2017 Texas Traffic Safety Conference

Intersection Control Evaluation (ICE) Policies & Procedures Overview

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FHWA Office of Safety

U.S. Department of Transportation
Federal Highway Administration

Safe Roads for a Safer Future
Investment in roadway safety saves lives
http://safety.fhwa.dot.gov

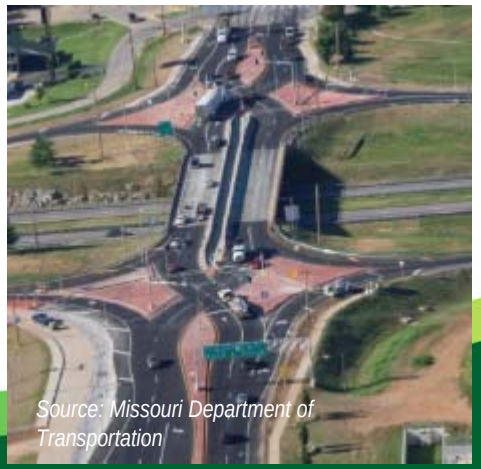
Innovative Intersections

Key characteristics:

- Improve the way ***people*** move across intersections
- Eliminate, relocate or modify conflict points
- Strategically optimize traffic control

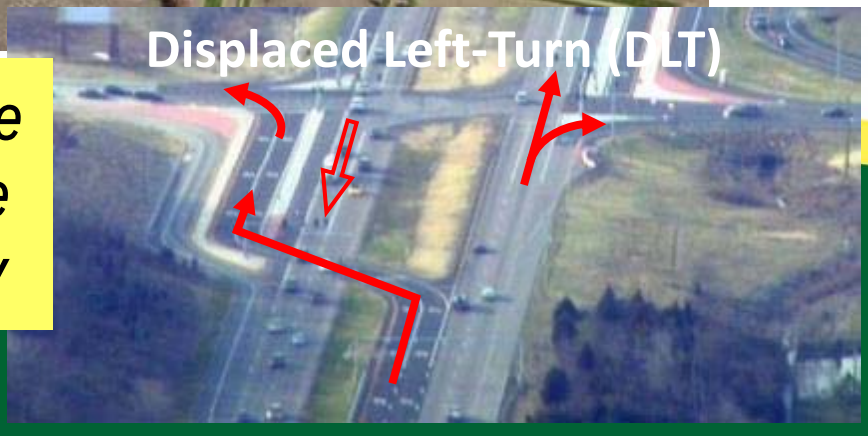
"cho·re·og·ra·phy"


Source: FHWA


Source: Missouri Department of Transportation


Source FHWA

Intersection & Interchange Geometrics (IIG)



These designs reduce severe crashes while enhancing efficiency

SAFETY

- **Fewer, less severe conflict points**
- **Speed management potential**
- **Significant crash reductions**

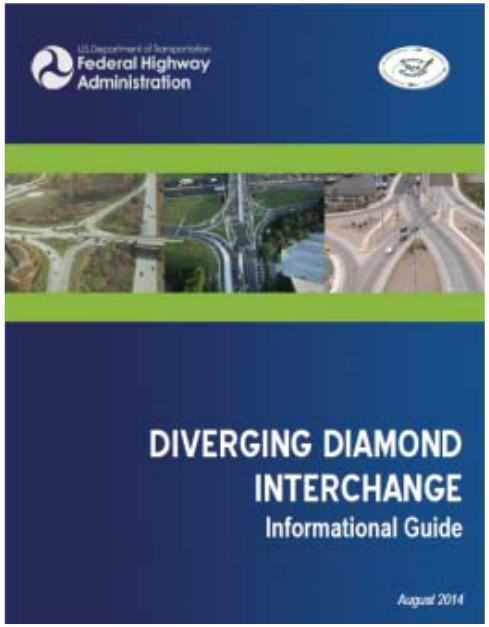
MOBILITY

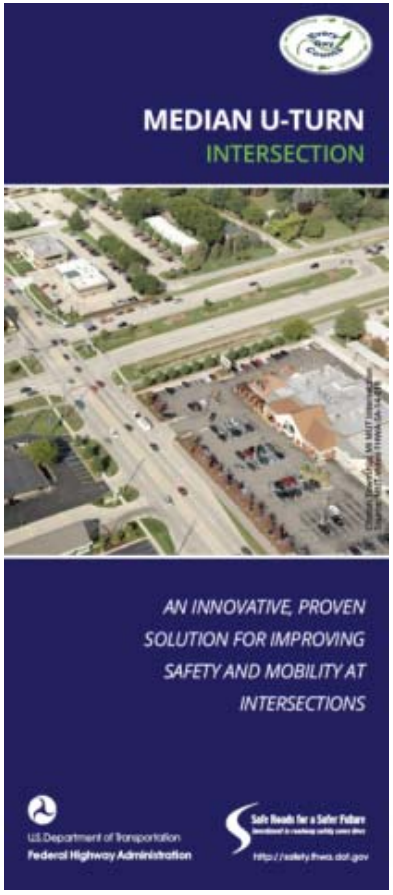
- **Less delay**
- **Reduced congestion**
- **New/more pedestrian and bike opportunities**

VALUE

- **All Users**
- **Less ROW**
- **Decreased costs**
- **Quicker construction**
- **Balanced solutions**

Innovative Intersections Resources





http://www.youtube.com/USDOTFHWA

Long Term Vision

Agencies include these EDC intersection designs in their evaluation processes or policies in a manner that ensures they are considered and evaluated alongside other improvement alternatives, and implemented when appropriate.

Intersection Control Evaluation

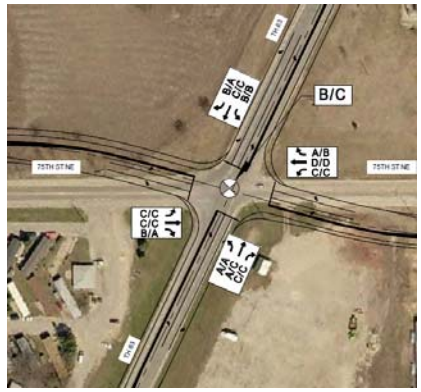
Policies/Procedures

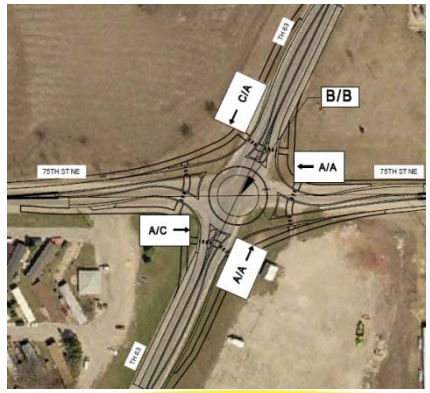
Why is ICE needed?

- Sustain IIG progress achieved through EDC2
- Ensure routine, objective and consistent consideration
- Complements performance-oriented program framework and value-based project delivery
- Overcome inertia of past practice…

Intersection Control Inertia

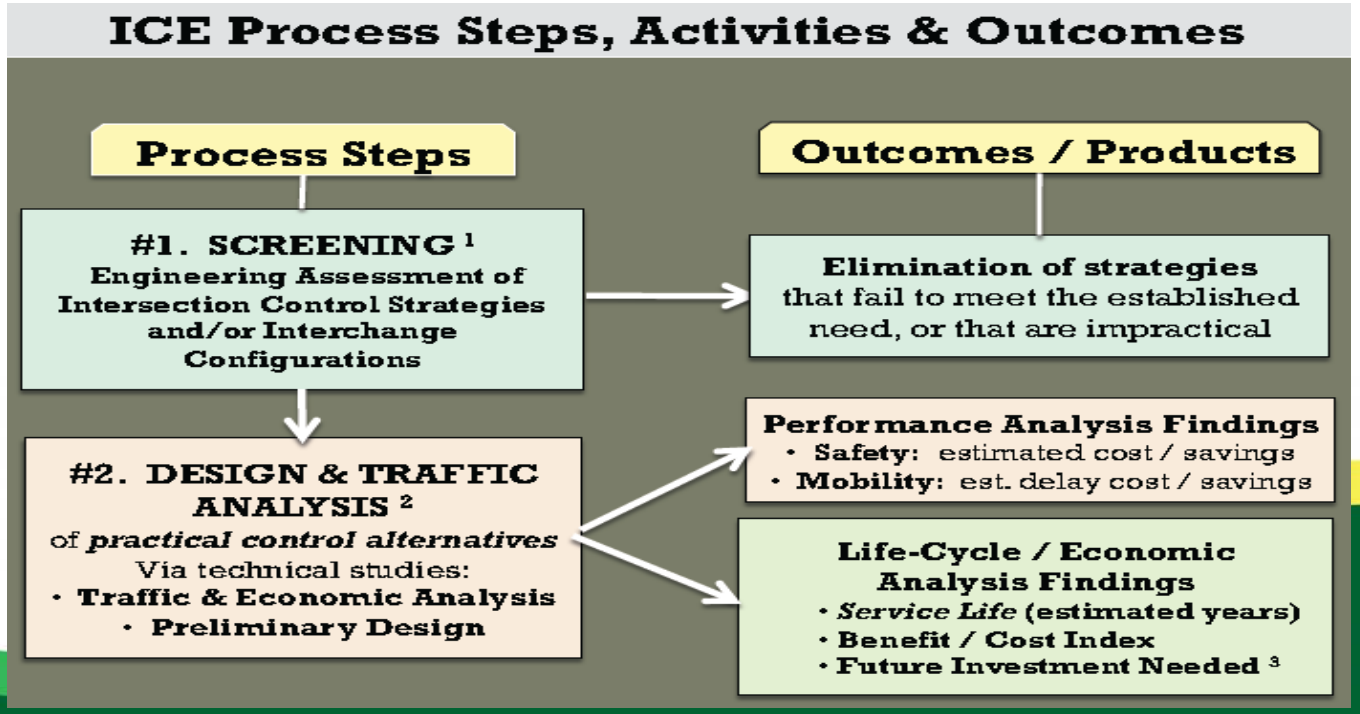
- Mostly “de facto” minor route stop (TWSC), All Way Stop (AWSC) or Traffic Signal
- Viewed through a mainline operations lens (i.e., volumes-based warrants)
- Separate and involved process(es) for “other”, non-conventional alternatives
  - Some policies require roundabout “consideration”





ICE **Policies & Procedures**

A performance-based framework that utilizes a consistent process and objective metrics to vet intersection geometry and control alternatives



Generally, ICE is…

- A <u>policy</u> and a <u>process</u>

POLICY

Establishes the general applicability and future effect; sets forth a course of action, plan or procedure; expectation that it will be implemented and adhered to without deviation

PROCESS

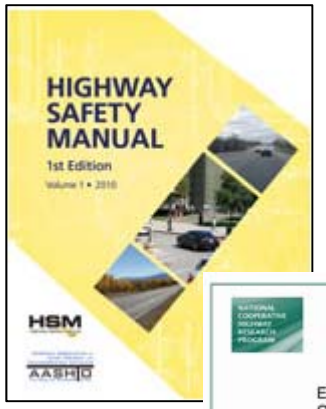
Describes the framework and methodologies by which a Policy can be successfully implemented; details the actions or steps to be taken to achieve a particular end; facilitates consistency of effort and results

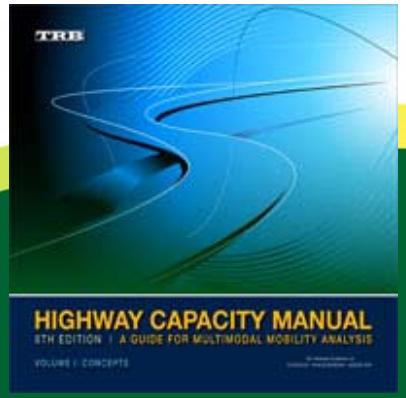
Attributes of ICE

- Determine the “best value” geometric design and traffic control for a given intersection
- Safety, operational, multimodal, environmental, ROW, cost and political impacts weighed
- All design alternatives receive preliminary screening, i.e. “*do they work?*” litmus test
- Short list of alternatives with highest potential effectiveness are carried forward to help shape an appropriate project scope

ICE **Performance Criteria**

- Safety (substantive HSM-based)
- Operations (core MOEs)
- Non-Motorized (Peds/Bikes)
- Freight Network (incl. OSOW)
- Right-of-Way Impacts
- Practical Feasibility (i.e., local posture)
- Environmental Impacts
- Costs (Initial and lifecycle)





Core Benefits of ICE

- Quantification, documentation of decision
- Process breeds consistency, familiarity
- Important criteria analyzed form basis of defensible decision
  - **Multimodal Safety** (quantitative)
  - Multimodal Operations (quantitative)
  - Environmental, Construction, ROW and Maintenance Costs (quantitative)
  - Political and Public acceptability (qualitative)

ICE Lead States & Lessons

- California (2013)

  http://www.dot.ca.gov/hq/traffops/signtech/signdel/policy/13-02.pdf

- Indiana (2014)

  http://www.in.gov/indot/files/ROP_IntersectionDecisionGuide.pdf

- Minnesota (2007)

  http://www.dot.state.mn.us/trafficeng/safety/ice/

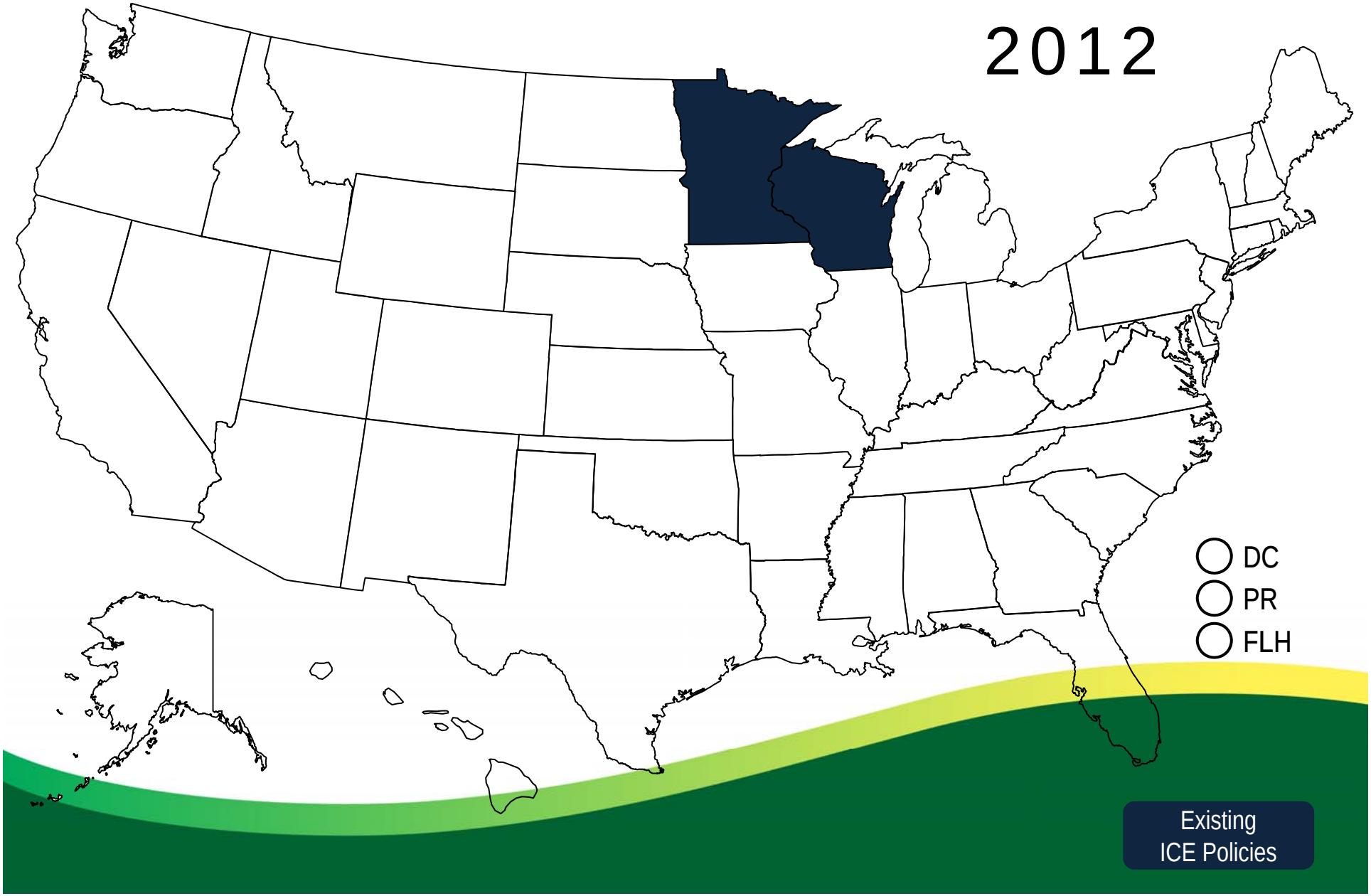
- Washington (2015)

  http://www.wsdot.wa.gov/publications/manuals/fulltext/M22-01/1300.pdf

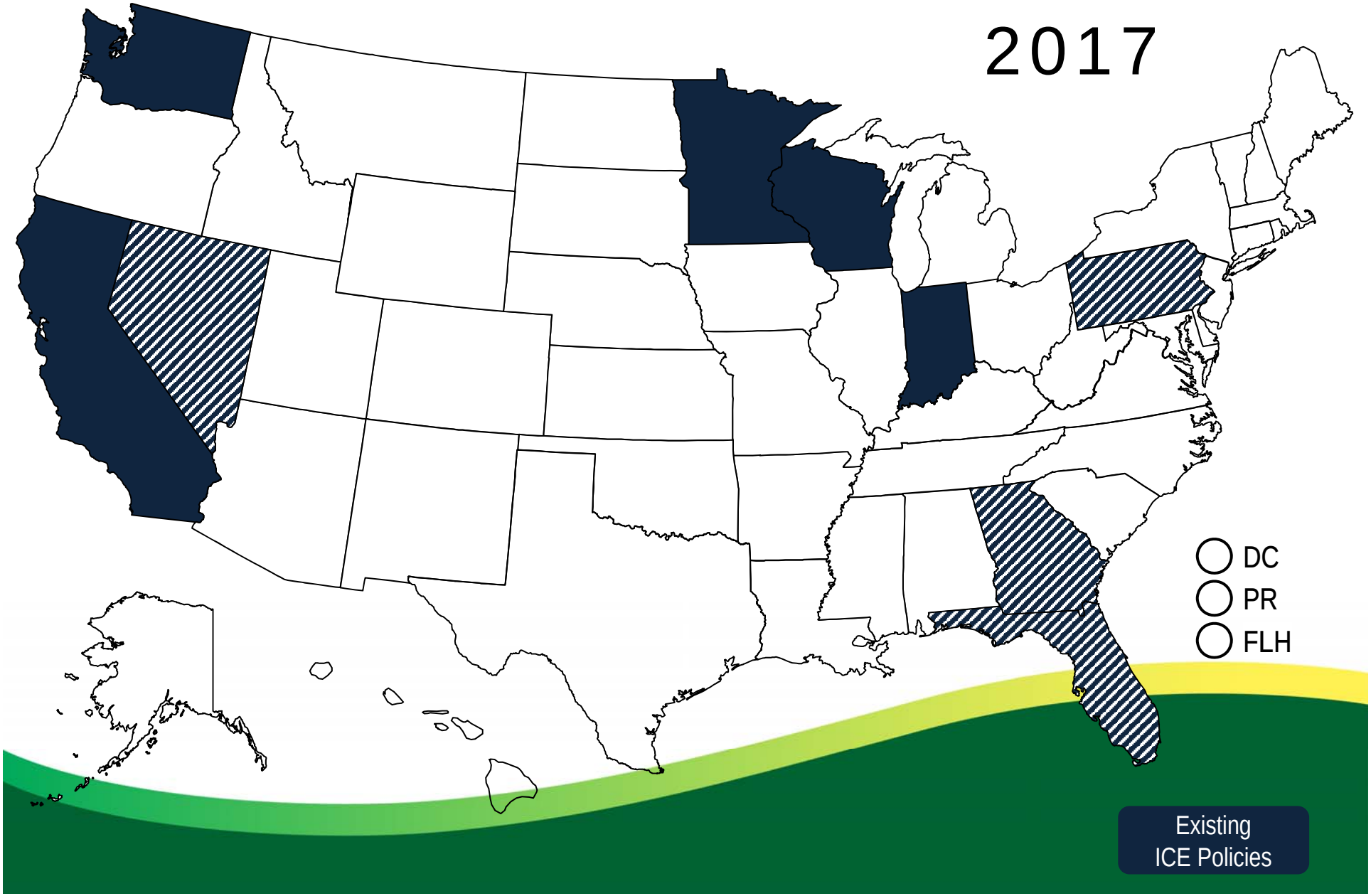
- Wisconsin (2008)

  http://roadwaystandards.dot.wi.gov/standards/fdm/11-25.pdf#fd11-25-3.1

ICE Policies & Procedures



ICE Policies & Procedures

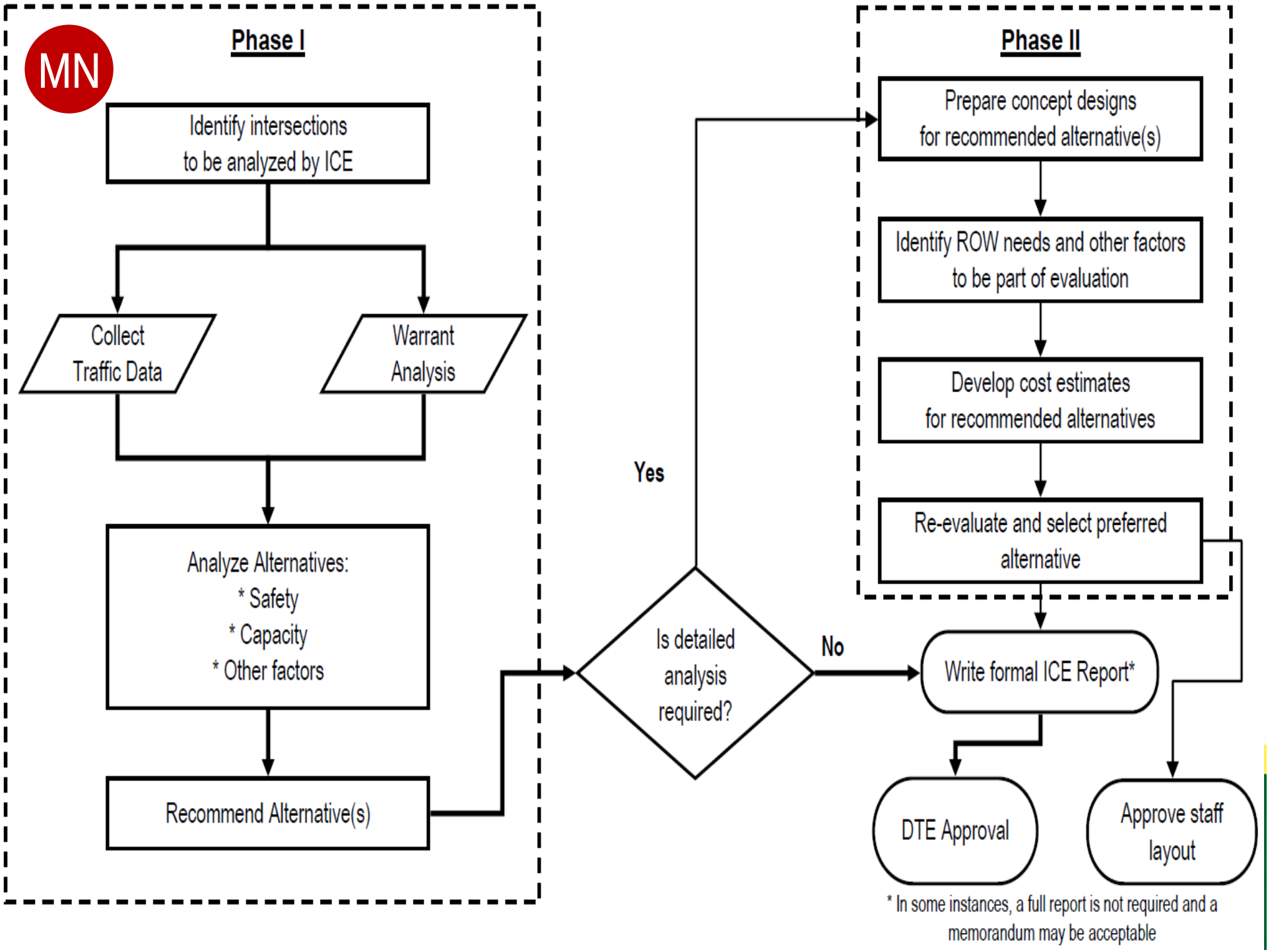


Lead State Lessons Learned

- ICE helped meet the following needs:
  - Helped advance alternative intersections
  - Incorporates safety performance in to scoping stage
  - Helped vet possibilities for context and risk
  - Addressed concerns about documentation sufficiency and consistency
  - Provides a basis for early non-motorized (ped/bike) assessment

Lead State Approaches

- Typically a 2-Stage Screening Process
- Stage 1 is a high-level assessment that considers all possibilities but quickly filters down to a short list
- Stage 2 is a more rigorous assessment of the selected performance criteria


MN
Phase I
Identify intersections to be analyzed by ICE
Collect Traffic Data
Warrant Analysis
Analyze Alternatives:
* Safety
* Capacity
* Other factors
Recommend Alternative(s)
Is detailed analysis required?
Yes
No
Phase II
Prepare concept designs for recommended alternative(s)
Identify ROW needs and other factors to be part of evaluation
Develop cost estimates for recommended alternatives
Re-evaluate and select preferred alternative
Write formal ICE Report*
DTE Approval
Approve staff layout
* In some instances, a full report is not required and a memorandum may be acceptable

ICE Process Steps, Activities & Outcomes

CA

Process Steps

#1. SCREENING [1]
Engineering Assessment of Intersection Control Strategies and/or Interchange Configurations

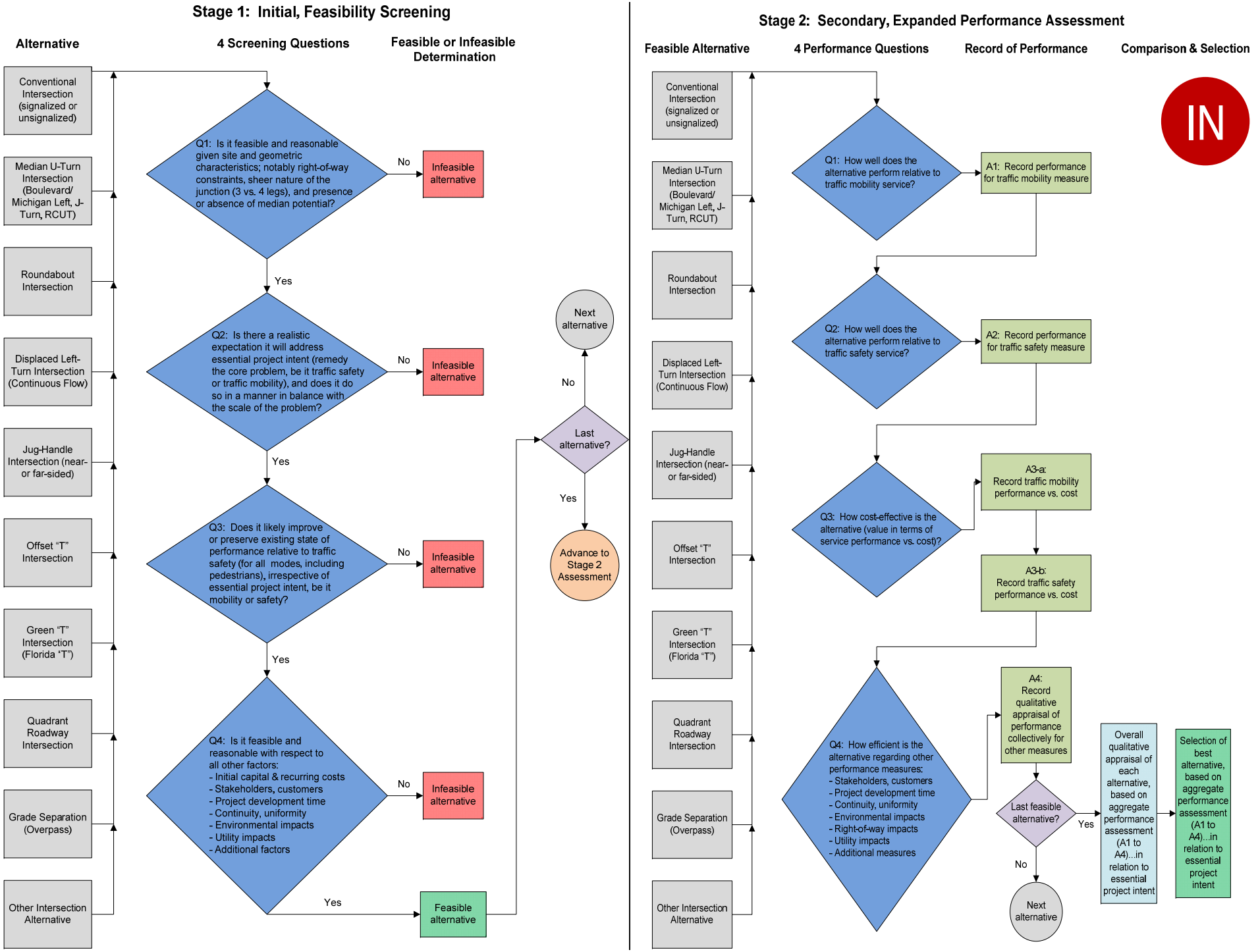
#2. DESIGN & TRAFFIC ANALYSIS [2]
of ***practical control alternatives***
Via technical studies:
- **Traffic & Economic Analysis**
- **Preliminary Design**

Outcomes / Products

Elimination of strategies that fail to meet the established need, or that are impractical

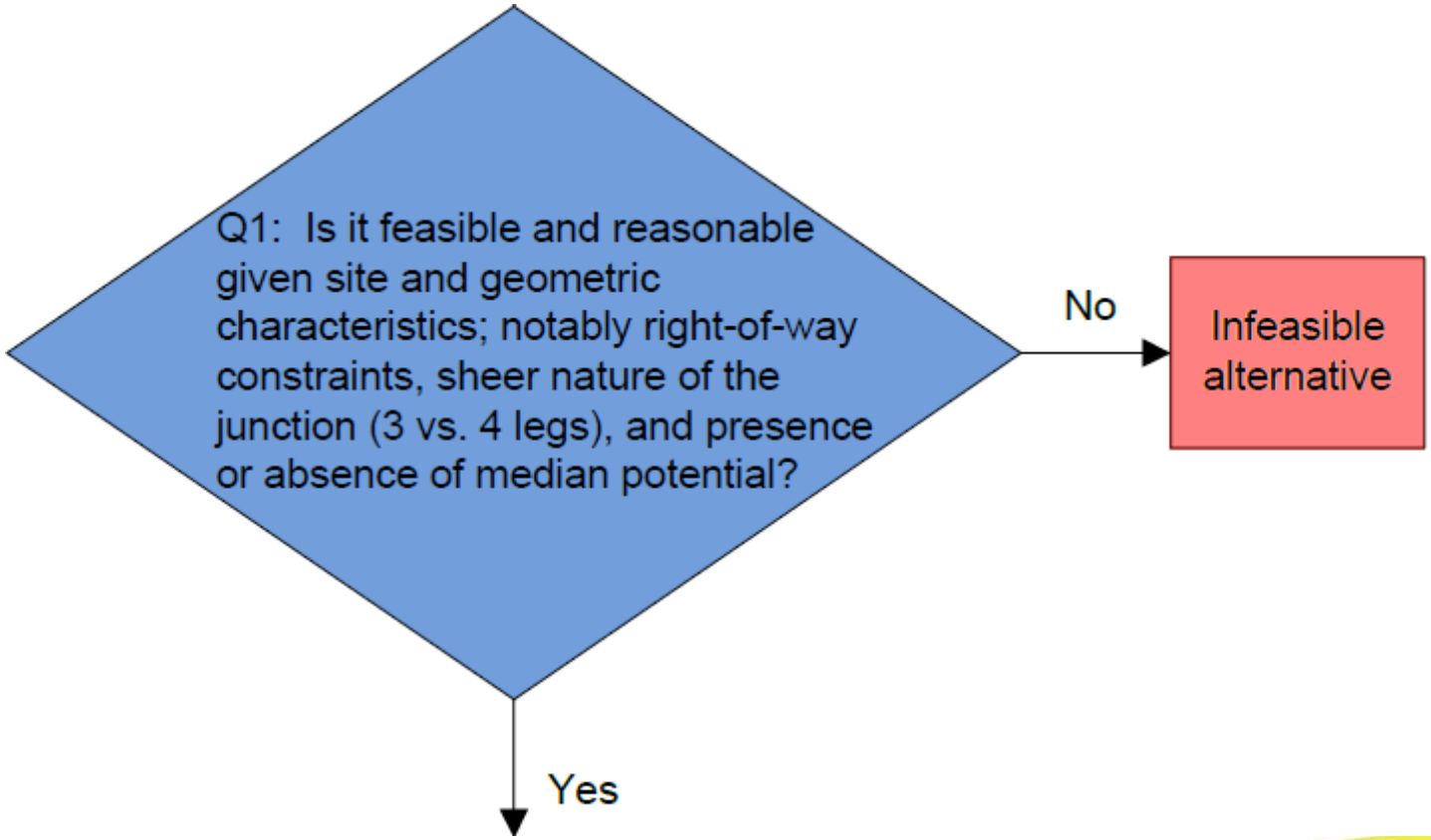
Performance Analysis Findings
- **Safety:** estimated cost / savings
- **Mobility:** est. delay cost / savings

Life-Cycle / Economic Analysis Findings
- ***Service Life*** **(estimated years)**
- **Benefit / Cost Index**
- **Future Investment Needed** [3]


Stage 1: Initial, Feasibility Screening
Alternative
4 Screening Questions
Feasible or Infeasible Determination
Conventional Intersection (signalized or unsignalized)
Median U-Turn Intersection (Boulevard/ Michigan Left, J-Turn, RCUT)
Roundabout Intersection
Displaced Left-Turn Intersection (Continuous Flow)
Jug-Handle Intersection (near- or far-sided)
Offset "T" Intersection
Green "T" Intersection (Florida 'T')
Quadrant Roadway Intersection
Grade Separation (Overpass)
Other Intersection Alternative
Q1: Is it feasible and reasonable given site and geometric characteristics; notably right-of-way constraints, sheer nature of the junction (3 vs. 4 legs), and presence or absence of median potential?
No
Infeasible alternative
Yes
Q2: Is there a realistic expectation it will address essential project intent (remedy the core problem, be it traffic safety or traffic mobility), and does it do so in a manner in balance with the scale of the problem?
No
Infeasible alternative
Yes
Q3: Does it likely improve or preserve existing state of performance relative to traffic safety (for all modes, including pedestrians), irrespective of essential project intent, be it mobility or safety?
No
Infeasible alternative
Yes
Q4: Is it feasible and reasonable with respect to all other factors:
- Initial capital & recurring costs
- Stakeholders, customers
- Project development time
- Continuity, uniformity
- Environmental impacts
- Utility impacts
- Additional factors
No
Infeasible alternative
Yes
Feasible alternative
Next alternative
No
Last alternative?
Yes
Advance to Stage 2 Assessment
Stage 2: Secondary, Expanded Performance Assessment
Feasible Alternative
4 Performance Questions
Record of Performance
Comparison & Selection
IN
Conventional Intersection (signalized or unsignalized)
Median U-Turn Intersection (Boulevard/ Michigan Left, J-Turn, RCUT)
Roundabout Intersection
Displaced Left-Turn Intersection (Continuous Flow)
Jug-Handle Intersection (near- or far-sided)
Offset "T" Intersection
Green "T" Intersection (Florida "T")
Quadrant Roadway Intersection
Grade Separation (Overpass)
Other Intersection Alternative
Q1: How well does the alternative perform relative to traffic mobility service?
A1: Record performance for traffic mobility measure
Q2: How well does the alternative perform relative to traffic safety service?
A2: Record performance for traffic safety measure
Q3: How cost-effective is the alternative (value in terms of service performance vs. cost)?
A3-a: Record traffic mobility performance vs. cost
A3-b: Record traffic safety performance vs. cost
Q4: How efficient is the alternative regarding other performance measures:
- Stakeholders, customers
- Project development time
- Continuity, uniformity
- Environmental impacts
- Right-of-way impacts
- Utility impacts
- Additional measures
A4: Record qualitative appraisal of performance collectively for other measures
Last feasible alternative?
Yes
No
Next alternative
Overall qualitative appraisal of each alternative, based on aggregate performance assessment (A1 to A4)...in relation to essential project intent
Selection of best alternative, based on aggregate performance assessment (A1 to A4)...in relation to essential project intent

INDIANA DECISION PROCESS

STAGE 1 SCREENING QUESTION AND DETERMINATION (Y/N)



INDIANA DECISION PROCESS

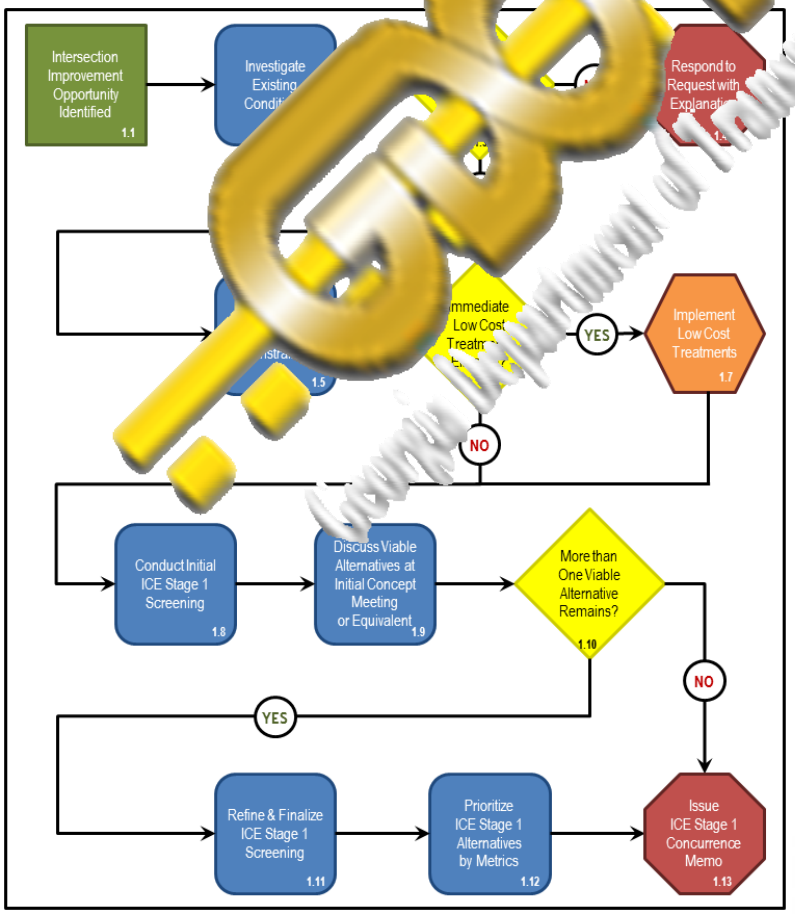
STAGE 1 RECORD SHEET

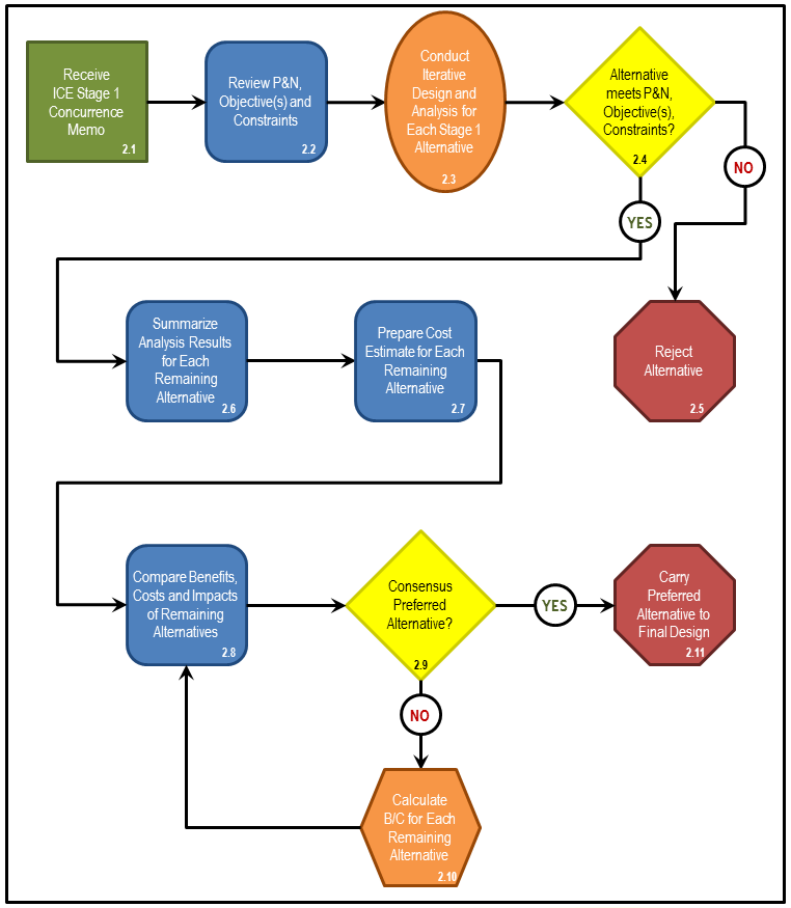
Appendix A

Record Sheet for Stage 1: Initial, Feasibility Screening

Alternative		Answer to Question #1	Answer to Question #2	Answer to Question #3	Answer to Question #4	Feasible or Infeasible?	Specific Notes
Conventional Intersection		○ Yes ○ No	○ Yes ○ No	○ Yes ○ No	○ Yes ○ No	○ Yes ○ No	
Median U-Turn Inter-section	Boule-vard Left	○ Yes ○ No	○ Yes ○ No	○ Yes ○ No	○ Yes ○ No	○ Yes ○ No	
	J-Turn or RCUT	○ Yes ○ No	○ Yes ○ No	○ Yes ○ No	○ Yes ○ No	○ Yes ○ No	
Roundabout Intersection		○ Yes ○ No	○ Yes ○ No	○ Yes ○ No	○ Yes ○ No	○ Yes ○ No	

...CTION CONTROL EVALUATION (ICE) POLICY





STAGE 1

STAGE 2

ICE Screening Tools

Capacity Analysis for Planning of Junctions

CAP-X

FHWA CAP-X Spreadsheet Tool

- http://www.fhwa.dot.gov/software/research/operations/cap-x/

Capacity Analysis for Planning of Junctions

Input Worksheet

Project Name:	"Enter the Project Title here (Input worksheet)"
Project Number:	"Enter the Project Number here (Input worksheet)"
Location	"Enter the Project Location here (Input worksheet)"
Date	"Enter the date here (Input worksheet)"

Traffic Volume Demand

	Volume (Veh/hr)				Percent (%)	
	U-Turn	Left	Thru	Right	Truck	Volume Growth
Eastbound	0	630	0	0	0.00%	0.00%
Westbound	0	175	0	0	0.00%	0.00%
Southbound	0	225	1220	730	0.00%	0.00%
Northbound	0	420	1645	350	0.00%	0.00%
Adjustment Factor	0.80	0.95		0.85		
Suggested	**0.80**	**0.95**		**0.85**		
Truck to PCE Factor				**Suggested = 2.00**	2.00	
Critical Lane Volume				1600		

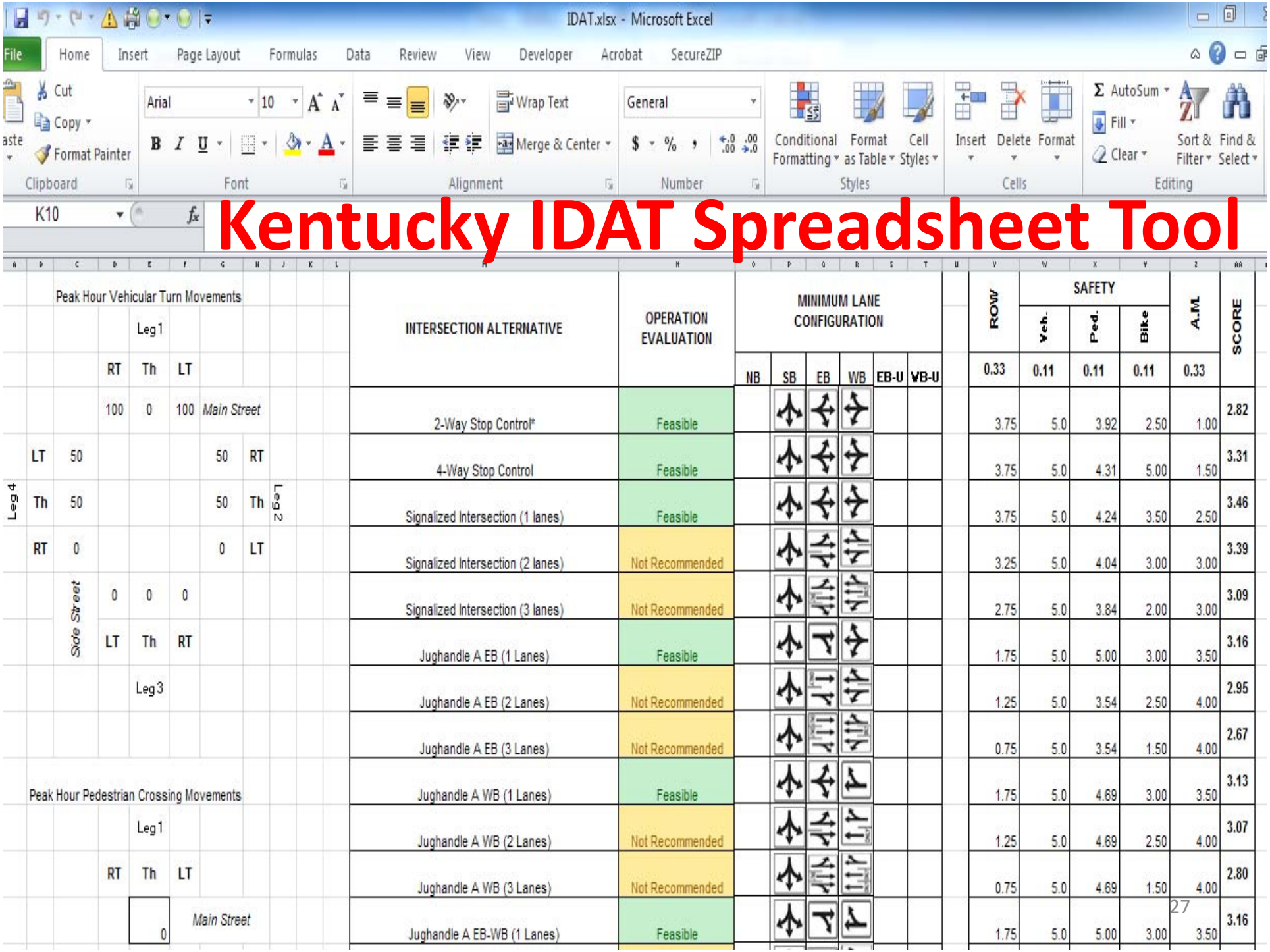
Capacity Analysis for Planning of Junctions

Input Worksheet

		Critical Lane Volume Sum			
Project Name:	"Enter the Project Title here (Input worksheet)"	Acceptable Configurations			
Project Number:	"Enter the Project Number here (Input worksheet)"	< 1200	200 – 139	400 – 159	≥ 1600
Location	"Enter the Project Location here (Input worksheet)"	6	4	4	18
Date	"Enter the date here (Input worksheet)"				

Results for Intersections

#	TYPE OF INTERSECTION	Sheet	Zone 1 (North)		Zone 2 (South)		Zone 3 (East)		Zone 4 (West)		Zone 5 (Center)		Overall v/c Ratio	Ranking
			CL V	VIC	CL V	VIC	CL V	VIC	CL V	VIC	CL V	VIC		
1	Conventional	FULL									***	***	1.60	14
2	Conventional Shared RT LN	CSRL									***	***	1.28	12
3.1	Quadrant Roadway	S-W			***	***			925	##	971	##	1.07	7
3.2		N-E	***	***			900	##			***	***	0.98	4
3.3		S-E			***	***	***	***			***	##	0.98	4
3.4		N-W	***	1.12					***	***	***	##	1.12	8
4.1	Partial Displaced Left Turn	N-S	***	***	***	##					***	##	0.86	1
4.2		E-W					167	##	472	##	***	***	0.87	3
5	Displaced Left Turn	FULL	***	***	***	##	167	##	472	##	***	##	0.86	1
6.1	Restricted Crossing U-Turn	N-S	***	##	***	***	***	***	***	***			1.00	6
6.2		E-W	***	***	***	***	***	***	***	***			1.78	15
7.1	Median U-Turn	N-S	***	***	***	***					***	1.31	1.31	13
7.2		E-W					744	##	565	##	***	1.17	1.17	11
8.1	Partial Median U-Turn	N-S	***	1.01	***	***					***	1.13	1.13	9
8.2		E-W					481	##	424	##	***	1.13	1.13	9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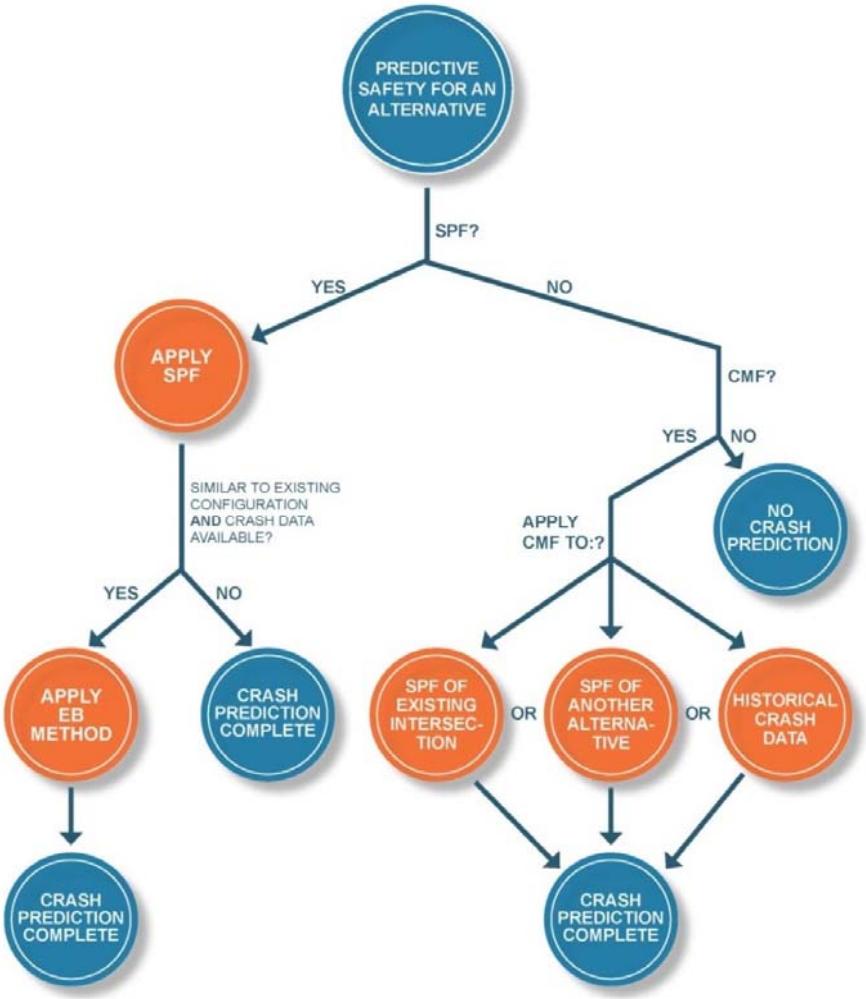
File
Home
Insert
Page Layout
Formulas
Data
Review
View
Developer
Acrobat
SecureZIP
Cut
Copy
Format Painter
Clipboard
Arial
10
Font
Wrap Text
Merge & Center
Alignment
General
Number
Conditional Formatting
Format as Table
Cell Styles
Styles
Insert
Delete
Format
Cells
AutoSum
Fill
Clear
Sort & Filter
Find & Select
Editing
K10
Kentucky IDAT Spreadsheet Tool
Peak Hour Vehicular Turn Movements
Leg 1
RT Th LT
100 0 100 Main Street
LT 50 50 RT
Th 50 50 Th
RT 0 0 LT
Leg 4
Leg 2
Side Street
0 0 0
LT Th RT
Leg 3
Peak Hour Pedestrian Crossing Movements
Leg 1
RT Th LT
0
Main Street
INTERSECTION ALTERNATIVE
OPERATION EVALUATION
MINIMUM LANE CONFIGURATION
NB SB EB WB EB-U WB-U
ROW
SAFETY
Veh.
Ped.
Bike
A.M
SCORE
0.33 0.11 0.11 0.11 0.33
2-Way Stop Control* Feasible 3.75 5.0 3.92 2.50 1.00 2.82
4-Way Stop Control Feasible 3.75 5.0 4.31 5.00 1.50 3.31
Signalized Intersection (1 lanes) Feasible 3.75 5.0 4.24 3.50 2.50 3.46
Signalized Intersection (2 lanes) Not Recommended 3.25 5.0 4.04 3.00 3.00 3.39
Signalized Intersection (3 lanes) Not Recommended 2.75 5.0 3.84 2.00 3.00 3.09
Jughandle A EB (1 Lanes) Feasible 1.75 5.0 5.00 3.00 3.50 3.16
Jughandle A EB (2 Lanes) Not Recommended 1.25 5.0 3.54 2.50 4.00 2.95
Jughandle A EB (3 Lanes) Not Recommended 0.75 5.0 3.54 1.50 4.00 2.67
Jughandle A WB (1 Lanes) Feasible 1.75 5.0 4.69 3.00 3.50 3.13
Jughandle A WB (2 Lanes) Not Recommended 1.25 5.0 4.69 2.50 4.00 3.07
Jughandle A WB (3 Lanes) Not Recommended 0.75 5.0 4.69 1.50 4.00 2.80
Jughandle A EB-WB (1 Lanes) Feasible 1.75 5.0 5.00 3.00 3.50 3.16

SPICE Tool *(Safety Performance for ICE)*



- Joint project with HSMI-PFS
- Under development, scheduled for completion in 2018 (beta testing 2017)
- Contractor is KLS Engineering and Kittelson & Associates

Federal Highway Administration (FHWA)		
Safety Performance for Intersection Control Evaluation Tool		
Results		
Summary of crash prediction results for each alternative		
Project Information		
Project Name:	Test	
Intersection:	A Street/B Street	
Agency:	FHWA	
Project Reference:	99999	
City:	Anywhere	
State:	Maryland	
Date:	42697	
Analyst:	PMJ	
Crash Prediction Summary		
Alternative 1		
Time Period	Total Crashes	Fatal-Injury Crashes
Opening Year		
Design Year		
Total Project Life Cycle		
Alternative 2		
Time Period	Total Crashes	Fatal-Injury Crashes
Opening Year		
Design Year		
Total Project Life Cycle		

Inputs Complete - Compute Results

Life-Cycle Cost Estimation Tool (LCCET)

- Product of NCHRP Project 03-110
- Developed by Kittelson
- Examples and Case Studies Developed
- More info at http://www.trb.org/Main/Blurbs/173928.aspx


RESOURCES

Image courtesy of Caleb Roenigk (CC BY 2.0)

NCHRP PROJECT 03-110

FINAL PRODUCT
NCHRP Web-Only Document 220: Estimating the Life-Cycle Cost of Intersection Designs
trb.org/Main/Blurbs/173928.aspx

NCHRP SENIOR PROGRAM OFFICER
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PRINCIPAL INVESTIGATOR
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ADDITIONAL RESOURCES
LCCET spreadsheet: onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w220LCCET.xlsm

Case studies
trb.org/Main/Blurbs/173928.aspx

TRB webinar
trb.org/Calendar/Blurbs/173933.aspx

ICE and Other DOT Policies/Programs

- Protocol(s) for New Traffic Signal Requests
- State Highway Access Permits (i.e., for new developments)
- Congestion Mitigation Projects (corridor or intersection)
- HSIP Intersection Projects (B/C basis?)
- Locally-initiated Projects affecting State Highways
- Roundabouts Consideration Requirements or Guidance

Applicability of ICE

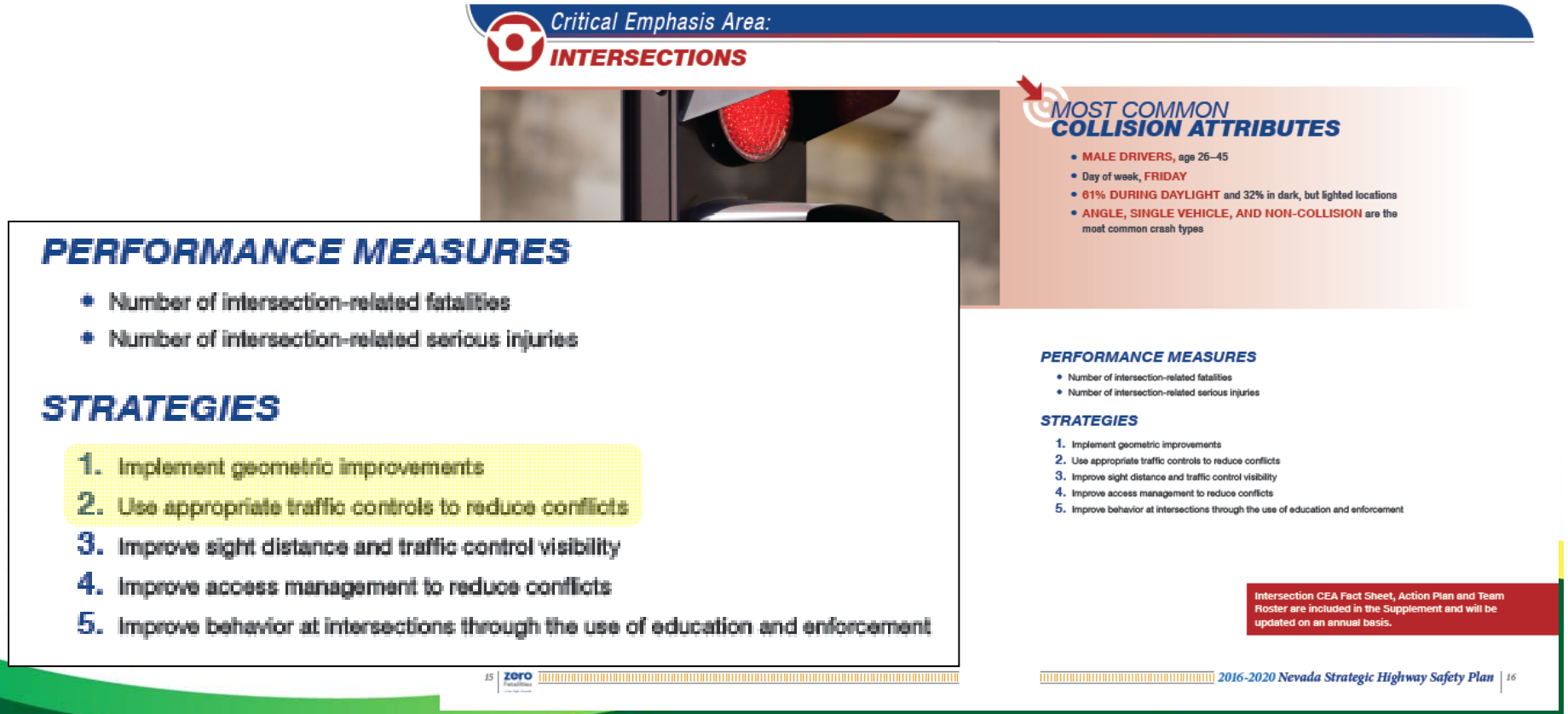
- New Intersection (Any Control)
- Modification to an Intersection

} Intersection Improvement

  - Reconstruction, Major Rehabilitation/Modernization
  - Expansion (add-lanes, aux-lanes, widening, etc.)
  - Warrant-based Control Change
    (TWSC-AWSC, TWSC-SIGNAL, AWSC-SIGNAL)
  - Change in Basic Geometry
    (Conventional-Roundabout, SLR-MLR, Conventional-U-Turn, Roundabout-??)

Wide Applicability = Leverage!

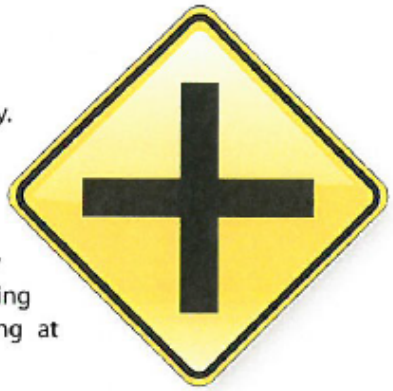
ICE is *cross-cutting* and can link SHSP to **all** facets of highway program (not just HSIP)



*SHSP: Strategic Highway Safety Plan [https://safety.fhwa.dot.gov/shsp/]

^HSIP: Highway Safety Improvement Program [https://safety.fhwa.dot.gov/hsip/hsip.cfm]

SERIOUS CRASH TYPE

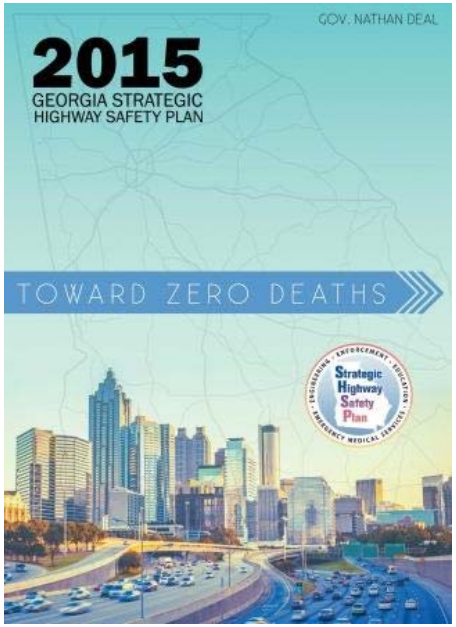


The serious crash type task team addresses intersection safety and roadway departure safety.

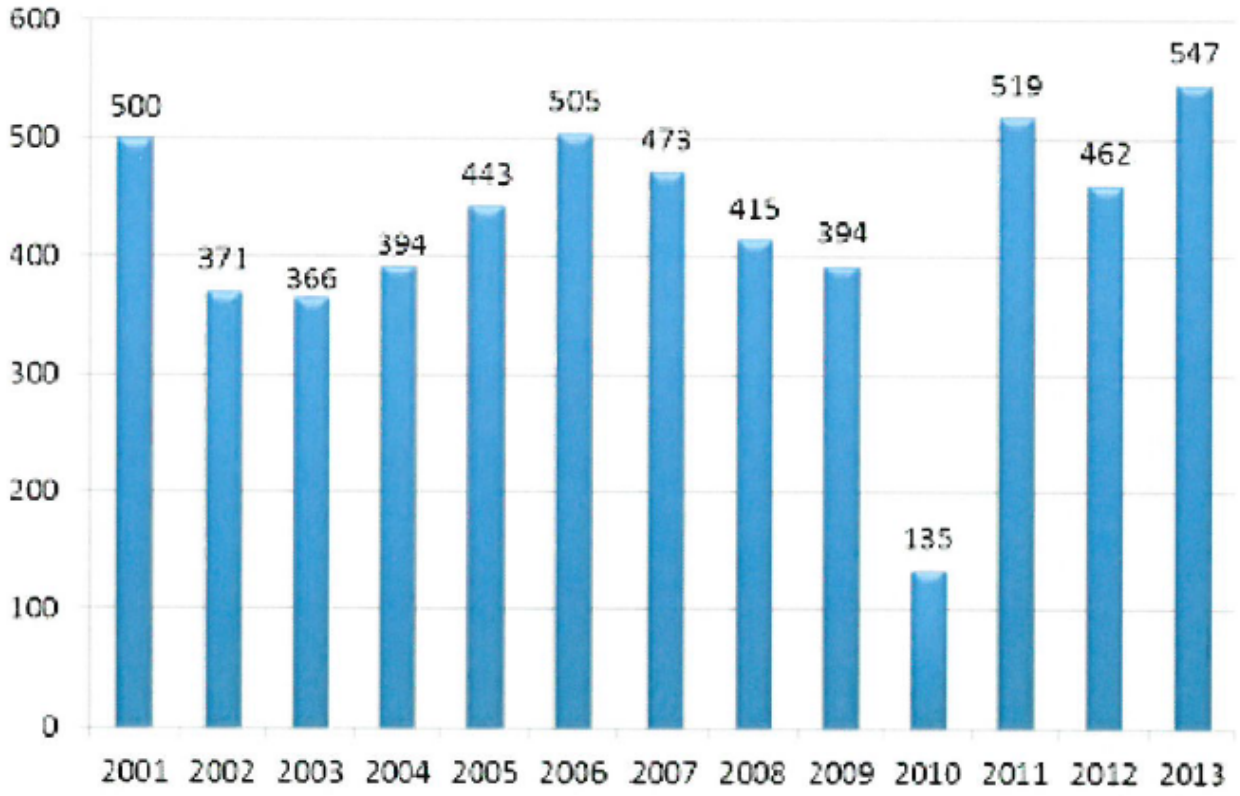
i. Intersection Safety

Nationally, intersection fatalities comprise 21 percent of all fatalities and approximately 50% of serious injuries. The Intersection Safety Task Team's Vision is to reduce the frequency and severity of intersection crashes along all routes in the state of Georgia by implementing proven safety countermeasures. The performance goal is to reduce fatalities occurring at intersections from 547 in calendar year 2013 to 465 in calendar year 2015.

The Intersection Safety Task Team is comprised of Georgia Department of Transportation (GDOT) safety personnel along with other GDOT safety partners. The purpose of this team is to identify and implement safety strategies using engineering, education, enforcement, and emergency medical services.



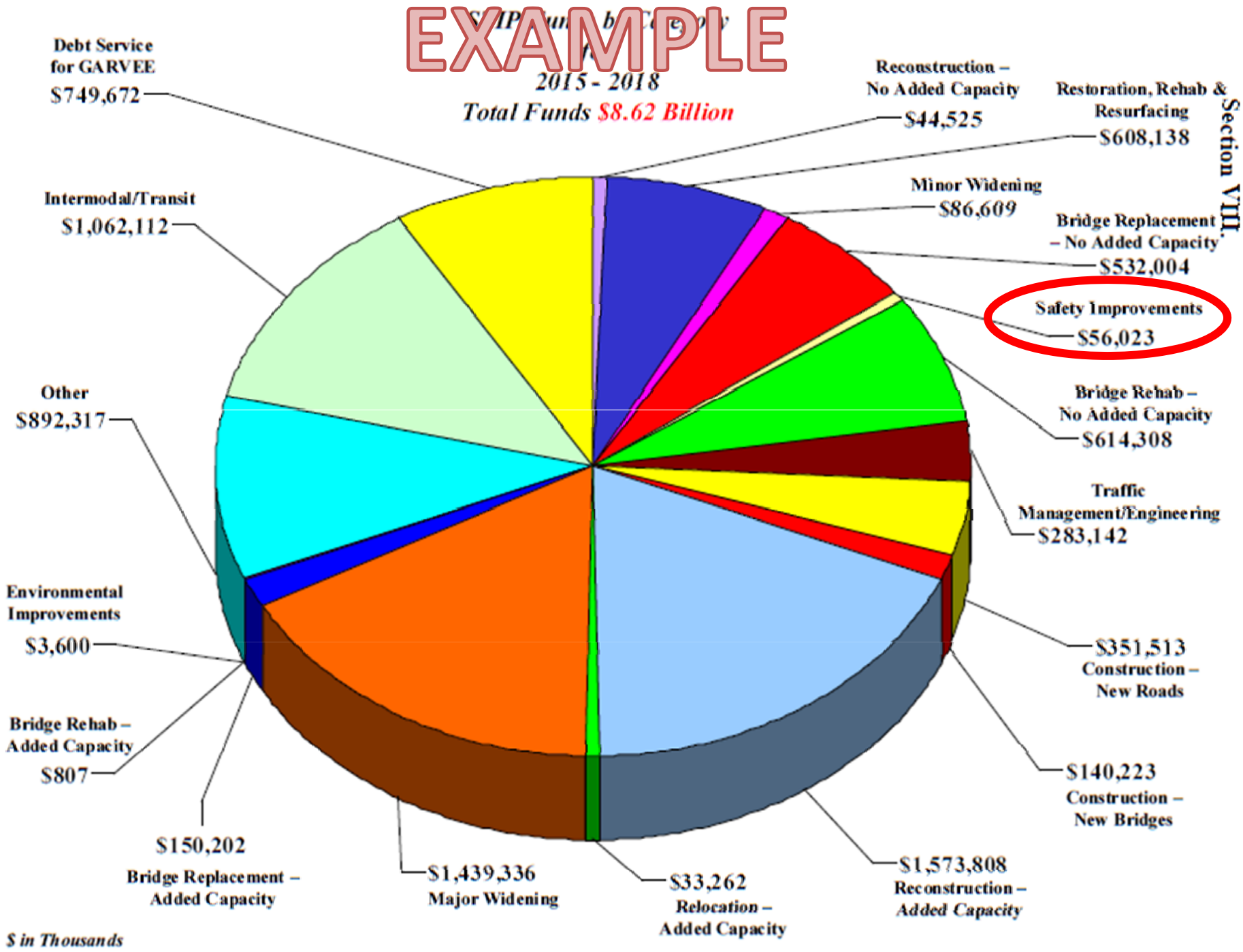
Annual Intersection Fatalities



Reduce 547 to 465 in 2 years = 15% reduction

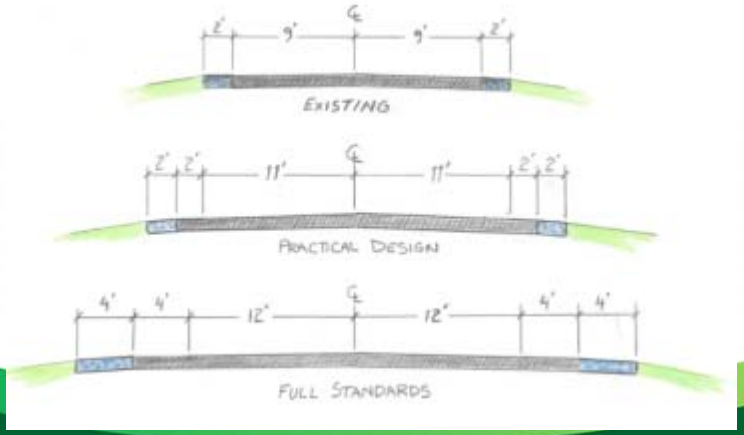
82 LIVES SAVED

EXAMPLE


2015 - 2018
Total Funds $8.62 Billion
Debt Service for GARVEE
$749,672
Reconstruction – No Added Capacity
$44,525
Restoration, Rehab & Resurfacing
$608,138
Minor Widening
$86,609
Bridge Replacement – No Added Capacity
$532,004
Safety Improvements
$56,023
Bridge Rehab – No Added Capacity
$614,308
Traffic Management/Engineering
$283,142
$351,513
Construction – New Roads
$140,223
Construction – New Bridges
$1,573,808
Reconstruction – Added Capacity
$33,262
Relocation – Added Capacity
$1,439,336
Major Widening
$150,202
Bridge Replacement – Added Capacity
$807
Bridge Rehab – Added Capacity
$3,600
Environmental Improvements
$892,317
Other
$1,062,112
Intermodal/Transit
$ in Thousands

ICE is Complementary with PBPD*

- Emphasis on objective, measurable, performance-based solutions
- Leveraging and adapting existing conditions to something better
- Engineered solutions – intersection "choreography"



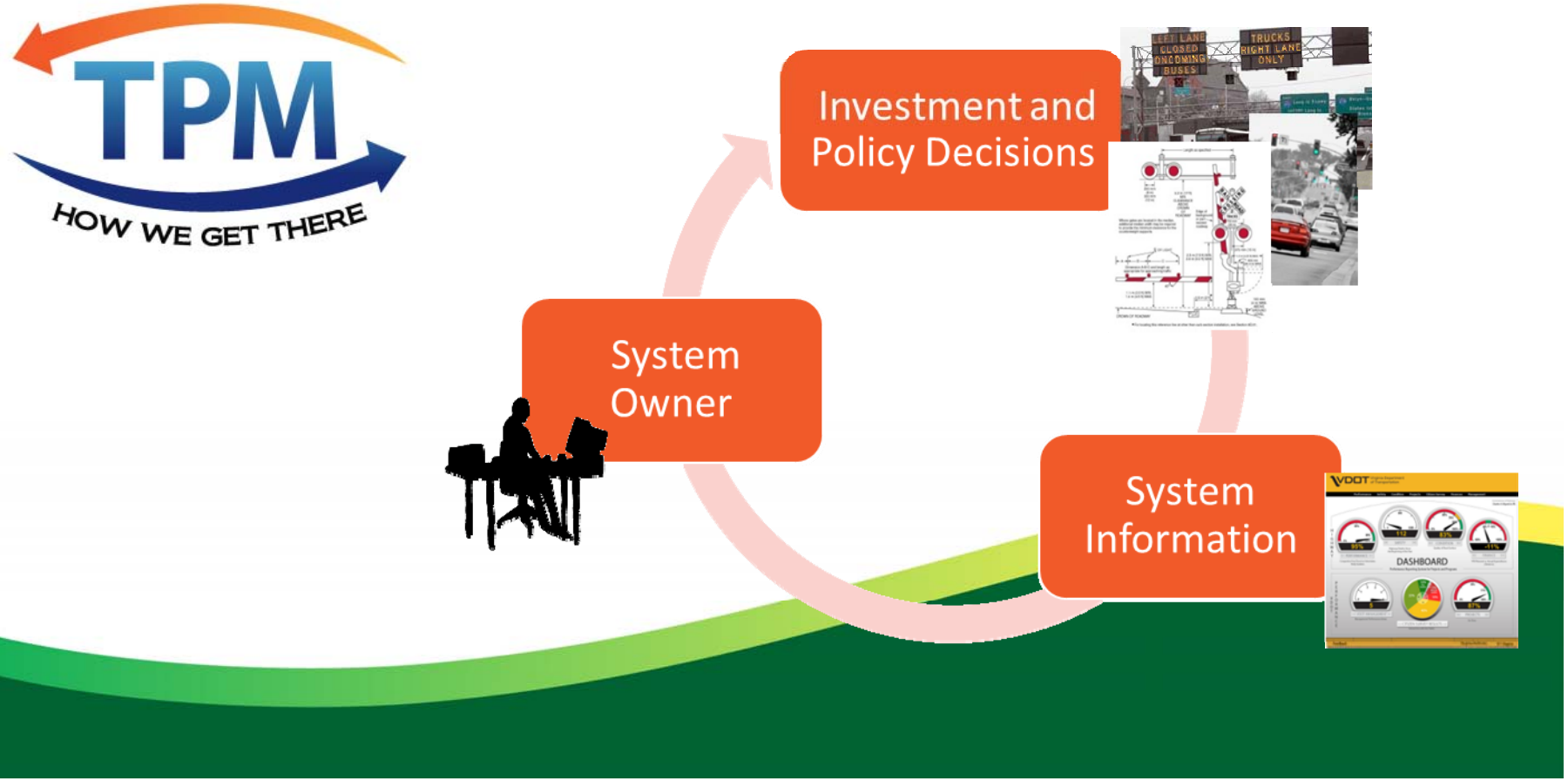
* PBPD = Performance-Based Practical Design

“Practical” IIG Outcomes

- Build more *good* projects (intersections) rather than fewer *great* ones – steady, incremental and measurable system improvement
- Approach grounded in performance management – project, corridor & system
- Considers present, interim and long term goals
- Innovative intersections/interchanges become mainstream, common solutions

Transportation Performance Management

Defined as a strategic approach that uses system information to make investment and policy decisions to achieve national performance goals



1. National Goals

National Goals

TPM
HOW WE GET THERE

- Safety
- Infrastructure condition
- Congestion reduction
- System reliability
- Freight movement and economic vitality
- Environmental sustainability
- Reduced project delivery delays

ICE and Safety PM Final Rule

- Safety PM Final Rule establishes 5 performance measures to carry out HSIP (5-year rolling avgs):
  - (1) Number of Fatalities
  - (2) Rate of Fatalities per 100 million VMT
  - (3) Number of Serious Injuries
  - (4) Rate of Serious Injuries per 100 million VMT
  - (5) Number of Non-motorized Fatalities and Serious Injuries
- States establish and report on targets; annual evaluation on meeting or making significant progress toward targets

ICE Policies/Procedures can help achieve Safety PM targets across entire highway program (Not limited to HSIP)!

For More Information

- Transportation Performance Management
  www.fhwa.dot.gov/TPM/
- Safety Performance Management
  http://safety.fhwa.dot.gov/hsip/spm/
- Every Day Counts
  https://www.fhwa.dot.gov/innovation/everydaycounts/
- Innovative Intersections
  https://safety.fhwa.dot.gov/intersection/

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