICAT version updates.

INTERSECTIONS WORKSHEET

The **Intersections** worksheet provides descriptions and graphics of each intersection type included for evaluation and links to national guides or publications that describe each intersection type in greater detail.

INTERSECTION DATA WORKSHEET

The **Intersection Data** worksheet begins the ICAT data entry process. **Figure 1** illustrates a blank worksheet and requested inputs for project, traffic, and safety data. Here and throughout the tool, orange text or boxes indicate **required** data inputs, and blue text or boxes indicate **optional** data inputs.

Project traffic and safety data input for a case study example project is illustrated in **Figure 2**, and requires the following:

- Project number and responsible person/agency
- County and CDOT region
- Major/Minor Road names and drop downs for roadway typology, turn lanes, right-of-way, speed limits and Major Road direction; note intersection lanes are determined by road typology, and if turn lanes are different by approach, choose the most conservative (most turn lanes) for entire street
- Area type, terrain, and existing intersection control
- Preparing agency name, date, and brief project description
- Project opening and design years and intersection K-factor (% of daily traffic occurring in the peak hour). While these factors are used to make traffic volume projection estimates, known traffic forecast data can be included using traffic data overrides tables.
- Crash history data (number of PDO, injury and fatal crashes) and LOSS factor obtained using DiExSys or state LOSS database.

Figure 3 illustrates the project example traffic data entry which is located outside the worksheet print border. Users can input data for up to two evaluation periods (typically AM and PM peak periods). The existing peak period volumes, approach growth rates, truck percentages and pedestrian volumes are input using the tables to the right (grey shaded area) and volume data is automatically copied onto the traffic diagrams. Based on input data, the worksheet will auto-calculate daily intersection entry volumes, approach volumes and Average Daily Traffic (ADT) volumes for existing, opening-year and design-year scenarios. If opening and design year traffic volumes and/or ADT volumes are known from other sources, the calculated volumes based on the input growth rate can be overwritten using the tables outside the worksheet print border.

Figure 1: Blank Intersection Data Worksheet

Figure 2: Project Information (Example Case)

Figure 3: Traffic Data Entry

STAGE I WORKSHEET

The **Stage1** worksheet serves as a screening effort meant to eliminate non-competitive options and to identify which alternatives merit further considerations in Stage II based on their practical feasibility. **Figure 4** illustrates the Stage I worksheet where intersection screening evaluations and justifications are made.

The top left portion of the worksheet includes project information data carried forward from the Introduction worksheet. The user must select between two and five alternatives to be carried forward using the drop-down box in the upper right.

Users can create conventional alternatives (i.e. adding left or right turns and/or median and signal improvements) using the drop-down boxes to the right outside the print border and/or “write in” an improvement alternative not in the defined list of alternatives in the orange boxes. Selection of either results in automatic carryover to Stage II but selections will require additional steps to determine safety and cost estimate data required that would otherwise be auto populated in the Stage II worksheet (described in a later section).

Users should practice good engineering judgement in responding to the following 15 evaluation questions (listed in **Figure 5**) by selecting 0, 1, or 2 in the orange boxes below each question. Note that questions 4, 5, 7, 12 and 13 are auto populated based on previous data inputs.

1. Is ROW on major road constrained?
2. Is ROW on minor road constrained?
3. Are Intersection quadrants constrained?
4. Are there intersection safety issues?
5. Are there significant pedestrian crossings?
6. Is there significant bicycle activity?
7. Are one or more approach speeds high?
8. Do roadway contexts, characteristics transition at this intersection?
9. Are there numerous driveways near intersection? Assume future conditions (i.e. can/will driveways be closed as part of project?)
10. Is intersection isolated or part of network / dense network?
11. Is project location currently a T-intersection? Or can minor street thru or left turn movements be eliminated?
12. Based on V/C calculations, are design year no-build volumes high?
13. Are existing year left turning movement volumes high?
14. Is there a possibility to convert to interchange in next 20 years?
15. Are construction costs a primary decision factor?

These inputs are used to better understand the intersection context, impacts, and needs (illustrated in **Figure 6**), so that each intersection alternative is given an overall Stage I assessment score. Alternatives with the highest scores are highlighted in blue and become the shortlisted alternatives carried into Stage II for more detailed analysis.

Once the 15 questions are answered and overall scores are determined, users can either “deselect” an alternative or select an alternative not in the shortlist by placing an “X” or “Y”, respectively, to the right of the total score. A justification for the selection/deselection must be entered in the column to the right. Final selected alternatives highlighted in blue are automatically carried forward into the Stage II worksheet.

Figure 4: Stage I Worksheet

Figure 5: Evaluation Questions

Right of Way	Safety	Roadway Context	Operations/Maintenance	Costs
Q1: Is ROW on major road constrained? (0=no, 1=somewhat, 2=highly)	Q6: Is there significant bicycle activity? (0=no, 1=moderate, 2=high)	Q9: Do roadway contexts, characteristics transition at intersection? (0=no, 1=yes)	Q10: What is adjacent intersection spacing? (0=isolated, 1=network, 2=dense network)	Q15: Are costs a primary decision factor? (0=no, 1=somewhat, 2=yes)
Q2: Is ROW on minor road constrained? (0=no, 1=somewhat, 2=highly)	Q7: Are one or more approach speeds high? (0=no, 1=moderate, 2=high)	Q10: Are there numerous driveways near intersection? (0=no, 1=few, 2=many)	Q11: Is this a T-intersection? Or can minor ST thru or left turn be eliminated? (0=no, 2=yes)	
Q3: Intersection quadrants constrained? (0=no, 1=somewhat, 2=highly)	Q8: Are there significant pedestrian crossings? (0=no, 1=moderate, 2=high)	Q11: Are design or no-build volumes high? No-build 2043 V/C=1.6; (0=low, 2=mod, 4=high)	Q12: Are design or no-build volumes high? No-build 2043 V/C=1.6; (0=low, 2=mod, 4=high)	
Q4: Are there intersection safety issues? (0=no, 1=moderate, 2=crash hot spot)	Q9: Are there numerous driveways near intersection? (0=no, 1=few, 2=many)	Q12: Are design or no-build volumes high? No-build 2043 V/C=1.6; (0=low, 2=mod, 4=high)	Q13: Are eas LT volumes high? (Max 2021 LT -270 vph) (0=no, 1=somewhat, 2=yes)	
Q5: Are there significant pedestrian crossings? (0=no, 1=moderate, 2=high)	Q10: What is adjacent intersection spacing? (0=isolated, 1=network, 2=dense network)	Q13: Are eas LT volumes high? (Max 2021 LT -270 vph) (0=no, 1=somewhat, 2=yes)	Q14: Could intersection become interchange in next 20 yrs? (0=no, 1=maybe, 2=probably)	
Q6: Is there significant bicycle activity? (0=no, 1=moderate, 2=high)	Q11: Is this a T-intersection? Or can minor ST thru or left turn be eliminated? (0=no, 2=yes)	Q14: Could intersection become interchange in next 20 yrs? (0=no, 1=maybe, 2=probably)		
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Q11: Is this a T-intersection? Or can minor ST thru or left turn be eliminated? (0=no, 2=yes)				
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Q13: Are eas LT volumes high? (Max 2021 LT -270 vph) (0=no, 1=somewhat, 2=yes)				
Q14: Could intersection become interchange in next 20 yrs? (0=no, 1=maybe, 2=probably)				
Q15: Are costs a primary decision factor? (0=no, 1=somewhat, 2=yes)				

Figure 6: Example Stage I Selections (from Case Study)

Selecting/Deselecting Alternatives

Mini Roundabout	23.0		
Single Lane Roundabout	29.0	X	Does not meet plan for future widening
Multilane Roundabout	23.0	Y	Locally preferred alternative
RCUT / J-Turn (stop control)	26.5		



developed and Maintained in Cooperation with Georgia DOT

ICAT STAGE 2: ALTERNATIVE SELECTION DECISION RECORD

CDOT ICAT Version 1.0 | Release 2.0

CDOT Project Number: 0012345

Project Location: Ute Hwy (CO-66) @ Pace Street

Existing Intersection Control: Signalized Intersection

County/Region: Boulder / CDOT Region 4

Area Type: Suburban

Prepared by: Region 4 Traffic Engineer

Date: 8/23/2021

Type of Project: Safety Improvement Project

Existing / Design Year No-Build Traffic Operations

Traffic Analysis Measure of Effectiveness

Traffic Analysis Software Used

Analysis Time Period

	Intersection Delay	
	Synchro 10	
	AM Peak Hr	PM Peak Hr
2021 Existing No-Build Peak Hr Intersection Delay	40.0 sec	55.0 sec
2021 Existing No-Build Peak Hr Intersection V/C ratio	0.60	0.90
2043 Design Yr No-Build Peak Hr Intersection Delay	65.0 sec	80.0 sec
2043 Design Yr No-Build Peak Hr Intersection V/C ratio	1.10	1.25

Moving down the worksheet, **Figure 11** illustrates the input of cost data for each of the selected alternatives (alternative names are auto populated on the top row). The cost estimate data generated in the **Costs** worksheet is auto populated in this table. If cost estimates are independently generated for one or all of the selected alternatives, construction, ROW, environmental mitigation, utility, and design and contingency costs can be directly entered using the override table to right (lower half of Figure 8). The last row in this table can be used to adjust the costs by a percentage to better meet cost expectations.

Figure 12 illustrates data inputs for operational and safety analysis of the build conditions for each alternative. As for the design year no-build analyses, build condition alternative analyses must be performed using standard traffic analysis tools outside of the Stage II worksheet. The build analyses should use the design year traffic volumes (from the intersection data worksheet) and include the alternative intersection lanes and geometry. The tool uses traditional delay and v/c measures (from HCM, Synchro, etc.) or network wide MOEs from (from simulation model tools) and operational results are entered below each alternative.

Intersection safety performance measures are generated using Crash Modification Factors (CMF's) in FHWA's CMF clearinghouse (<http://www.cmfclearinghouse.org>). Most CMFs from known before-and-after intersection projects (i.e improvement from a 2-way stop to a single-lane roundabout) are auto-populated from the clearinghouse data, including source listings; however, when no CMF clearinghouse data exists, or the user feels that using a different clearinghouse data CMF is more appropriate, a table to the right can be used to define or override CMF data for PDO and injury/fatal crash types and source data. Note that leaving the field blank (CMF=0%) means that there are no perceived safety benefits (or disbenefits) of the alternative and the safety score will be zero for that alternative.

Figure 13 illustrates inputs of potential environmental impacts for each alternative (none, minimal & significant). If there are potential impacts, the Environmental score is decreased. Also, remember to return to the **Costs** worksheet to enter a cost estimate for each mitigation (highlighted in orange). Stakeholder support of alternatives (both local community and Region support) should be determined and entered using dropdowns (strong, positive, neutral, negative, opposition or unknown).

The final ICAT Stage II scores and rankings are provided at the bottom of the worksheet. The final score is based on cost, operations, safety, environmental and stakeholder input data and weighted percentages for each evaluation factor. Make sure all worksheet data has been completed before relying on any results. Lastly, use the data field at the bottom to provide comments or explain unique data input or results.

ENVIRONMENTAL DATA WORKSHEET

The **ENV** worksheet is only used when there are potential significant environmental impacts for one or more alternatives. **Figure 14** illustrates the ENV worksheet, where any potentially significant environmental impacts are to be documented (indicated in bold text as "significant" in the drop-down box in Stage II). The goal of this worksheet is to document that reasonable mitigation (or avoidance) can be achieved (that would otherwise disqualify this alternative) before that alternative is selected as a preferred solution.

Figure 11: Alternative Cost Data

Alternatives Analysis	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Proposed Control Type Improvement:	Multilane Roundabout	Medians Add FYA	Superstreet / RCI	Continuous Green-T
Project Cost (From Cost Worksheet)	Add addtl description here	Add addtl description here	Add addtl description here	Add addtl description here
Construction Cost	\$1,283,037	\$400,000	\$1,403,215	\$673,383
ROW Cost	\$0	\$0	\$283,058	\$0
Environmental Cost	\$31,250	\$0	\$50,000	\$25,000
Reimbursable Utility Cost	\$64,152	\$25,000	\$70,161	\$20,202
Design & Contingency Cost	\$641,519	\$80,000	\$701,608	\$336,692
Cost Adjustment (justification req'd)	+25%	0%	0%	0%
Total Cost	\$2,019,957	\$505,000	\$2,508,042	\$1,055,277

Cost Data Override (if generated independent of CostEst Tool)				
	Multilane Roundabout	Medians Add FYA	Superstreet / RCI	Continuous Green-T
Construction Cost	\$0	\$400,000	\$0	\$0
ROW Cost	\$0	\$0	\$0	\$0
Environmental Cost	\$0	\$0	\$0	\$0
Reimbursable Utility Cost	\$0	\$25,000	\$0	\$0
Design/Contingency Cost	\$0	\$80,000	\$0	\$0
Cost Adjustment (justification required)	+25%	0%	0%	0%

Figure 12: Alternative Traffic Operations and Safety

Alternatives Analysis	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Proposed Control Type Improvement:	Multilane Roundabout	Medians Add FYA	Superstreet / RCI	Continuous Green-T
Traffic Operations				
Traffic Analysis Software Used	SIDRA 7	Synchro 10	Synchro 10	Synchro 10
Analysis Period	AM Peak Hr / PM Peak Hr	AM Peak Hr / PM Peak Hr	AM Peak Hr / PM Peak Hr	AM Peak Hr / PM Peak Hr
2043 Design Yr Build Intersection Delay	30.0 sec : 35.0 sec	55.0 sec : 65.0 sec	40.0 sec : 48.0 sec	35.0 sec : 45.0 sec
2043 Design Yr Build Intersection V/C	0.65 : 0.75	0.95 : 1.10	0.75 : 0.90	0.60 : 0.85
Safety Analysis				
Predefined CRF: PDO	26%	0%	15%	4%
Predefined CRF: Fatal/Inj	71%	0%	15%	4%
Predefined CRF Source:	FHWA Clearinghouse IDs: 4196 / 4195	-	FHWA Clearinghouse ID 9984	CDOT Study ID 8655
User Defined CRF: PDO		8%		
User Defined CRF: Fatal/Inj		8%		
User Defined CRF Source (write in if applicable):		CMF Clearinghouse		

Figure 13: Environmental/Stakeholder Data & Final Results

Environmental Impacts				
Historic District/Property:	None	None	None	None
Archaeology Resources:	None	None	None	None
Graveyard:	None	None	None	None
Stream:	Minimal	None	None	None
UST/Hazmat:	None	None	None	None
Park Land:	None	None	None	None
EJ Community:	None	None	None	None
Floodplain:	None	None	Significant	Minimal
Wetland:	None	None	None	None
T&E Species Habitat:	None	None	None	None
Note: Be sure to go back to Costs worksheet to enter mitigation costs for each noted impact				
Stakeholder Support:				
Local Community Support	Supportive	Neutral	Negative	Neutral
CDOT Region Support	Supportive	Negative	Supportive	Neutral
Final ICAT Stage 2 Score:	6.1	3.1	3.0	3.8
Rank of Control Type Alternatives	1	3	4	2

Figure 14: Environmental Impacts Worksheet


INTERSECTION CONTROL ASSESSMENT TOOL (ICAT): ENVIRONMENTAL FACTORS
Developed and Maintained in Cooperation with Georgia DOT
CDOT ICAT Version 1.0 | Release Date: 9/17/2021

Project Information
 Project Location: Ute Hwy (CO-66) @ Pace Street Area Type: Suburban
 County: Boulder Prepared By: Region 4 Traffic Engineer
 CDOT Region: Region 4 Date: 8/23/2021

Environmental Factors
 In the box below, document any significant environmental factors for any alternative considered. Include a plan and costs for mitigation that retains the proposed intersection type as a viable alternative. Include in ICAT documentation package only if one or more alternatives have significant impacts.

Proposed Intersection Control #1: Multilane Roundabout
 None

Proposed Intersection Control #2: Medians Add FYA
 None