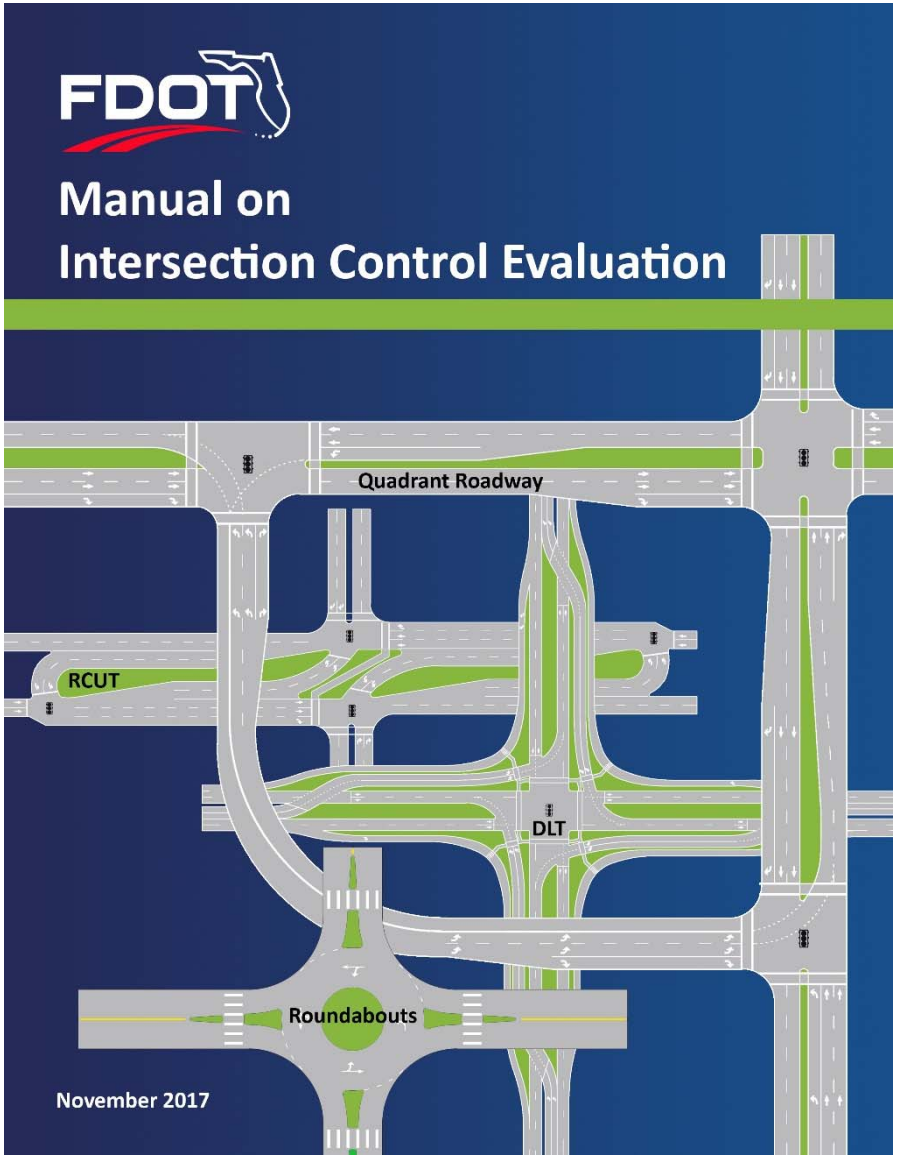
2019 INTERSECTION CONTROL EVALUATION

MANAGERS TRAINING

FDOT

ICE OVERVIEW AGENDA

- Why ICE?
- When ICE is Required?
- Applicability and Process
- Tools and Resources
- Forms



TRAINING OUTCOME GOALS

1. Understand the intent and purpose of ICE procedure

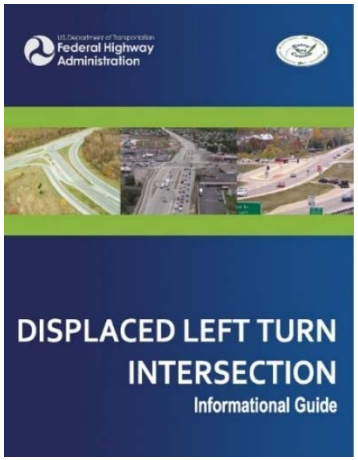
2. Be aware of the readily available resources
   - ICE Forms, CAP-X, SPICE, ICE Tool, Synchro Templates

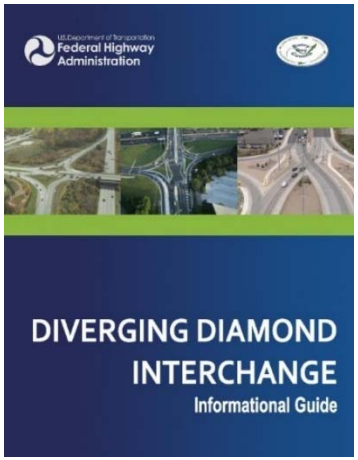
3. Understand the level of effort needed to conduct ICE
   - Data Collection
   - Evaluation
   - Documentation

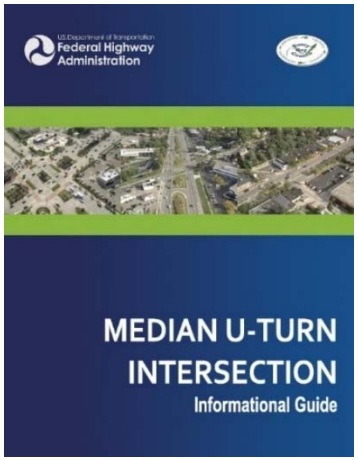
4. Case Study: demonstrate the use of tools

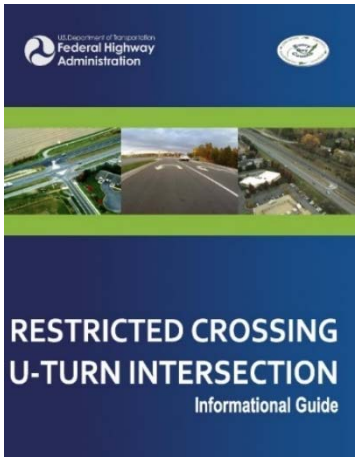
WHY ICE IN FLORIDA?

- Intersection choices have historically been stop control, signalization and recently roundabouts
- Raise awareness and increase use of alternative intersections
- Consider context classifications, safety, and all road users
  - Support SHSP by addressing one of the 13 emphasis areas: Intersection Safety
- Quantitative analysis to select intersection control types
- FDOT Developed ICE Manual and Tools
  - ICE Manual released Nov. 1, 2017
  - Spreadsheet tools developed to support safety, operations and benefit-cost analyses

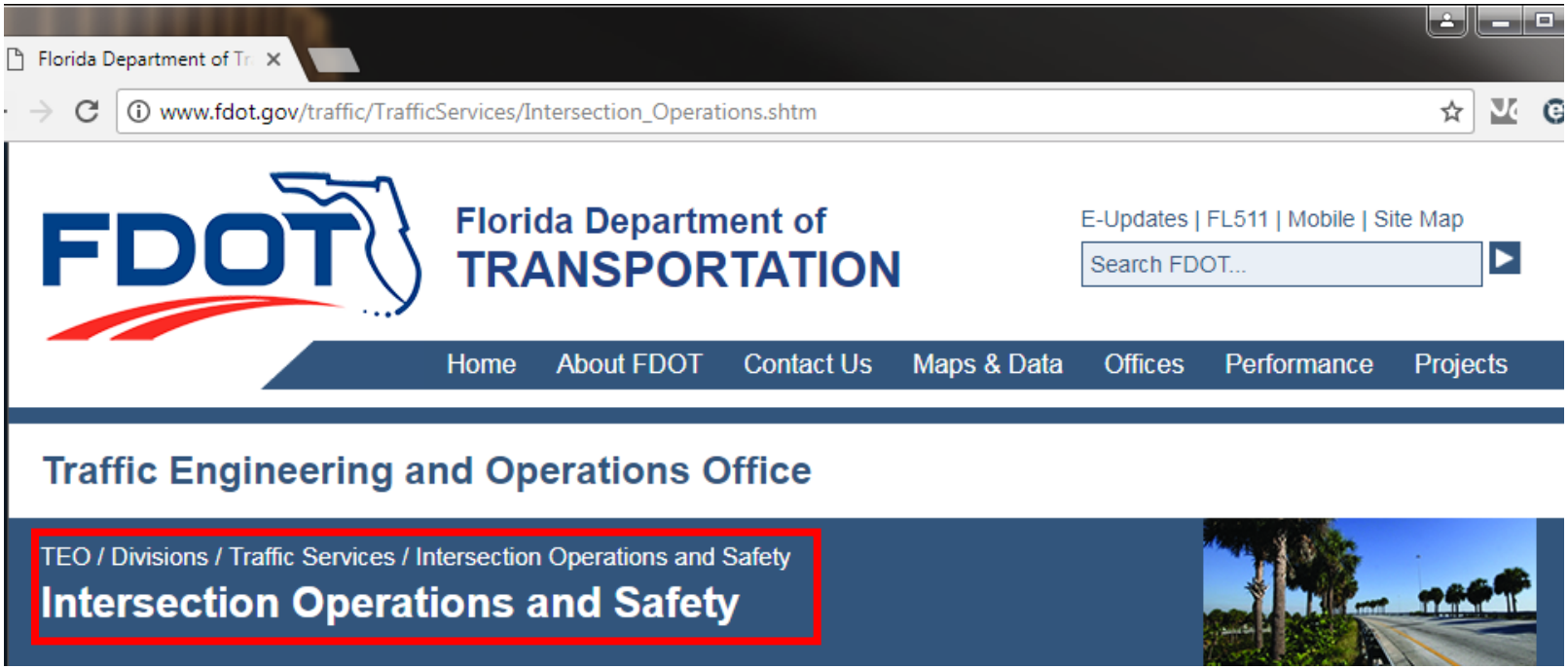








AVAILABLE RESOURCES



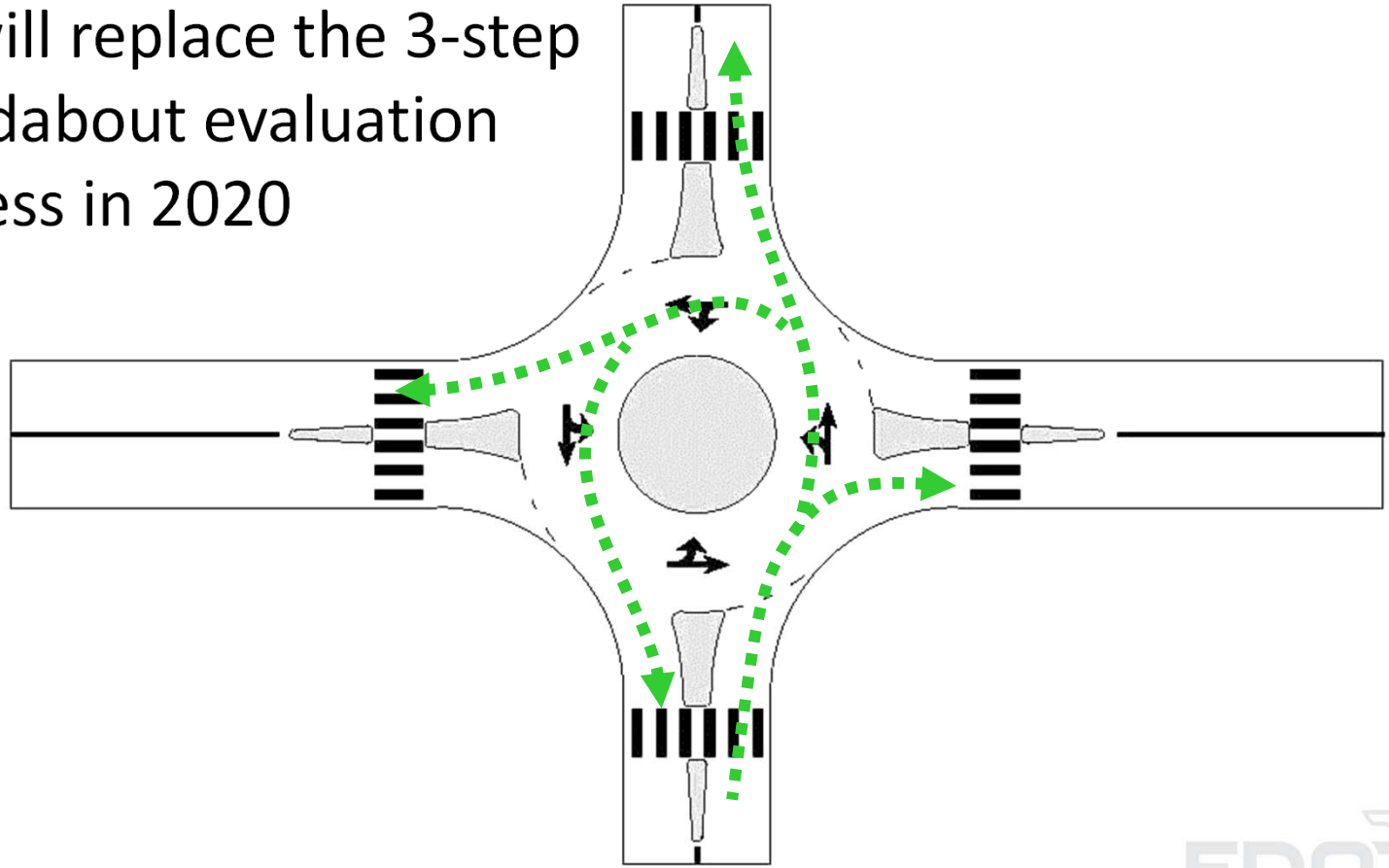
http://www.fdot.gov/traffic/TrafficServices/Intersection_Operations.shtm

ICE PURPOSE

- Consistently consider multiple context-sensitive control strategies when planning a new or modified intersection through…
  - Informed decision-making considering
    - purpose and need, context classification, safe travel facilities for all road users, with the overall best value
  - Select a context-sensitive control strategy considering
    - the goals and needs of the community and all road users
  - Measure the control strategy's value using
    - performance-based criteria
- Promotes thoughtful consideration of alternative intersection types through quantitative analysis

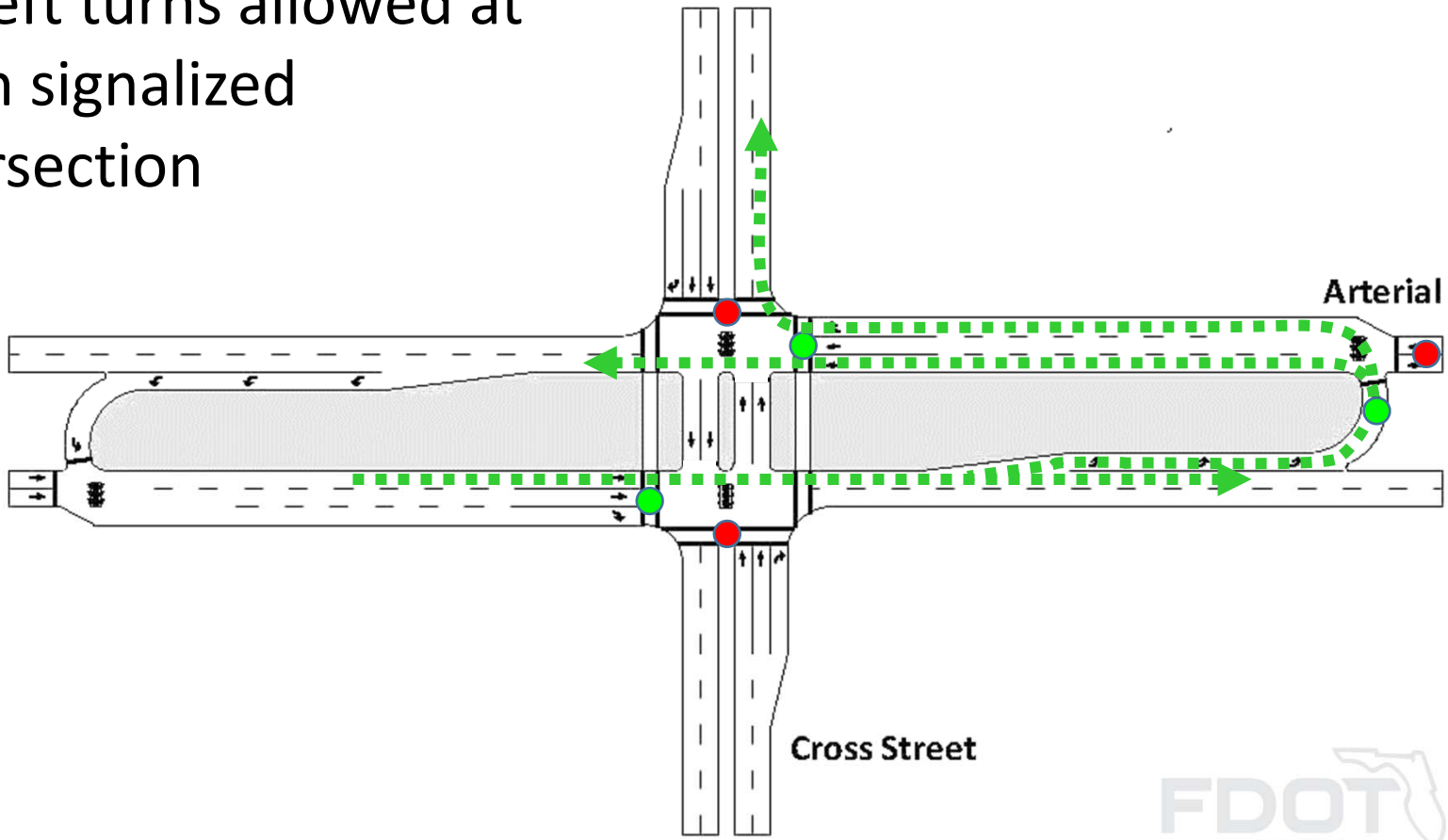
Roundabout

ICE will replace the 3-step roundabout evaluation process in 2020



Median U-Turn (MUT)

No left turns allowed at main signalized intersection



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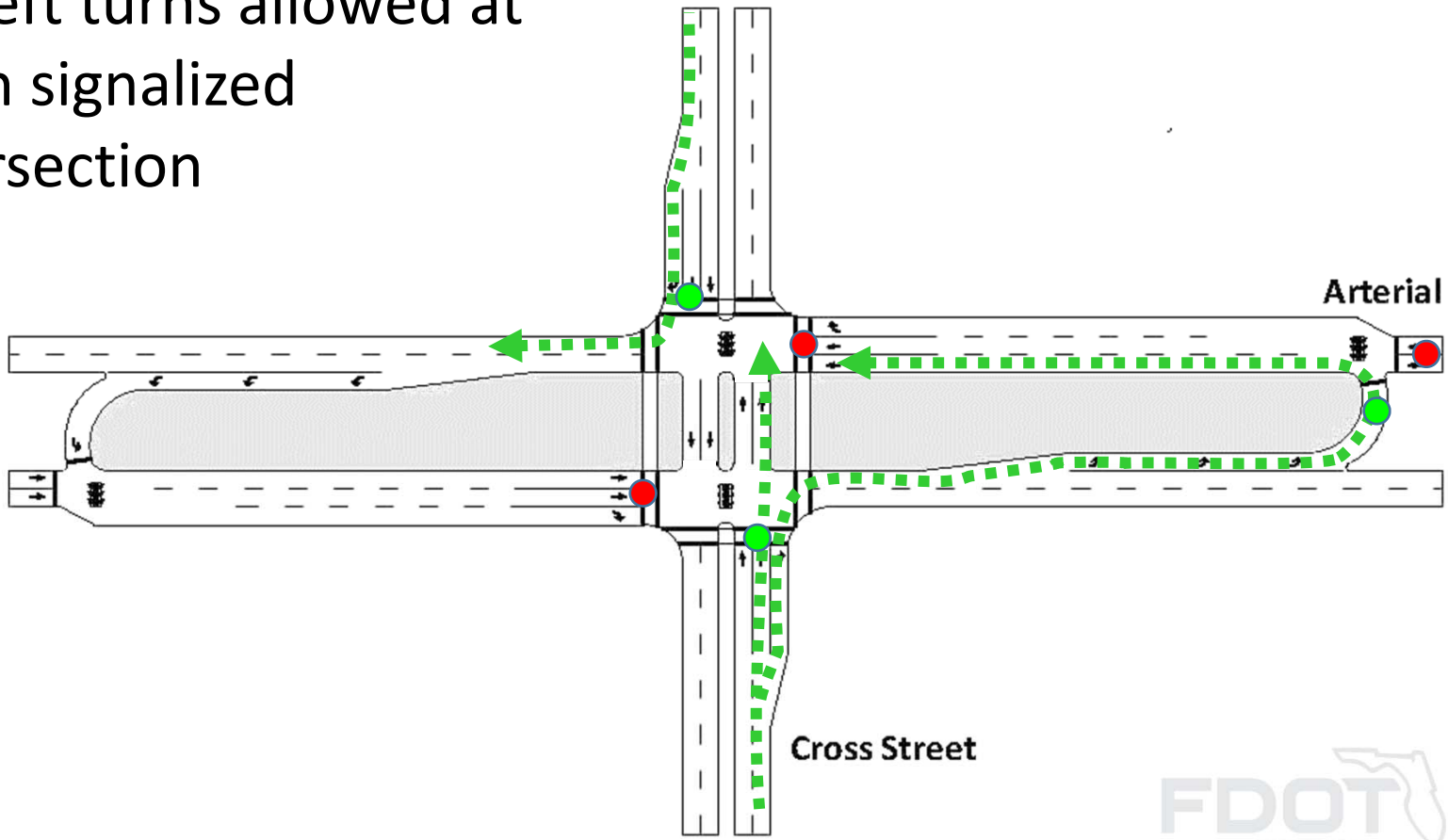
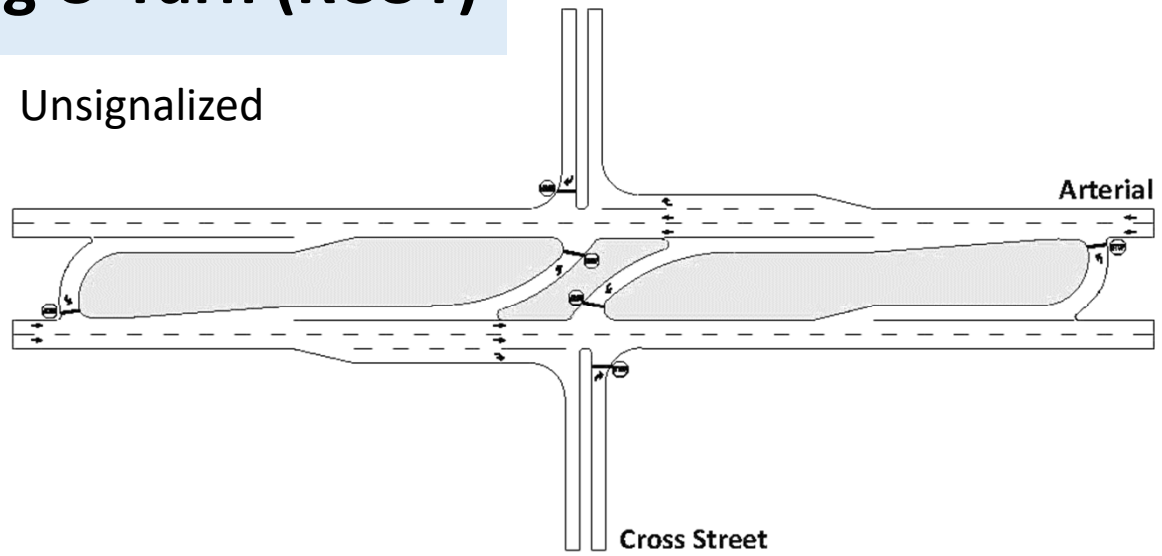
No left turns allowed at main signalized intersection

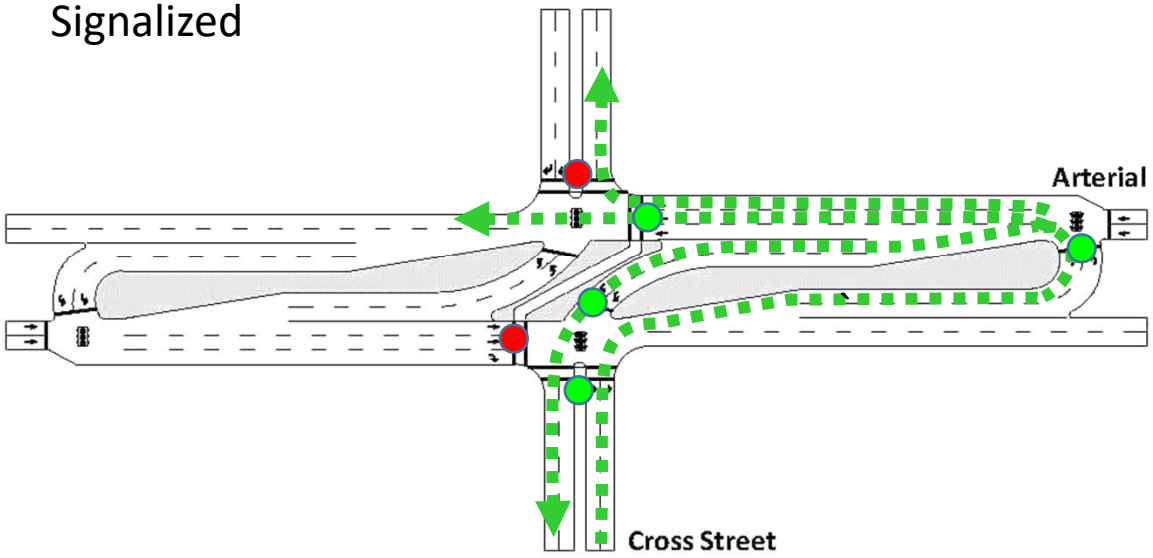


Restricted Crossing U-Turn (RCUT)

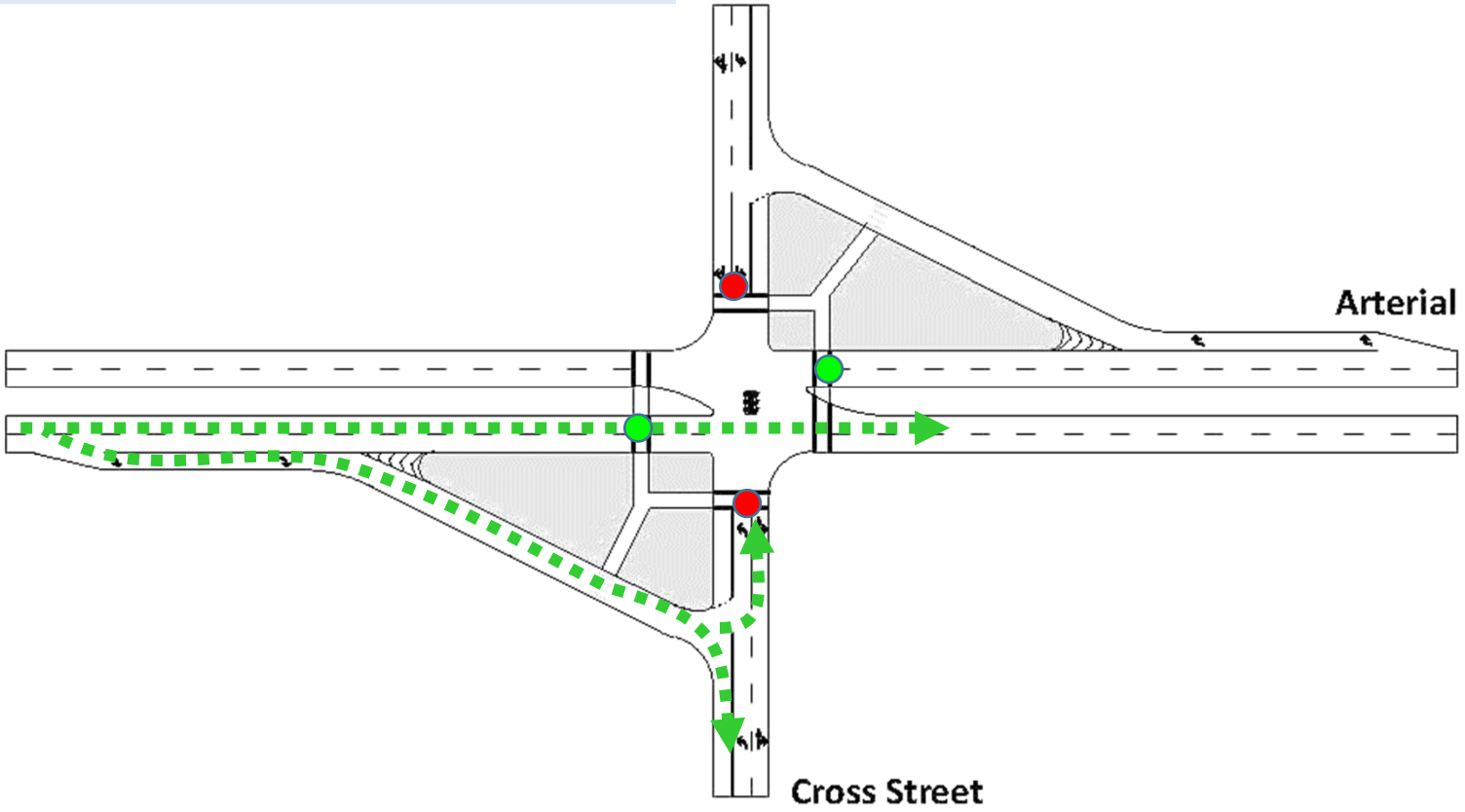
Unsignalized



Signalized

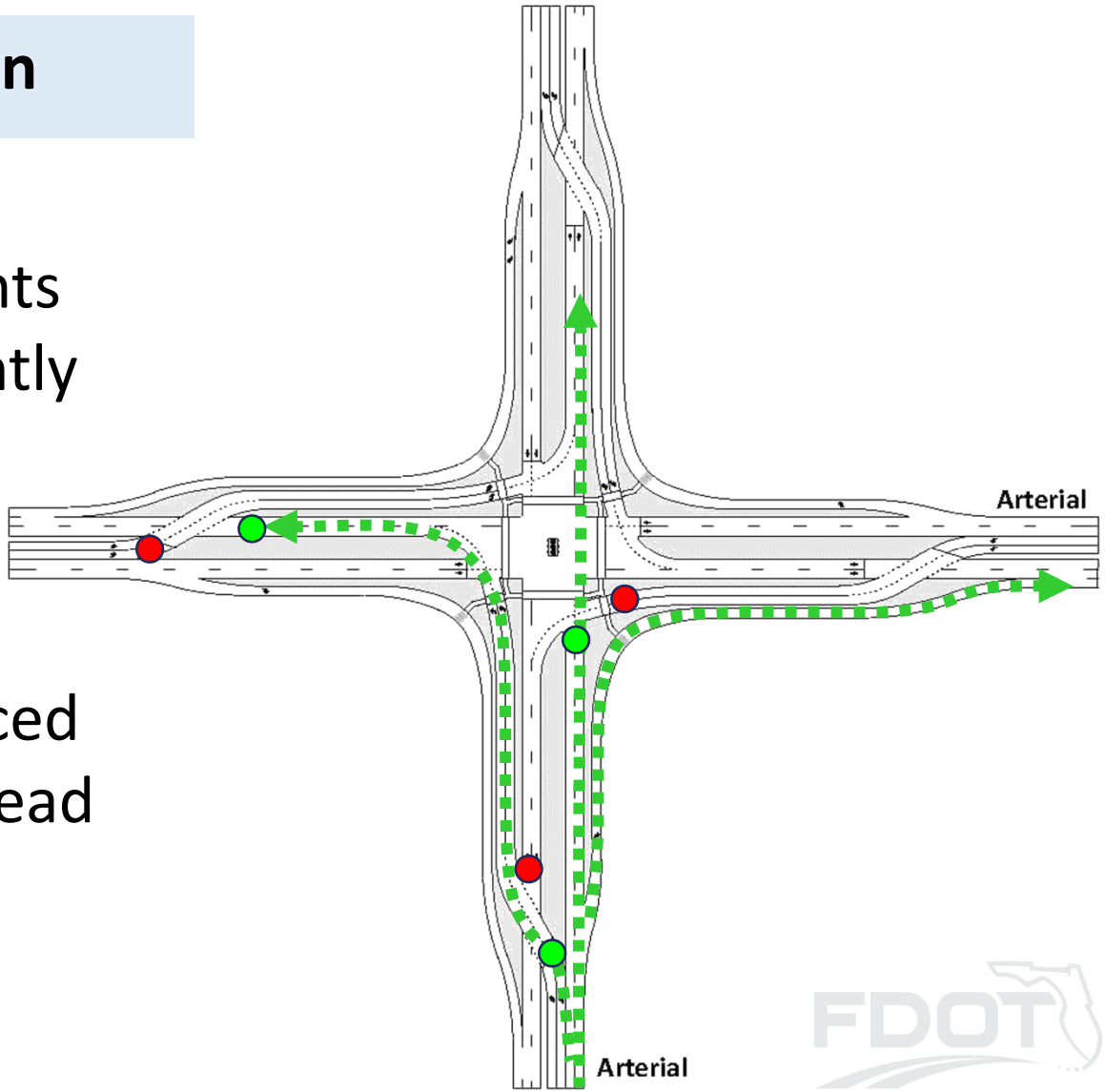


Jughandle

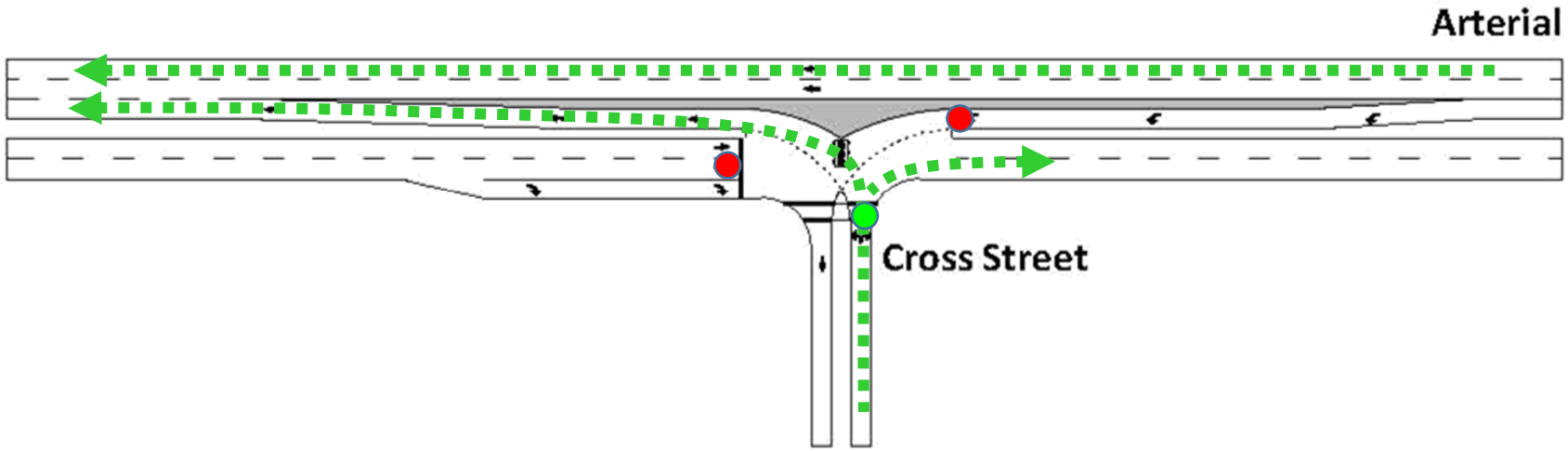


Displaced Left Turn

- Left turns and through movements operate concurrently
- Also called continuous flow intersection
- Could have displaced lefts on 2 legs instead of all 4

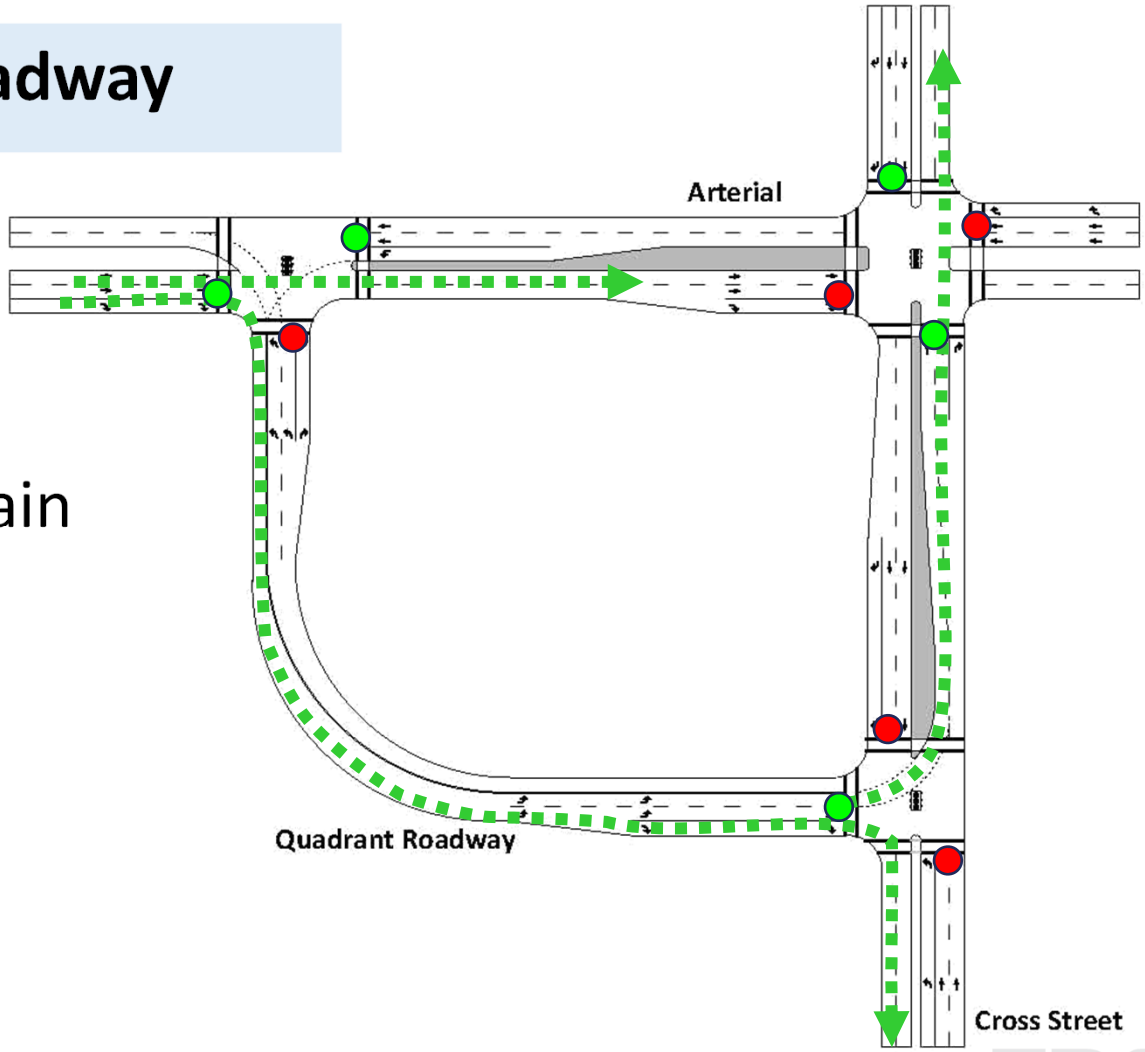


Continuous Green T



Quadrant Roadway

No left turns allowed at main signalized intersection



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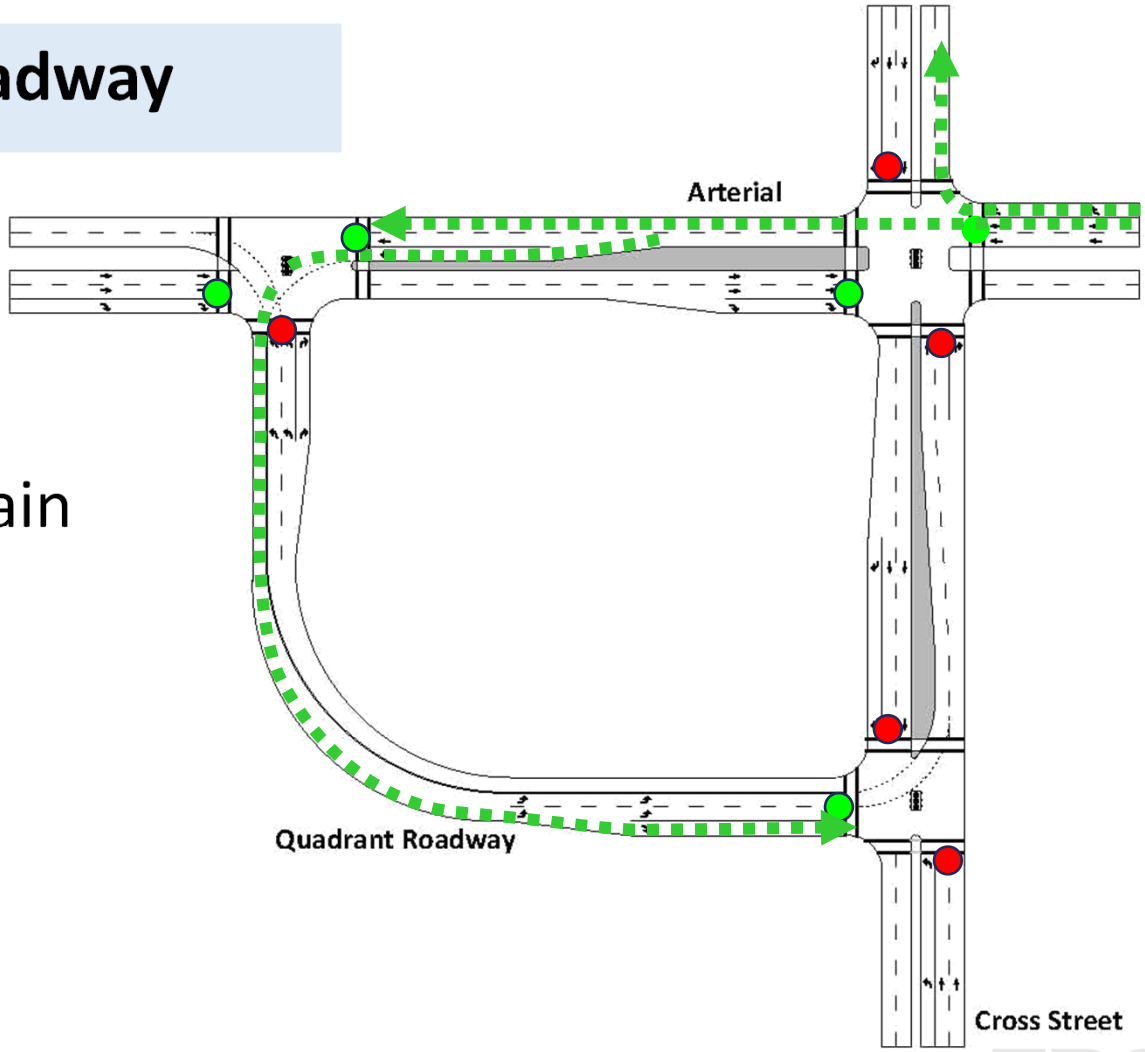

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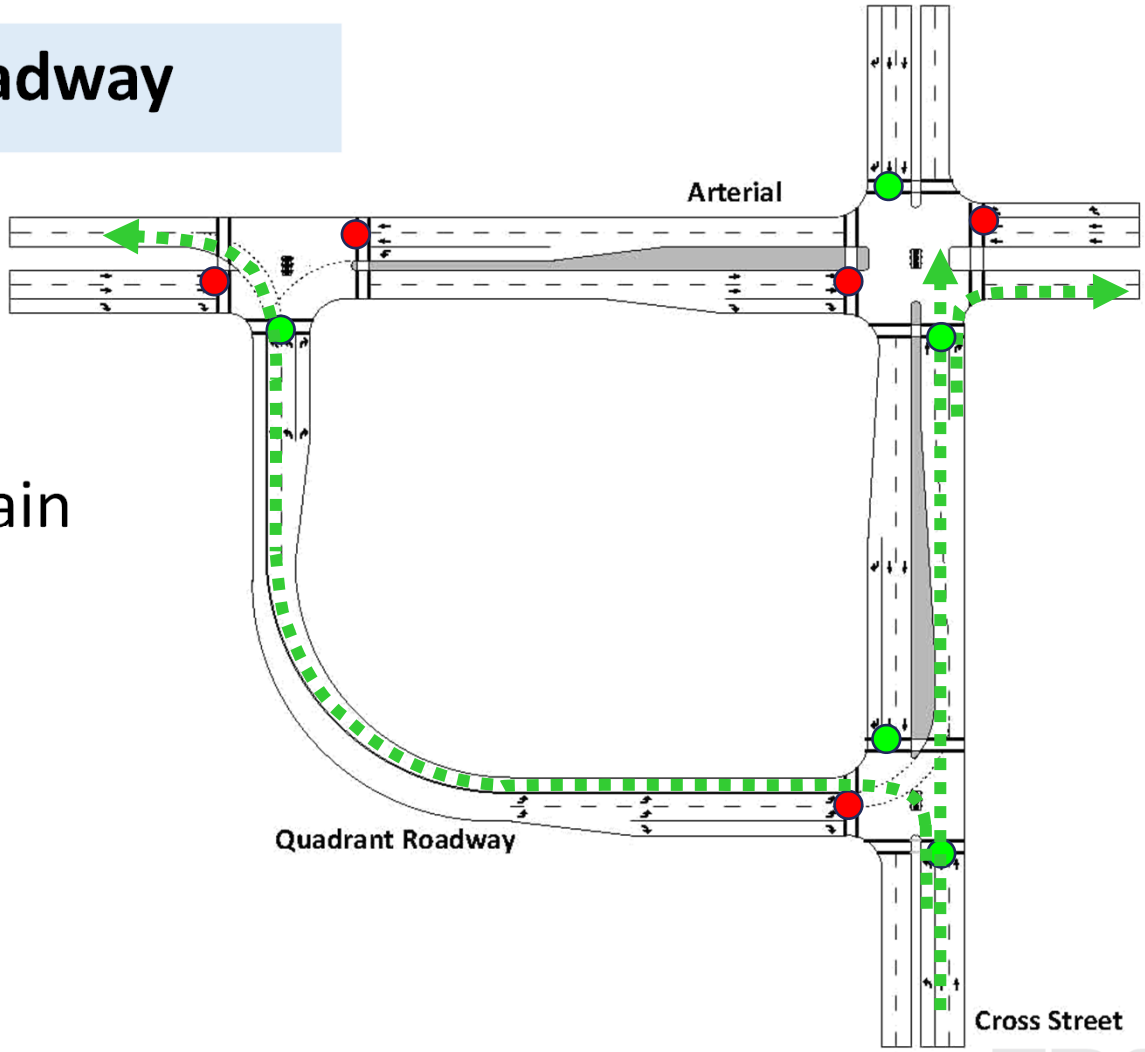
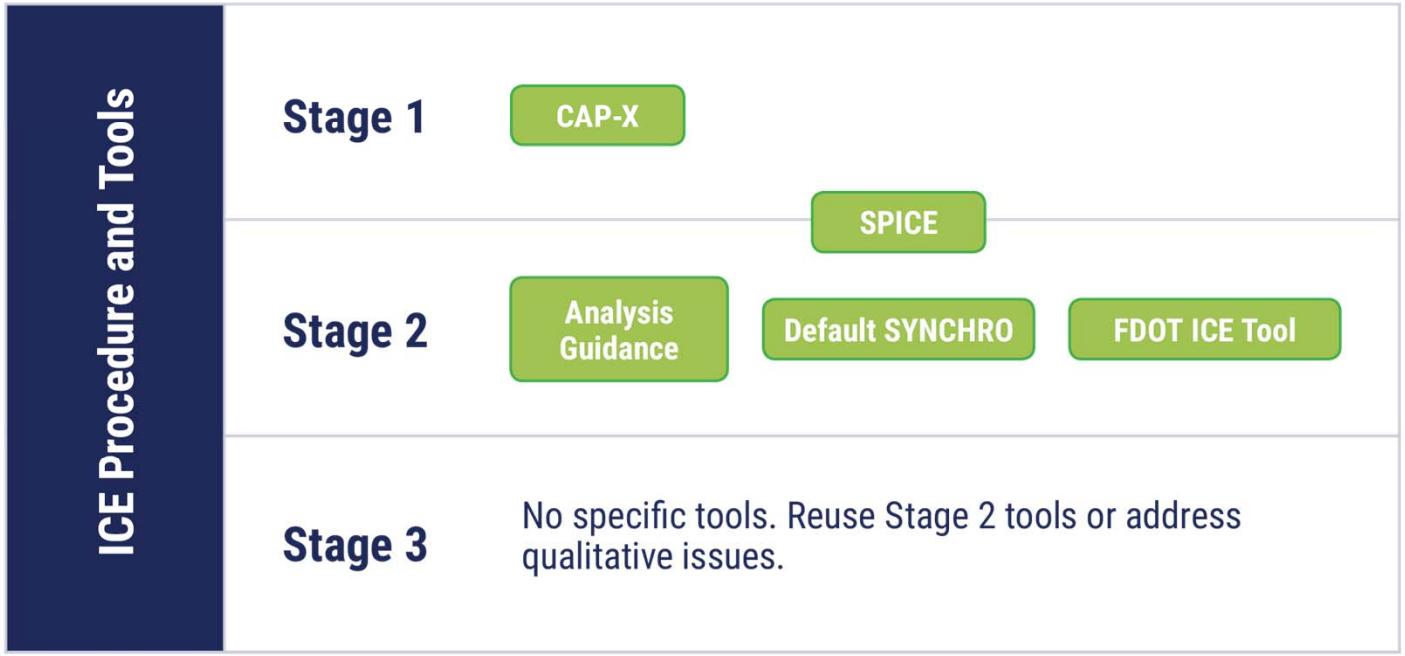


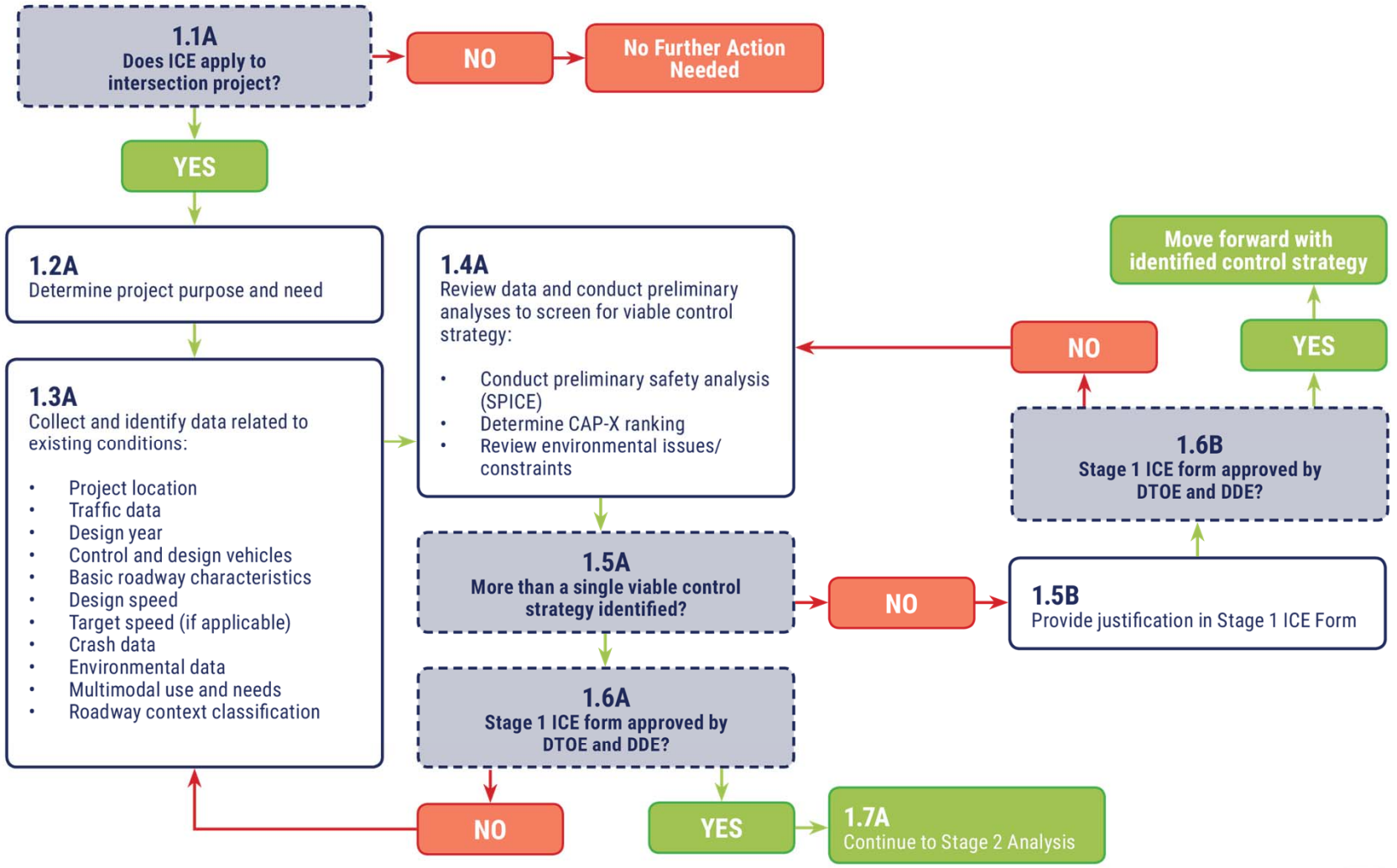
STAGES OF ICE

Stage 1	Stage 2	Stage 3
Screening	Preliminary Control Strategy Assessment	Detailed Control Strategy Assessment



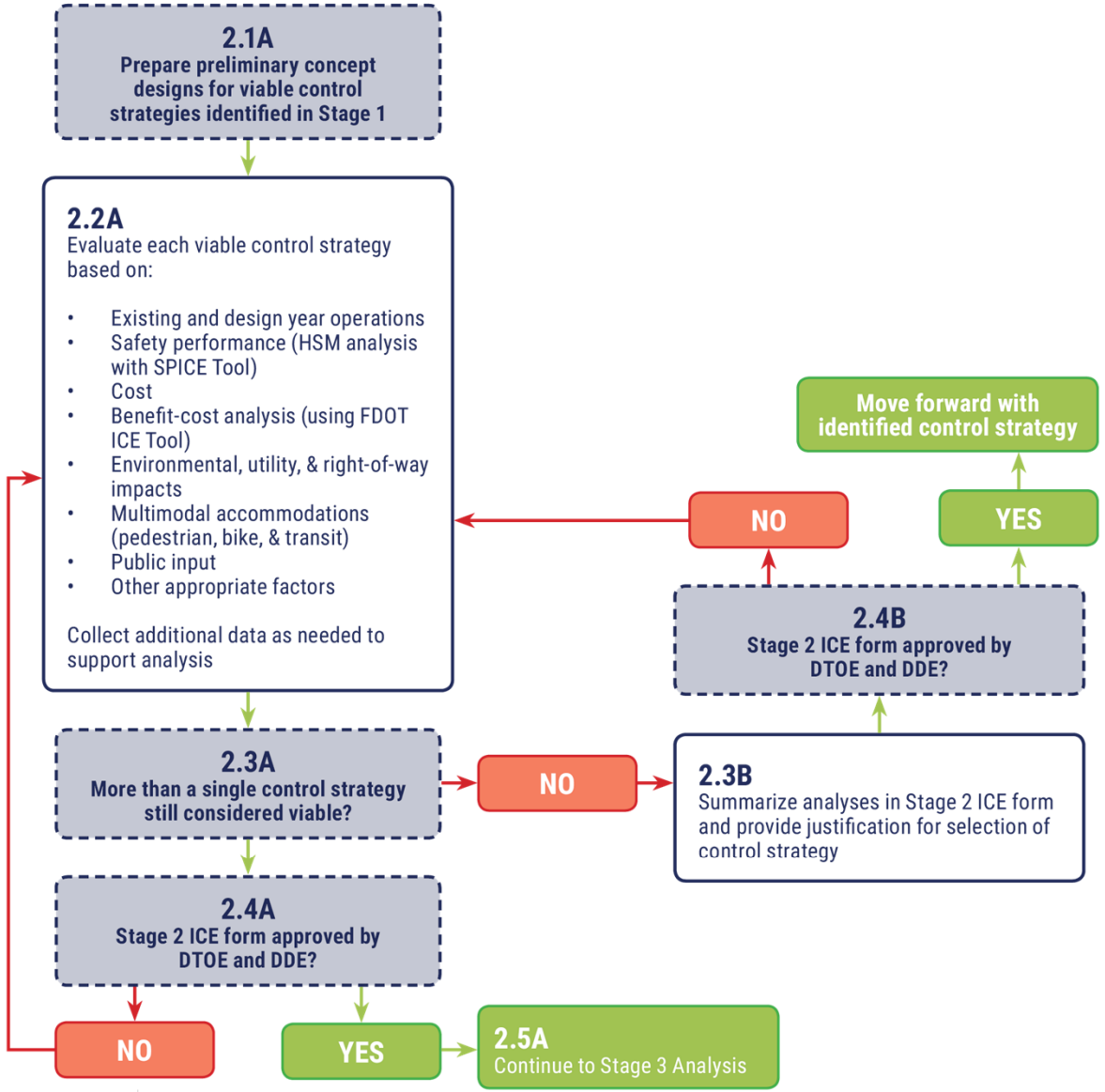
Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Figure 1; Page 7

ICE STAGE 1 PROCESS



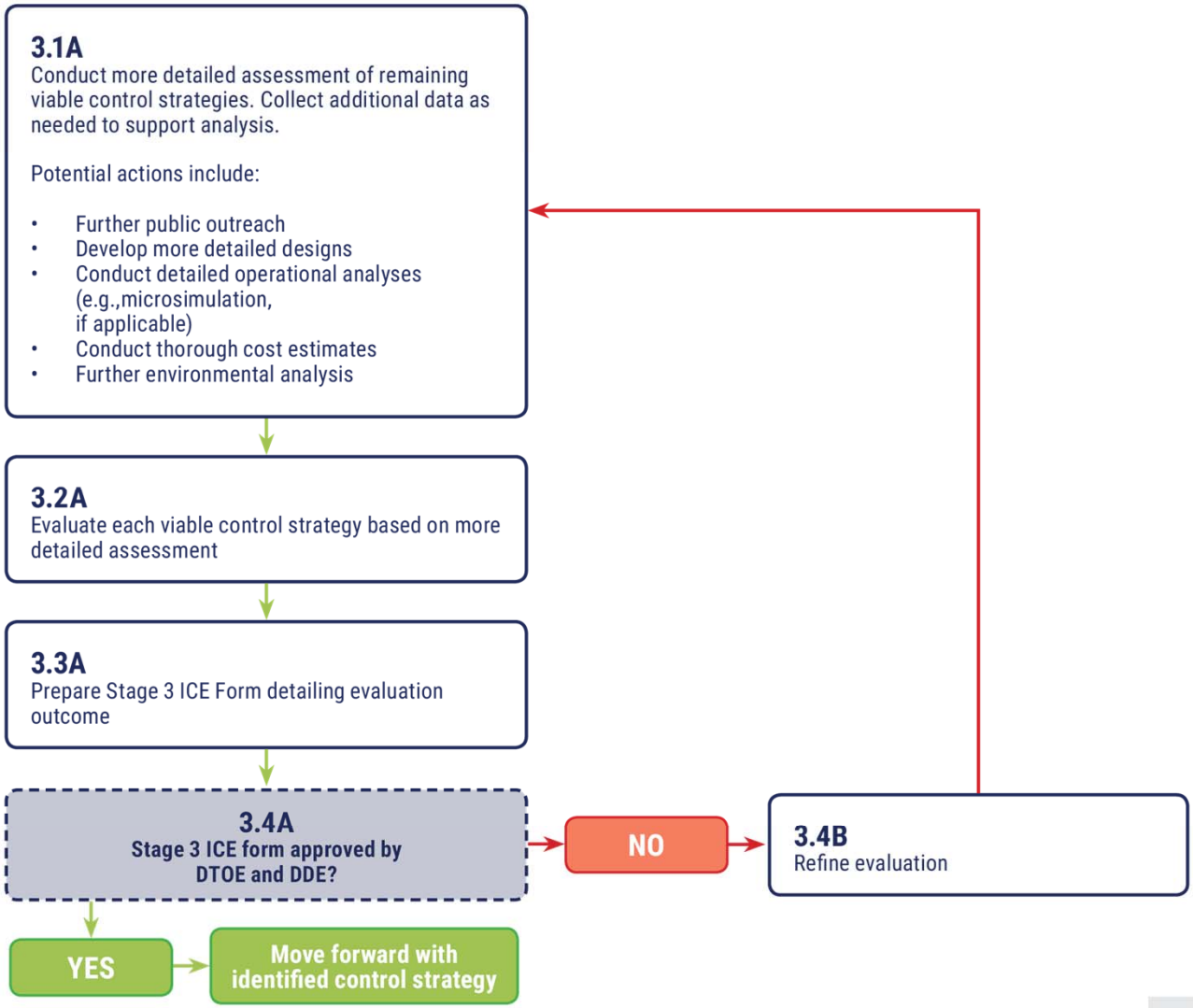
Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Figure 2; Page 10

ICE STAGE 2 PROCESS



Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Figure 3; Page 14

ICE STAGE 3 PROCESS



Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Figure 4. Page 18

STAGES OF ICE

Is there one viable control strategy or more than one?

If only one control strategy, Stages 2 and 3 are not necessary

Intent - Don't make ICE a burden if the choice is straightforward

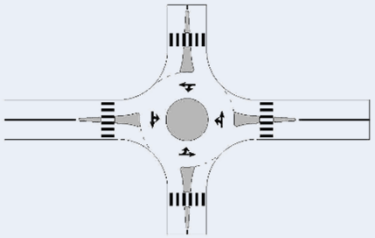
WHO COMPLETES THE FORM?

- FDOT staff
- Consultants

Driveway / Connection Permits on State Highways

- Applicant

- **Procedure includes:**
  - Appendix A with information on intersection forms
  - List of references and tools (*Specifics covered later today*)
  - Recommended Analysis Tools

Intersection Control Type			Mode Accommodations			Reference Material	Recommended Analysis Tool
Intersection Name	Illustration	Description	Vehicles	Pedestrians	Bicycles		
Roundabout							

GUIDANCE FOR ICE EVALUATION – APPENDIX A

	Mode Accommodations		
Description	**Vehicles**	**Pedestrians**	**Bicycles**
A subset of traffic circles that feature yield control of all entering vehicles, channelized approaches, and horizontal curvature and roadway elements to induce desirable vehicle speeds. Advantages: Usually reduced crashes and delay compared to signalized control Disadvantages: Usually higher cost and require more right-of-way than signalized control	Vehicles approaching the intersection must yield to vehicles circulating within the circulatory roadway.	Pedestrian crossings are located only across the legs of the roundabout, typically separated from the circulatory roadway by at least one vehicle length.	Bicyclists may ride in the roadway with vehicles or transition to multi-use paths via bicycle ramps (if present). Bike lanes should not be used at roundabouts

GUIDANCE FOR ICE EVALUATION – APPENDIX B

- Appendix B provides information details to be provided in ICE Forms
- Forms have to be approved by District Traffic Operations Engineer (DTOE) and District Design Engineer (DDE)
- One form available for each Stage
  - Excel Spreadsheet Format
    - Yellow cells provide a dropdown menu
    - Gray cells require manual input regarding project specific information
    - Auto-populates project information and control strategies to Stage 2 and Stage 3

Florida Department of Transportation

Intersection Control Evaluation Form 750-010-003

Intersection Control Evaluation (ICE) Form

Stage 1: Screening

To fulfill the requirements of Stage 1 (Screening) of FDOT's ICE procedures, complete the following form and append all supporting documentation. Completed forms can be submitted to the District Traffic Operations Engineer (DTOE) and District Design Engineer (DDE) for the project's approval.

Project Name		FDOT Project #		Date	
Submitted By		Agency/Company		Email	
FDOT Context Classification		FDOT District		County	

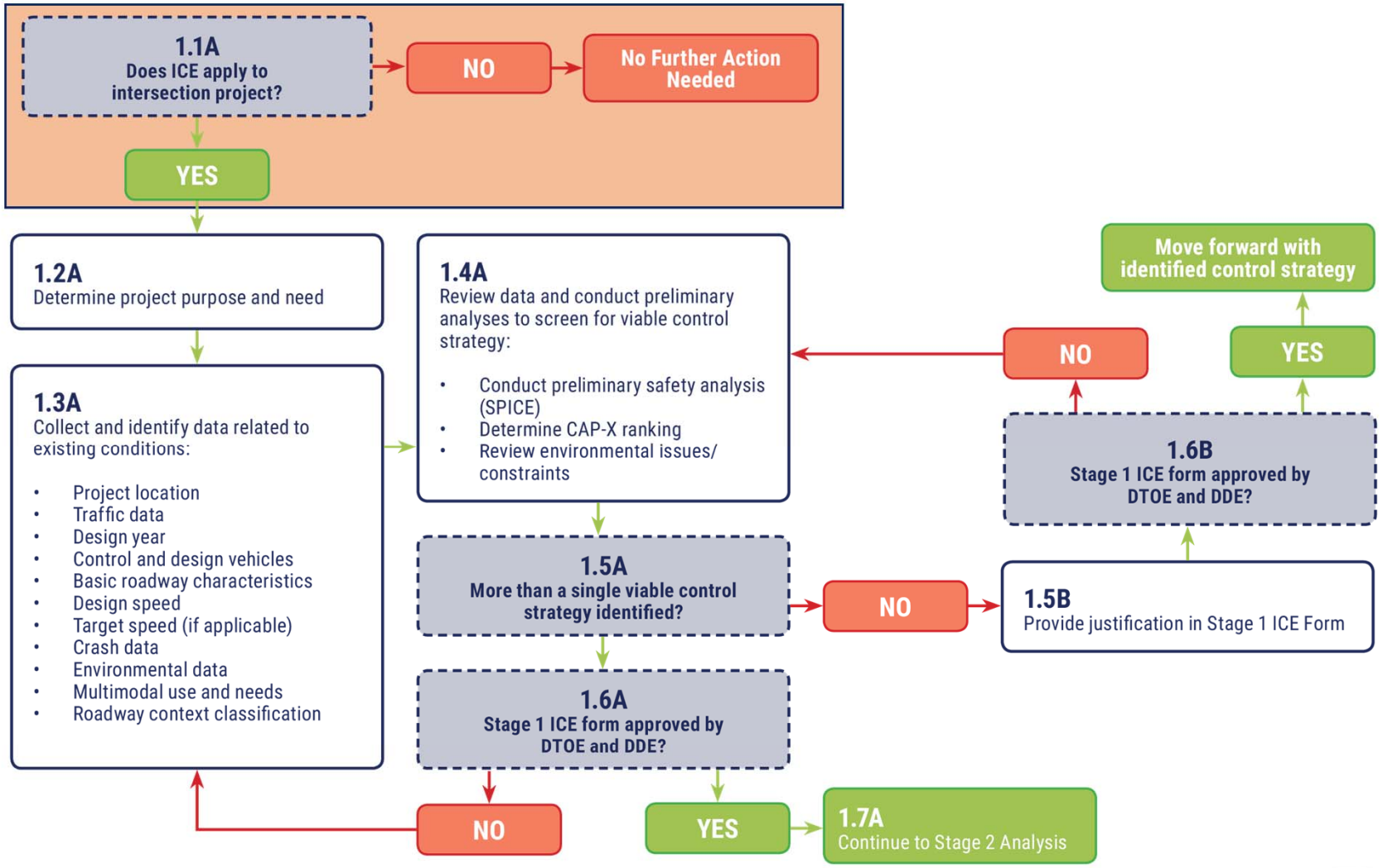
FDOT ICE IMPLEMENTATION PLAN

- 2018: Training and Acclimation
  - Implementation Focus: District Training
    - Two intersections per district
- 2019: Districts Identify & Conduct ICE Analysis for Additional Locations
  - Implementation Focus: Refine ICE Process
    - Evaluate minimum of three projects in these offices/focus areas
      - PD&E
      - Traffic Operations
      - Access Management/Permitting
  - Conduct second round ICE Training
- 2020: Full ICE Procedure Implementation by Districts
  - Implementation Focus: Mainstream ICE Process
    - ICE Manual Procedures fully effective January 1, 2020
    - Quality Assistance Reviews (QAR) starting in Year 4

PROCESS WALKTHROUGH

STAGE 1

ICE STAGE 1 PROCESS



Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Figure 2; Page 10

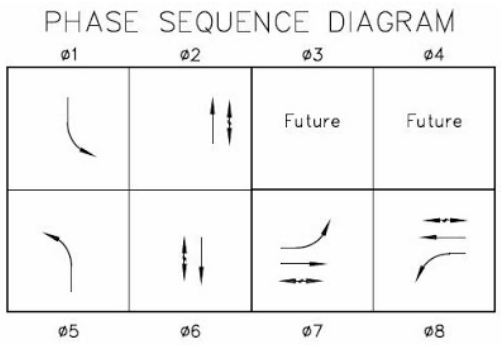
ICE is REQUIRED when

- New signalization is proposed
- Major reconstruction of existing signalized intersection is proposed
  - Adding exclusive left turns, adding intersection legs
- Conversion of a directional or bi-directional median opening to a full median opening is proposed
- Driveway/Connection permit applications for Category E, F, G
- District Design Engineer (DDE) and District Traffic Operations Engineer (DTOE) consider an ICE a good fit for the project

Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Section 2.3; Page 5

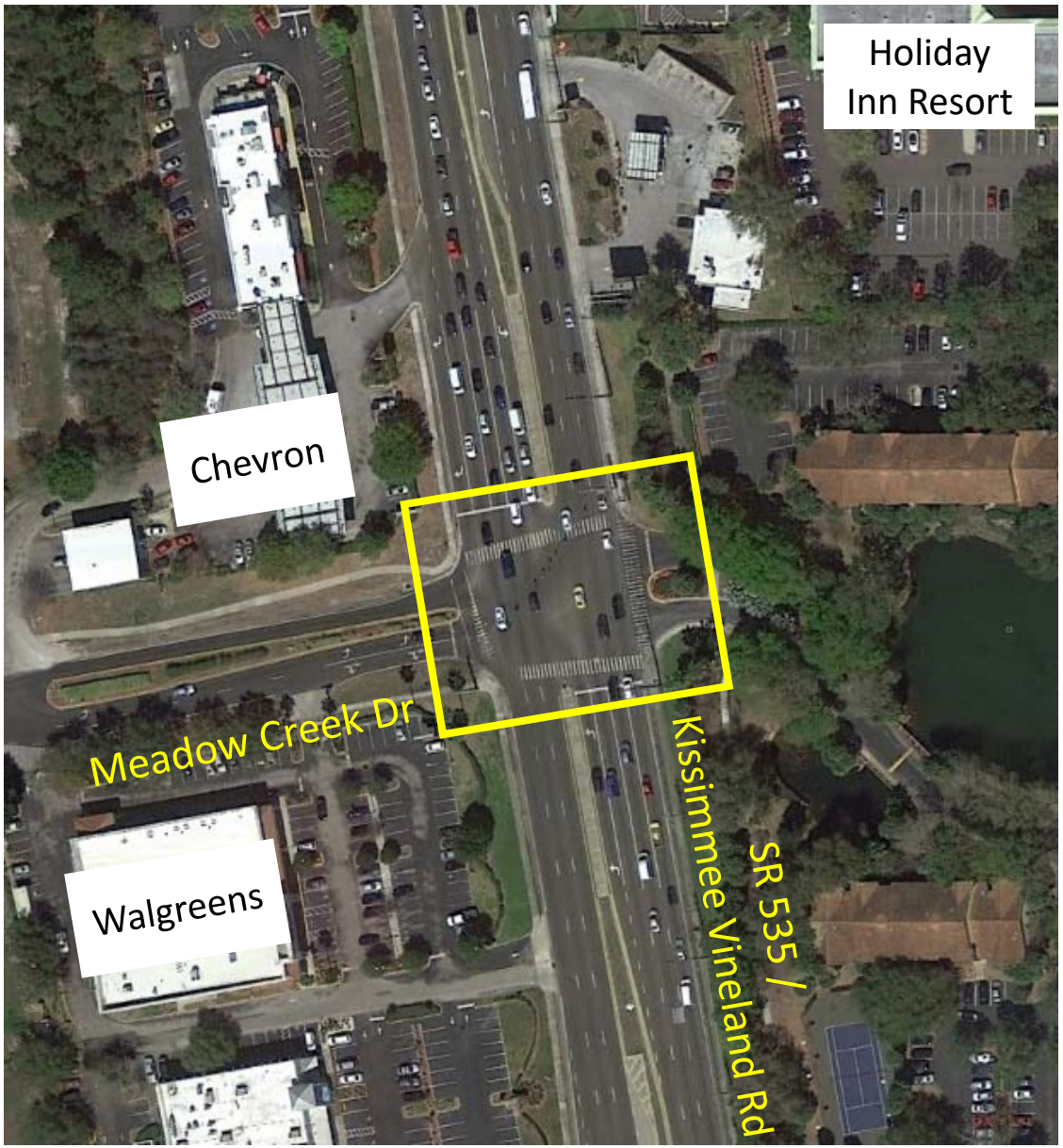
ICE NOT REQUIRED

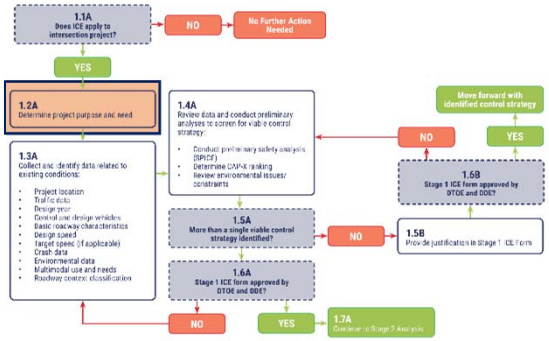
- Work does not include substantive proposed changes to intersection
  - Mill and resurface pavement; changing full median opening to directional median opening
- Minor intersection operational improvements
  - Adding right turn lane or signal phasing changes or equipment upgrades
- Encouraged for local roadways, not required
- Recommended for ramp terminal intersections (stop control, signalized, or yield), not required



Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Section 2.3; Page 5

1.2 A – PROJECT PURPOSE AND NEED

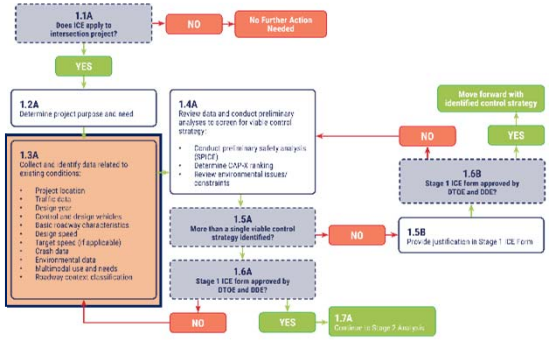




- Increasing throughput capacity along SR 535
- Pedestrian crossing safety
  - 1 marked pedestrian crossing for over a mile south of the I-4 interchange
  - Look for signalized crossing opportunities

1.3 A – DATA COLLECTION FOR EXISTING CONDITIONS

- Roadway Context Class
- Intersection Configuration
- Analysis Years
  - 2015 – Existing
  - 2020 – Opening
  - 2040 – Design
- Existing TMC
  - 2015 AM/PM
- Posted speeds
- AADTs
  - 2020 – Opening
  - 2040 – Design
- Truck Percentages
- Design Vehicle



Project Information

Project Name	SR 535 at Meadow Creek Drive		FDOT Project #			Date	03/29/18
Submitted By	KAI	Agency/Company	FDOT Central Office		Email		
FDOT Context Classification	C3C - Suburban Commercial		FDOT District	District 5	County	Orange	
Project Locality (*City/Town/Village*)	Unincorporated Orange County			Project Type	Multimodal Improvement		
Project Purpose (*What is the catalyst for this project and why is it being undertaken?*)	Study location currently a signalized intersection. The area is expected to experience an increase in throughput capacity along SR 535. Pedestrian crossing safety is one of the driving components to find alternative intersections as there is only 1 marked crossing for over a mile south of the I-4 interchange. The evaluation and implementation of alternative intersections at this location can help provide more signalized crossing opportunities.						
Project Setting Description (*Describe the area surrounding the intersection*)	SR 535 is classified as an urban minor arterial, 6-lane facility. The immediate land uses surrounding the intersection comprise mostly commercial use.						
Multimodal Context (*Describe the pedestrian, bicycle, and transit activity in the area and the potential for activity based on surrounding land uses and development patterns*)	5' sidewalks are provided on all four legs of the intersection and high emphasis crosswalks are provided an all intersection legs at Meadow Creek Dr. No bicycle lanes are provided, there are 2' curb and gutter on the inner and outside shoulders of SR 535.						

ICE Forms For Reporting, Not Analysis

Basic Intersection Information

Major Street Information										
Route #:	535	Route Name(s)	Kissimmee Vineland Road					Milepost	1.903	
Existing Control Type	Signal			Existing AADT	49,700		Design Year AADT		70,000	
Design Vehicle	Interstate Semitrailer (WB-62)			Control Vehicle	Interstate Semitrailer (WB-62)					
Primary Functional Classification		Urban Minor Arterial					Design Speed (mph)		45	
Secondary Functional Classification (if app.)							Target Speed (mph) [if app.]			

Approach #1	Direction	Northbound	Number of Lanes		Study Period #1 Traffic Volumes		Study Period #2 Traffic Volumes		
	Sidewalks along	Neither side of the approach	Left-Turn	1					
	Crosswalk on Approach?	Yes	Left-Through		Weekday AM Peak		Weekday PM Peak		
	On-Street Bike Facilities?	No	Through	2	Left	41	Left	67	
	Multi-Use Path?	No	Left-Through-Right		Through	1,710	Through	1,487	
	Scheduled Bus Service?	No	Through-Right	1	Right	6	Right	17	
	Bus Stop on Approach?	No	Right-Turn		Daily Truck %		2.5%		
Approach #2	Direction	Southbound	Number of Lanes		Study Period #1 Traffic Volumes		Study Period #2 Traffic Volumes		
	Sidewalks along:	Neither side of the approach	Left-Turn	1					
	Crosswalk on Approach?	Yes	Left-Through		Weekday AM Peak		Weekday PM Peak		
	On-Street Bike Facilities?	No	Through	3	Left	39	Left	101	
	Multi-Use Path?	No	Left-Through-Right		Through	1,118	Through	1,647	
	Scheduled Bus Service?	No	Through-Right		Right	63	Right	154	
	Bus Stop on Approach?	No	Right-Turn	1	Daily Truck %		3.5%		

Basic Intersection Information

Minor Street Information											
Route #:		Route Name(s)	Meadow Creek Drive/Lake Vining Drive					Milepost (if app.)			
Existing Control Type		Signal		Existing AADT	4,000		Design Year AADT		5,000		
Design Vehicle	School Bus (S-BUS-36)			Control Vehicle	School Bus (S-BUS-36)						
Primary Functional Classification		Urban Local						Design Speed (mph)		35	
Secondary Functional Classification (if app.)								Target Speed (mph) [if app.]			
Approach #1	Direction	Eastbound	Number of Lanes			Study Period #1 Traffic Volumes		Study Period #2 Traffic Volumes			
	Sidewalks along:	Both sides of the approach	Left-Turn	1							
	Crosswalk on Approach?	Yes	Left-Through			Weekday AM Peak		Weekday PM Peak			
	On-Street Bike Facilities?	No	Through			Left	113	Left	212		
	Multi-Use Path?	Yes	Left-Through-Right			Through	2	Through	13		
	Scheduled Bus Service?	Yes	Through-Right	1		Right	43	Right	73		
	Bus Stop on Approach?	No	Right-Turn			Daily Truck %		9.0%			
Approach #2	Direction	Westbound	Number of Lanes			Study Period #1 Traffic Volumes		Study Period #2 Traffic Volumes			
	Sidewalks along:	Neither side of the approach	Left-Turn								
	Crosswalk on Approach?	Yes	Left-Through			Weekday AM Peak		Weekday PM Peak			
	On-Street Bike Facilities?	No	Through			Left	21	Left	22		
	Multi-Use Path?	No	Left-Through-Right	1		Through	2	Through	3		
	Scheduled Bus Service?	No	Through-Right			Right	58	Right	39		
	Bus Stop on Approach?	No	Right-Turn			Daily Truck %		0.0%			

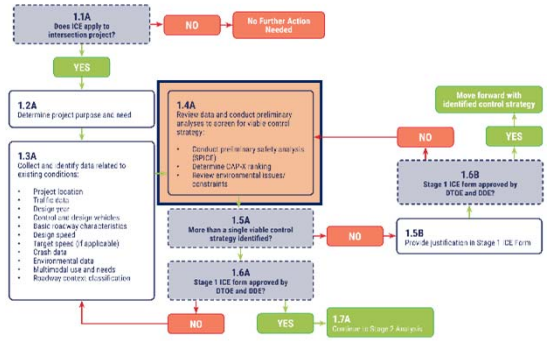
Crash History

Crash History (Existing Intersections Only)
Append the most recent five-years of crash data for the intersection from the CAR System. If the crash data evidences any issues relating to safety performance, discuss briefly here:
The most recent five years of crash data on record (2013-2017) was collected for the study intersection. Over the five-year history, 240 total crashes were reported with two involving a fatality and 58 resulting in injury. One of the fatalities was a pedestrian crash and the second fatality involved a rear-end crash. The pedestrian fatal crash 3:30AM and the rear-end fatality occurred at 8:40 AM. 40 of the injury crashes were rear-end, 6 were angle crashes and 4 were "other" crashes. Rear-end is the most common crash type and sideswipe and "other" are next with 26 and 15 crashes, respectively. Right-turn and left-turn are next with 18 and 10 crashes, respectively.

1.5 B – FDOT ICE FORMS – STAGE 1

Control Strategy Evaluation						
Provide a brief justification as to why each of the following control strategies should be advanced or not. Justification should consider potential environmental impacts						
Control Strategy	CAP-X Outputs			SPICE Ranking	Strategy to Be Advanced?	Justification
	V/C Ratio		Multimodal Score			
Two-Way Stop-Controlled						
All-Way Stop-Controlled						
Signalized Control						
Roundabout						
Median U-Turn						
RCUT (Signalized)						
RCUT (Unsignalized)						
Jughandle						
Displaced Left Turn						
Continuous Green Tee						
Quadrant Roadway						

1.4 A – CONDUCT CAP-X



ICE Procedure and Tools

Stage 1	**CAP-X**			
		SPICE		
Stage 2	**Analysis Guidance**	**Default SYNCHRO**	**FDOT ICE Tool**	
Stage 3	No specific tools. Reuse Stage 2 tools or address qualitative issues.			


TOOLS
CAP-X
FDOT

1.4 A – VISION AND NEED FOR THE CAP-X TOOL

- Capacity Analysis for Planning of Junctions (CAP-X)
- FHWA tool for planning-level capacity assessment
- Stage 1 tool for Intersection Control Evaluation
- Initial operational screening of intersection control alternatives
  - Can be used during project's scoping stage
- Simple tool for efficient comparisons
  - User-friendly
  - Only requires readily available inputs
- FDOT updates
  - Incorporation of multimodal considerations
  - Improved input sheets and output comparisons
  - Updated inputs to reflect FDOT default values
  - HCM 6th Edition roundabout capacity analysis
  - Added stop controlled intersections
  - Additional intersection alternatives

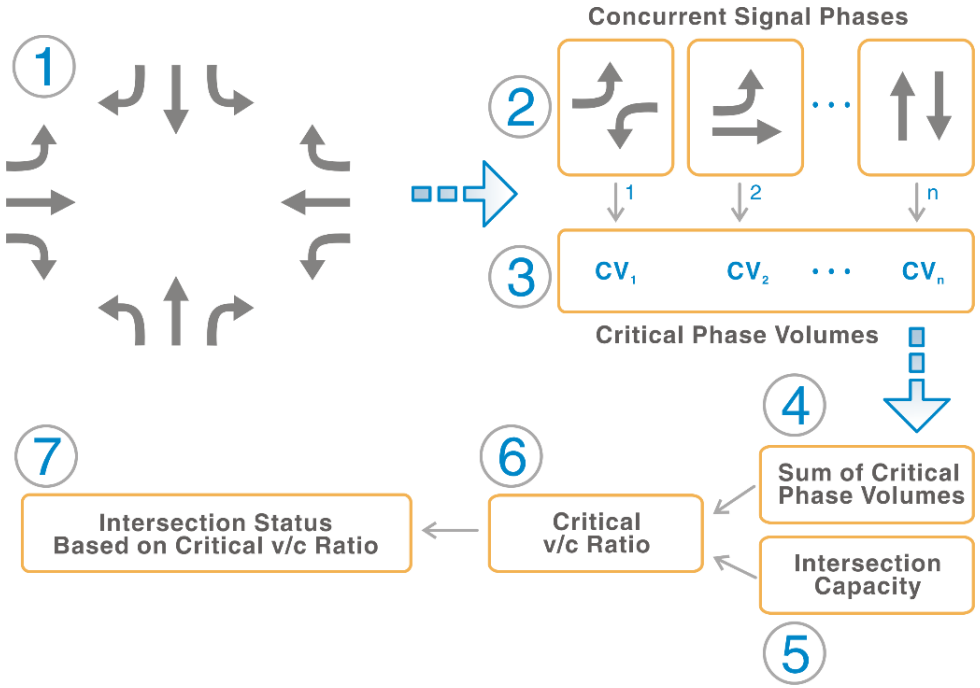
1.4 A – CAP-X TOOL OVERVIEW

- Conducts critical movement analysis (CMA) to gauge the potential performance of intersection and interchange types
- CMA identifies the critical movements at an intersection and estimates whether the intersection is operating below, near, at, or over capacity;
- Includes vast majority of intersections and interchange types

- At-Grade Intersections
  - All Way Stop Control
  - Two Way Stop Control
  - Traffic Signal
  - Continuous Green-T
  - Quadrant Roadway
  - Displaced Left Turn
  - Median U-Turn
  - Restricted Crossing U-Turn
- Roundabouts
  - 50 and 75 ICD Mini-roundabouts
  - 1-Lane Roundabouts
  - 2-Lane Roundabouts
  - Hybrid 1x2 lane configurations
- Grade-Separated Interchanges
  - Traditional Diamond
  - Partial Cloverleaf
  - Displaced Left Turn
  - Diverging Diamond Interchange
  - Single Point Diamond

WHAT IS CRITICAL MOVEMENT ANALYSIS?

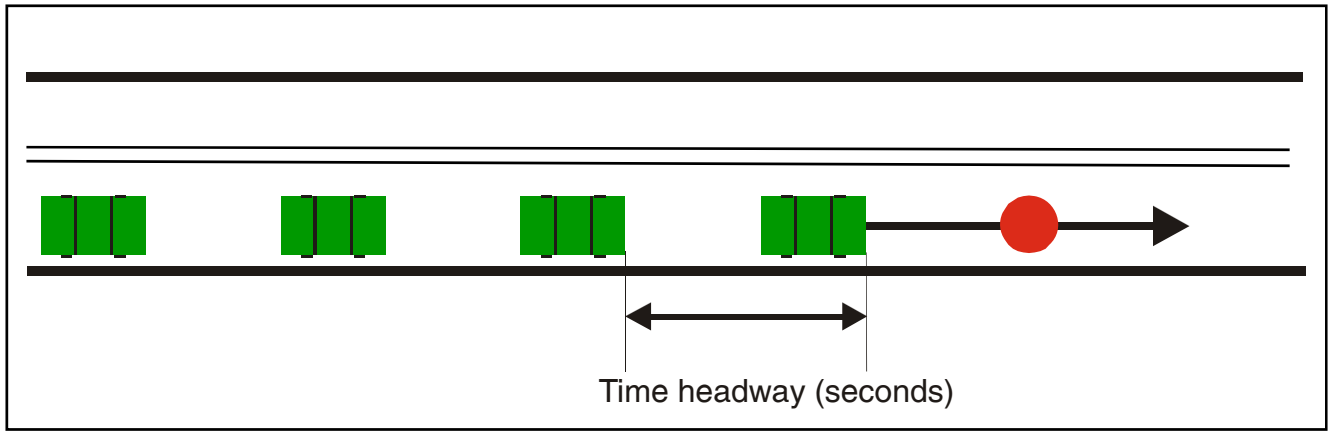
Included in the 1985 HCM and NCHRP Report 812: Signal Timing Manual, 1st Edition



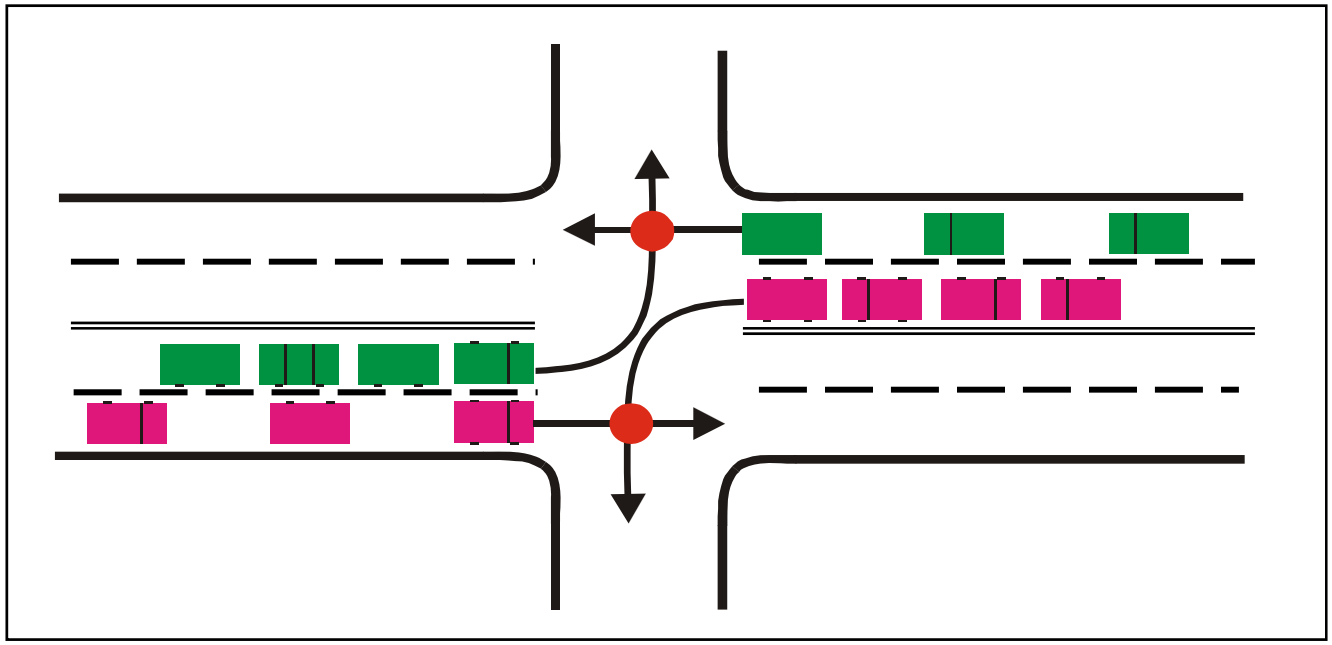
Source: Traffic Signal Timing Manual – 1st Edition

1) Identify movements served, # lanes and volumes per lane
2) Arrange in desired sequence of phases
3) Determine critical volume per lane to be accommodated
4) Sum the critical volumes
5) Determine maximum critical volume for intersection – CAP-X
6) Determine volume to capacity ratio

WHAT IS THE CAPACITY OF A POINT?

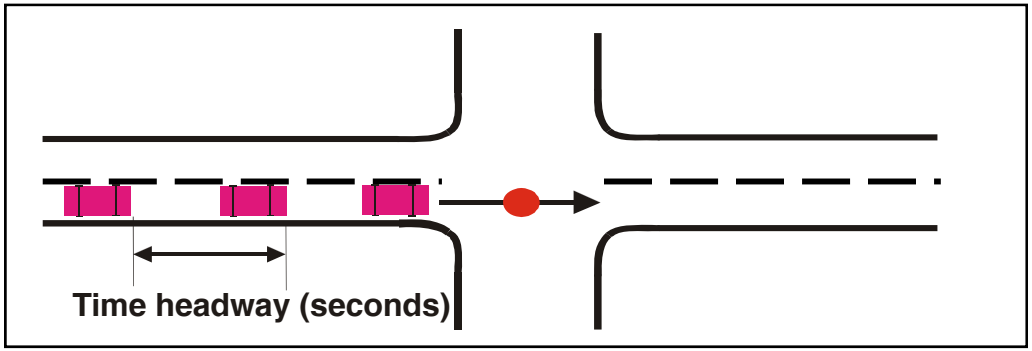


$$Capacity = \frac{3{,}600}{t}$$



The point serving the highest total demand for the east-west movements contributes to the total critical volume for the intersection.

WHAT IS THE CAPACITY OF A POINT?



Capacity of Intersection is essentially saturation flow rate minus sum of lost times.

$$c = s * \frac{g}{C}$$

4 critical phases/cycle

$$c = 1{,}950 * \frac{(120sec - 4 * 4sec)}{120sec} = 1{,}690$$

2 critical phases/cycle

$$c = 1{,}950 * \frac{(120sec - 2 * 4sec)}{120sec} = 1{,}820$$

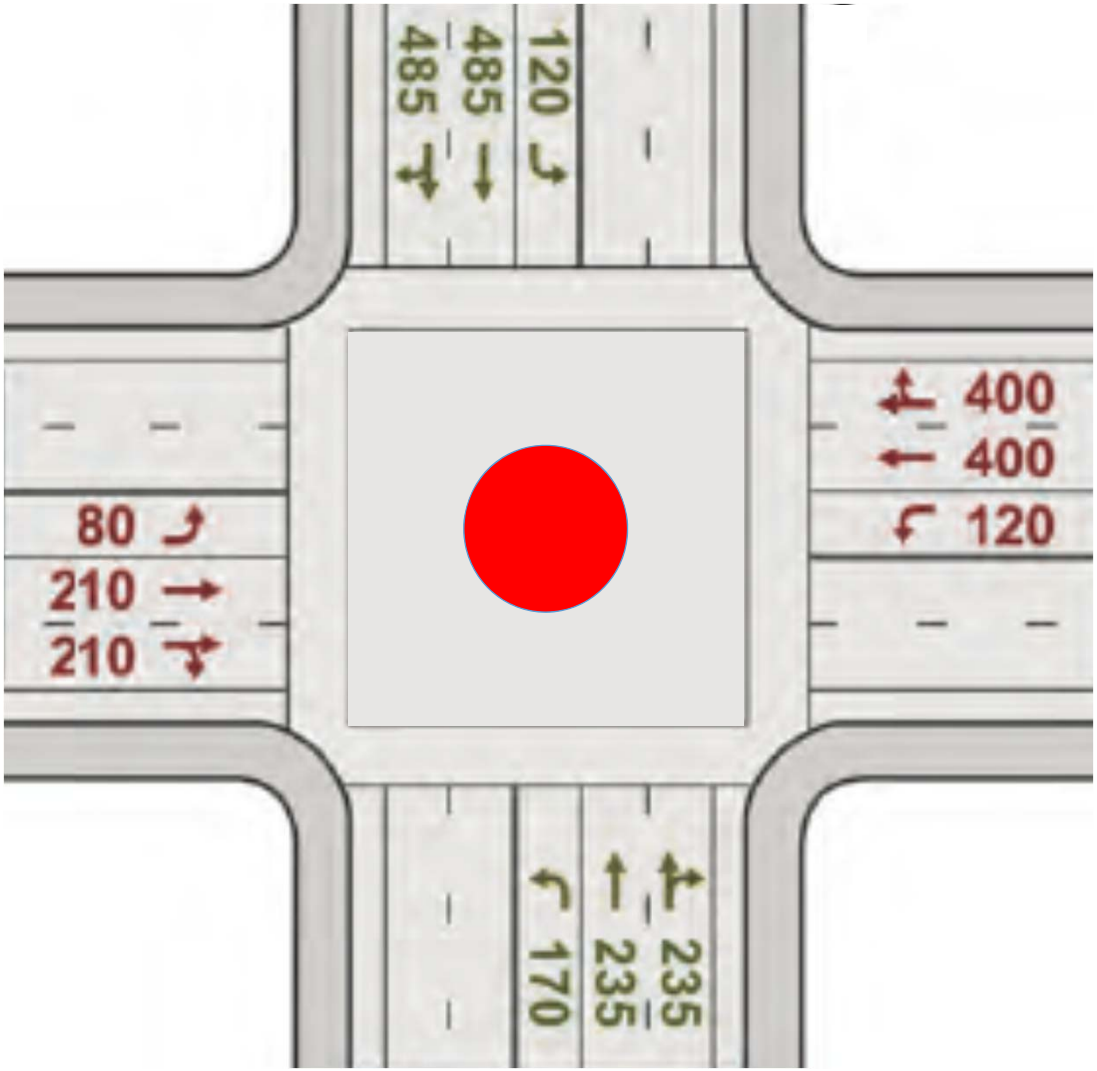
Assumptions:

- *s = Base Sat Flow = 1,950 pc/h/ln*
- *C = 120-second cycle length*
- *g = green time per phase*
- *4 seconds lost time/phase*

Cap-X Default Values

Critical Lane Volume Threshold	2-phase signal	**Suggested = 1800**	**1800**
	3-phase signal	**Suggested = 1750**	**1750**
	4-phase signal	**Suggested = 1700**	**1700**

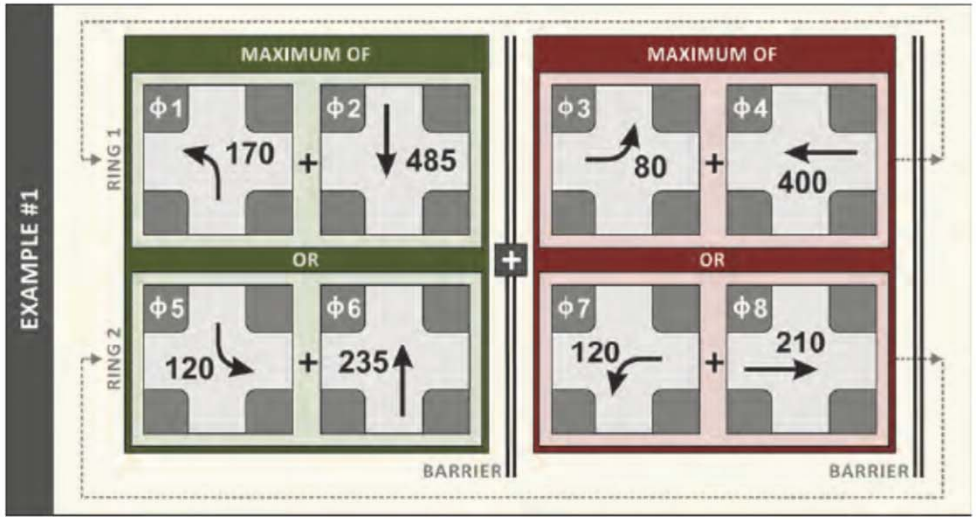
CMA EXAMPLE: IS THIS INTERSECTION OVER CAPACITY?

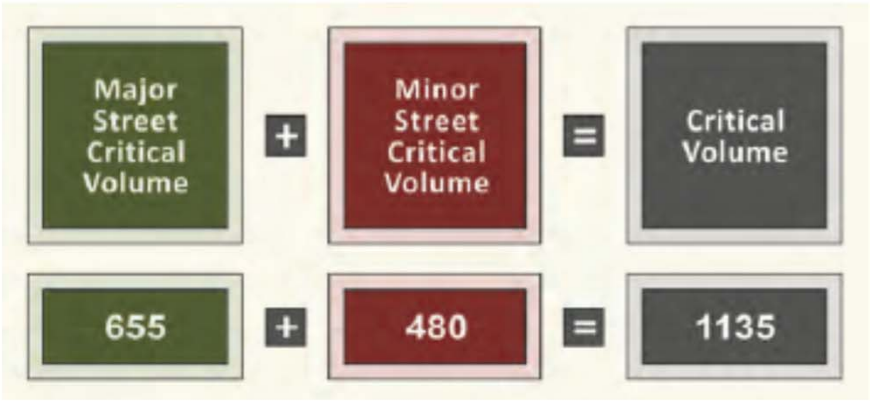


What is the Capacity of this point?

What is the sum of critical movements at this point?

CMA EXAMPLE: WHAT IS THE V/C RATIO?





$$\frac{v}{c} = \frac{1135}{1700} = 0.67$$

1.4 A – WHEN TO CHANGE THE DEFAULTS?

Cap-X Default Values

Critical Lane Volume Threshold	2-phase signal	**Suggested = 1800**	**1800**
	3-phase signal	**Suggested = 1750**	**1750**
	4-phase signal	**Suggested = 1700**	**1700**

Assumptions:

- *Base Sat Flow = 1,950 pc/h/ln*
- *120-second cycle length*
- *4 seconds lost time/phase*
- *2/3/4 critical phases*

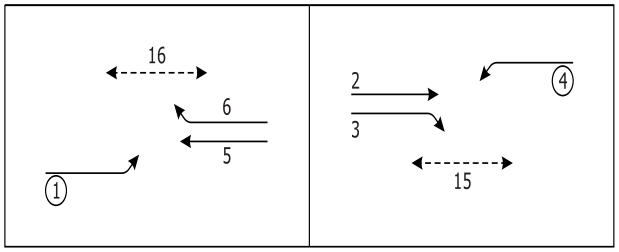
- Consider changing default values, when assumptions are not met
- Saturation Flow Rate is likely lower for rural intersections!
- Recommend to keep defaults to extent possible
- Note that v/c ratios close to 1.0 will always be re-evaluated in ICE Stage 2

ANALYSIS FOR UNSIGNALIZED INTERSECTIONS

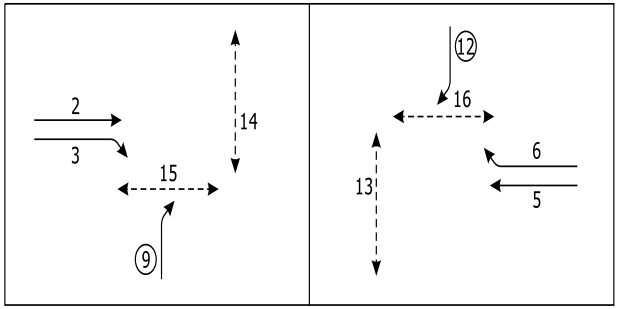
- All-Way Stop Controlled Intersection
  - Critical Movement Analysis applies directly
- Two-Way Stop Controlled (TWSC) Intersection
  - Capacity of Rank 2 through 4 movements are function of gap acceptance parameters and relative flow rates
  - Cap-X uses HCM Planning and Preliminary Engineering Applications Guide (PPEAG) planning-level methods
- Unsignalized RCUT
  - Similar to TWSC with different gap acceptance values
  - Cap-X uses modified PPEAG planning-level methods
- Roundabouts
  - Entry capacity defined by gap acceptance and conflicting flow rate (more straightforward than others)
  - Cap-X uses HCM 6th Edition capacity model directly

HCM CHAPTER 20 - TWSC RANK 2 THROUGH 4 MOVEMENTS

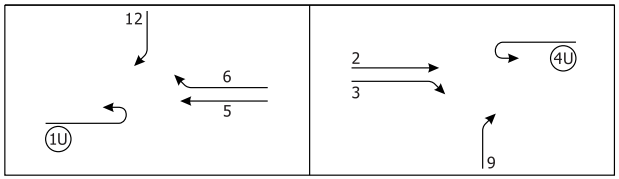
- Rank 2
  - Major-Street Left-Turn: Movements 1 and 4



  - Minor-Street Right-Turn: Movements 9 and 12



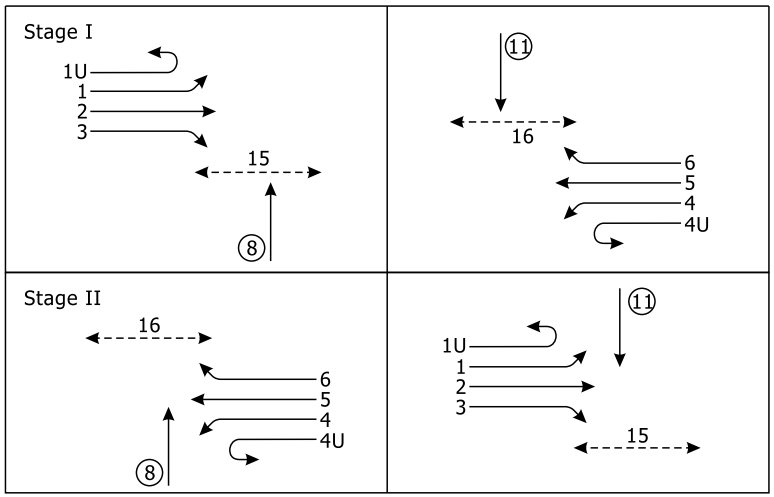
  - Major-Street U-Turn: Movements 1U and 4U



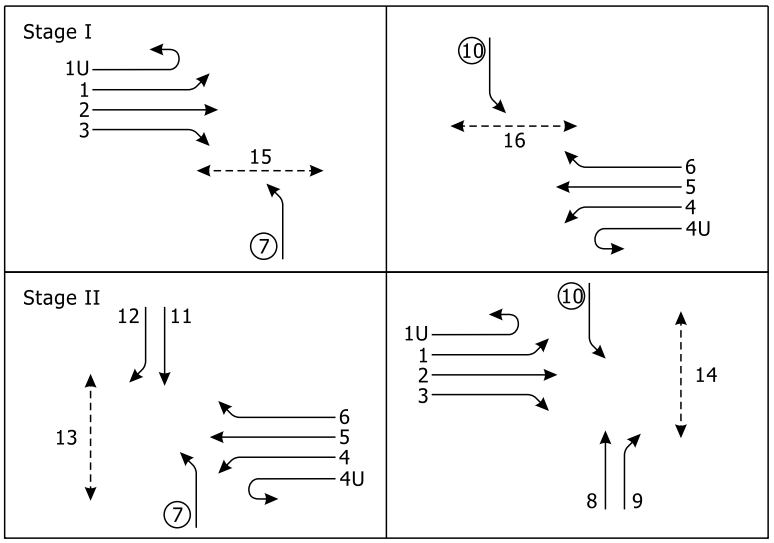
  - Minor-Street Pedestrian Movements: Rank 2, Movements 13 and 14

HCM CHAPTER 20 - TWSC RANK 2 THROUGH 4 MOVEMENTS

Rank 3 - Minor-Street Through: Movements 8 and 11



Rank 4 - Minor-Street Left-Turn: Movements 7 and 10



1.4 A – CAP-X INPUTS

Traffic Volume Demand						
	Volume (Veh/hr)				Percent (%)	
	U-Turn	Left	Thru	Right	Heavy Vehicles	Volume Growth
Eastbound	0	113	2	43	14.00%	0.00%
Westbound	0	21	2	58	0.00%	0.00%
Southbound	0	39	1118	63	5.00%	0.00%
Northbound	0	41	1710	6	3.00%	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	
FDOT Context Zone				**C3C-Suburban Commercial**		
Critical Lane Volume Threshold	2-phase signal			**Suggested = 1800**	**1800**	
	3-phase signal			**Suggested = 1750**	**1750**	
	4-phase signal			**Suggested = 1700**	**1700**	

Equivalent Passenger Car Volume				
	Volume (Veh/hr)			
	U-Turn	Left	Thru	Right
Eastbound	0	113	2	43
Westbound	0	21	2	58
Southbound	0	41	1174	66
Northbound	0	42	1761	6

- Movement Volumes
- Multimodal level of activity (FDOT addition)
- Additional planning-level values
- Individual analysis spreadsheets required for each study period (AM, Midday, PM Peak)

1.4 A – CAP-X INPUTS

Step 2A: Base Conditions Analysis

Project Name:	*SR 535 at MeadowCreek Drive ICE Training*
Project Number:	*XXXXX.XX*
Location:	*Orlando, FL*
Date:	2016 AM
Major Street Direction	North-South

Existing Intersection Configuration	*Traffic Signal*

Number of Lanes for Existing Configuration
(Can be edited in "3- Alt Num Lanes Input" as needed)

TYPE OF INTERSECTION	Sheet	Northbound				Southbound				Eastbound				Westbound			
		U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Traffic Signal	FULL		1	3	0		1	3	1		1	1	0		0	1	0

Results for Existing Configuration

TYPE OF INTERSECTION	Sheet	Zone 1 (North)		Zone 2 (South)		Zone 3 (East)		Zone 4 (West)		Zone 5 (Center)			
		CLV	V/C	CLV	V/C	CLV	V/C	CLV	V/C	CLV	V/C		
Traffic Signal	FULL	--	--	--	--	--	--	--	--	834	*0.55*	--	--

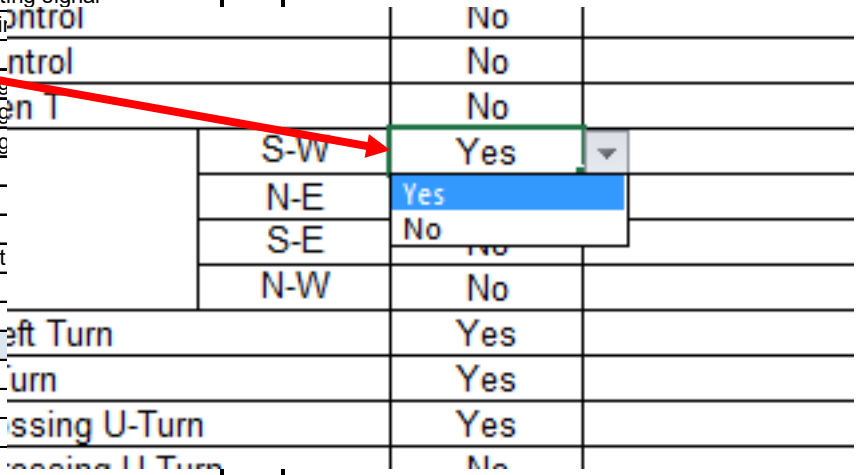
Existing Configuration Results

Overall v/c Ratio	0.55	Pedestrian Accommodation	Fair	Bicycle Accommodation	Fair	Transit Accommodation	Good

1.4 A – CAP-X INPUTS

Step 2B: Alternative Selection

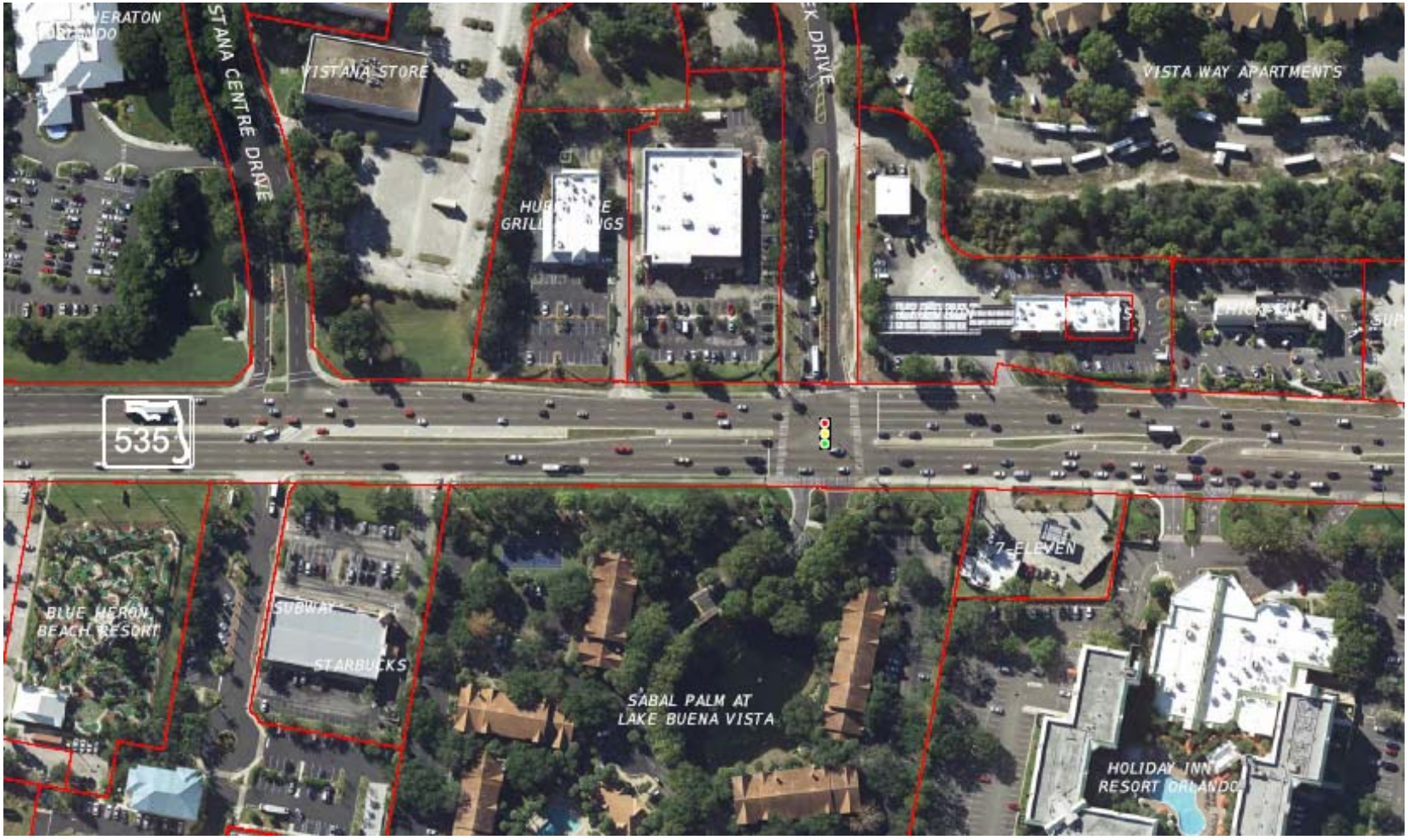
Rankings Inclusion		Yes/No	Comment
At-Grade Non-Roundabout Intersections?		Yes	
Traffic Signal		Yes	
Two-Way Stop Control		No	Existing signal
All-Way Stop Control		No	Existing signal
Continuous Green T		No	4 leg in
Quadrant Roadway	S-W	Yes	
	N-E	No	Would go throug
	S-E	No	Would go throug
	N-W	No	Would go throug
Partial Displaced Left Turn		Yes	
Displaced Left Turn		Yes	
Signalized Restricted Crossing U-Turn		Yes	
Unsignalized Restricted Crossing U-Turn		No	Exist
Median U-Turn		Yes	
Partial Median U-Turn		Yes	
Roundabouts?		No	
50 ICD Miniroundabout			
75 ICD Miniroundaobut			
1x1			
1x2			
2x1			
2x2			
Grade Separated Interchanges?		No	
Diamond			
Partial Cloverleaf A			
Partial Cloverleaf B			
Displaced Left Turn Interchange			
Diverging Diamond Interchange			
Single Point			



Continue to Step 3 Step 3

Introduction | Abbreviations & Assumptions | 1 - Volume Input | 2 - Base and Alt Sel | 3 - Alt Num Lanes Input | 4a - Detailed Results | 4b - Summary Results | 5a - Summary Report | 5b - Detailed Report

1.4 A – CAP-X INPUTS



0 40 200
Feet

1.4 A – CAP-X INPUTS

- New and revised input sheets to facilitate more efficient analysis
- Number of lanes inputs consolidated to a single worksheet
- Quadrant use respective intersection tabs.
- R-CUT and DLT, MUT (Full and Partial) require input for major street direction alternative

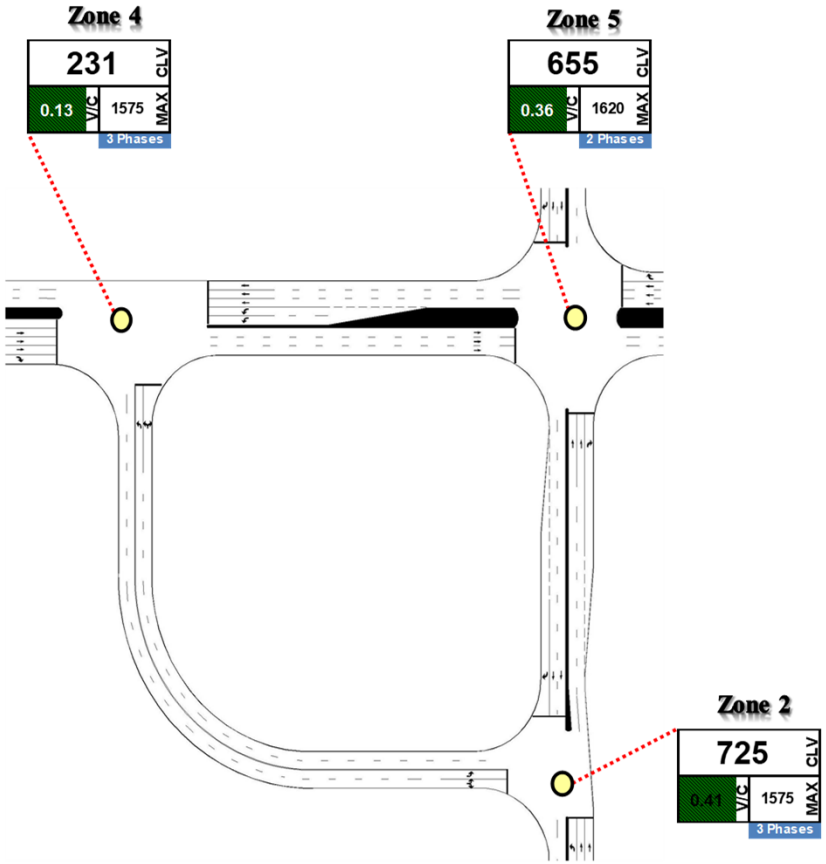
Number of Lanes for Non-roundabout Intersections																
TYPE OF INTERSECTION	Sheet	Northbound				Southbound				Eastbound				Westbound			
		U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Traffic Signal	FULL		1	3	0		1	3	1		1	1	0		0	1	0
Quadrant Roadway	S-W	Use the respective intersection tab(s) to specify the # of lanes inputs.															
Partial Displaced Left Turn	N-S		1	3	0		1	3	1		1	1	0		0	1	0
Displaced Left Turn	FULL		1	3	0		1	3	1		1	1	0		1	1	0
Signalized Restricted Crossing U-Turn	N-S	1	1	3	0	1	1	3	1				1				1
Median U-Turn	N-S	1		3	0	1		3	1			1	0			1	0
Partial Median U-Turn	N-S	1		3	0	1		3	1		1	1	0		0	1	0

1.4 A – CAP-X INPUTS: QUADRANT ROADWAY INTERSECTION

Quadrant Roadway Intersection (S-W)

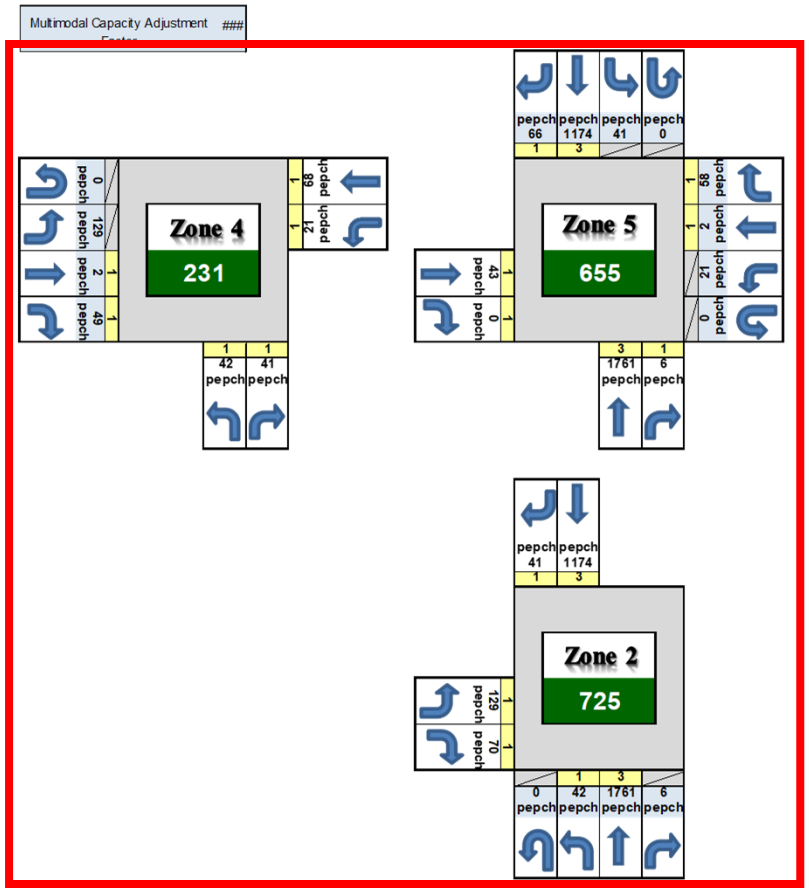
Design and Results

		Volume-to-Capacity Ratio			
Project Name:	SR 535 at Meadow Creek Drive ICE Training	< 0.750	0.750 - 0.875	0.875 - 1.00	≥ 1.00
Project Number:	XXXXX.XX	VOLUME / CAPACITY RATIO:		0.41	
Location	Orlando, FL				
Date	2016 AM				



Quadrant Roadway Intersection (S-W)

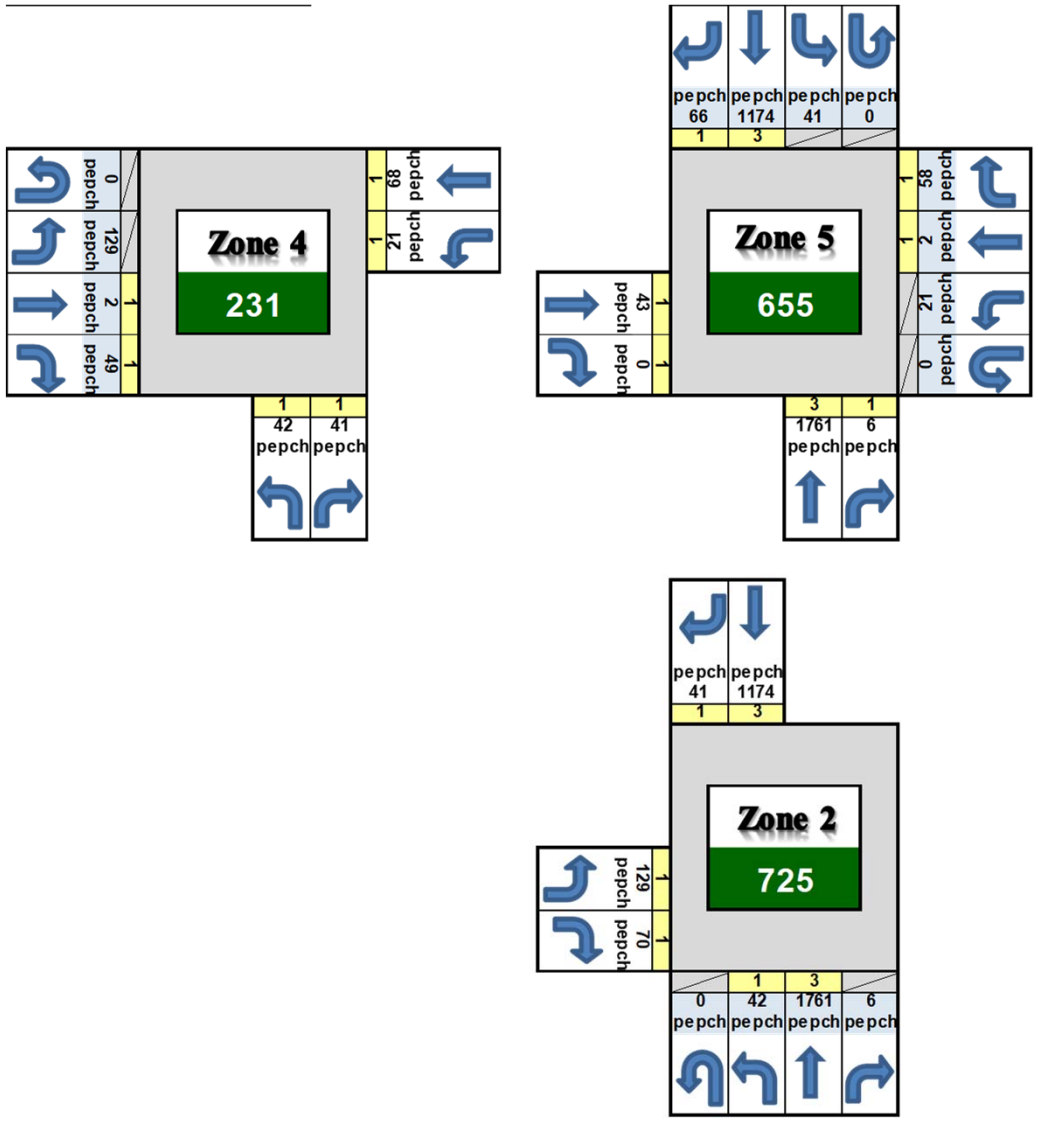
Data Input and Configuration



Back to Results

1 - Volume Input | 2 - Base and Alt Sel | 3 - Alt Num Lanes Input | 4a - Detailed Results | 4b - Summary Results | 5a - Summary Report | 5b - Detailed Report | Traffic Signal | QR S-W

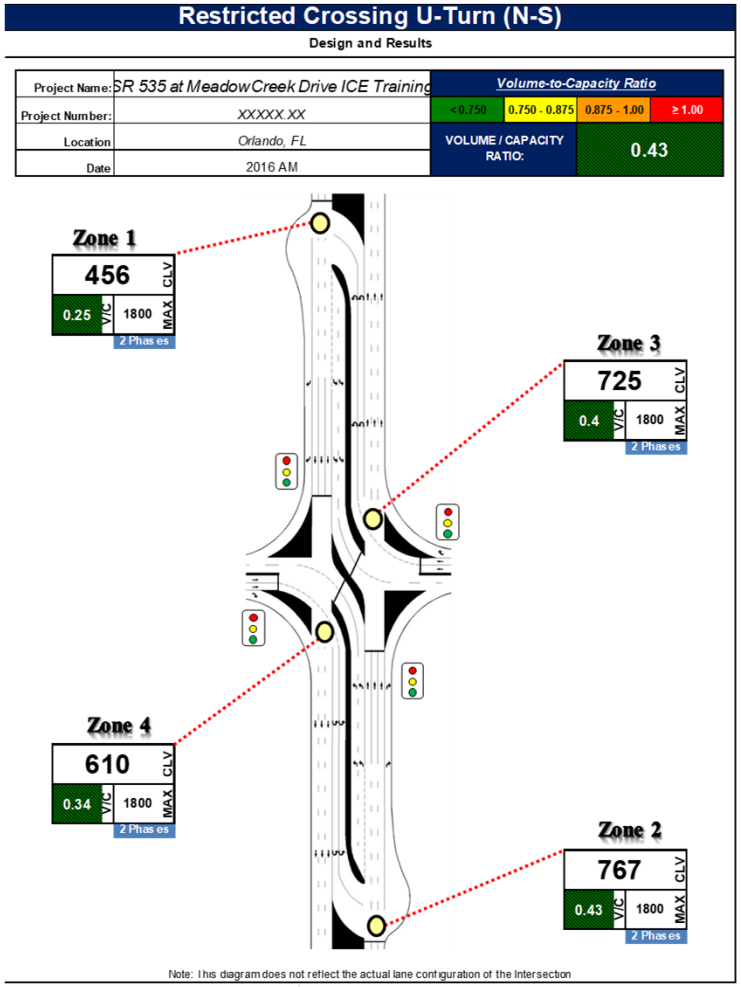
1.4 A – CAP-X INPUTS: QUADRANT ROADWAY

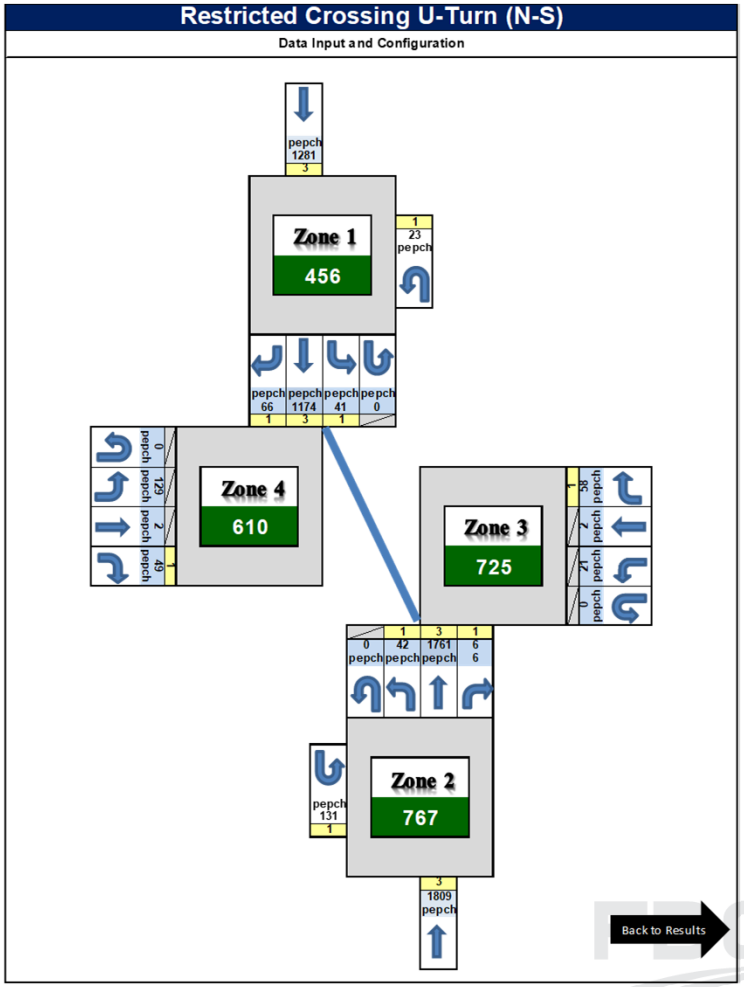


1 - Volume Input | 2 - Base and Alt Sel | 3 - Alt Num Lanes Input | 4a - Detailed Results | 4b - Summary Results | 5a - Summary Report | 5b - Detailed Report | Traffic Signal | QR S-W

1.4 A – CAP-X INTERSECTION OUTPUT

- Evaluation for each intersection alternative is presented using CMA
- Graphical intersection representation does not update with no. of lanes input





1.4 A – CAP-X MULTIMODAL ACCOMMODATIONS CONSIDERATIONS

- Multi-Modal Accommodation Framework custom-developed for FDOT
- Not true safety prediction, but more qualitative assessment
- Framework considers range of factors:
  - crossing control (signal vs. uncontrolled)
  - crossing width (short vs. long)
  - vehicle speed (slow vs. fast)
  - volume (high vs. low)
  - out-of-direction travel
- Factors evaluated for each crossing at each of the intersections
- Score aggregated across modes for entire intersection
- Weighting Factors: Pedestrians (x3), Bicycles (x2), Transit (x1)

1.4 A – CAP-X MM CONSIDERATIONS AND SCORING EXAMPLES

Multimodal Scoring Framework (1 - poor; 2 - adequate; 3 - good)					
Control Type	**Speed**	**Exposure**	**Ped**	**Bike**	**Transit**
Yield/Uncontrolled	Slow	Short	3	3	-
	Slow	Long	2	3	-
	Fast	Short	2	2	-
	Fast	Long	1	2	-
Signalized	Slow	Short	3	3	-
	Slow	Long	2	3	-
	Fast	Short	3	3	-
	Fast	Long	2	2	-
No accommodations	N/A		1	1	1
Out of direction travel			-	-	2
Same As Signal			-	-	3

	Major Street Scores			Minor Street Scores		
Type	**Ped**	**Bike**	**Transit**	**Ped**	**Bike**	**Transit**
	Scoring Results			Scoring Results		
Conventional Traffic Signal	2	2	3	3	3	3
Conventional Signal Shared RTLT	2	2	3	3	3	3
Two-Way Stop Control	1	2	3	3	3	3
All-Way Stop Control	3	3	3	3	3	3
Partial Displaced Left Turn	2	2	3	2	2	3
Displaced Left Turn	2	2	3	2	2	3
RCUT	3	3	3	3	3	2
Unsignalized RCUT	2	2	3	3	3	2
MUT	3	3	3	3	3	2

1.4 A – CAP-X FULL OUTPUT

- Full results provided for each zone of each alternative
- Includes multimodal details based on specified level of activity

Project Name:	SR 535 at Meadow Creek Drive ICE Training	*Estimated Volume-to-Capacity Ratio*			
Project Number:	XXXXX.XX	Number of Configurations			
Location	Orlando, FL	< 0.750	0.750 - 0.875	0.875 - 1.00	≥ 1.00
Date	2016 AM	7	0	0	0

Results for Non-roundabout Intersections

TYPE OF INTERSECTION	Sheet	Zone 1 (North)		Zone 2 (South)		Zone 3 (East)		Zone 4 (West)		Zone 5 (Center)		Overall v/c Ratio	Pedestrian Accommodations	Bicycle Accommodations	Transit Accommodations
		CLV	V/C	CLV	V/C	CLV	V/C	CLV	V/C	CLV	V/C				
Traffic Signal	FULL									851	0.56	0.56	Fair	Fair	Good
Quadrant Roadway	S-W			725	0.41			231	0.13	655	0.36	0.41	Fair	Fair	Fair
Partial Displaced Left Turn	N-S	692	0.38	459	0.25					806	0.46	0.46	Fair	Fair	Good
Displaced Left Turn	FULL	692	0.38	459	0.25	71	0.04	180	0.10	725	0.40	0.40	Fair	Fair	Good
Signalized Restricted Crossing U-Turn	N-S	456	0.25	767	0.43	725	0.40	610	0.34			0.43	Good	Good	Fair
Median U-Turn	N-S	506	0.28	816	0.45					755	0.42	0.45	Good	Good	Fair
Partial Median U-Turn	N-S	480	0.27	654	0.36					820	0.47	0.47	Good	Good	Fair

1.4 A – CAP-X SUMMARY OUTPUTS

- Summary with dynamic rankings based on V/C
- Includes multimodal details based on level of activity (based purely on intersection control)

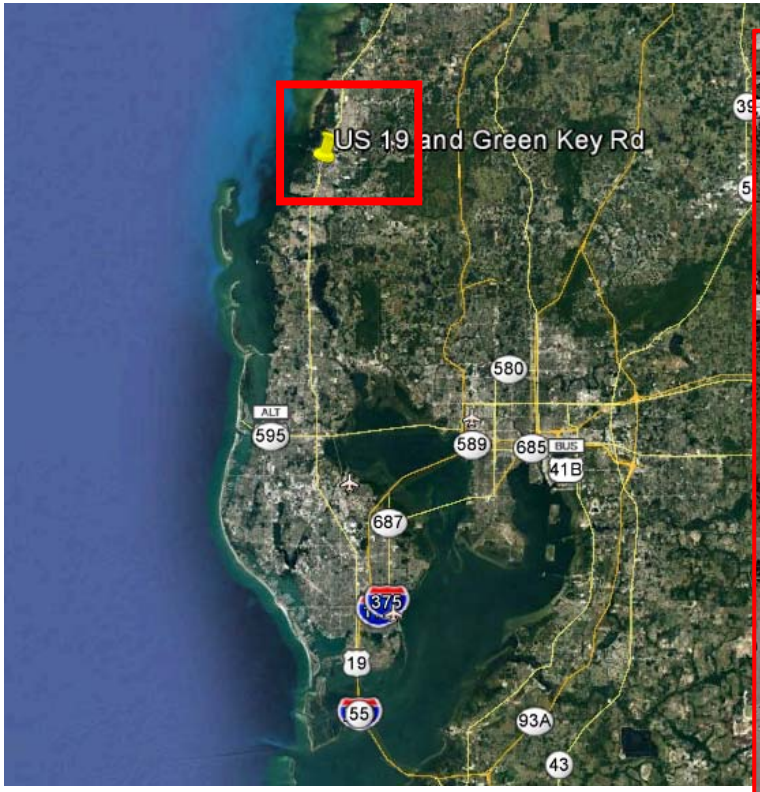
TYPE OF INTERSECTION	Overall V/C Ratio	V/C Ranking	Multimodal Score	Pedestrian Accommodations	Bicycle Accommodations	Transit Accommodations
Displaced Left Turn	0.40	1	4.8	Fair	Fair	Good
Quadrant Roadway S-W	0.41	2	4.4	Fair	Fair	Fair
Signalized Restricted Crossing U-Turn N-S	0.43	3	6.3	Good	Good	Fair
Median U-Turn N-S	0.45	4	6.3	Good	Good	Fair
Partial Displaced Left Turn N-S	0.46	5	4.8	Fair	Fair	Good
Partial Median U-Turn N-S	0.47	6	6.3	Good	Good	Fair
Traffic Signal	0.56	7	4.8	Fair	Fair	Good

1.4 A – CAP-X IN FDOT ICE FORMS – STAGE 1

Control Strategy Evaluation						
Provide a brief justification as to why each of the following control strategies should be advanced or not. Justification should consider potential environmental impacts.						
Control Strategy	CAP-X Outputs			SPICE Ranking	Strategy to Be Advanced?	Justification
	V/C Ratio		Multimodal Score			
	Weekday AM Peak	Weekday PM Peak				
Two-Way Stop-Controlled	-	-	-			
All-Way Stop-Controlled	-	-	-			
Signalized Control	0.56	0.68	4.8			
Roundabout	-	-	-			
Median U-Turn	0.45 (Full) 0.47 (Partial)	0.53 (Full) 0.57 (Partial)	6.3 (Both)			
RCUT (Signalized)	0.43	0.57	6.3			
RCUT (Unsignalized)	-	-	-			
Jughandle						
Displaced Left-Turn	0.40 (Full) 0.46 (Partial)	0.50 (Full) 0.55 (Partial)	4.8 (Both)			
Continuous Green Tee	-	-	-			
Quadrant Roadway	0.41	0.55	4.4			

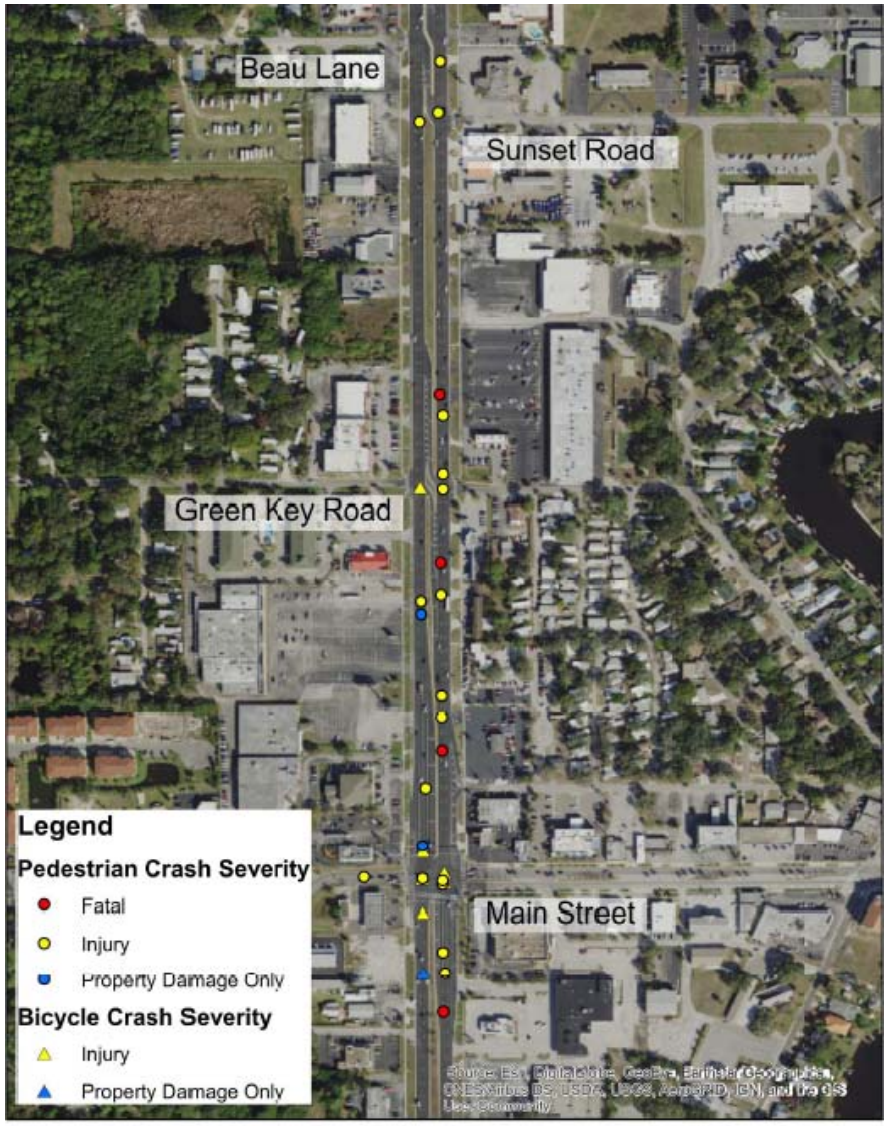
SCENARIO WITH BI-DIRECTIONAL MEDIAN OPENING

SCENARIO WITH BI-DIRECTIONAL MEDIAN OPENING



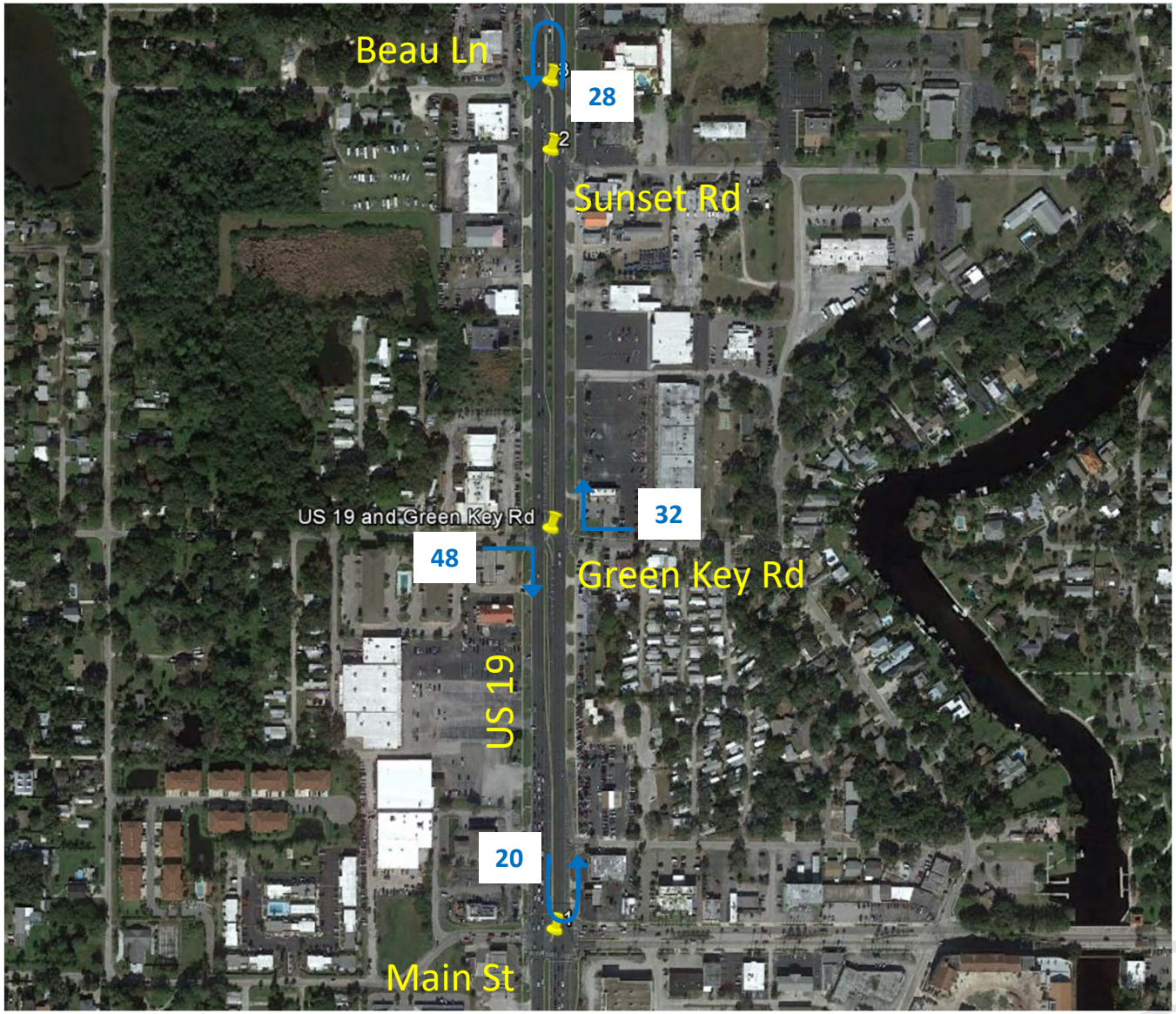
- Currently TWSC with bidirectional median opening
- Multiple pedestrian fatalities in the vicinity

BI-DIRECTIONAL MEDIAN: US 19 / GREEN KEY RD – SAFETY OVERVIEW



- 2012 – 2016 Crash Data Summary:
  - 53 Total Crashes
  - 2 Fatalities
    - Pedestrian crashes
  - 20 Injury Crashes
  - 30 Property Damage Only Crashes
- 2 additional pedestrian fatalities south of Green Key Rd
- 2017 – 2018 Crash Data from Signal Four Analytics
  - 38 Total Crashes
    - 12 Injury Crashes
    - 26 Property Damage Only
    - No fatalities

BI-DIRECTIONAL MEDIAN: US 19 / GREEN KEY RD – PM VOLUMES



1.4 A – CAP-X INPUTS

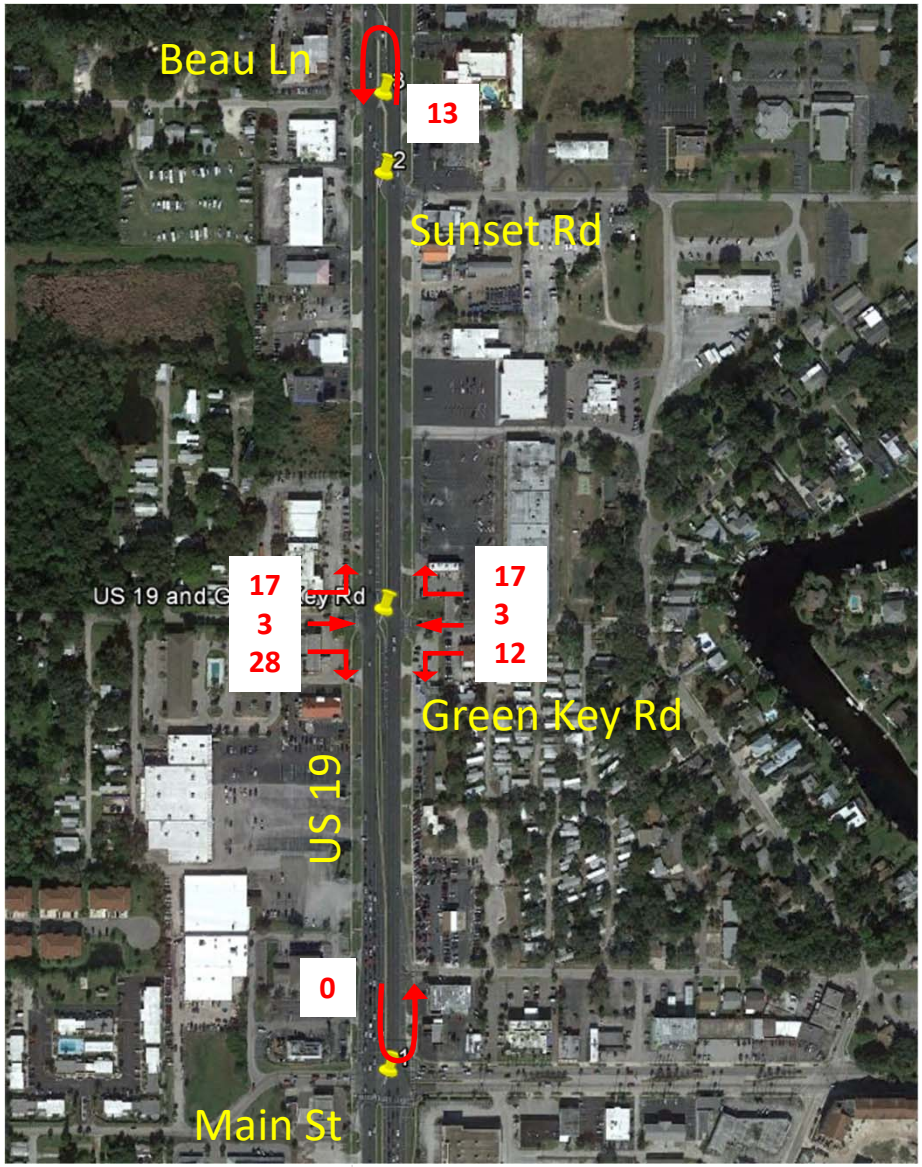
Traffic Volume Demand						
	Volume (Veh/hr)				Percent (%)	
	U-Turn	Left	Thru	Right	Heavy Vehicles	Volume Growth
Eastbound	0	17	3	28	2.20%	0.00%
Westbound	0	12	3	17	0.00%	0.00%
Southbound	27	48	1722	44	2.00%	0.00%
Northbound	37	51	2496	25	2.00%	0.00%
Adjustment Factor	0.80	0.95		0.85		
Suggested	**0.80**	**0.95**		**0.85**		
Truck to PCE Factor				**Suggested = 2.00**	2.00	
FDOT Context Zone				**C3C-Suburban Commercial**		
Critical Lane Volume Threshold		2-phase signal		**Suggested = 1800**	**1800**	
		3-phase signal		**Suggested = 1750**	**1750**	
		4-phase signal		**Suggested = 1700**	**1700**	

Equivalent Passenger Car Volume				
	Volume (Veh/hr)			
	U-Turn	Left	Thru	Right
Eastbound	0	17	3	28
Westbound	0	12	3	17
Southbound	28	49	1756	45
Northbound	38	52	2546	26

- CAP-X is set up for the existing intersection to be either signalized or two-way stop controlled
  - Data needs are TMCs at study intersection
- Existing conditions: bi-directional median opening
  - Data needs include downstream intersections with U-turn movements
- **Use engineering judgement to redistribute volumes**

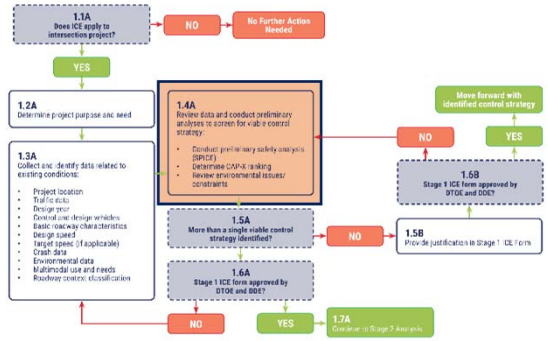
Introduction | Abbreviations & Assumptions | 1 - Volume Input | 2 - Base and Alt Sel | 3 - Alt Num Lanes Input | 4a - Detailed Results | 4b - Summary Results | 5a - Summary Report | 5b - Detailed Report

US 19 / GREEN KEY RD – VOLUME REDISTRIBUTION



- TMCs data collection included intersections with U-turn movements allowed
- Use U-turn information to guide redistribution of existing counts

1.4 A – CONDUCT SPICE



ICE Procedure and Tools		
Stage 1	CAP-X	SPICE
Stage 2	Analysis Guidance	Default SYNCHRO, FDOT ICE Tool
Stage 3	No specific tools. Reuse Stage 2 tools or address qualitative issues.	

SPICE is used in both: Stage 1 and Stage 2 analyses

TOOLS

SPICE – STAGE 1

FDOT

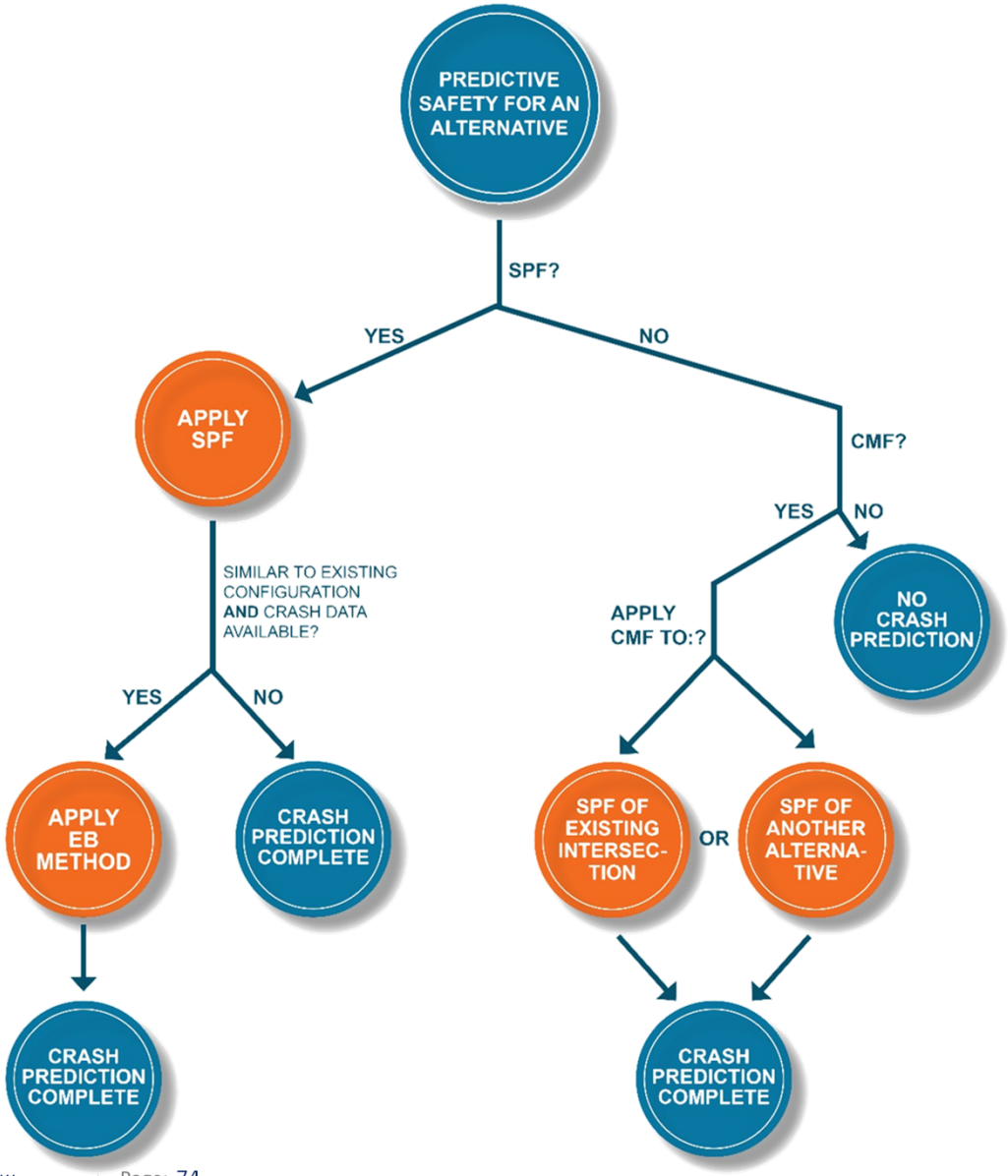
1.4 A – VISION AND NEED FOR THE SPICE TOOL

- Safety Performance Intersection Control Evaluations (SPICE)
- Safety comparisons of intersections becoming more common – ICE, increased use of HSM in general, etc.
- FHWA recognizes everyone is struggling with them
  - Which Crash Modification Factor (CMF) is *right*?
  - What should the CMF be applied to (existing, another alt, etc.)?
  - New Safety Performance Functions (SPFs) being produced through NCHRP (such as 6 and 8 lane arterials/roundabouts) and FDOT research for RCUTs.
- Simple tool needed for safety comparisons only
  - Same level of effort as CAP-X

1.4 A – SPICE TOOL OVERVIEW

- Performs predictive safety analysis of at-grade intersection alternatives/control types and ramp terminal intersections
  - Implements the methodologies of the Highway Safety Manual (HSM)
  - For interchanges, only analyzes ramp terminals for diamond (D4)
- Developed with goal to be user-friendly
  - Only requires data inputs readily available to the analyst
  - Option to conduct planning level analysis
- Allows simultaneous evaluation of multiple alternatives and control types
- Tool will work for vast majority of intersections
- Development of FHWA SPICE tool ongoing
- Preliminary FDOT version now available

1.4 A – SPICE TOOL OVERVIEW



1.4 A – SPICE – INTRODUCTION

Federal Highway Administration (FHWA)

Safety Performance for Intersection Control Evaluation Tool

Introduction	Overview
The Safety Performance for Intersection Control Evaluation (SPICE) Tool was developed to provide an easy-to-use tool that automates the predictive safety analysis of intersections. This tool will allow analysts conducting Intersection Control Evaluations (ICE) to be equipped with necessary safety information during the decision-making process, without having to research a myriad of crash modification factors (CMFs) and Safety Performance Functions (SPFs) in multiple sources. The SPICE tool will perform a comparative predictive safety analysis of different intersection control strategies. The results – crash frequency and severity for each alternative – will then enable safety performance of alternatives to be considered quantitatively like traffic operations, construction cost, maintenance cost, or other factors.	The SPICE Tool performs safety analysis of at-grade intersection forms/control types and ramp terminal intersections of diamond interchanges. This user-friendly tool requires only data inputs that are readily available to the analyst. In addition, the SPICE tool has an option to conduct planning level analysis, where the tool assumes default values for data inputs that are challenging to obtain in the early stages of a project and/or have a very minor impact on the results. The SPICE tool assumes that certain attributes of the intersection – AADT, facility type, and number of legs – are the same for all alternatives. If they are not, users will be required to use the tool twice to get results. The tool will not allow simultaneous evaluation of at-grade intersections and ramp terminal intersections. For projects where analysis of both intersections and interchanges is needed, users are required use the tool twice to get results.

Worksheets

Project Information: Provide general project information for reference purposes only.

Definitions: Reference sheet with additional information related to inputs for the SPICE tool.

Control Strategy Selection: Choose between At-Grade or Ramp Terminal intersection types to be included in the SPICE analysis.

At-Grade Inputs: SPF and Part C CMF inputs for At-Grade intersections (hidden if Ramp Terminals are being analyzed).

Ramp Terminal Inputs: SPF and Part C CMF inputs for Ramp Terminal intersections (hidden if At-Grade intersections are being analyzed).

Calibration: Input optional override values for SPF calibration factors from locally-developed or updated information.

Results: Summary of opening year and (if applicable) design year and total project life cycle crash frequency and crash severity.

Additional Worksheets: Additional worksheets to support the underlying Macros. Not to be updated by users unless updating future tool versions.

Maintenance	Input Legend	
Version: SPICE Tool 1.0		Required data entry field
Maintained By: TBD		Optional data entry field
Contact Information: TBD		Planning-Level Default Input
Disclaimer		Data entry field not used

Disclaimers may be added, if needed.

1.4 A – SPICE: INPUTS AND CONTROL STRATEGY SELECTION

Control Strategy Selection and Inputs

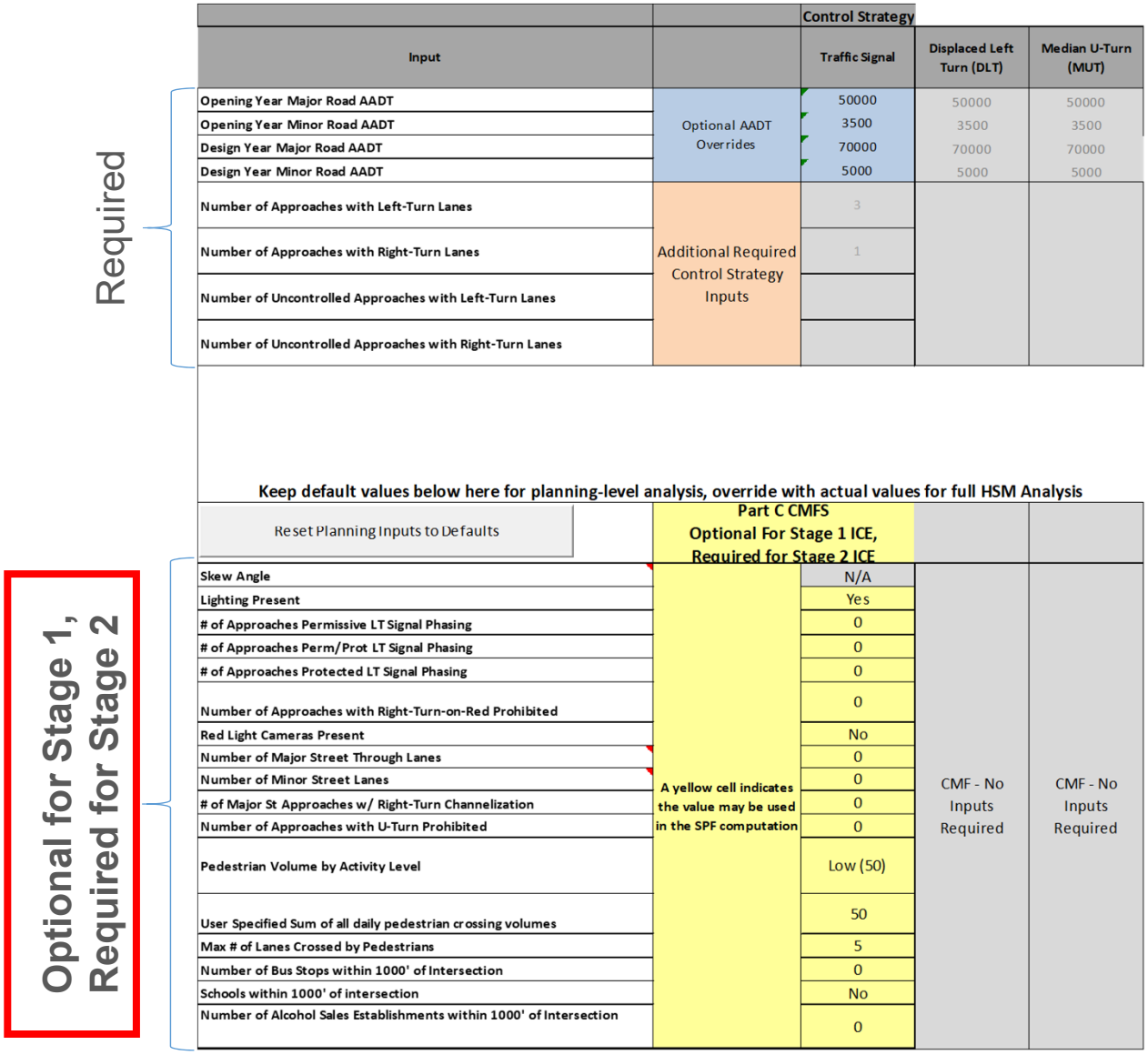
Specify the Facility Level Inputs and the Control Strategies to be included in the SPICE Analysis.

Intersection Type	At-Grade Intersections
Analysis Year	Opening and Design Year
Opening Year	2020
Design Year	2040
Facility Type	On Urban and Suburban Arterial
Number of Legs	4-leg
1-Way/2-Way	2-way Intersecting 2-way
# of Major Street Lanes (both directions)	6 or more
Major Street Approach Speed	Less than 55 mph
Opening Year - Major Road AADT	50,000
Opening Year - Minor Road AADT	3,500
Design Year - Major Road AADT	70,000
Design Year - Minor Road AADT	5,000

For more information on how to determine these values, see the "Definitions" worksheet

Control Strategy	Include	Base Intersection		
Traffic Signal	Yes	--		
Traffic Signal (Alternative Configuration)	No	--		
Minor Road Stop	No	--		Design Year AADT Outside of SPF Development Range
All Way Stop	No	--		
1-Lane Roundabout	No	--	Opening Year AADT Outside of SPF Development Range	Design Year AADT Outside of SPF Development Range
2-Lane Roundabout	No	--	Opening Year AADT Outside of SPF Development Range	Design Year AADT Outside of SPF Development Range
Displaced Left Turn (DLT)	Yes	Traffic Signal		
Median U-Turn (MUT)	Yes	Traffic Signal		
Signalized Restricted Crossing U-Turn (RCUT)	Yes	--		Design Year AADT Outside of SPF Development Range
Unsignalized Restricted Crossing U-Turn (RCUT	No	--	Opening Year AADT Outside of SPF Development Range	Design Year AADT Outside of SPF Development Range
Continuous Green-T Intersection	No	Traffic Signal		
Jughandle	Yes	Traffic Signal		
Other 1	No	Traffic Signal	*Please Select	
Other 2	No	Minor Road Stop	*Please Select	

1.4 A – SPICE: AT-GRADE INTERSECTION INPUTS



Input		Control Strategy: Traffic Signal	Displaced Left Turn (DLT)	Median U-Turn (MUT)
Opening Year Major Road AADT	Optional AADT Overrides	50000	50000	50000
Opening Year Minor Road AADT		3500	3500	3500
Design Year Major Road AADT		70000	70000	70000
Design Year Minor Road AADT		5000	5000	5000
Number of Approaches with Left-Turn Lanes	Additional Required Control Strategy Inputs	3		
Number of Approaches with Right-Turn Lanes		1		
Number of Uncontrolled Approaches with Left-Turn Lanes				
Number of Uncontrolled Approaches with Right-Turn Lanes				

Required

Keep default values below here for planning-level analysis, override with actual values for full HSM Analysis

Reset Planning Inputs to Defaults	Part C CMFS Optional For Stage 1 ICE, Required for Stage 2 ICE			
Skew Angle	A yellow cell indicates the value may be used in the SPF computation	N/A	CMF - No Inputs Required	CMF - No Inputs Required
Lighting Present		Yes		
# of Approaches Permissive LT Signal Phasing		0		
# of Approaches Perm/Prot LT Signal Phasing		0		
# of Approaches Protected LT Signal Phasing		0		
Number of Approaches with Right-Turn-on-Red Prohibited		0		
Red Light Cameras Present		No		
Number of Major Street Through Lanes		0		
Number of Minor Street Lanes		0		
# of Major St Approaches w/ Right-Turn Channelization		0		
Number of Approaches with U-Turn Prohibited		0		
Pedestrian Volume by Activity Level		Low (50)		
User Specified Sum of all daily pedestrian crossing volumes		50		
Max # of Lanes Crossed by Pedestrians		5		
Number of Bus Stops within 1000' of Intersection		0		
Schools within 1000' of intersection		No		
Number of Alcohol Sales Establishments within 1000' of Intersection		0		

Optional for Stage 1, Required for Stage 2

Intersection Control Evaluation: Overview | Page: 77

Introduction | Project Information | Definitions | Control Strategy Selection | At-Grade Inputs | Calibration | Historical | Results | Notes | User Selections | Labels

- AADT Volumes for major/minor roads for the opening and design years
- Number of major approaches with left-turn or right-turn lanes
- Stage 1 - Pre-filled planning-level defaults
  - Can be overridden by analyst
- Stage 2 - Detailed information for CMF Analysis

At-Grade Intersection to include in SPICE Tool

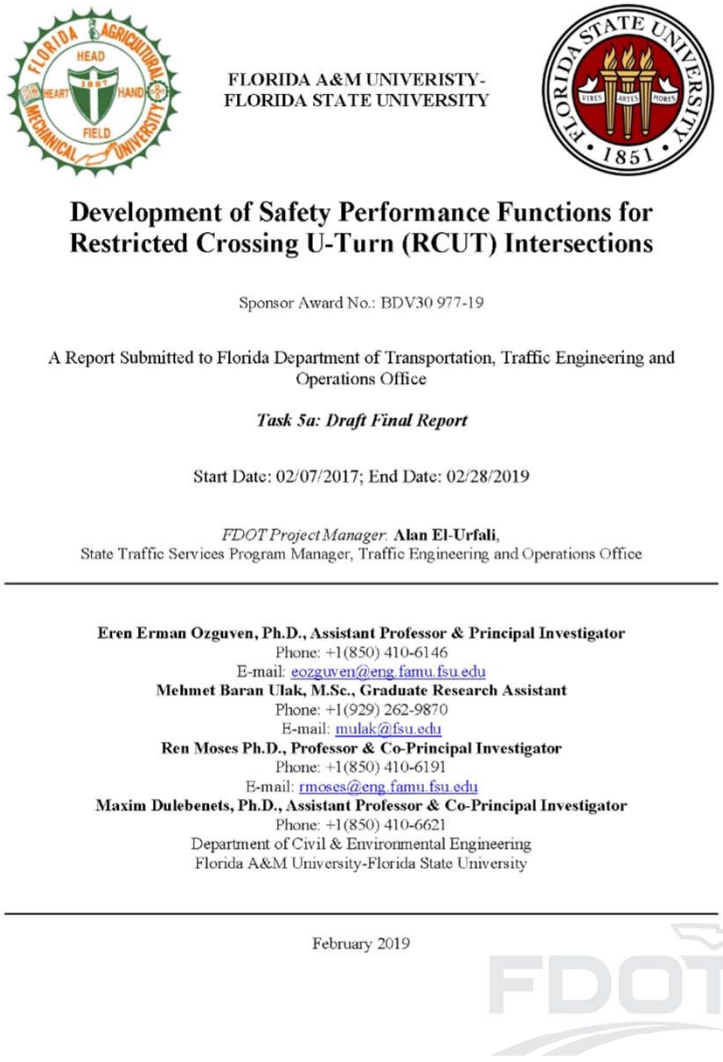
Traffic Signal	On Rural Two Lane Highway	3 leg	-	-	1	SPF under development in 17-68
	On Rural Multilane Highway	3 leg	-	-	3	SPF under development in 17-68
		3 leg	2x2	6 or more	7	SPF from 17-58
		4 leg	2x2	6 or more	8	SPF from 17-58
		3 leg	1x2	-	9	SPF from 17-58
		4 leg	1x2	-	10	SPF from 17-58
		3 leg	1x1	-	11	SPF from 17-58
		4 leg	1x1	-	12	SPF from 17-58
		5 leg	-		13	SPF under development in 17-68
	On High Speed (50+ MPH) Urban and Suburban Arterial	3 leg	-	-	14	SPF under development in 17-68
		4 leg	-	-	15	SPF under development in 17-68
		5 leg	-	-	18	SPF under development in 17-68
		3 leg	2x2	6 or more	23	SPF from 17-58
		4 leg	2x2	6 or more	24	SPF from 17-58
		3 leg	1x2	-	25	SPF from 17-58
		4 leg	1x2	-	26	SPF from 17-58
		3 leg	1x1	-	27	SPF from 17-58
		4 leg	1x1	-	28	SPF from 17-58
	On High Speed (50+ MPH) Urban and Suburban Arterial	3 leg	-	-	29	SPF under development in 17-68
		4 leg	-	-	30	SPF under development in 17-68
All-Way Stop	On Rural Two Lane Highway	4 leg	-	-	31	SPF under development in 17-68
	On Urban and Suburban Arterial	3 leg	-	-	32	SPF under development in 17-68
	On Urban and Suburban Arterial	4 leg	-	-	33	SPF under development in 17-68

Legend

Completed SPF - include in SPICE Tool
SPF Under Development - Include in SPICE Tool
Exclude from SPICE Tool

RCUT SPFs

- HSM does not have SPFs for RCUTs, none planned for HSM 2
- FDOT developed their own
  - Data from 14 states, but not FL (no RCUTs)
  - Majority of US RCUTs



FLORIDA A&M UNIVERISTY-
FLORIDA STATE UNIVERSITY

Development of Safety Performance Functions for Restricted Crossing U-Turn (RCUT) Intersections

Sponsor Award No.: BDV30 977-19

A Report Submitted to Florida Department of Transportation, Traffic Engineering and Operations Office

Task 5a: Draft Final Report

Start Date: 02/07/2017; End Date: 02/28/2019

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State Traffic Services Program Manager, Traffic Engineering and Operations Office

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Department of Civil & Environmental Engineering
Florida A&M University-Florida State University

February 2019

RCUT SPF Inputs

	S	U	Definition
Major Road AADT	X	X	Maximum of the two major approach AADTs
Minor Road AADT	X	X	Maximum of the two minor approach AADTs
# U-Turns	X	X	# of U-turn crossovers (1 or 2), not # of U-turn lanes
# Major Roadway Lanes	X		# of entering lanes on major approach with most entering lanes
Total Offset Distance (ft)	X		Sum of distances between center of the intx and each crossover
Number of Driveways	X	X	Driveways within whole footprint (crossover to crossover)
Total Decel. Lane Length (ft)	X	X	Sum of length of deceleration lanes at each crossover
Total Accel Lane Length (ft)		X	Sum of length of accel lanes at each crossover
# of Left Turn Lanes	X		Max # of left turn lanes from major road to minor road
Major Road Speed Limit (mph)	X		Major approach speed limit
Total Median Width (ft)	X		Sum of median widths on both major street approaches
Max Median Width (ft)		X	Maximum of the median width on each major street approach

S = Signalized RCUT, U = Unsignalized RCUT

RCUT SPFs Limitations

- Major road AADTs above 65K will experience higher crashes
- When minor road AADTs are higher than 17,500 higher crashes can be expected
- Minor road AADT's threshold decreases with major volumes > 55K AADT

Major Road AADT	Ratio Factor	Minor Road AADT Limit
5,000	1.059	5,300
15,000	0.825	12,370
25,000	0.642	16,050
35,000	0.500	17,500
45,000	0.390	17,530
55,000	0.303	16,690
65,000	0.236	15,360

1.4 A – SPICE: CRASH PREDICTION OUTPUTS

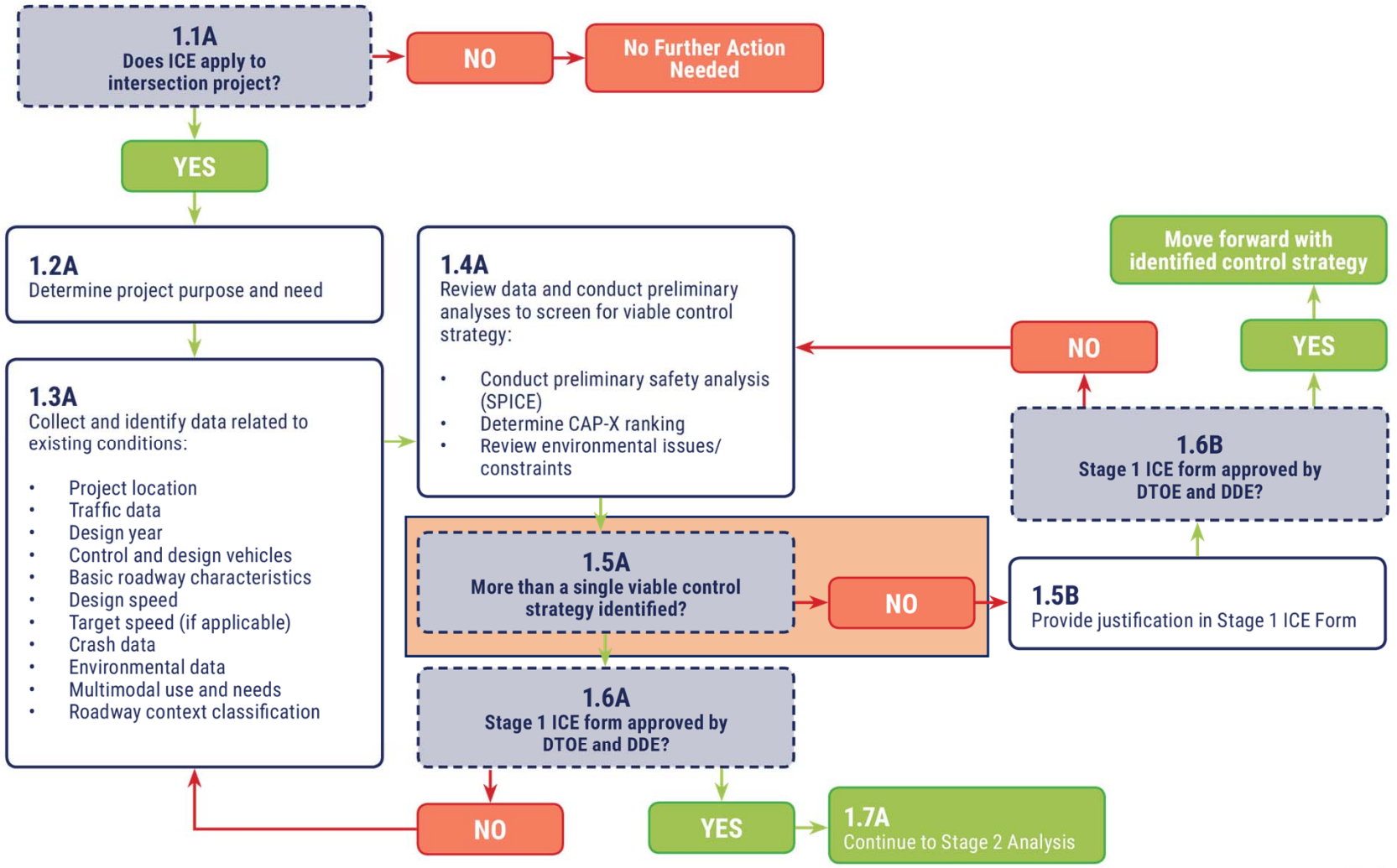
- Computes predicted crashes for all selected control strategy types
- Predicted crashes are broken into “Total” and “Fatal & Injury” groups
- Ranking is based on “Fatal & Injury” crashes.

Crash Prediction Summary							
Control Strategy	**Crash Type**	**Opening Year**	**Design Year**	**Total Project Life Cycle**	**Rank**	**AADT Within Prediction Range?**	**Source of Prediction**
Traffic Signal	Total	7.65	9.37	179.06	5	Yes	Uncalibrated SPF
	Fatal & Injury	4.12	5.11	97.12			
Displaced Left Turn (DLT)	Total	6.73	8.24	157.58	3	N/A	CMF
	Fatal & Injury	3.62	4.50	85.47			
Median U-Turn (MUT)	Total	6.50	7.96	152.20	1	N/A	CMF
	Fatal & Injury	2.88	3.58	67.99			
Signalized RCUT	Total	13.07	22.12	366.83	4	No	Uncalibrated SPF
	Fatal & Injury	3.30	5.83	94.91			
Jughandle	Total	5.66	6.93	132.51	2	N/A	CMF
	Fatal & Injury	3.05	3.78	71.87			

1.4 A – SPICE IN FDOT ICE FORMS – STAGE 1

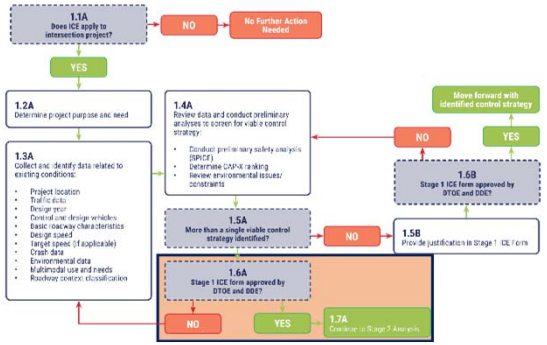
Control Strategy Evaluation						
Provide a brief justification as to why each of the following control strategies should be advanced or not. Justification should consider potential environmental impacts.						
Control Strategy	CAP-X Outputs			SPICE Ranking	Strategy to Be Advanced?	Justification
	V/C Ratio		Multimodal Score			
	Weekday AM Peak	Weekday PM Peak				
Two-Way Stop-Controlled	-	-	-	-	No	Currently a signalized intersection.
All-Way Stop-Controlled	-	-	-	-	No	Currently a signalized intersection.
Signalized Control	0.56	0.68	4.8	5	Yes	The existing condition will move forward in the analysis as the future no-build condition.
Roundabout	-	-	-	-	No	
Median U-Turn	0.45 (Full) 0.47 (Partial)	0.53 (Full) 0.57 (Partial)	6.3 (Both)	1	Yes	The full MUT would force EB/WB left turns to drive straight through the intersection with limited U-turn locations available on the minor street legs. The
RCUT (Signalized)	0.43	0.57	6.3	4	Yes	
RCUT (Unsignalized)	-	-	-	-	No	
Jughandle				2	No	ROW impacts would outweigh the benefit.
Displaced Left-Turn	0.40 (Full) 0.46 (Partial)	0.50 (Full) 0.55 (Partial)	4.8 (Both)	3	Yes	Low left turning volume from the minor road to justify the associated costs with a full DLT. The study intersection has heavier left turning volumes
Continuous Green Tee	-	-	-	-	No	The study intersection is a 4-leg intersection and a Green T is not feasible.
Quadrant Roadway	0.41	0.55	4.4		No	The re-routing of the left turns at the study intersection would not represent a significant operational improvement. The roadway network

ICE STAGE 1 PROCESS



Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Figure 2; Page 10

1.6 A – ICE FORM APPROVAL



Resolution					
To be filled out by FDOT District Traffic Operations Engineer and District Design Engineer					
Project Determination	Multiple Viable Alternatives Identified: Continue to Stage 2				
Comments					
DTOE Name		Signature		Date	
DDE Name		Signature		Date	

ICE ANALYSIS IN PD&E PROJECT – STAGE 1

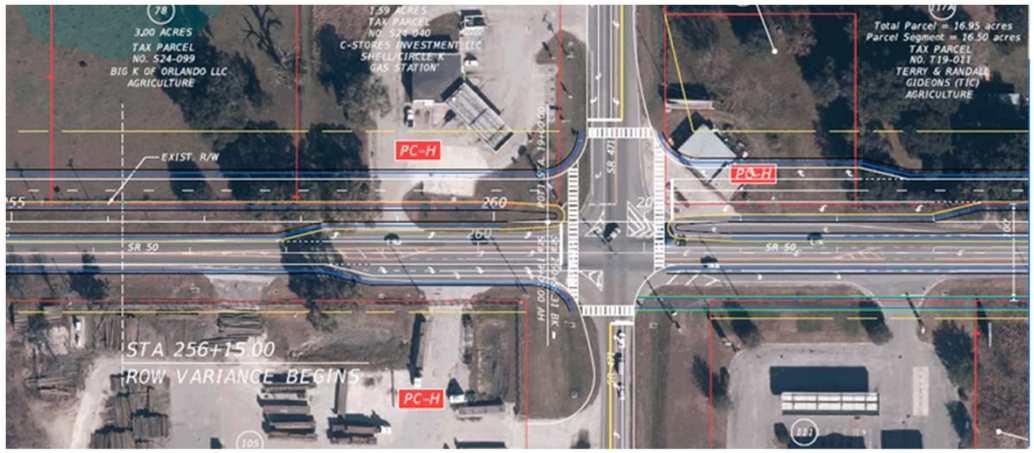
- Conduct as part of PD&E's Alternatives Analysis
- Typically applicable to roadway widening projects, new alignments or major intersection upgrades
- Project Traffic Analysis Report (PTAR) identifies existing and potential signalized intersections in design year
    - Candidates for ICE analysis
- Conduct Stage 1 ICE using design year volumes and future lane geometry from PTAR
    - Assume signalized intersection to be base condition

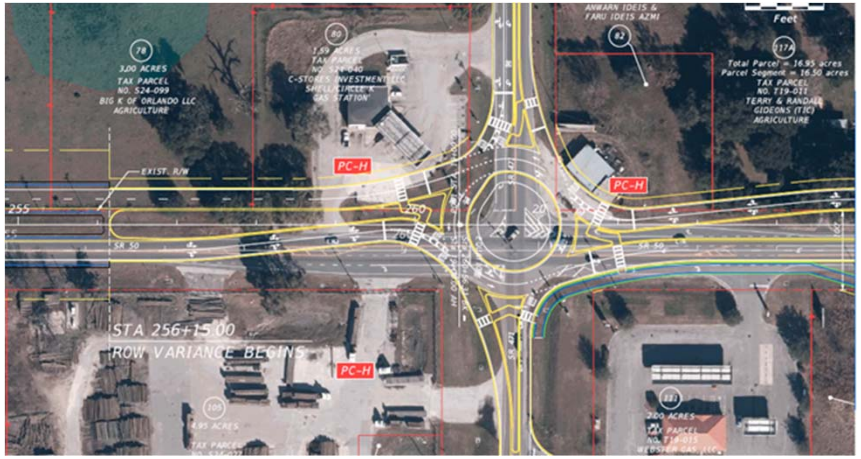
ICE ANALYSIS IN PD&E PROJECT – STAGE 2

- Conduct Stage 2 ICE using PTAR's opening and design year volumes
  - Stage 2 concept development, ROW and construction cost estimates are part of PD&E Alternatives Analysis
- Suggest Stage 2 ICE be completed before Alternatives Public Workshop
  - Workshop should show best innovative intersection(s) plus signalized intersection to gain public feedback
- Stage 3 ICE is not required for PD&E projects as unanswered Stage 2 issues become a part of PD&E process

STAGE 2 ROW & CONSTRUCTION ESTIMATES

- Estimates need to start and end at same location for all alternatives
  - Need to consider changes in R/W requirements and costs
- Example 2 lane to 4 lane widening PD&E
  - Traffic signal and Roundabout

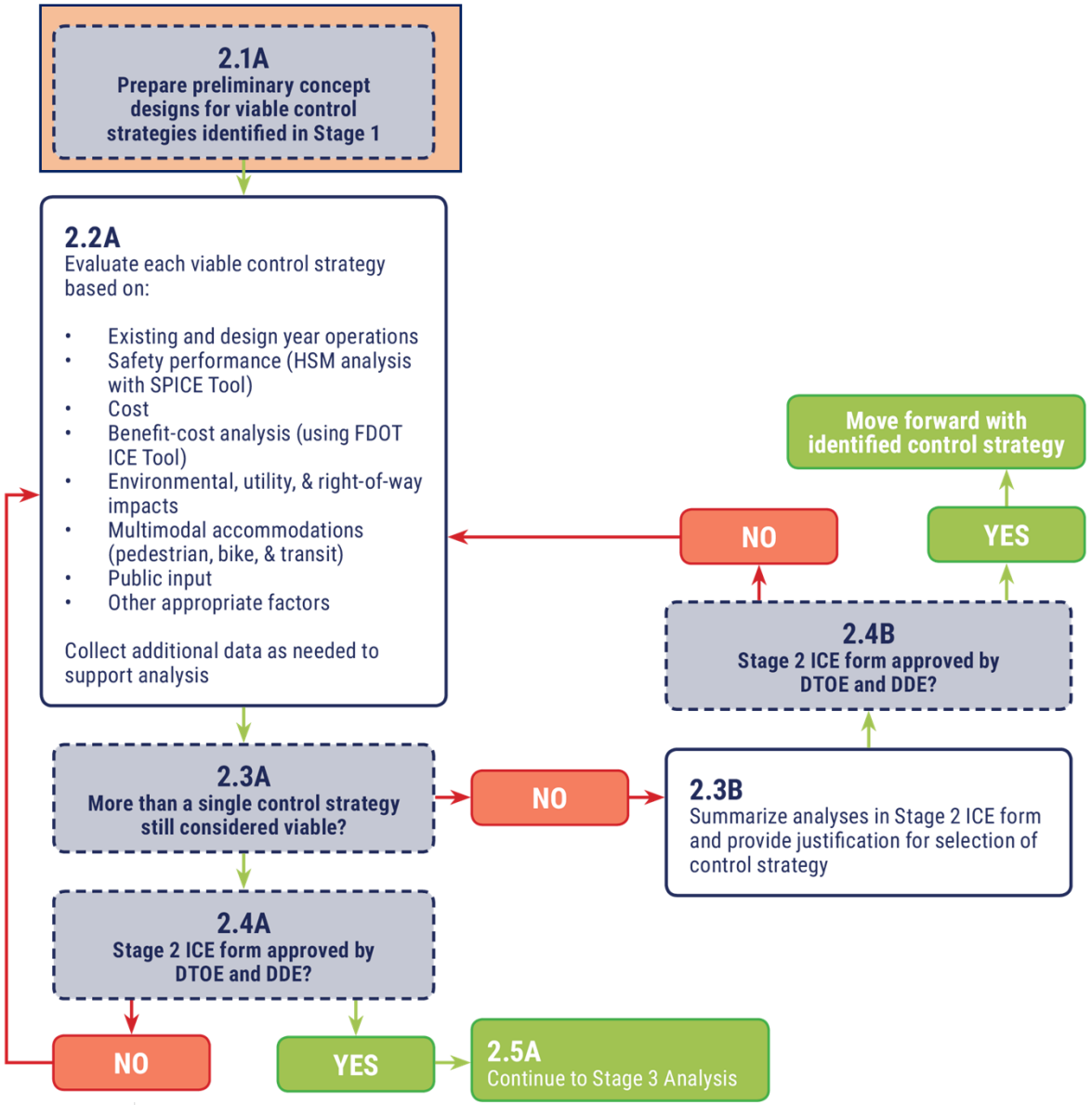




PROCESS WALKTHROUGH

STAGE 2

ICE STAGE 2 PROCESS



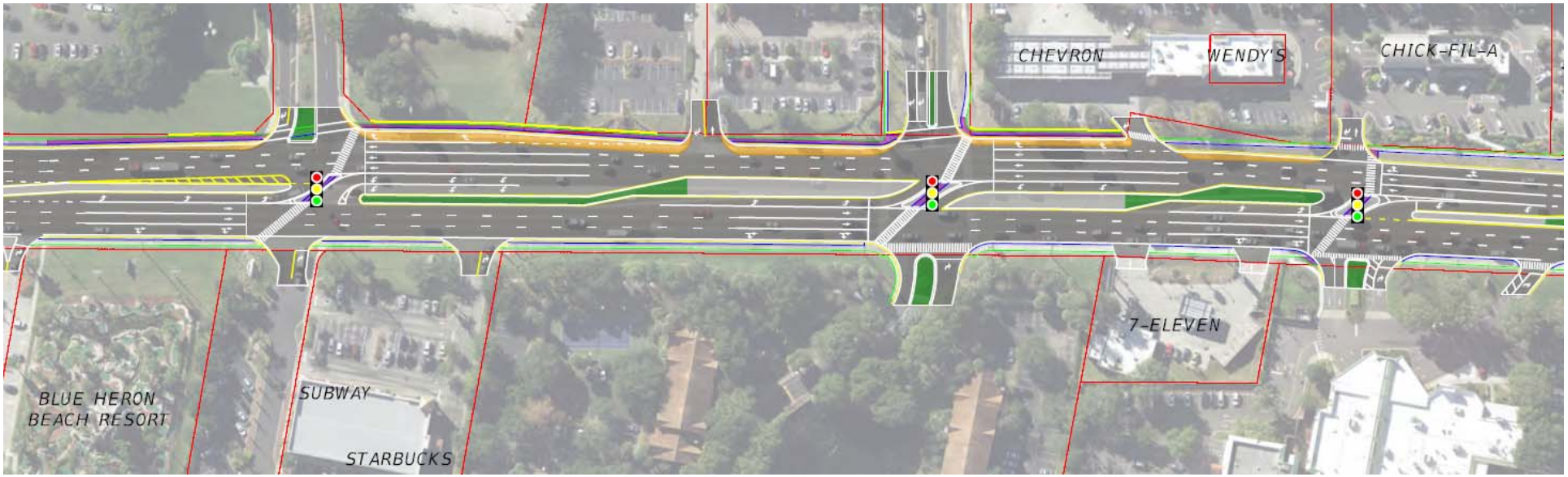
Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Figure 3; Page 14

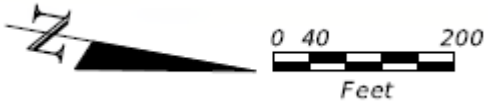
TOOLS

CONCEPT DEVELOPMENT

Signalized Restricted Crossing U-Turn N-S

- Construction - $1,300,000
- Design Cost - $430,000
- ROW Cost - $500,000



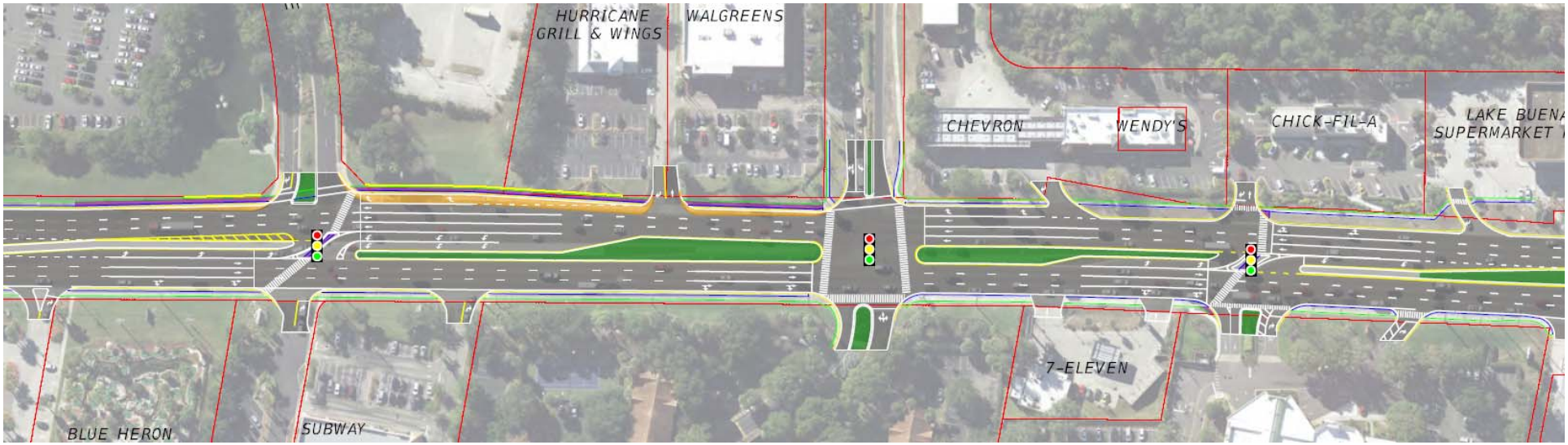


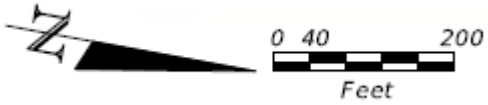
Median U-Turn N-S

Construction - $1,220,000

Design Cost - $320,000

ROW Cost - $510,000



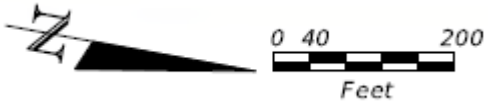


Partial DLT N-S

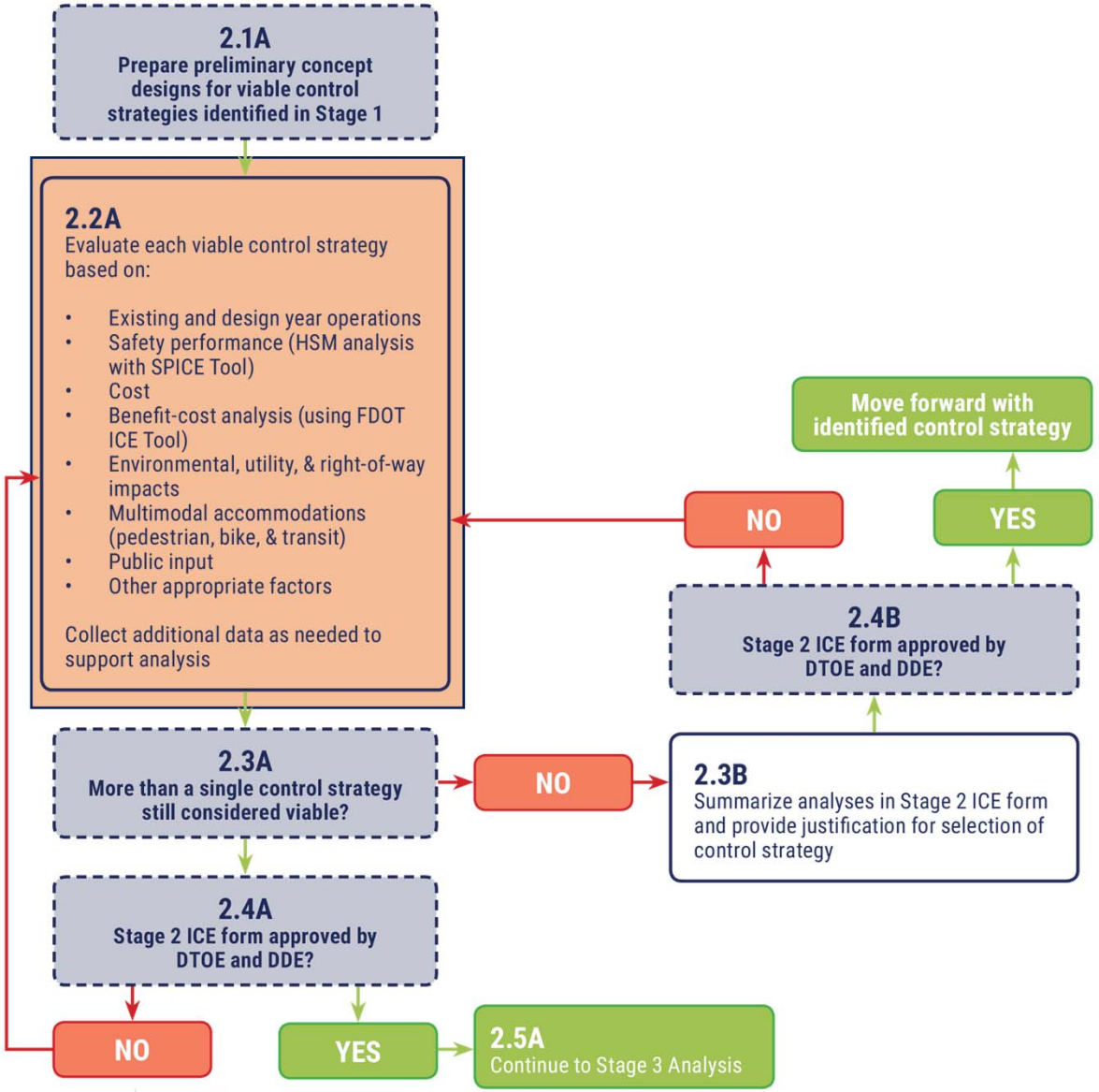
Construction - $1,170,000

Design Cost - $320,000

ROW Cost - $4,500,000



ICE STAGE 2 PROCESS

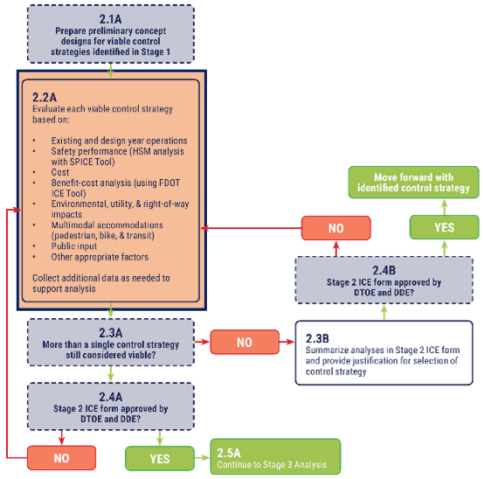


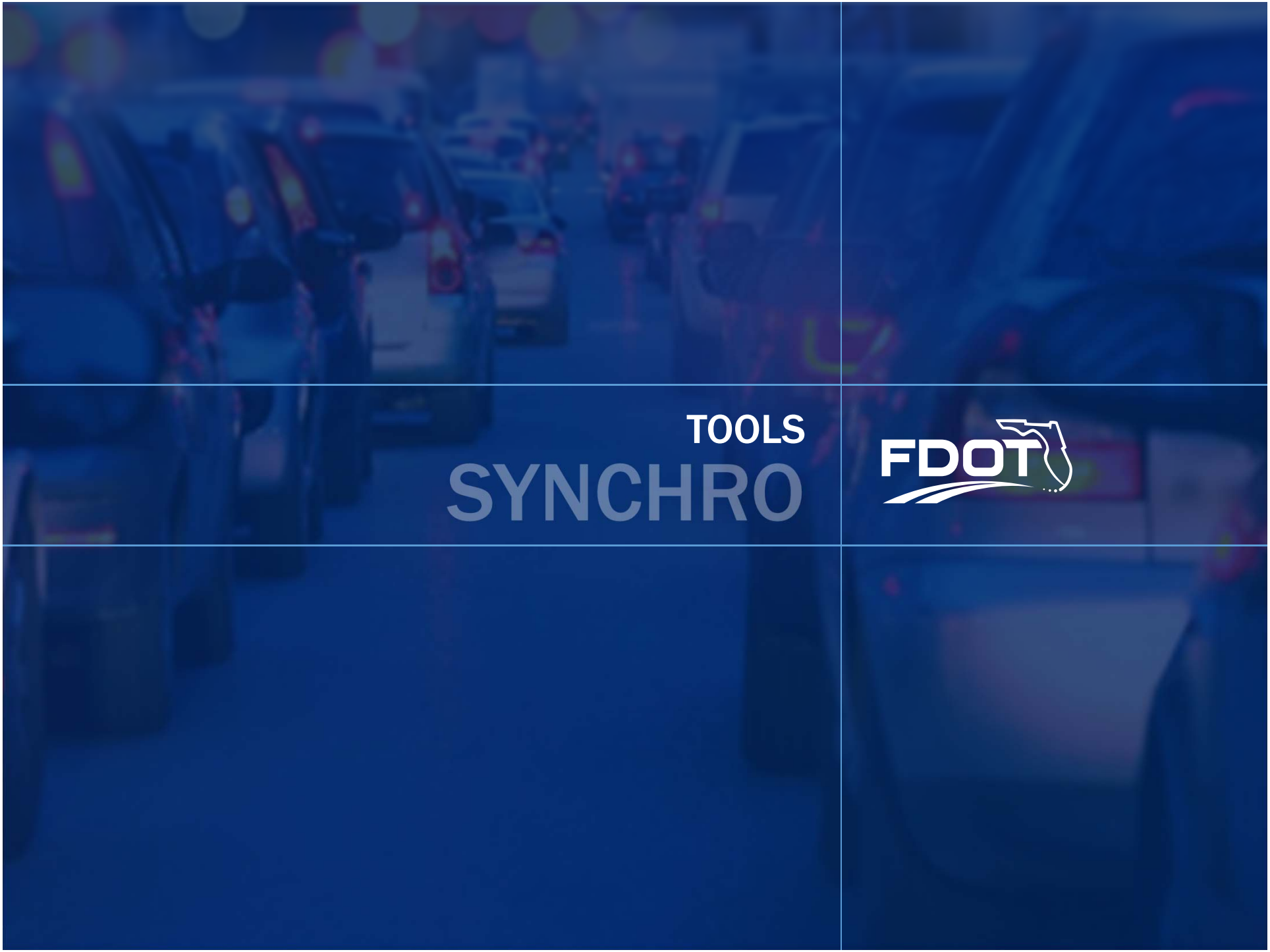
Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Figure 3; Page 14

ICE PROCEDURE

ICE Procedure and Tools

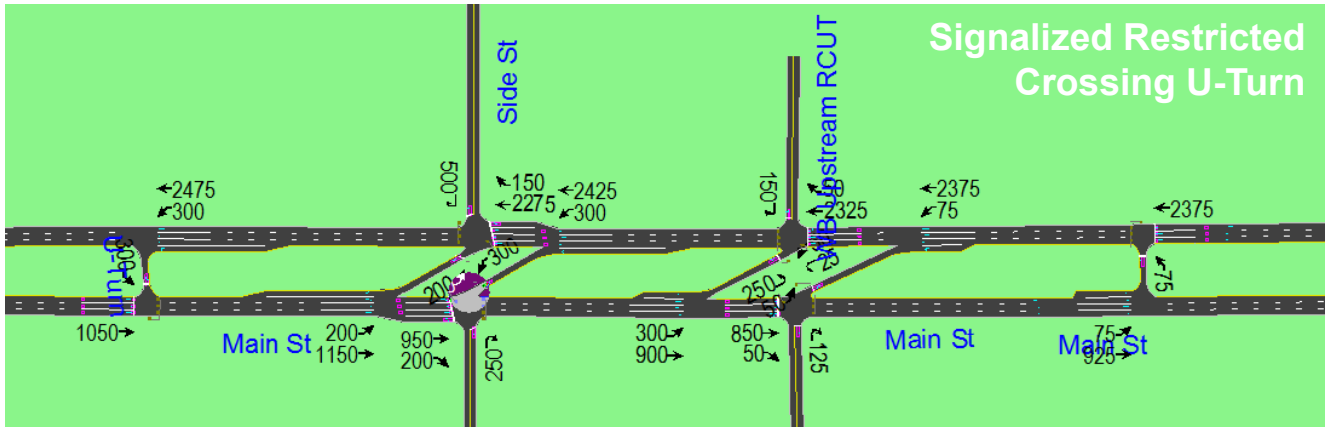
Stage 1	CAP-X	SPICE	
Stage 2	Analysis Guidance	Default SYNCHRO	FDOT ICE Tool
Stage 3	No specific tools. Reuse Stage 2 tools or address qualitative issues.		




TOOLS
SYNCHRO
FDOT

2.2 A – SYNCHRO DEFAULT VALUES

- Library of SYNCHRO default files
  - Include proper default signal phasing and saturation flow
- Review of documents for Florida SYNCHRO practice:
  - FDOT Traffic Analysis Handbook (March 2014)
  - FDOT 2013 Quality/Level of Service Handbook



LANE SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBR	NBR2	SWL2	SWL	SWR
Lanes and Sharing (#RL)												
Traffic Volume (vph)	0	950	200	0	0	0	0	0	250	0	300	0
Future Volume (vph)	0	950	200	0	0	0	0	0	250	0	300	0
Street Name							Side St					
Link Distance (ft)	—	150	—	—	426	—	671	—	—	—	167	—
Link Speed (mph)	—	30	—	—	30	—	30	—	—	—	30	—
Set Arterial Name and Speed	—	EB	—	—	WB	—	NB	—	—	—	SW	—
Travel Time (s)	—	3.4	—	—	9.7	—	15.3	—	—	—	3.8	—
Ideal Satd. Flow (vphpl)	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950

2.2 A – ADJUSTED SYNCHRO DEFAULT VALUES

Model Parameter	Default SYNCHRO Value	FDOT Recommended Value	Value Used in SYNCHRO
Peak Hour Factor (PHF)	0.92	Conceptual planning and preliminary engineering levels of analyses may use a PHF of 1.0	1.0 per Quality/Level of Service Handbook – also consistent with the CAP-X assumptions
Base Saturation Flow Rate (passenger cars per hour per lane, pcphpl)	1,900 pcphpl	1,950 pcphpl on arterials and other interrupted flow facilities	1,950 pcphpl per Quality/Level of Service Handbook
Lane Utilization Factor	Varies depending on the number of lanes and lane type	Default lane utilization factors should be overridden with field measurements when more vehicles use one lane group than the other As demand approaches capacity, lane utilization factors that are closer to 1.0 may be used	Default factors were used in the model
Heavy Vehicle Proportion	2%	Heavy vehicle percentages should be calculated based on the existing turning movement counts data. In absence of counts data, guidelines provided in the HCM-based Tools should be used	Default 2% was used

SYNCHRO INNOVATIVE INTERSECTION TEMPLATES: VISION AND NEED

- Stage 2 tool for more detailed operational analysis of alternative intersections

- Need for SYNCHRO templates
  - Modeling alternative intersections in SYNCHRO can be challenging
  - Developing SYNCHRO files on a case-by-case basis is time consuming and prone to error
  - Need for a consistent modeling approach for fair comparisons

- Designed to be quick and easy to use tool
  - Default SYNCHRO files requiring limited data inputs
  - Parameters consistent with HCM 6th Edition and FDOT recommendations

- Flexible enough to accommodate all intersection alternatives and various geometries

2.2 A – ALTERNATIVE INTERSECTION ANALYSIS IN HCS

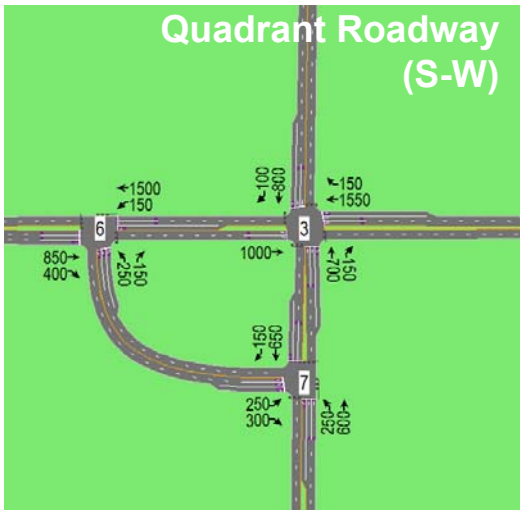
- The latest release of HCS (Release 7.2.1) includes only MUT, RCUT, and DLT, not all the alternative intersections

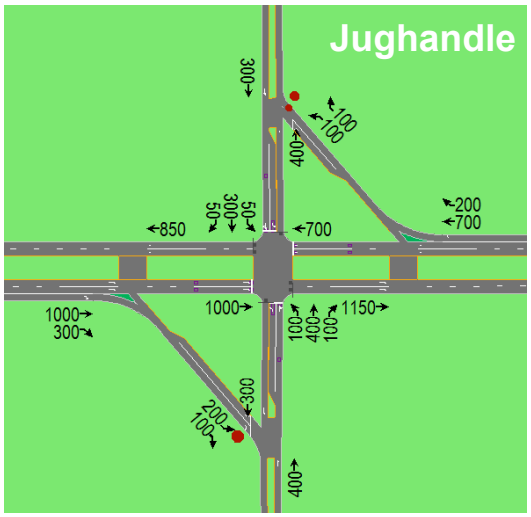
- Modeling everything in one platform (e.g., SYNCHRO) provides consistency across results
  - The ICE tool has worksheets for computing DLT, PDLT, MUT, PMUT, Two Way Stop Control and Signalized RCUT delay from SYNCHRO outputs in manner consistent with HCM 6th Edition

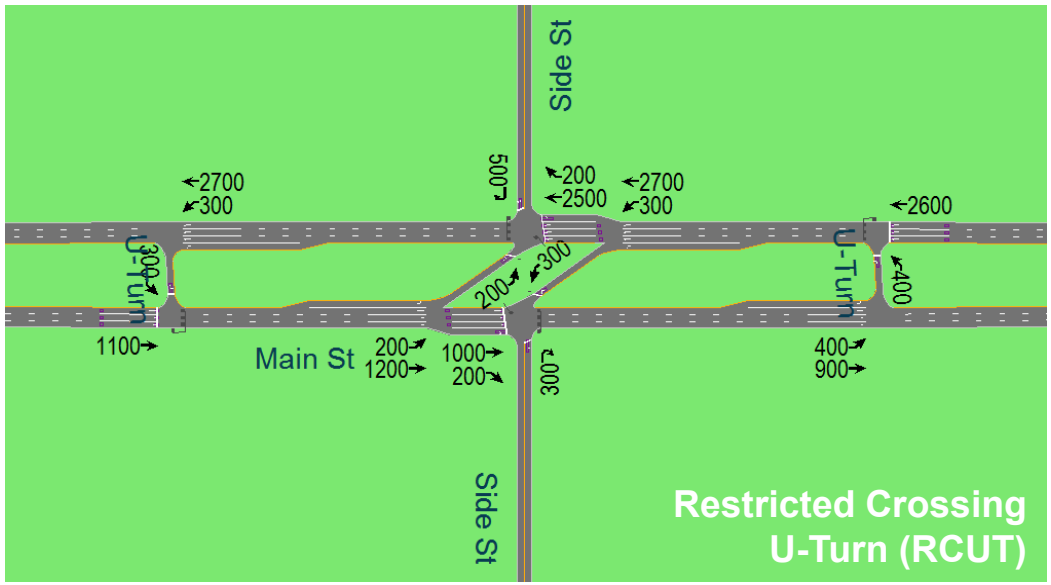
- Modeling alternative intersections in HCS is complicated and creates challenges

2.2 A – SYNCHRO TEMPLATES OVERVIEW

- Median U-Turn (MUT)
- Restricted Crossing U-Turn (RCUT)
  - Unsignalized
  - Signalized
  - Expanded to corridors
- Jug-handle
- Displaced Left Turn (DLT)
  - Full
  - Partial
- Continuous Green T
- Quadrant Roadway
- Diverging Diamond Interchange (DDI)





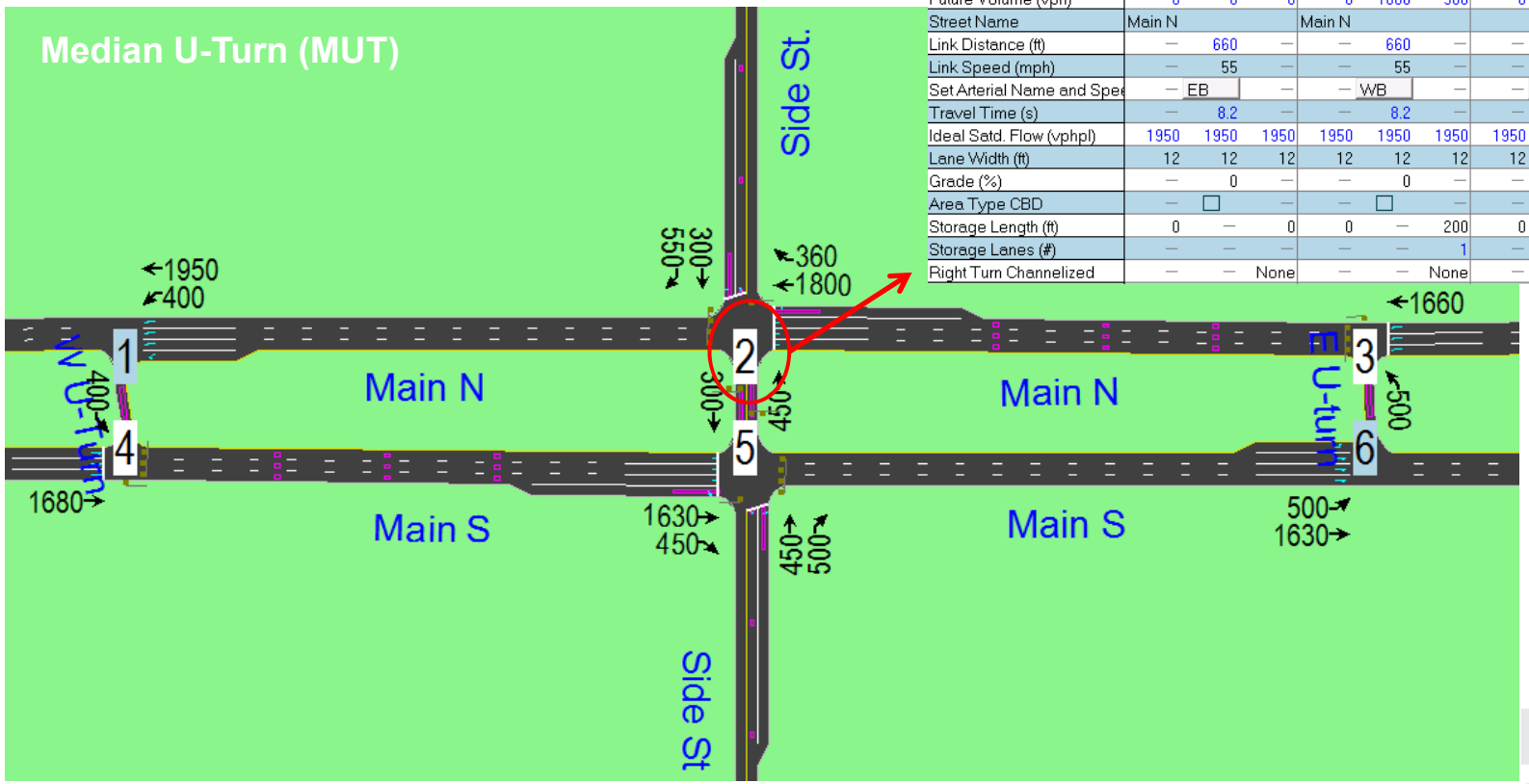


2.2 A – SYNCHRO TEMPLATES: BASIC REQUIRED INPUTS

(LANE CONFIGURATIONS)

- Lane configurations
  - Number of lanes, storage length, link speed, channelized right turn, etc.

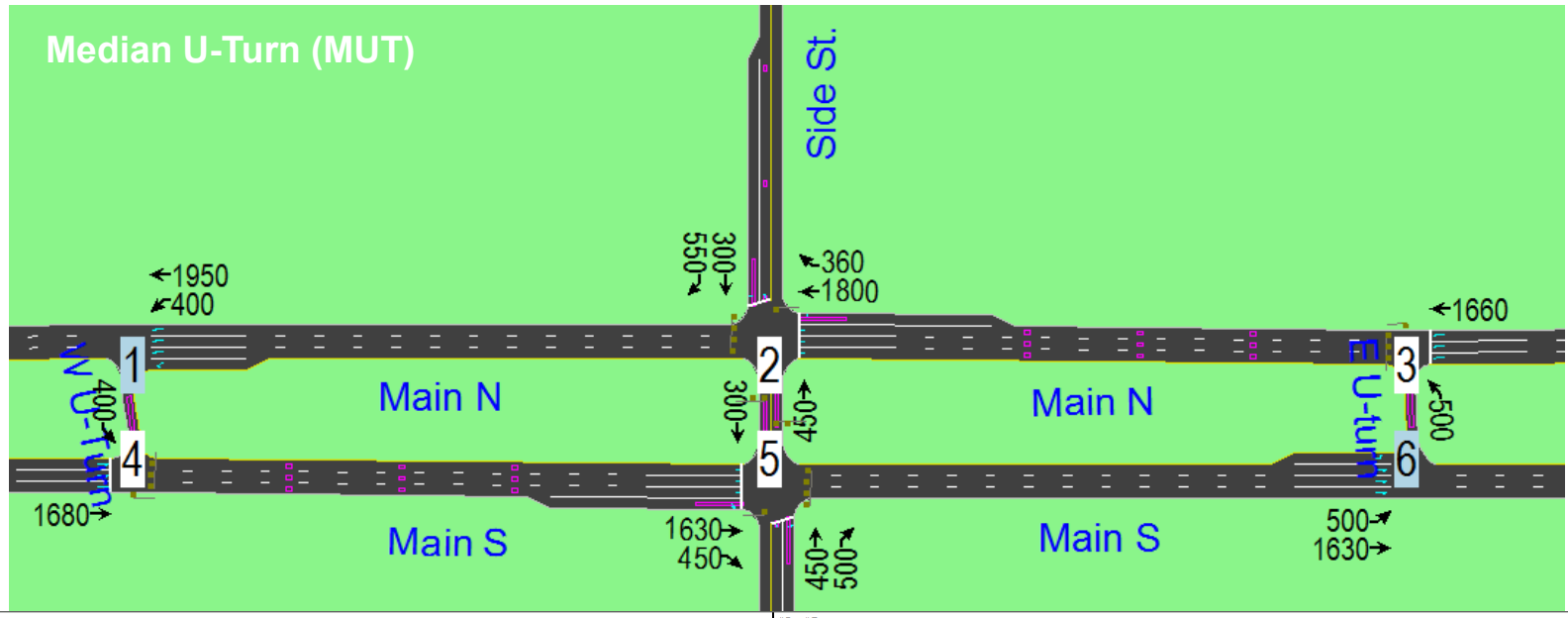
LANE SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lanes and Sharing (#RL)												
Traffic Volume (vph)	0	0	0	0	1800	360	0	450	0	0	300	550
Future Volume (vph)	0	0	0	0	1800	360	0	450	0	0	300	550
Street Name	Main N			Main N						Side St.		
Link Distance (ft)	–	660	–	–	660	–	–	100	–	–	500	–
Link Speed (mph)	–	55	–	–	55	–	–	40	–	–	40	–
Set Arterial Name and Spee	–	EB	–	–	WB	–	–	NB	–	–	SB	–
Travel Time (s)	–	8.2	–	–	8.2	–	–	1.7	–	–	8.5	–
Ideal Satd. Flow (vphpl)	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)	–	0	–	–	0	–	–	0	–	–	0	–
Area Type CBD	–	☐	–	–	☐	–	–	☐	–	–	☐	–
Storage Length (ft)	0	–	0	0	–	200	0	–	0	0	–	250
Storage Lanes (#)	–	–	–	–	–	1	–	–	–	–	–	1
Right Turn Channelized	–	–	None	–	–	None	–	–	None	–	–	None

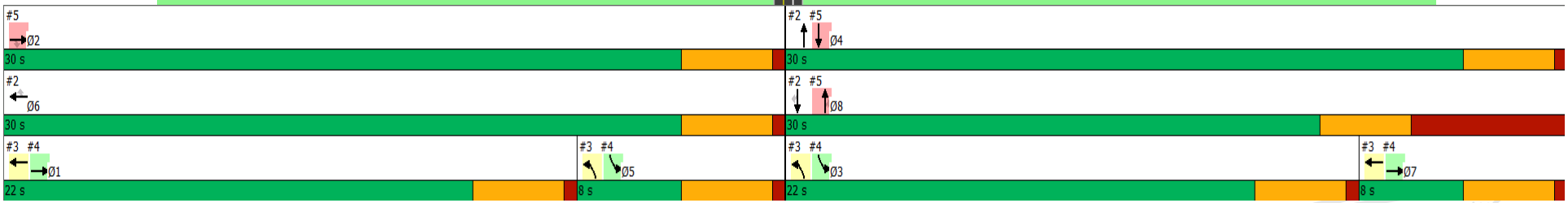


2.2 A – SYNCHRO TEMPLATES: BASIC REQUIRED INPUTS

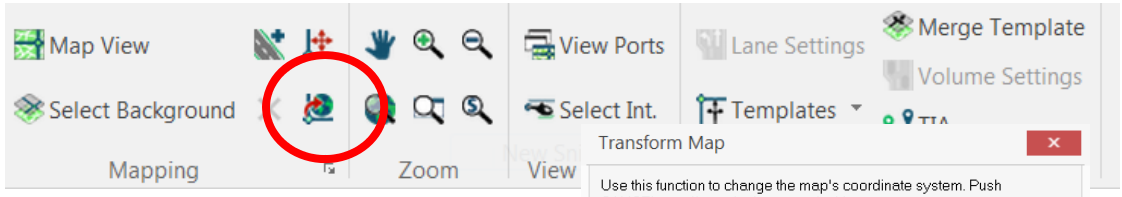
(SIGNAL TIMING)

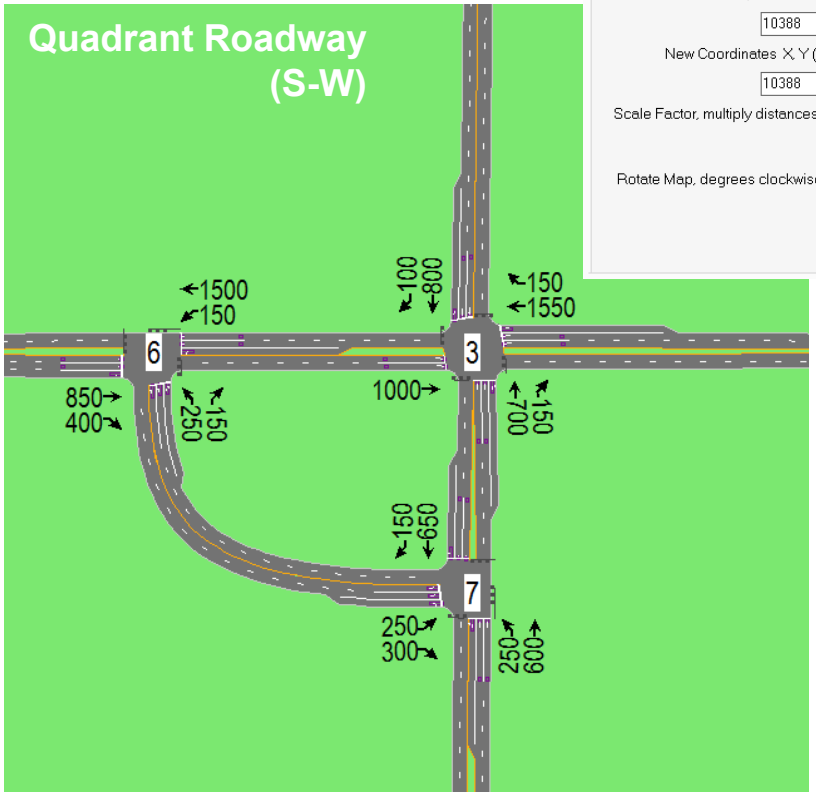
- Signal Timing (modeled as clustered or stand-alone intersections)
  - Splits, yellow and all-red times, pedestrian intervals, right-turn-on-red, minimum and maximum green intervals, etc.

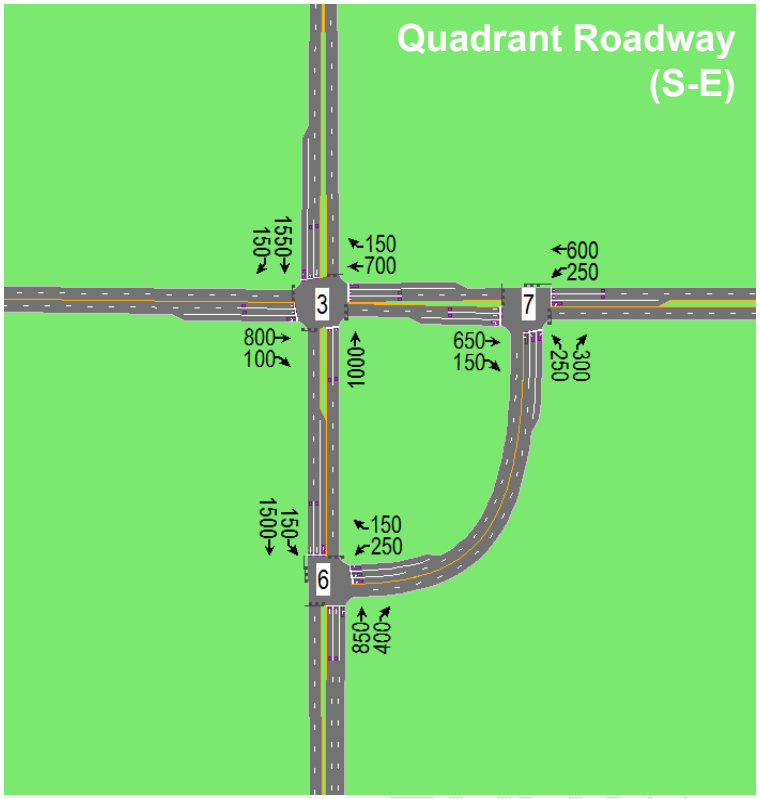




2.2 A – DEALING WITH INTERSECTION ORIENTATION







- Platoon Ratio
  - Describes the quality of signal progression for the corresponding movement group
  - Definition – HCM 6th Edition Equation 19-5

Platoon Ratio	Arrival Type	Progression Quality
0.33	1	Very poor
0.67	2	Unfavorable
1.00	3	Random arrivals
1.33	4	Favorable
1.67	5	Highly favorable
2.00	6	Exceptionally favorable

Source: HCM 6th Edition Exhibit 19-13 Relationship Between Arrival Type and Progression Quality

2.2 A – PLATOON RATIO APPLICATION

- Evaluated progression between intersection types
- Assumptions for Theoretical Analysis

	Volumes	Roadway Configuration	Posted speed limit	Saturation flow rate	Cycle length	
					Signalized and DLT	MUT and RCUT
Major road*	500 vehicles peak direction/hr/ln	4 lanes divided w/LT and RT lanes	45 mph	1,950 veh/h/ln	180 sec	90 sec
Minor road	25% of major street volumes		35 mph	1,950 veh/h/ln		

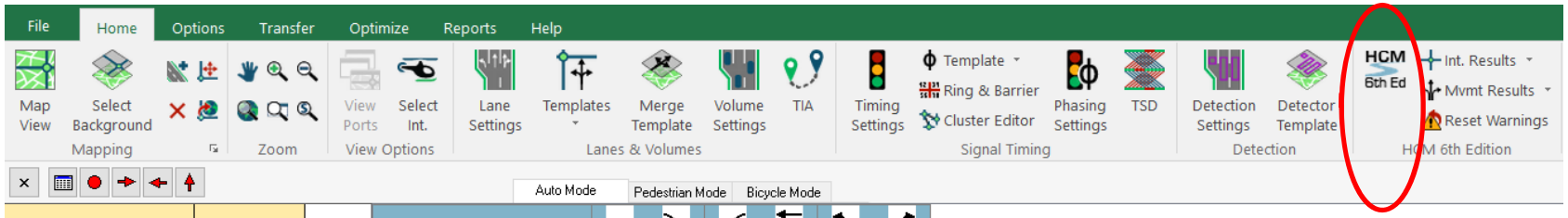
* ¼ mile major intersection spacing

- Signal timings optimized with Synchro
- VISSIM analysis for performance measures to estimate HCM platoon ratio

2.2 A – PLATOON RATIO ESTIMATES FOR CORRIDORS

Analysis Intersection	Upstream Intersection	Platoon Ratio
Standard Signal	Standard Signal	1.38
	Roundabout	1.00
	RCUT	1.25
	MUT	1.21
	DLT	1.15
RCUT	Standard Signal	1.24
	Roundabout	1.00
	RCUT	1.46
	MUT	1.43
	DLT	1.21
MUT	Standard Signal	1.25
	Roundabout	1.00
	RCUT	1.48
	MUT	1.52
	DLT	1.15
DLT	Standard Signal	1.15
	Roundabout	0.99
	RCUT	1.20
	MUT	1.20
	DLT	1.33

2.2 A – PLATOON RATIO APPLICATION



Auto Mode | Pedestrian Mode | Bicycle Mode

HCM 6th INTERSECTION	
Node #	17
Description	
Control Type	Actd-Coord
Cycle Length (s)	90.0
Lock Timings	☐
HCM Equilibrium Cycle(s)	90.0
HCM Control Delay(s)	11.9
HCM Intersection LOS	B
Analysis Time Period (h)	0.25
Saturation Flow Rate (pc/h/ln)	—
Use Saturation Flow Rate	☐
Sneakers Per Cycle (veh)	2.0
Number of Calc.Iterations	35
Stored Passenger Car Length (ft)	25
Stored Heavy Vehicle Length (ft)	45
Probability Peds. Pushing Button	0.51
Deceleration Rate (ft/s/s)	4.00
Acceleration Rate (ft/s/s)	3.50
Distance Between Stored Cars (ft)	8.00
Queue Length Percentile	50
Left-Turn Equivalency Factor	1.05
Right-Turn Equivalency Factor	1.18
Heavy Veh Equivalency Factor	2.00
Critical Gap for Perm. Left Turn (s)	4.5
Follow-up Time Perm Excl Left(s)	2.5
Follow-up Time Perm Shrd Left(s)	4.5
Stop Threshold Speed (mph)	5.0
Critical Merge Gap (s)	3.7

HCM 6th Settings	EBT	EBR	WBL	WBT	NBL	NBR
Lanes and Sharing (#RL)						
Traffic Volume (vph)	0	0	0	2000	250	0
Future Volume (vph)	0	0	0	2000	250	0
Turn Type	—	—	—	—	Prot	—
Protected Phases	—	—	—	6	8	—
Permitted Phases	—	—	—			—
Lagging Phase?	—	—	—	☑	—	—
Opposing right-turn lane influen	—	—	—	—	—	—
+ Signal Timing Details						
Recall Mode	—	—	—	C-Max	Max	—
+ Adjusted Flow Rate (veh/h)				2000	250	
Adjusted No of Lanes	—	—	—	2	1	—
Pedestrian volume (p/h)	—	0	—	—	—	0
Bicycle volume (bicycles/h)	—	0	—	—	—	0
Right Turn on Red Volume (vph)	—	0	—	—	—	0
+ Ideal Satd. Flow (vphpl)	1950	1950	1950	1950	1950	1950
Work zone on approach?	☐	—	—	☐	☐	—
Total Approach Width	—	—	—	—	—	—
Lanes open during work zone	—	—	—	—	—	—
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
HCM Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00
Initial Queue (veh)	—	—	—	0	0	—
Include Unsignalized Delay?	—	—	—	—	—	—
Unsig. Movement Delay (s/veh)	—	—	—	—	—	—
Right Turn Channelized	—	None	—	None	—	None
HCM 6th Capacity (veh/h)	—	—	—	2533	0	—
HCM Volume/Capacity	—	—	—	0.790	0.000	—
HCM Lane Group Delay(s/veh)	—	—	—	11.9	0.0	—
HCM Lane Group LOS	—	—	—	B	A	—
HCM Approach Delay (s/veh)	—	—	—	11.9	0.0	—
HCM Approach LOS	N/A	—	—	B	A	—

2.2 A – PLATOON RATIO APPLICATION: RCUT W/UPSTREAM RCUT

HCM 6th Settings	EBT	EBR	WBL	WBT	NBL	NBR
Lanes and Sharing (#RL)						
Traffic Volume (vph)	0	0	0	2000	250	0
Future Volume (vph)	0	0	0	2000	250	0
Turn Type	—	—	—	—	Prot	—
Protected Phases	—	—	—	6	8	—
Permitted Phases	—	—	—			—
Lagging Phase?	—	—	—	☑	—	—
Opposing right-turn lane influen	—	—	—	—	—	—
+ Signal Timing Details						
Recall Mode	—	—	—	C-Max	Max	—
+ Adjusted Flow Rate (veh/h)	—	—	—	2000	250	—
Adjusted No of Lanes	—	—	—	2	1	—
Pedestrian volume (p/h)	—	0	—	—	—	0
Bicycle volume (bicycles/h)	—	0	—	—	—	0
Right Turn on Red Volume (vph)	—	0	—	—	—	0
+ Ideal Satd. Flow (vphpl)	1950	1950	1950	1950	1950	1950
Work zone on approach?	☐	—	—	☐	☐	—
Total Approach Width	—	—	—	—	—	—
Lanes open during work zone	—	—	—	—	—	—
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
HCM Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00
Initial Queue (veh)	—	—	—	0	0	—
Include Unsignalized Delay?	—	—	—	—	—	—
Unsig. Movement Delay (s/veh)	—	—	—	—	—	—
Right Turn Channelized	—	None	—	None	—	None
HCM 6th Capacity (veh/h)	—	—	—	2533	0	—
HCM Volume/Capacity	—	—	—	0.790	0.000	—
HCM Lane Group Delay(s/veh)	—	—	—	11.9	0.0	—
HCM Lane Group LOS	—	—	—	B	A	—
HCM Approach Delay (s/veh)	—	—	—	11.9	0.0	—
HCM Approach LOS	N/A	—	—	B	A	—

Synchro 10 Default Parameter

Note the change in delay/LOS

HCM 6th Settings	EBT	EBR	WBL	WBT	NBL	NBR
Lanes and Sharing (#RL)						
Traffic Volume (vph)	0	0	0	2000	250	0
Future Volume (vph)	0	0	0	2000	250	0
Turn Type	—	—	—	—	Prot	—
Protected Phases	—	—	—	6	8	—
Permitted Phases	—	—	—			—
Lagging Phase?	—	—	—	☑	—	—
Opposing right-turn lane influen	—	—	—	—	—	—
+ Signal Timing Details						
Recall Mode	—	—	—	C-Max	Max	—
+ Adjusted Flow Rate (veh/h)	—	—	—	2000	250	—
Adjusted No of Lanes	—	—	—	2	1	—
Pedestrian volume (p/h)	—	0	—	—	—	0
Bicycle volume (bicycles/h)	—	0	—	—	—	0
Right Turn on Red Volume (vph)	—	0	—	—	—	0
+ Ideal Satd. Flow (vphpl)	1950	1950	1950	1950	1950	1950
Work zone on approach?	☐	—	—	☐	☐	—
Total Approach Width	—	—	—	—	—	—
Lanes open during work zone	—	—	—	—	—	—
HCM Platoon Ratio	1.00	1.00	1.00	1.46	1.00	1.00
HCM Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00
Initial Queue (veh)	—	—	—	0	0	—
Include Unsignalized Delay?	—	—	—	—	—	—
Unsig. Movement Delay (s/veh)	—	—	—	—	—	—
Right Turn Channelized	—	None	—	None	—	None
HCM 6th Capacity (veh/h)	—	—	—	2533	0	—
HCM Volume/Capacity	—	—	—	0.790	0.000	—
HCM Lane Group Delay(s/veh)	—	—	—	2.6	0.0	—
HCM Lane Group LOS	—	—	—	A	A	—
HCM Approach Delay (s/veh)	—	—	—	2.6	0.0	—
HCM Approach LOS	N/A	—	—	A	A	—

2.2 A – PLATOON RATIO APPLICATION

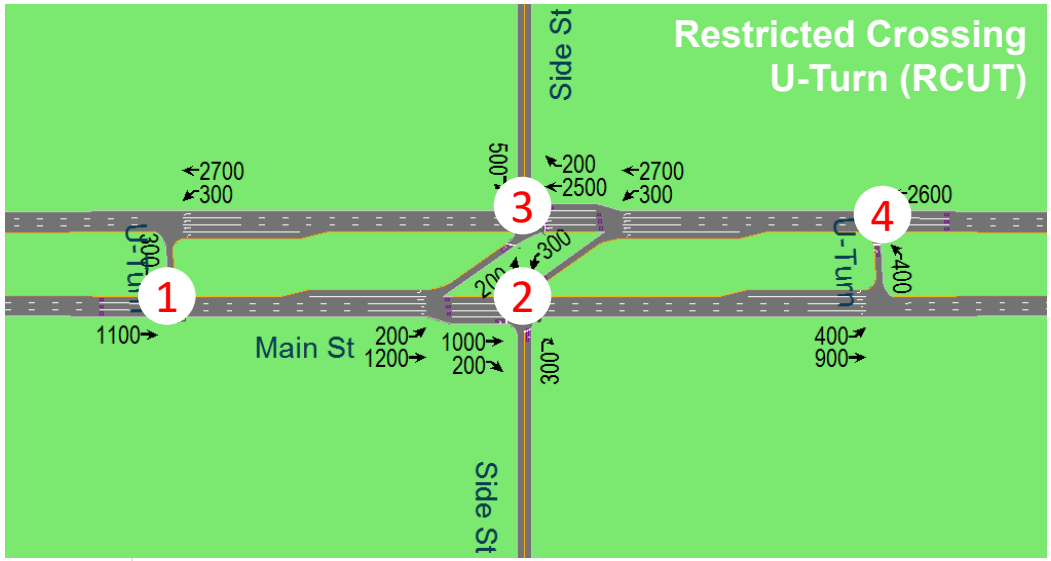
- Isolated intersection with other intersections greater than ½ mile away and no coordination
  - Platoon ratios should NOT be applied

- Intersection within a coordinated signal system i.e. Standard Signal to Standard Signal, RCUT to RCUT (Super Street), RCUT to Standard Signal, etc.
  - Platoon ratios may be applied

- Platoon ratios are applied to major road through movements only

2.2 A – RCUT, MUT and DLT DELAY OVERVIEW

- Signalized Restricted Crossing U-Turns (RCUTs) can be analyzed in SYNCHRO
  - Limitations: SYNCHRO doesn't know you're modeling an RCUT
  - Assumes it is a network of 4 separate signals
- FDOT ICE tool provides a worksheet to overcome this limitation
  - User enters lane group delay outputs from each intersection's SYNCHRO report
  - User enters travel speed and distance to crossovers to account for out of direction travel
  - FDOT ICE tool computes single delay value for signalized RCUT consistent with HCM 6th Edition (with assumed coordination of signals)
  - FDOT ICE tool also has MUT, DLT and TWSC worksheets



2.2 A – SYNCHRO INNOVATIVE INTERSECTION TEMPLATES: RESULTS

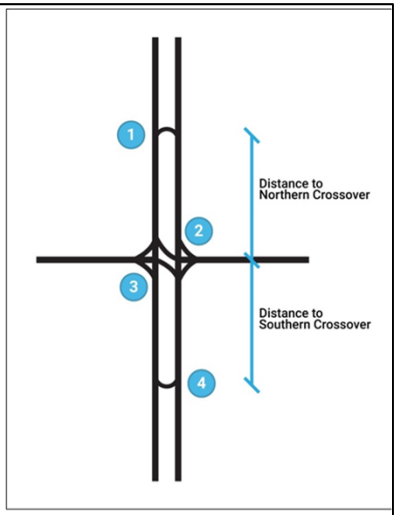
- Custom delay input sheets from SYNCHRO to ICE tool
  - Converts movement delays (e.g., from SYNCHRO) to a single intersection delay
  - Optional specification of weekend peak delays

RCUT N-S

Use this sheet to enter the delay information for a Signalized RCUT with the major street running North-South. (Requires turning movement count demand inputs)

User must enter value on this sheet

	Southern Crossover	Northern Crossover
Distance from main intersection to:	700	900
Free-flow speed on major street:	45	



*Volumes are computed based on values entered in DemandCounts and Exhibit 6-2 of FHWA RCUT Guide

Opening Year AM Peak				
Intersection 1	SB Thru	NB U-Turn		
Volume	1316	23		
Delay	2.4	16.7		
Intersection 2	NB Left	NB Thru	NB Right	WB Right
Volume	41	1976	8	81
Delay	35.1	6.1	2.7	25
Intersection 3	SB Left	SB Thru	SB Right	EB Right
Volume	39	1235	65	158
Delay	23.7	4.7	2.5	24.2
Intersection 4	NB Thru	SB U-Turn		
Volume	1910	115		
Delay	6.8	24.2		

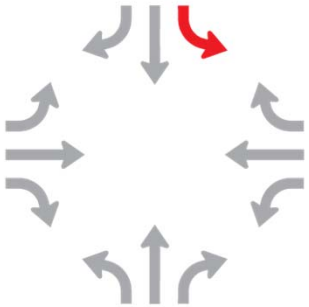
Opening Year PM Peak				
Intersection 1	SB Thru	NB U-Turn		
Volume	2379	25		
Delay	5.3	34.2		
Intersection 2	NB Left	NB Thru	NB Right	WB Right
Volume	68	1834	30	64
Delay	22.4	2.4	0.1	37.7
Intersection 3	SB Left	SB Thru	SB Right	EB Right
Volume	101	2146	157	299
Delay	53.2	9.7	3.8	47.9
Intersection 4	NB Thru	SB U-Turn		
Volume	1707	225		
Delay	9.2	32.6		

Opening Year Weekend Peak				
Intersection 1	SB Thru	NB U-Turn		
Volume	0	0		
Delay				
Intersection 2	NB Left	NB Thru	NB Right	WB Right
Volume	0	0	0	0
Delay				
Intersection 3	SB Left	SB Thru	SB Right	EB Right
Volume	0	0	0	0
Delay				
Intersection 4	NB Thru	SB U-Turn		
Volume	0	0		
Delay				

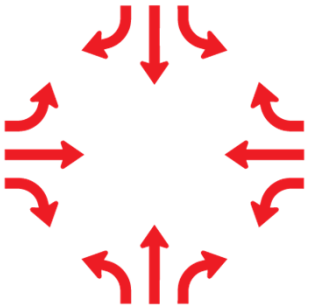
2.2 A – TWSC DELAY

- In a typical traffic study, delay of the critical movement is reported
  - Critical movement = lane group with highest delay
  - Prevents major street through movements with zero delay from “hiding” a low volume, high delay movement in an average

- For life cycle cost analysis considering every vehicle, average delay is needed
  - FDOT ICE tool has a feature for computing this in cases when software does not provide it



Used in typical traffic study (assumes southbound left has highest delay)



Used in life cycle cost analysis

2.2 A – ICE FORM STAGE 2

Operational Analyses

Summarize the results of the peak hour analysis performed for each control strategy. Select analysis year based on guidance in the ICE procedures document. Refer to Exhibit 19-8 of the *Highway Capacity Manual, 6th Edition* (HCM6) to determine the appropriate LOS based on intersection delay (*hover over this cell for Exhibit 19-8*).

Design Vehicle	Interstate Semitrailer (WB-62)	Control Vehicle	Interstate Semitrailer (WB-62)

Opening Year	2020

Control Strategy	Peak Hour	Weekday AM Peak		Peak Hour	Weekday PM Peak	
	LOS	Delay (sec.)	All Queues Accommodated?	LOS	Delay (sec.)	All Queues Accommodated?
Signalized Control	C	20.1	Yes	C	28.9	Yes
Median U-Turn	B	12.1	Yes	B	14.6	Yes
RCUT (Signalized)	B	14.0	Yes	C	20.5	Yes
Displaced Left-Turn	B	12.6	Yes	B	19.7	Yes

DesignYear	2040

Control Strategy	Peak Hour	Weekday AM Peak		Peak Hour	Weekday PM Peak	
	LOS	Delay (sec.)	All Queues Accommodated?	LOS	Delay (sec.)	All Queues Accommodated?
Signalized Control	C	22.2	Yes	D	35.4	Yes
Median U-Turn	B	12.2	Yes	C	23.0	Yes
RCUT (Signalized)	C	21.8	Yes	D	49.4	No
Displaced Left-Turn	B	15.7	Yes	C	25.6	Yes

2.2 A – ICE FORM STAGE 2

ICE
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Exhibit 19-8
LOS Criteria: Motorized Vehicle Mode

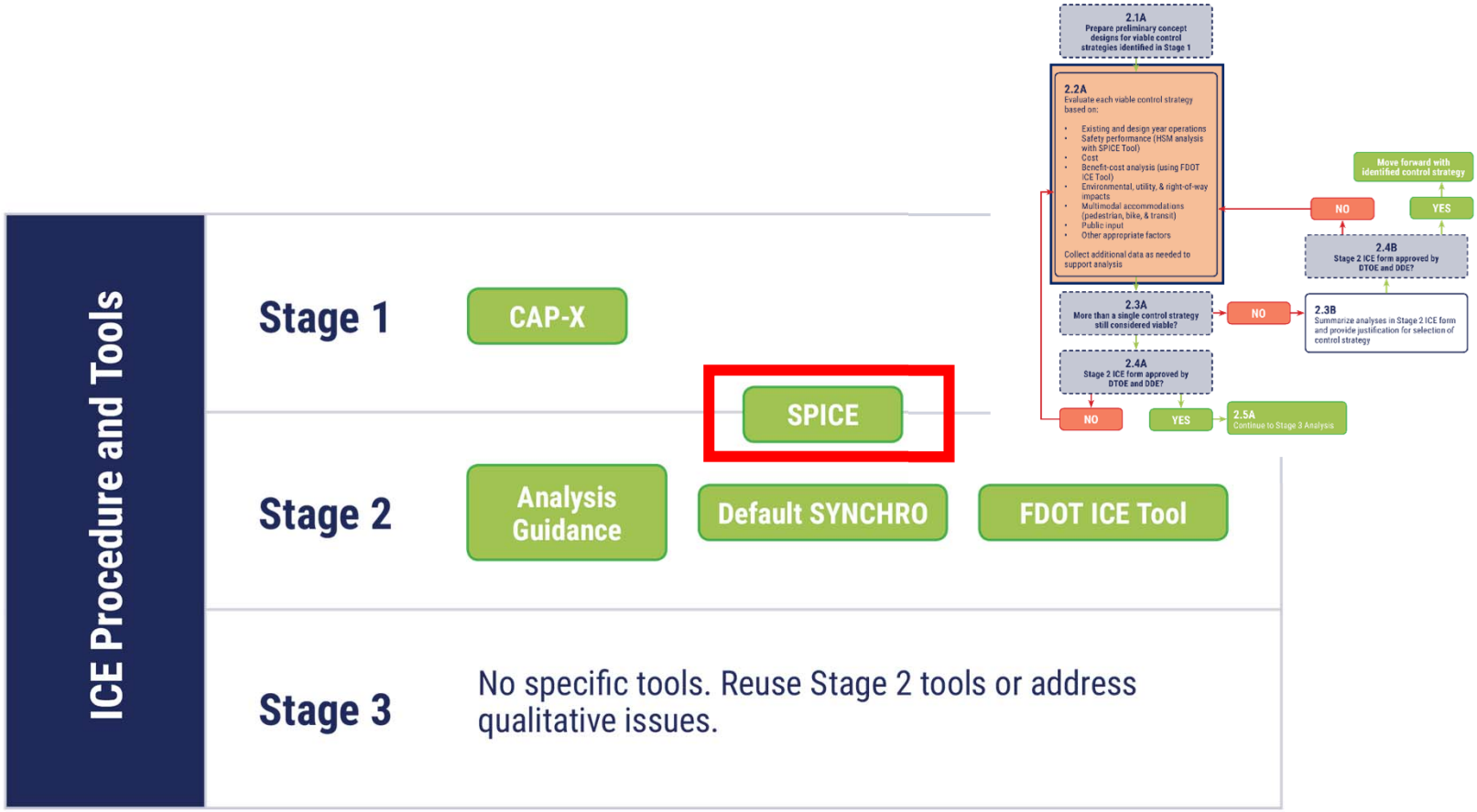
Exhibit 19-8 lists the LOS thresholds established for the motorized vehicle mode at a signalized intersection.

Control Delay (s/veh)	LOS by Volume-to-Capacity Ratio[a] ≤1.0	>1.0
≤10	A	F
>10–20	B	F
>20–35	C	F
>35–55	D	F
>55–80	E	F
>80	F	F

Note: [a] For approach-based and intersectionwide assessments, LOS is defined solely by control delay.

Source: Exhibit 19-8 of the Highway Capacity Manual, 6th Edition (HCM6)

2.2 A – CONDUCT SPICE ANALYSIS



SPICE is used in both: Stage 1 and Stage 2 analyses

TOOLS

SPICE – STAGE 2

FDOT

2.2A – SPICE: BASIC INPUTS AND CONTROL STRATEGY SELECTION

Control Strategy Selection and Inputs

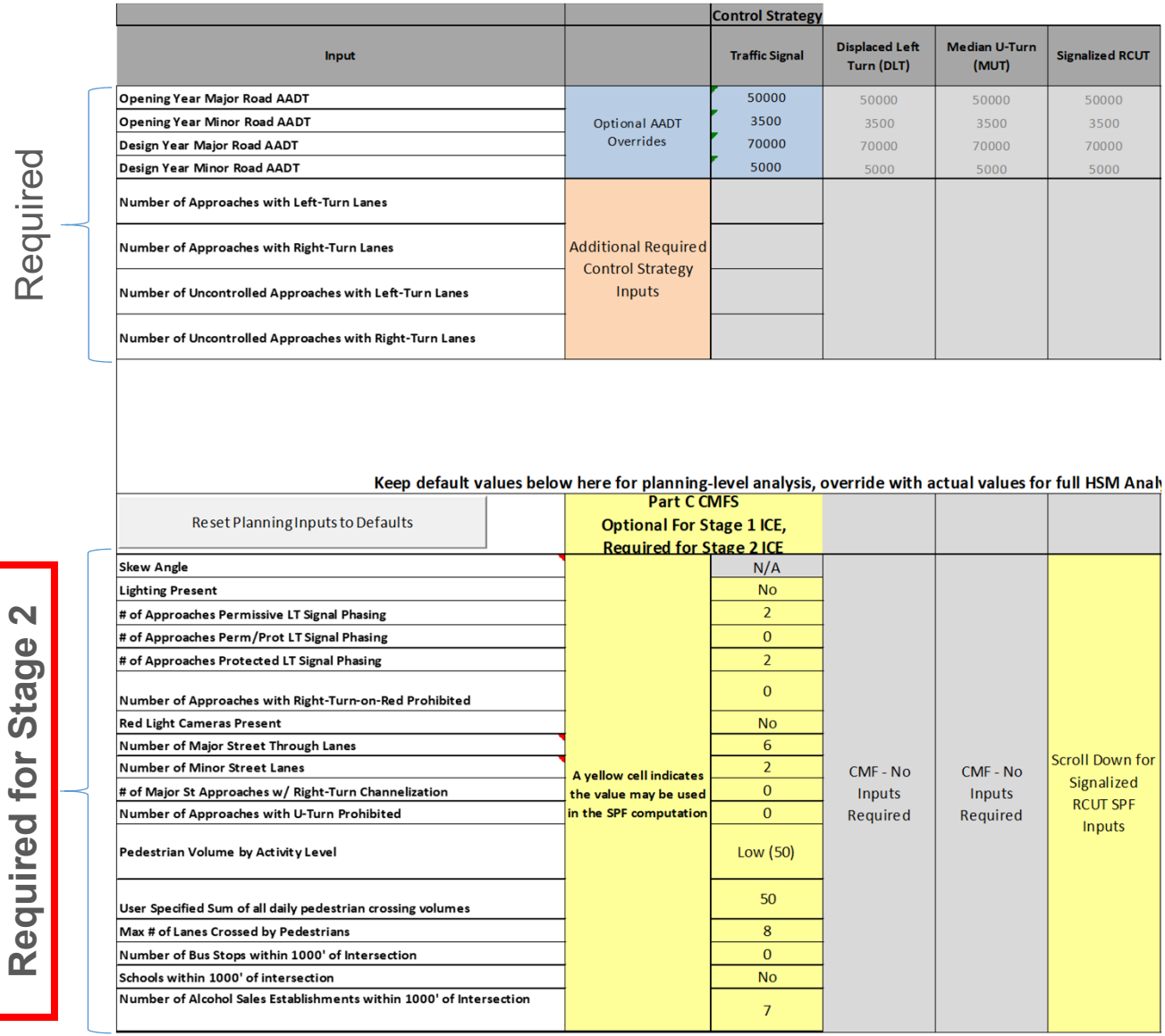
Specify the Facility Level Inputs and the Control Strategies to be included in the SPICE Analysis.

Intersection Type	At-Grade Intersections
Analysis Year	Opening and Design Year
Opening Year	2020
Design Year	2040
Facility Type	On Urban and Suburban Arterial
Number of Legs	4-leg
1-Way/2-Way	2-way Intersecting 2-way
# of Major Street Lanes (both directions)	6 or more
Major Street Approach Speed	Less than 55 mph
Opening Year - Major Road AADT	50,000
Opening Year - Minor Road AADT	3,500
Design Year - Major Road AADT	70,000
Design Year - Minor Road AADT	5,000

For more information on how to determine these values, see the "Definitions" worksheet

Control Strategy	Include	Base Intersection		
Traffic Signal	Yes	--		
Traffic Signal (Alternative Configuration)	No	--		
Minor Road Stop	No	--		Design Year AADT Outside of SPF Development Range
All Way Stop	No	--		
1-Lane Roundabout	No	--	Opening Year AADT Outside of SPF Development Range	Design Year AADT Outside of SPF Development Range
2-Lane Roundabout	No	--	Opening Year AADT Outside of SPF Development Range	Design Year AADT Outside of SPF Development Range
Displaced Left Turn (DLT)	Yes	Traffic Signal		
Median U-Turn (MUT)	Yes	Traffic Signal		
Signalized Restricted Crossing U-Turn (RCUT)	Yes	--		Design Year AADT Outside of SPF Development Range
Unsignalized Restricted Crossing U-Turn (RCUT	No	--	Opening Year AADT Outside of SPF Development Range	Design Year AADT Outside of SPF Development Range
Continuous Green-T Intersection	No	Traffic Signal		
Jughandle	No	Traffic Signal		
Other 1	No	Traffic Signal	*Please Select	
Other 2	No	Minor Road Stop	*Please Select	

2.2A – SPICE STAGE 2: AT-GRADE INTERSECTION INPUTS



Input		Control Strategy: Traffic Signal	Displaced Left Turn (DLT)	Median U-Turn (MUT)	Signalized RCUT
Opening Year Major Road AADT	Optional AADT Overrides	50000	50000	50000	50000
Opening Year Minor Road AADT		3500	3500	3500	3500
Design Year Major Road AADT		70000	70000	70000	70000
Design Year Minor Road AADT		5000	5000	5000	5000
Number of Approaches with Left-Turn Lanes	Additional Required Control Strategy Inputs				
Number of Approaches with Right-Turn Lanes					
Number of Uncontrolled Approaches with Left-Turn Lanes					
Number of Uncontrolled Approaches with Right-Turn Lanes					

Required

Keep default values below here for planning-level analysis, override with actual values for full HSM Anal

Reset Planning Inputs to Defaults	Part C CMFS Optional For Stage 1 ICE, Required for Stage 2 ICE			
Skew Angle	A yellow cell indicates the value may be used in the SPF computation	N/A	CMF - No Inputs Required	CMF - No Inputs Required
Lighting Present		No		
# of Approaches Permissive LT Signal Phasing		2		
# of Approaches Perm/Prot LT Signal Phasing		0		
# of Approaches Protected LT Signal Phasing		2		
Number of Approaches with Right-Turn-on-Red Prohibited		0		
Red Light Cameras Present		No		
Number of Major Street Through Lanes		6		
Number of Minor Street Lanes		2		
# of Major St Approaches w/ Right-Turn Channelization		0		
Number of Approaches with U-Turn Prohibited		0		
Pedestrian Volume by Activity Level		Low (50)		
User Specified Sum of all daily pedestrian crossing volumes		50		
Max # of Lanes Crossed by Pedestrians		8		
Number of Bus Stops within 1000' of Intersection		0		
Schools within 1000' of intersection		No		
Number of Alcohol Sales Establishments within 1000' of Intersection		7		

Optional for Stage 1, Required for Stage 2

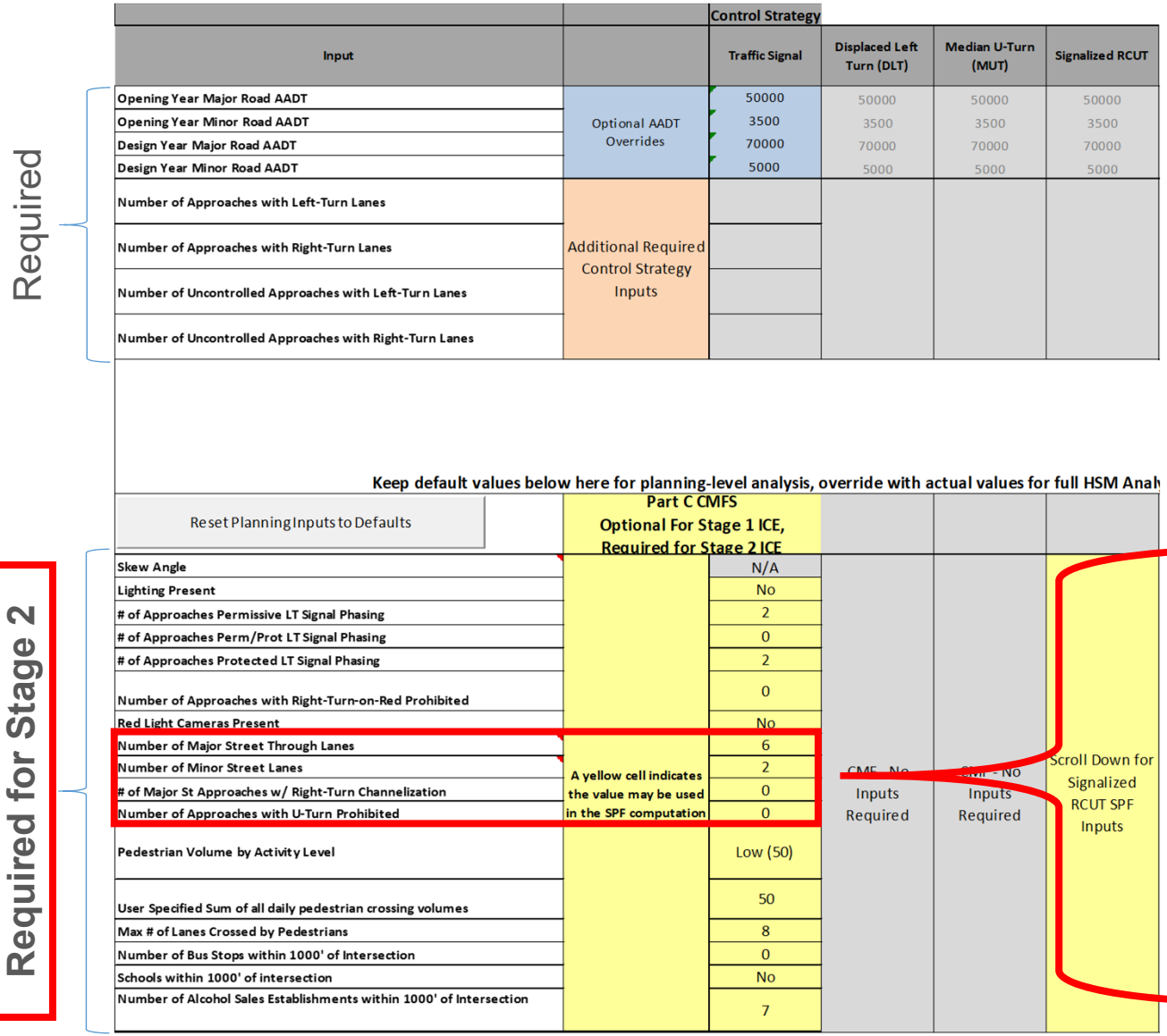
Scroll Down for Signalized RCUT SPF Inputs

Intersection Control Evaluation: Overview | Page: 120

Introduction | Project Information | Definitions | Control Strategy Selection | At-Grade Inputs | Calibration | Historical | Results | Notes | User Selections | Labels

- AADT Volumes for major/minor roads for the opening and design years
- Number of major approaches with left-turn or right-turn lanes
- Pre-filled planning-level defaults
  - Can be overridden by analyst

2.2A – SPICE STAGE 2: AT-GRADE INTERSECTION INPUTS



Input		Control Strategy: Traffic Signal	Displaced Left Turn (DLT)	Median U-Turn (MUT)	Signalized RCUT
Opening Year Major Road AADT	Optional AADT Overrides	50000	50000	50000	50000
Opening Year Minor Road AADT		3500	3500	3500	3500
Design Year Major Road AADT		70000	70000	70000	70000
Design Year Minor Road AADT		5000	5000	5000	5000
Number of Approaches with Left-Turn Lanes	Additional Required Control Strategy Inputs				
Number of Approaches with Right-Turn Lanes					
Number of Uncontrolled Approaches with Left-Turn Lanes					
Number of Uncontrolled Approaches with Right-Turn Lanes					

Required

Keep default values below here for planning-level analysis, override with actual values for full HSM Anal

Reset Planning Inputs to Defaults	Part C CMFS Optional For Stage 1 ICE, Required for Stage 2 ICE				
Skew Angle		N/A			
Lighting Present		No			
# of Approaches Permissive LT Signal Phasing		2			
# of Approaches Perm/Prot LT Signal Phasing		0			
# of Approaches Protected LT Signal Phasing		2			
Number of Approaches with Right-Turn-on-Red Prohibited		0			
Red Light Cameras Present		No			
Number of Major Street Through Lanes	A yellow cell indicates the value may be used in the SPF computation	6	CMF - No Inputs Required	CMF - No Inputs Required	Scroll Down for Signalized RCUT SPF Inputs
Number of Minor Street Lanes		2			
# of Major St Approaches w/ Right-Turn Channelization		0			
Number of Approaches with U-Turn Prohibited		0			
Pedestrian Volume by Activity Level		Low (50)			
User Specified Sum of all daily pedestrian crossing volumes		50			
Max # of Lanes Crossed by Pedestrians		8			
Number of Bus Stops within 1000' of Intersection		0			
Schools within 1000' of intersection		No			
Number of Alcohol Sales Establishments within 1000' of Intersection		7			

Optional for Stage 1, Required for Stage 2

- 6-lane inputs only
  - # Major Street Through Lanes
  - # Minor Street Lanes
  - # Major Approaches w/RT Channelization
  - # Approaches w/U-turn Prohibited

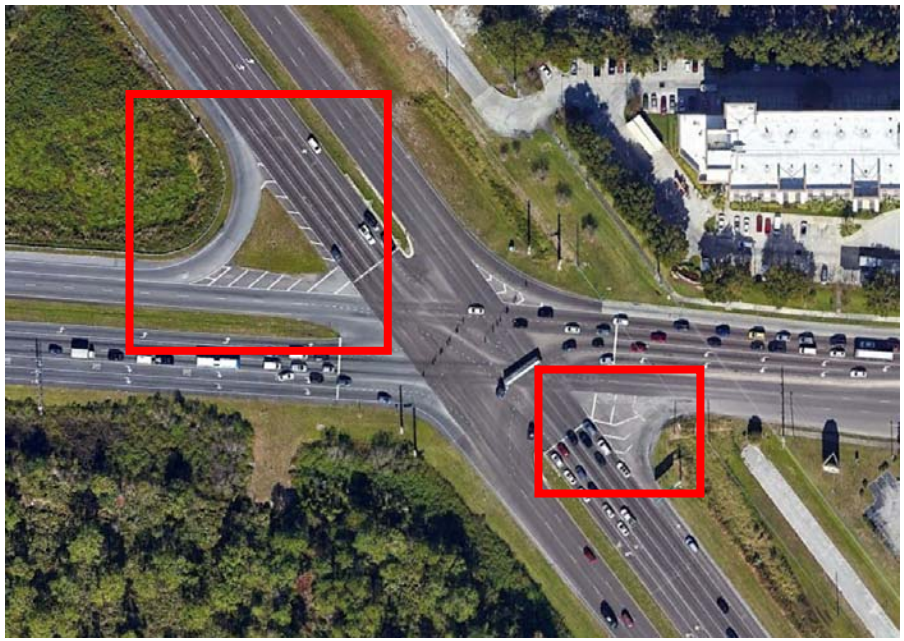
Intersection Control Evaluation: Overview | Page: 121

Introduction | Project Information | Definitions | Control Strategy Selection | At-Grade Inputs | Calibration | Historical | Results | Notes | User Selections | Labels

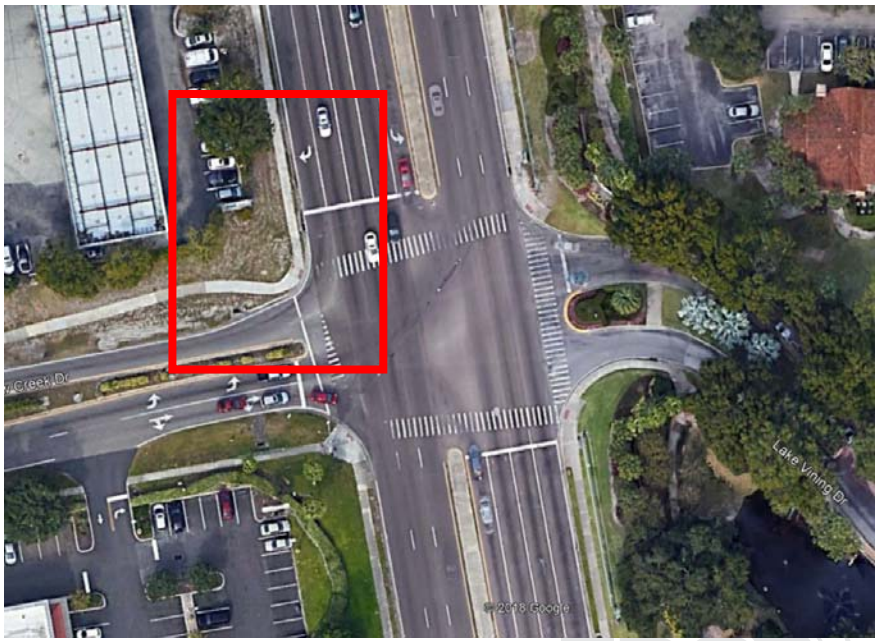
2.2A – SPICE STAGE 2: AT-GRADE INTERSECTION INPUTS

Right Turn Channelization - When a marked or raised-curb island is present, or when the right turner can make a free or yield-controlled turning movement. Applies to major road only.

Major road right turn channelization



No major road right turn channelization



2.2A – SPICE: ROUNDABOUT CMF INPUTS

Right-Turn Channelization CMF

The base condition for CMF_{ut} is absence of right-turn channelization at both approaches on the major street of an intersection. The CMF is determined using the following equation.

$$CMF_{ut} = e^{(0.2175 * n_{ch})} \quad (163)$$

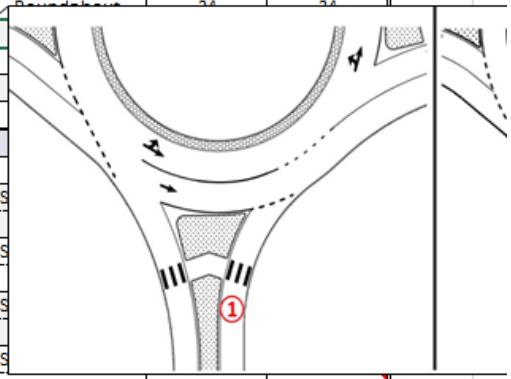
This CMF applies to the total intersection crashes (not including vehicle-pedestrian and vehicle-bicycle collisions) and is applicable only to signalized intersections. The proposed CMF suggests that the right-turn channelization at both approaches on the major street of an intersection would be associated with 24-percent increase in crashes. Bonneson and Pratt (2009) developed a CMF and found that installation of right-turn channelization on both approaches on the major street of a four-leg signalized intersection would be associated with a 20-percent increase in fatal and injury crashes. Bauer and Harwood (1998) derived a CMF value of 1.35, suggesting a 35-percent increase in crashes, for the provision of right-turn channelization at all approaches of a four-leg stop-controlled intersections. They stated that this finding seems counterintuitive, in that provision of right-turn channelization should be associated with a decrease in crashes. Bonneson and Pratt (2009) suggested that the increase in crashes may be due to the higher speeds associated with a free right-turn movement at a right-turn channel, compared to the slower

2.2A – SPICE: ROUNDABOUT CMF INPUTS

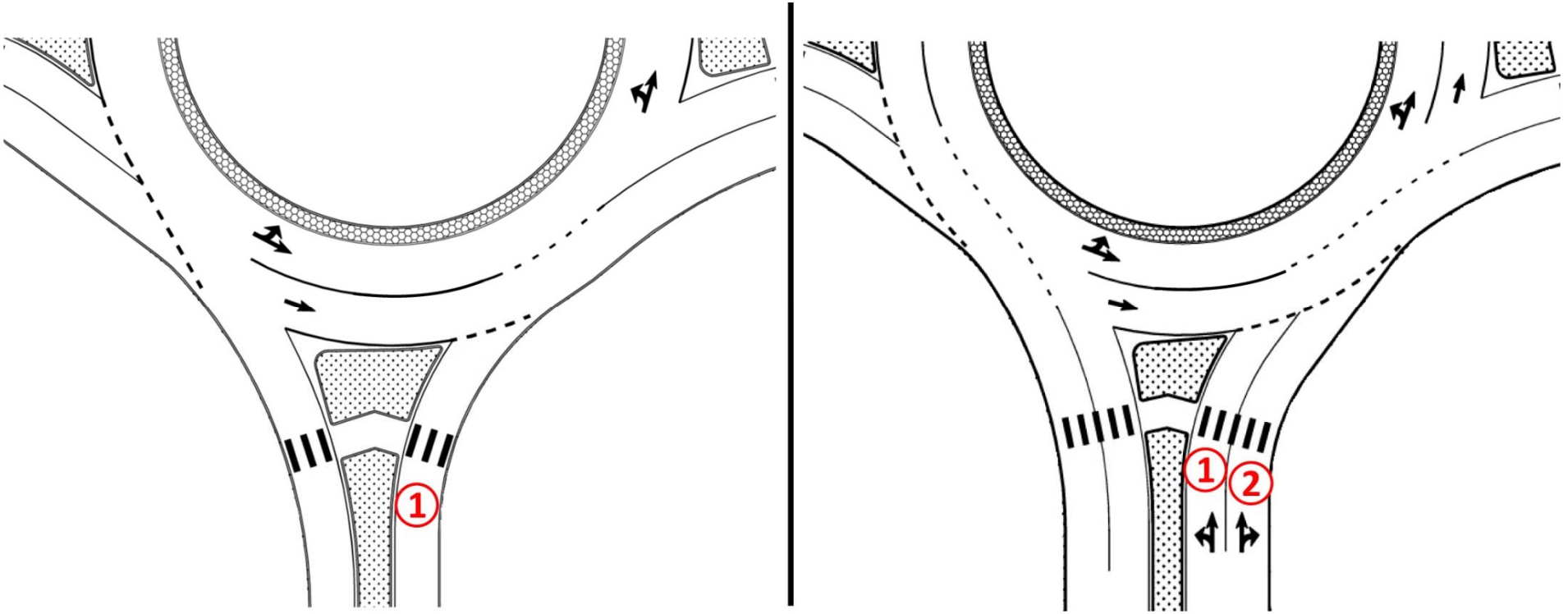
Input		Control Strategy: Traffic Signal	Control Strategy: 2-lane Roundabout
	Roundabout CMF Inputs		
Inscribed Circle Diameter (ft)			
Leg 1 (Major Leg #1)	Leg 1 (Major Leg #1)		
Opening Year Entering AADT			25,000
Leg has Right-Turn Bypass			No
# of Access Points within 250' of Yield Line			
Entering Width (ft)			34
# of Entering Lanes			2
# of Circulating Lanes			2
Leg 2 (Major Leg #2)	Leg 2 (Major Leg #2)		
Opening Year Entering AADT			25,000
Leg has Right-Turn Bypass			No
# of Access Points within 250' of Yield Line			
Entering Width (ft)			34
# of Entering Lanes			2
# of Circulating Lanes			2
Leg 3 (Minor Leg #1)	Leg 3 (Minor Leg #1)		
Opening Year Entering AADT			1750
Leg has Right-Turn Bypass			No
# of Access Points within 250' of Yield Line			
Entering Width (ft)			24
# of Entering Lanes			2
# of Circulating Lanes			2
Leg 4 (Minor Leg #2)	Leg 4 (Minor Leg #2)		
Opening Year Entering AADT			1,750
Leg has Right-Turn Bypass			No
# of Access Points within 250' of Yield Line			
Entering Width (ft)			24
# of Entering Lanes			2
# of Circulating Lanes			2

2.2A – SPICE STAGE 2: ROUNDABOUT CMF INPUTS

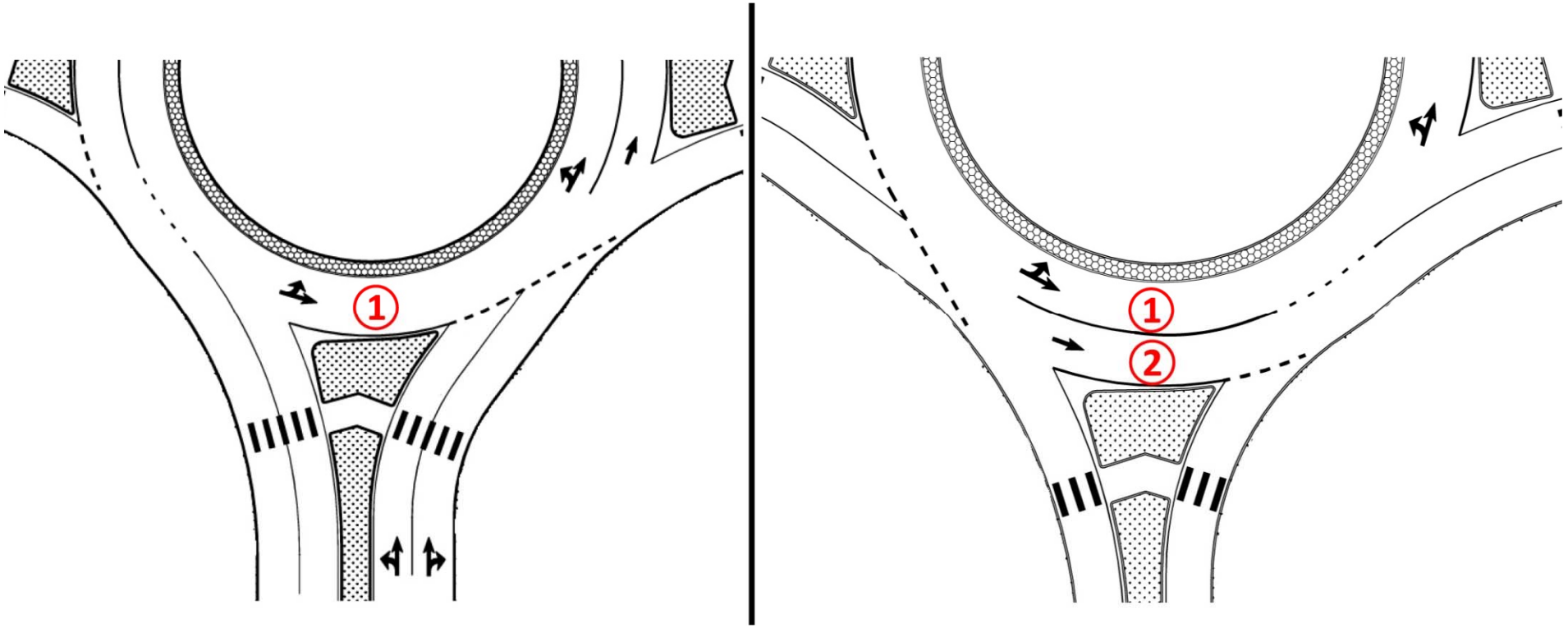
User Input Variable	Units	Definition	Applicable Ranges		
			Range for:	Lower Limit	Upper Limit
Control Strategy Selection					
Number of Major Street Lanes	lanes	Number of lanes on the major street (both directions - does not include turn lanes)	-	-	-
At-Grade Intersection Inputs					
Major/Minor Road AADT	veh/day	Average annual daily traffic (AADT) volume for the major and minor street approaches (see table for ranges).	See table starting in column I (to the right).		
Skew Angle	degrees	Intersecting angle between major street and minor street approaches *(hover cursor for graphical representation)*	-	-	-
Number of Major Street Through Lanes	lanes	Number of through lanes on the major street (both directions - includes shared through lanes)	-	-	-
Number of Minor Street Lanes	lanes	Number of lanes on the minor street (both directions - does not include turn lanes)	-	-	-
Inscribed Circle Diameter	feet		Roundabout	90	160
Opening Year Entering AADT	veh/day		Roundabout	See Table in Column O	
Leg has Right-Turn Bypass	yes/no		Roundabout	-	-
Access Point within 250' of Yield Line	-		Roundabout	0	8
Entering Width	feet				
Number of Entering Lanes	lanes	Number of lanes entering a leg of the roundabout *(hover cursor for graphical representation)*.			
Number of Circulating Lanes	lanes	Number of lanes circulating a leg of the roundabout *(hover cursor for graphical representation)* .			
Ramp Terminal Intersection Inputs					
Crossroad	-	References the major street of the ramp terminal intersection (i.e., the non-ramp terminal legs)			
Crossroad AADT - Inside Leg	veh/day	AADT volume of the crossroad leg located between the two ramp terminals of the interchange			
Crossroad AADT - Outside Leg	veh/day	AADT volume of the crossroad leg located outside of the interchange			
Ramp AADT - Exit	veh/day	AADT volume of the exit ramp			
Ramp AADT - Entrance	veh/day	AADT volume of the entrance ramp			
			Signalized	0	31,000
Exit Ramp Skew Angle	degrees	Skew angle equals 90 minus the intersection angle (in degrees) (*hover cursor for graphical representation*).	Stop-Controlled	0	70
Presence of Non-Ramp Public Street Leg	yes/no	Any ramp that has a fourth leg that: (1) is a public street serving two-way traffic and (2) intersects with the crossroad at the terminal. At most ramp terminals, the public street leg will be on the opposite side of the crossroad from the exit ramp.	-	-	-
			Stop-Controlled	1	2



2.2A – SPICE STAGE 2: ROUNDABOUT ENTRY LANES



2.2A – SPICE STAGE 2: ROUNDABOUT CIRCULATING LANES



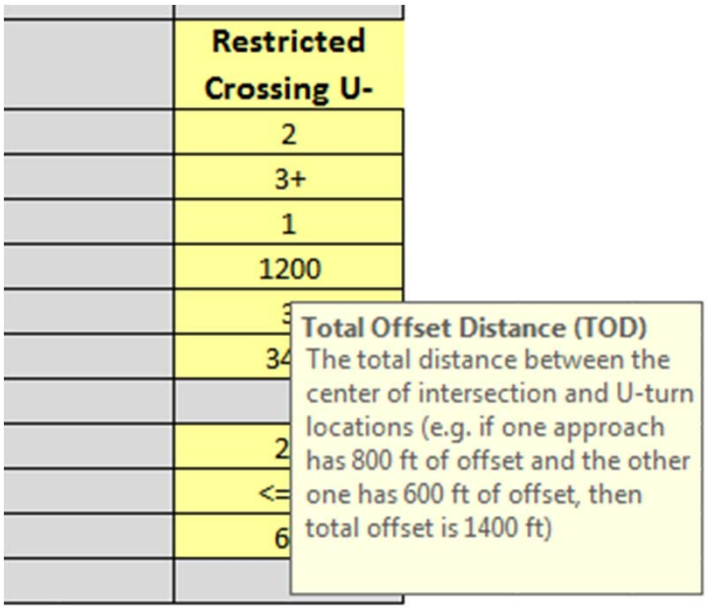
2.2A – SPICE: RCUT CMF INPUTS

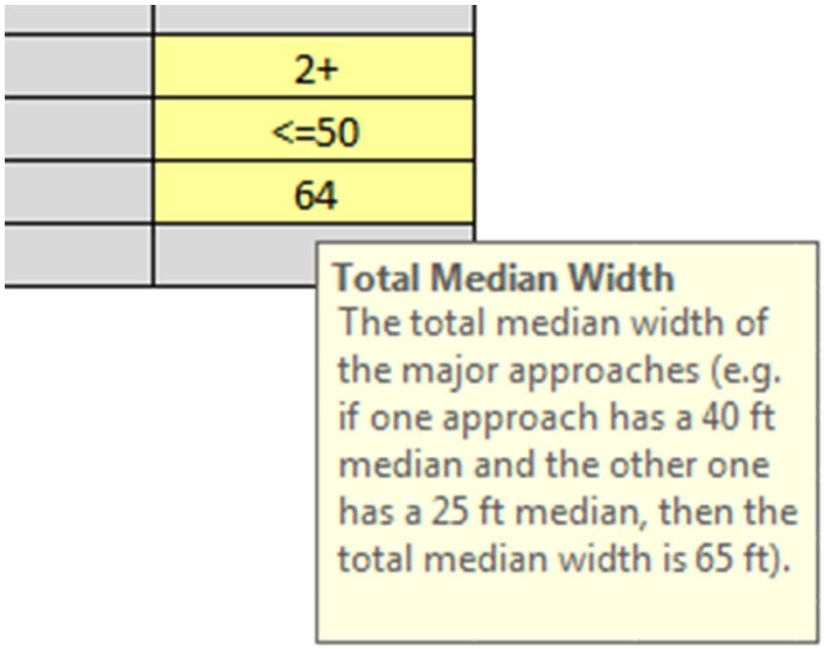
- RCUT SPFs have new variables and new input area in SPICE for CMFs

		Control Strategy			
Input		Traffic Signal	Traffic Signal (Alt)	Signalized RCUT	Unsignalized RCUT
Number of Bus Stops within 1000' of Intersection Schools within 1000' of intersection Number of Alcohol Sales Establishments within 1000' of Intersection	A yellow cell indicates the value may be used in the SPF computation			Scroll Down for Signalized RCUT SPF Inputs	Scroll Down for Unsignalized RCUT SPF Inputs
				Restricted Crossing U-Turn (RCUT) CMF Inputs	
# U-Turns				1	1
# of Major Roadway Lanes				2	
# of Minor Roadway Lanes				2	
Total Offset Distance (ft)				1250	1250
Number of Driveways				4	4
Total Deceleration Lane Length (ft)				750	750
Total Acceleration Lane Length (ft)					750
Number of Left-Turn Lanes From Major Road				1	
Major Road Speed Limit (mph)				<=50	
Total Median Width (ft)				65	
Maximum Median Width (ft)					40

RCUT CMFs in SPFs DEFINITIONS

- Total Offset Distance CMF – crashes increase with increased offset distance
- Median width CMF – crashes reduce with greater median width





2.2A – SPICE: CMF SPECIFICATION AND OPTIONAL LOCAL CALIBRATION

- Crash Modification Factors (CMFs) used when Safety Performance Functions (SPFs) are unavailable
- Traffic signal is the base condition.

Local CMFs				
Optional - Override default CMFs with locallly-developed or new CMFs				
Control	**Type of Crashes**	**Default CMF**	**Optional User Override**	**Use Value**
Displaced Left Turn (DLT)	Total	0.88		0.88
	Fatal-Injury	0.88		0.88
Median U-Turn (MUT)	Total	0.85		0.85
	Fatal-Injury	0.46		0.46
Continuous Green-T Intersection	Total	0.96		0.96
	Fatal-Injury	0.85		0.85
Jughandles	Total	0.74		0.74
	Fatal-Injury	0.74		0.74
Crossover Traffic Signal (of Diverging Diamond Interchange)	Total	0.67		0.67
	Fatal-Injury	0.59		0.59

- CMFs can be overridden with local values
- FDOT intersection calibration factors are included but can be overridden.

2.2A – SPICE: HISTORICAL CRASH DATA

- Empirical Bayes (EB) Analysis – recommend to use min. of 5 years crash data
- Existing intersection must be signalized or minor road stop
- Only applies EB to intersections with CMFs – DLT & MUT not Roundabout & RCUT

Historical Crash Data Input

Note: In order to use Empirical Bayes (EB), the historical intersection type must be a traffic signal or a minor road stop. Additionally, this alternative must be selected to be included in the analysis, and the historical intersection specified below. Up to 10 years of historical data can be used to perform the EB adjustment.

Is historical crash data available?	Yes		
Number of years available:	5	(Up to 10)	First Year Data is available: 2013
Historical Intx Type:	4SG		

Historical Crash Counts		Year										
		2013	2014	2015	2016	2017	--	--	--	--	--	Total
Combined	Total	44	30	60	64	42	--	--	--	--	--	240
	Fatal/Injury	9	8	17	16	10						60
	PDO	35	22	43	48	32						180
Single-Vehicle	Total											
	Fatal/Injury											
	PDO											
Multiple-Vehicle	Total											
	Fatal/Injury											
	PDO											
Veh-Ped	Fatal/Injury	0	1	0	1	0						2
Veh-Bike	Fatal/Injury	0	0	0	0	0						0
Total	All	44	31	60	65	42	--	--	--	--	--	242

2.2A – SPICE: CRASH PREDICTION OUTPUTS

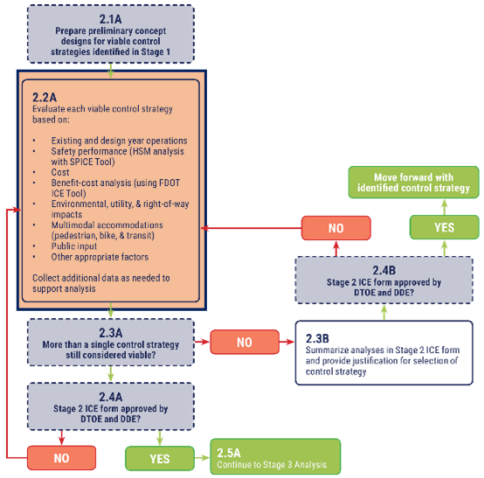
- Computes predicted crashes for all selected control strategy types
- Predicted crashes are broken into “Total” and “Fatal & Injury” groups
- Ranking is based on “Fatal & Injury” crashes.

Crash Prediction Summary							
Control Strategy	**Crash Type**	**Opening Year**	**Design Year**	**Total Project Life Cycle**	**Rank**	**AADT Within Prediction Range?**	**Source of Prediction**
Traffic Signal	Total	36.39	44.21	848.19	4	Yes	Uncalibrated SPF w/ EB
	Fatal & Injury	9.02	11.21	212.86			
Displaced Left Turn (DLT)	Total	32.02	38.90	746.41	2	N/A	CMF
	Fatal & Injury	7.94	9.86	187.31			
Median U-Turn (MUT)	Total	30.93	37.58	720.96	1	N/A	CMF
	Fatal & Injury	6.31	7.84	149.00			
Signalized RCUT	Total	31.42	53.16	881.50	3	No	Uncalibrated SPF
	Fatal & Injury	6.86	12.11	197.31			

ICE PROCEDURE

ICE Procedure and Tools

Stage 1	CAP-X	SPICE	
Stage 2	Analysis Guidance	Default SYNCHRO	FDOT ICE Tool
Stage 3	No specific tools. Reuse Stage 2 tools or address qualitative issues.		



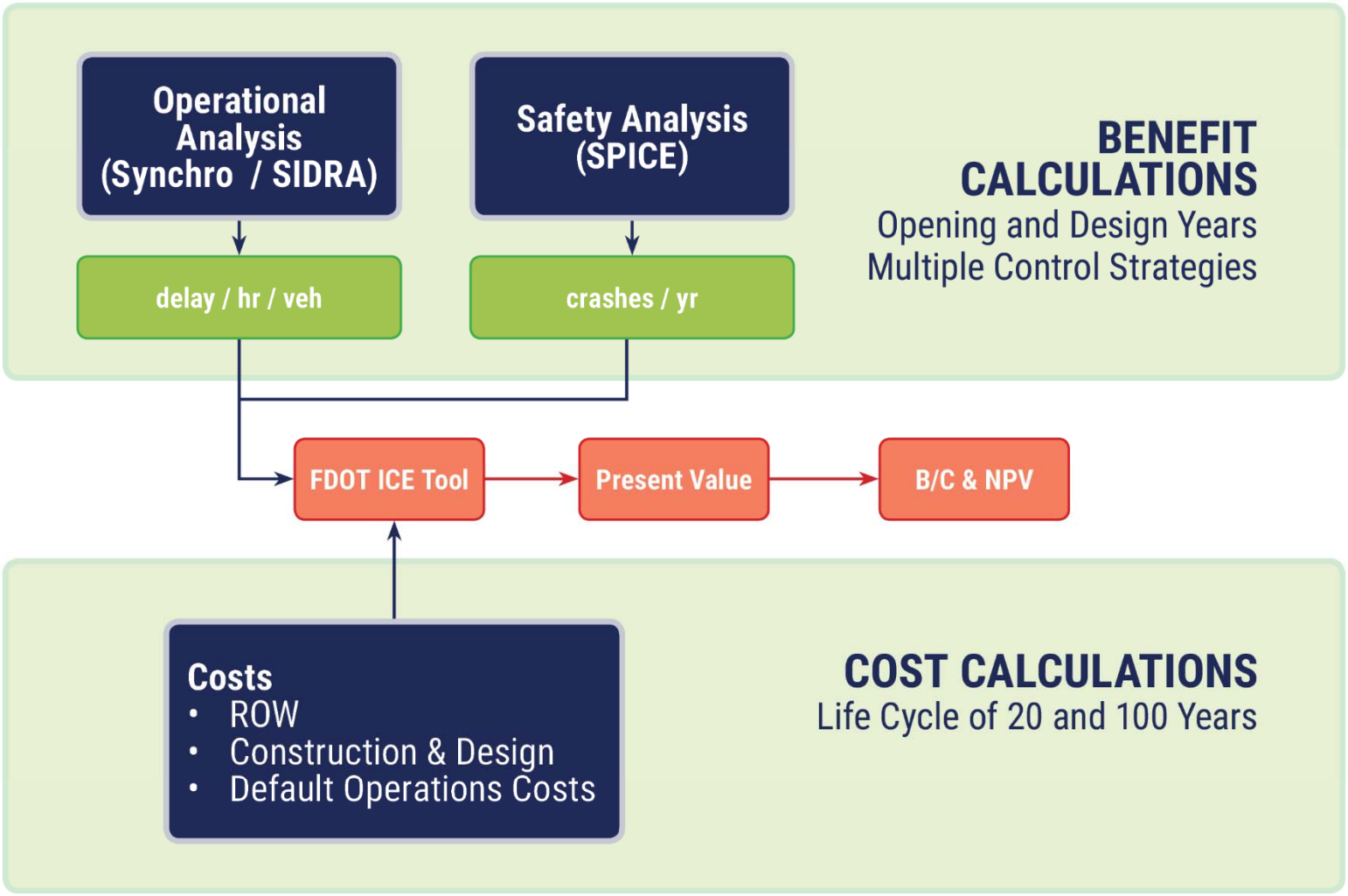
TOOLS

FDOT ICE TOOL

VISION AND NEED FOR THE FDOT ICE TOOL

- Stage 2 tool for financial analysis of intersection alternatives
- Needed inputs for life-cycle cost analysis
  - Safety - SPICE
  - Vehicular delay – SYNCHRO, VISSIM, HCS, SIDRA, etc.
  - Design, construction, right-of-way, and operating costs
- Conducts benefit-cost / net present value analysis
- Designed to be quick and easy to use – hour(s) not day(s)
  - Limit data inputs to readily available or computable values
  - Utilize information of previous stages of ICE analysis (e.g., SPICE tool)
- Flexible enough to accommodate all intersection alternatives

2.2 A – FDOT ICE TOOL OVERVIEW



2.2 A – FDOT ICE TOOL OVERVIEW

- Based on the NCHRP 3-110 Life Cycle Cost Estimation Tool (LCCET)
  - Macro-powered Excel spreadsheet
- Includes Florida hourly, daily, and monthly volume profiles for operational life-cycle cost analysis
  - Peak hour volumes are scaled to every hour of a project's lifespan
  - Defaults for urban vs rural, different functional classifications
- Major FDOT customizations
  - Simplified and improved input sheets
  - Local default values where applicable for monetized performance measures
  - Florida-specific volume profiles

2.2 A – FDOT ICE TOOL: STRATEGIES SELECTION

	Open Year	Design Year
Operating Cycle	2020	2040
Peak Hour Start	**From**	**To**
AM peak	7:00 AM	8:00 AM
PM peak	4:00 PM	5:00 PM
Weekend peak	10:00 AM	11:00 AM

Enter peak period begin and end times:

Select Analysis Basis: Specific Day/Month

Weekday Count: Tuesday, April 12, 2016 Enter dates as "mm/dd/yyyy"

Weekend Count: Enter dates as "mm/dd/yyyy"

Select facility type: 16 - Urban Minor Arterial

Show/Hide Detailed Demand Profiles

Specify total volumes or turning counts?

Turning Counts	(Select from drop-down menu)

Enter the turning movement counts in the DemandCounts worksheet for the peak hours. If data is not available for the weekend peak hour please leave blank.

Units	Year	
	Opening	Design
	2020	2040
	Intersection 1	
AM peak hour volume	veh/hr	3,465	4,713
PM peak hour volume	veh/hr	4,449	6,014
Weekend peak hour volume:	veh/hr		
Average annual auto occupancy	Passengers per vehicle	1.0	1.0
Average annual % trucks	Average %	3.1%	3.1%

At-Grade Control Strategies

Control #	Include	Short Name	Description
1	No	TWSC	Two-Way Stop Control
2	No	AllStop	All Way Stop
3	Yes	TrafficSignal	Traffic Signal
4	No	TrafficSignalAlt	Traffic Signal (Alt.)
5	No	Roundabout	Roundabout
6	Yes	DLT	Displaced Left Turn (DLT)
7	Yes	MUT	Median U-Turn (MUT)
8	Yes	SignalRCUT	Signalized Restricted Crossing U-Turn (RCUT)
9	No	UnsignalRCUT	Unsignalized Restricted Crossing U-Turn (RCUT)
10	No	GreenT	Continuous Green-T Intersection
11	No	Jughandle	Jughandle
12	No	Quadrant Itx	Quadrant Roadway Intersection
13	No	Other1	Other 1
14	No	Other2	Other 2

Setup Worksheets

Press the "Setup Worksheets" button to create hidden worksheets that compute performance measures for each selected control strategy.

2.2 A – FDOT ICE TOOL: FLORIDA DEMAND PROFILES

- Demand Profiles – Florida Daily & Monthly values by functional classification

Passenger Vehicle Demand Profile Parameters

Note: All charts illustrating volume profiles are shown to right of Column "R"

Review Daily Profile or Override Values:

Chart shown at right

Day of Week	04 - Rural Principal Arterial -- Other	06 - Rural Minor Arterial	07 - Rural Major Collector	08 - Rural Minor Collector	14 - Urban Principal Arterial -- Other	16 - Urban Minor Arterial	17 - Urban Major Collector
Monday	88.2%	80.6%	90.2%	79.9%	75.6%	75.1%	74.7%
Tuesday	97.9%	98.3%	96.3%	97.8%	101.3%	101.1%	101.7%
Wednesday	97.6%	102.2%	98.7%	106.1%	105.5%	106.8%	107.2%
Thursday	99.1%	103.2%	99.5%	103.8%	106.7%	107.3%	108.3%
Friday	102.6%	105.7%	102.4%	105.9%	107.3%	107.8%	108.0%
Saturday	114.3%	113.4%	112.6%	110.8%	111.2%	111.8%	109.9%
Sunday	100.1%	96.6%	100.2%	95.7%	92.4%	90.2%	90.1%

Review Monthly Profile or Override Values:

Chart shown at right

Month	Functional Class						
	04 - Rural Principal Arterial --	06 - Rural Minor Arterial	07 - Rural Major Collector	08 - Rural Minor Collector	14 - Urban Principal Arterial -- Other	16 - Urban Minor Arterial	17 - Urban Major Collector
January	92.5%	93.2%	95.7%	92.7%	98.3%	94.0%	101.7%
February	101.0%	102.6%	105.7%	102.3%	104.8%	103.1%	113.0%
March	107.1%	105.9%	110.6%	109.9%	107.1%	107.6%	113.5%
April	103.6%	103.8%	106.7%	105.2%	103.9%	100.6%	110.5%
May	103.2%	103.6%	103.1%	101.8%	98.0%	98.7%	102.7%
June	102.5%	101.0%	100.5%	95.4%	97.6%	95.0%	90.7%
July	100.2%	101.0%	97.7%	92.3%	96.2%	96.1%	89.5%
August	94.7%	98.3%	91.0%	94.6%	96.6%	96.9%	93.9%
September	94.5%	98.6%	89.2%	94.3%	96.1%	97.0%	94.7%
October	100.5%	100.6%	102.7%	100.6%	99.6%	102.5%	95.2%
November	101.5%	94.7%	98.9%	104.6%	101.2%	104.8%	96.9%
December	98.7%	96.9%	98.3%	106.4%	100.3%	103.5%	97.8%

2.2 A – FDOT ICE TOOL: FLORIDA DEMAND PROFILES

- Demand Profiles – Florida Weekday hourly values by functional classification
- Weekend values also available

Review Weekday Hourly Demand Profile or Override Values:
Chart shown at right

Category	Hour Starting	Functional Class						
		04 - Rural Principal Arterial --	06 - Rural Minor Arterial	07 - Rural Major Collector	08 - Rural Minor Collector	14 - Urban Principal Arterial --	16 - Urban Minor Arterial	17 - Urban Major Collector
Weekday	12:00 AM	0.7%	0.5%	0.5%	0.4%	0.8%	0.6%	0.5%
	1:00 AM	0.5%	0.3%	0.3%	0.2%	0.5%	0.4%	0.3%
	2:00 AM	0.4%	0.3%	0.3%	0.2%	0.4%	0.3%	0.2%
	3:00 AM	0.6%	0.4%	0.3%	0.2%	0.4%	0.3%	0.2%
	4:00 AM	1.1%	0.9%	0.8%	0.6%	0.7%	0.5%	0.4%
	5:00 AM	2.5%	2.3%	2.0%	1.8%	1.7%	1.5%	1.1%
	6:00 AM	4.8%	4.9%	4.3%	5.9%	4.2%	3.8%	3.6%
	7:00 AM	6.2%	6.9%	6.2%	8.6%	6.4%	6.2%	6.8%
	8:00 AM	5.7%	5.8%	5.7%	7.0%	6.3%	6.2%	6.7%
	9:00 AM	5.5%	5.6%	5.8%	5.0%	5.6%	5.6%	5.7%
	10:00 AM	5.8%	5.8%	6.2%	4.7%	5.6%	5.7%	5.6%
	11:00 AM	6.1%	6.2%	6.5%	4.7%	5.9%	6.1%	6.0%
	12:00 PM	6.2%	6.4%	6.7%	4.8%	6.3%	6.5%	6.4%
	1:00 PM	6.3%	6.4%	6.7%	5.3%	6.3%	6.5%	6.4%
	2:00 PM	6.6%	6.9%	7.0%	5.8%	6.6%	6.8%	6.8%
	3:00 PM	7.2%	7.7%	7.5%	7.0%	7.1%	7.4%	7.4%
	4:00 PM	7.8%	8.0%	7.8%	8.9%	7.5%	7.8%	8.0%
	5:00 PM	7.8%	8.0%	7.9%	10.2%	7.6%	7.9%	8.4%
	6:00 PM	5.8%	5.6%	5.8%	7.3%	6.0%	6.1%	6.3%
	7:00 PM	4.1%	3.9%	4.1%	4.2%	4.4%	4.5%	4.4%
	8:00 PM	3.1%	2.9%	3.0%	3.0%	3.5%	3.5%	3.4%
	9:00 PM	2.4%	2.1%	2.1%	2.0%	2.8%	2.8%	2.6%
	10:00 PM	1.7%	1.4%	1.5%	1.3%	2.1%	1.9%	1.7%
	11:00 PM	1.1%	0.9%	1.0%	0.8%	1.4%	1.2%	1.1%

2.2 A – FDOT ICE TOOL: DELAY

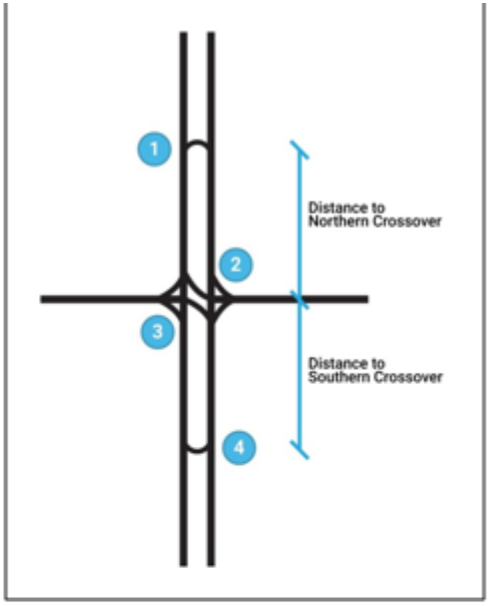
- AM and PM peak delay inputs
  - Required for opening and design years
  - Optional specification of weekend peak
  - Optional worksheets for aggregating a single delay value for MUTs, RCUTs, TWSC from multiple intersection SYNCHRO output sheets

				Opening Year		Design Year	
At-Grade Intersections				Average vehicle delay		Average vehicle delay	
Control Strategy		Delay Type	Units	AM peak	PM peak	AM peak	PM peak
Traffic Signal	Single Input	Single Input	sec/veh	20.1	28.9	22.2	35.4
Displaced Left Turn (DLT)	Single Input	Worksheet (Partial N-S)	sec/veh	12.6	19.7	15.7	25.6
Median U-Turn (MUT)	Select Input Type	Worksheet (N-S)	sec/veh	12.1	14.6	12.2	23.3
Signalized Restricted Crossing U-Turn (RCUT)	Select Input Type	Worksheet (N-S)	sec/veh	14.0	20.5	21.8	49.4

2.2 A – FDOT ICE TOOL: DELAY WORKSHEET

RCUT N-S

Use this sheet to enter the delay information for a Signalized RCUT with the major street running North-South. (Requires turning movement count demand inputs)



User must enter value on this sheet

	Southern Crossover	Northern Crossover
Distance from main intersection to:	700	900
Free-flow speed on major street:	45	

*Volumes are computed based on values entered in DemandCounts and Exhibit 6-2 of FHWA RCUT Guide

Opening Year AM Peak					Opening Year PM Peak					Opening Year Weekend Peak				
Intersection 1	SB Thru	NB U-Turn			Intersection 1	SB Thru	NB U-Turn			Intersection 1	SB Thru	NB U-Turn		
Volume	1316	23			Volume	2379	25			Volume	0	0		
Delay	2.4	16.7			Delay	5.3	34.2			Delay				
Intersection 2	NB Left	NB Thru	NB Right	WB Right	Intersection 2	NB Left	NB Thru	NB Right	WB Right	Intersection 2	NB Left	NB Thru	NB Right	WB Right
Volume	41	1976	8	81	Volume	68	1834	30	64	Volume	0	0	0	0
Delay	35.1	6.1	2.7	25	Delay	22.4	2.4	0.1	37.7	Delay				
Intersection 3	SB Left	SB Thru	SB Right	EB Right	Intersection 3	SB Left	SB Thru	SB Right	EB Right	Intersection 3	SB Left	SB Thru	SB Right	EB Right
Volume	39	1235	65	158	Volume	101	2146	157	299	Volume	0	0	0	0
Delay	23.7	4.7	2.5	24.2	Delay	53.2	9.7	3.8	47.9	Delay				
Intersection 4	NB Thru	SB U-Turn			Intersection 4	NB Thru	SB U-Turn			Intersection 4	NB Thru	SB U-Turn		
Volume	1910	115			Volume	1707	225			Volume	0	0		
Delay	6.8	24.2			Delay	9.2	32.6			Delay				

2.2 A – FDOT ICE TOOL: SAFETY

- Requires Total and Fatal & Injury crashes for each intersection
- Input SPICE Tool outputs

At-Grade Intersection	Crash Type	Opening Year	Design Year
Traffic Signal	Total	36.39	44.21
	Fatal & Injury	9.02	11.21
Displaced Left Turn (DLT)	Total	32.02	38.90
	Fatal & Injury	7.94	9.86
Median U-Turn (MUT)	Total	30.93	37.58
	Fatal & Injury	6.31	7.85
Signalized Restricted Crossing U-Turn (RCUT)	Total	31.42	53.16
	Fatal & Injury	6.86	12.11

CMFs			
	Displaced Left Turn (DLT)	Total	0.88
		Fatal & Injury	0.88
	Median U-Turn (MUT)	Total	0.85
		Fatal & Injury	0.70
	Signalized Restricted	Total	
		Fatal & Injury	

This table contains the same CMFs as the FDOT SPICE tool. The CMFs are automatically applied to the user inputs for Traffic Signal or Minor Road Stop, an can be overridden at the user's discretion.

2.2 A – FDOT ICE TOOL: OUTPUTS

Analysis Summary

Cost Categories	Net Present Value of Costs			
	Traffic Signal	Displaced Left Turn (DLT)	Median U-Turn (MUT)	Signalized Restricted Crossing U-Turn (RCUT)
Planning, Construction & Right of Way Costs	$ -	$ 2,390,000	$ 1,642,000	$ 1,830,000
Post-Opening Costs	$ 98,229	$ 238,276	$ 238,276	$ 238,276
Auto Passenger Delay	$ 35,897,182	$ 24,009,965	$ 20,363,630	$ 30,687,128
Truck Delay	$ 6,142,739	$ 4,107,923	$ 3,484,252	$ 5,246,883
Safety	$ 44,155,139	$ 38,856,522	$ 31,567,706	$ 40,016,414
Total cost	**$86,293,288**	**$69,602,686**	**$57,295,864**	**$78,018,702**

→ Net present value of Costs

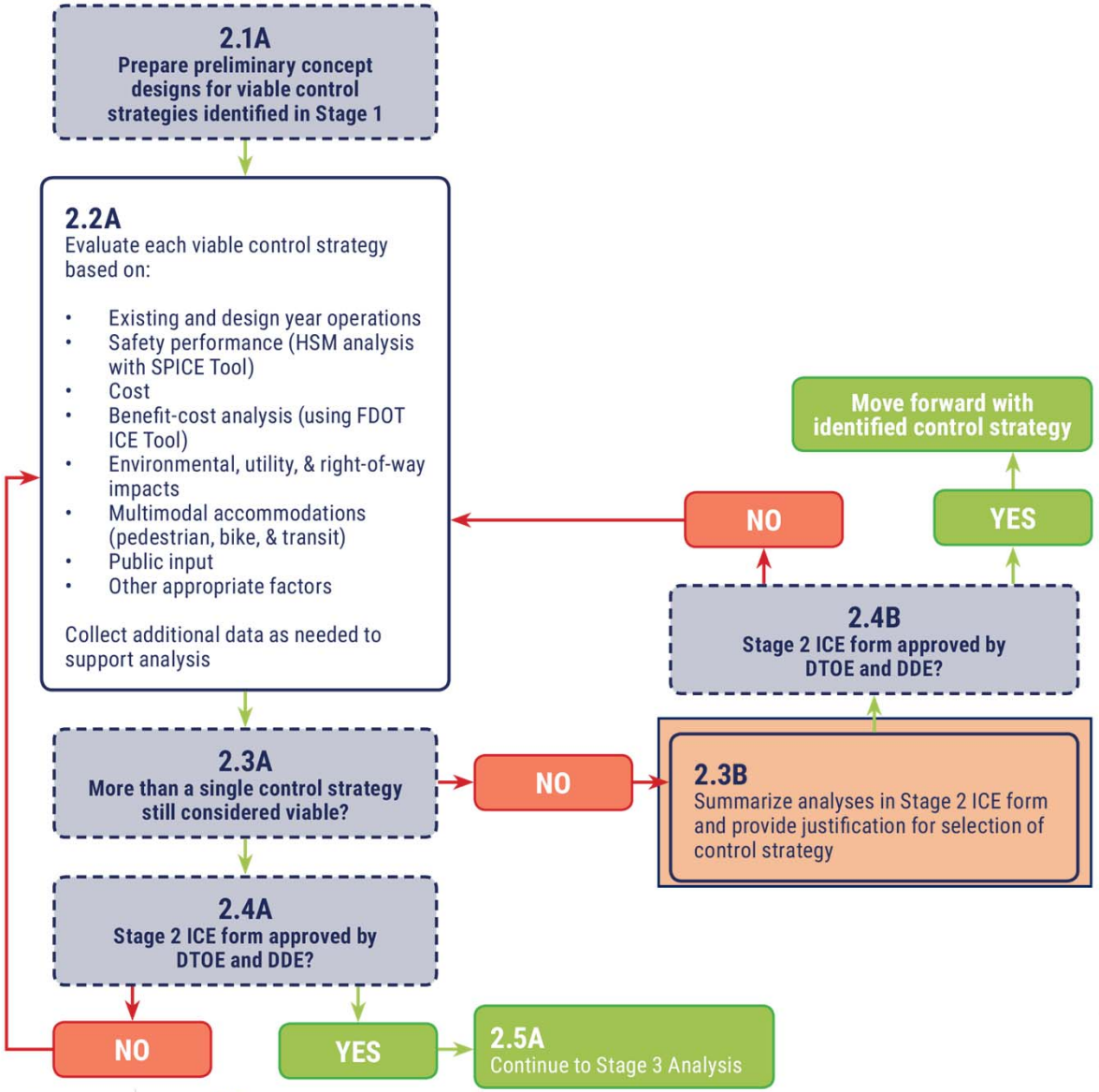
Select Base Case for Benefit-Cost Comparison: (Choose from list)	Traffic Signal

Benefit Categories	Net Present Value of Benefits Relative to Base Case			
	Traffic Signal	Displaced Left Turn (DLT)	Median U-Turn (MUT)	Signalized Restricted Crossing U-Turn (RCUT)
Auto Passenger Delay		$ 11,887,217	$ 15,533,552	$ 5,210,053
Truck Delay		$ 2,034,816	$ 2,658,487	$ 895,856
Safety		$ 5,298,617	$ 12,587,433	$ 4,138,724
Net Present Value of Benefits		**$ 19,220,650**	**$ 30,779,472**	**$ 10,244,634**
Net Present Value of Costs		**$ 2,530,048**	**$ 1,782,048**	**$ 1,970,048**
Net Present Value of Improvement		**$ 16,690,602**	**$ 28,997,424**	**$ 8,274,586**
Benefit-Cost (B/C) Ratio		**7.60**	**17.27**	**5.20**
Delay B/C		**5.50**	**10.21**	**3.10**
Safety B/C		**2.09**	**7.06**	**2.10**

→ Net present value of Benefits

→ Benefit-Cost Ratio (if Base Case exists)

ICE STAGE 2 PROCESS



Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Figure 3; Page 14

2.2 A – ICE FORM STAGE 2: DOCUMENTATION OF EVALUATION

Safety Performance							
Enter the most recent five (5) years of crash data from the CAR System.				Most recent year of crash data available		2017	
Crash Type		2013	2014	2015	2016	2017	Total
Combined	Total	44	30	60	64	42	240
	Fatal/Injury	9	8	17	16	10	60
	PDO	35	22	43	48	32	180
Single-Vehicle	Total						
	Fatal/Injury						
	PDO						
Multi-Vehicle	Total						
	Fatal/Injury						
	PDO						
Vehicle-Pedestrian	Fatal/Injury	0	1	0	1	0	2
Vehicle-Bicycle	Fatal/Injury	0	0	0	0	0	0
Total	All	44	31	60	65	42	242

2.2 A – ICE FORM STAGE 2: DOCUMENTATION OF EVALUATION

Apply the FDOT SPICE Tool to model anticipated safety performance of each control strategy. For intersection types not accommodated in the tool, manually apply crash modification factors detailed in the ICE procedures document or qualitatively describe anticipated safety impacts.

Control Strategy	Anticipated Impact on Safety Performance	Opening Year		Design Year	
		Predicted Total Crashes	Predicted Fatal+Injury Crashes	Predicted Total Crashes	Predicted Fatal+Injury Crashes
Signalized Control	The signalized control alternative is predicted to have the highest number of overall crashes as well as fatal/injury	36.39	9.02	44.21	11.21
Median U-Turn	PARTIAL - The MUT N-S control alternative is predicted to have the lowest number of overall and fatal/injury crashes.	30.93	6.31	37.58	7.84
RCUT (Signalized)	The RCUT control alternative is predicted to have the lowest number of overall crashes along with the partial	31.42	6.86	53.16	12.11
Displaced Left-Turn	PARTIAL - The DTL N-S control alternative is predicted to have the second lowest number of overall crashes and the	32.02	7.94	38.90	9.86

2.2 A – ICE FORM STAGE 2: DOCUMENTATION OF EVALUATION

Costs and Benefit/Cost Ratios						
Remaining cognizant of the current level of detail of each control strategy's conceptual design, provide a cost estimate for each. You may want to include costs for preliminary engineering, required right-of-way acquisitions, construction, and a contingency. Apply the FDOT ICE Tool to determine the delay benefit-cost ratio (B/C), safety B/C, overall B/C, and net-present value for each control stratetgy.						
			FDOT ICE Tool Outputs			
Control Strategy	ROW Costs ($)	Construction Costs ($)	Delay B/C	Safety B/C	Overall B/C	Net Present Value
Signalized Control	$0	$0	-	-	-	-
Median U-Turn	$510,000	$1,540,000	10.21	7.06	17.27	28,997,424
RCUT (Signalized)	$500,000	$1,730,000	3.10	2.10	5.20	8,274,586
Displaced Left-Turn	$4,500,000	$1,490,000	5.50	2.09	7.60	16,690,602

2.2 A – ICE FORM STAGE 2: DOCUMENTATION OF EVALUATION

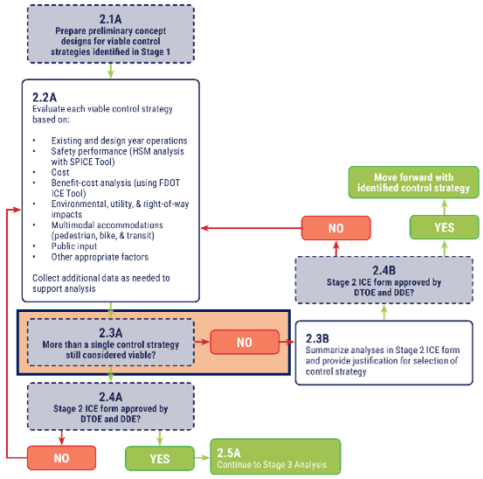
Multimodal Accomodations						
Note the existing/anticipated level of pedestrian/bicyclist activity at the study intersection during the peak hours of the typical day. See ICE procedures document for activity level thresholds:						
	Weekday AM Peak		Weekday PM Peak		Acitivity Level	
	Major Street	Minor Street	Major Street	Minor Street	Ped.	Bicycles
# of ped. crossings (both approaches, if app.):	17	20	67	14	Medium	Low
# of cyclists (both approaches, if app.):	0	0	0	0		
Summarize the ability of each viable control strategy to accommodate the exisitng/anticipated level of:						
Control Strategy	Pedestrians and Bicyclists	Transit Services	Freight Needs			
Signalized Control	The signalized control allows for ped crossing on all intersection legs. Bicycle facilities should still be	No change from existing.	No change from existing.			
Median U-Turn	PARTIAL - The MUT would allow ped crossings upstream and downstream U-turn locations.	No change from existing.	No change from existing.			
RCUT (Signalized)	The RCUT can provide ped x-walks on all intersection legs. Provides opportunities for ped	No change from existing.	No change from existing.			
Displaced Left-Turn	PARTIAL - The DTL would still allow ped crossings on all intersection legs, crossing distance	No change from existing.	No change from existing.			

2.2 A – ICE FORM STAGE 2: DOCUMENTATION OF EVALUATION

Environmental, Utility, and Right-of-Way Impacts	
Summarize any issues related to environmental, utility, or right-of-way (including relocation) impacts specific to each control strategy. Be sure to consider the NEPA requirements for each control type.	
Signalized Control	No impacts anticipated.
Median U-Turn	ROW acquisition needed on the SW corner of the intersection.
RCUT (Signalized)	ROW acquisition needed on the SW corner of the intersection.
Displaced Left-Turn	ROW acquisition needed on the NE and SW corners of the intersection. Two driveway will be closed due to intersection reconfiguration, one on each corner.

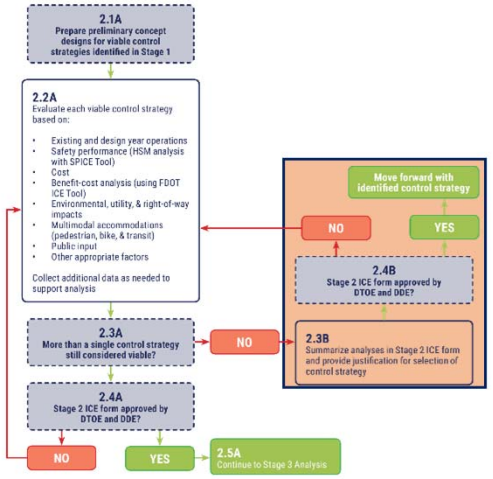
Public Input/Feedback (if appropriate)
Summarize any agency or public input regarding the control strategies:
None performed to date.

2.3 A – ICE FORM STAGE 2: VIABLE CONTROL STRATEGIES SELECTION



Control Strategy Evaluation		
Provide a brief justification as to why each of the following is either viable or not viable. If a single contr the only strategy to be advanced.		
Control Strategy	Strategy to be Advanced?	Justification
Signalized Control	No	The Signalized Control performs operationally slightly better than the RCUT for the 2040 PM but worse than the Partial MUT. From a safety perspective, the traffic signal performs worse than the Partial MUT, Signalized RCUT and Partial DLT.
Median U-Turn	Yes	PARTIAL - The MUT performs better than the Signalized Control, RCUT and Partial DLT control alternatives in terms of operations and safety (overall crashes and fatal/injury).
RCUT (Signalized)	No	The RCUT presents the worst performance when compared to the Signalized Control, PMUT and PDLT alternatives. In terms of safety benefit, the RCUT presents similar safety performance to the DLT with a slight increase in the predicted fatal/injury crashes.
Displaced Left-Turn	No	PARTIAL - The DLT performs better operationally than the signalized RCUT control alternative and the third overall safety performance when compared to the rest of the alternatives.

2.4 B – FDOT ICE FORM APPROVAL – STAGE 2



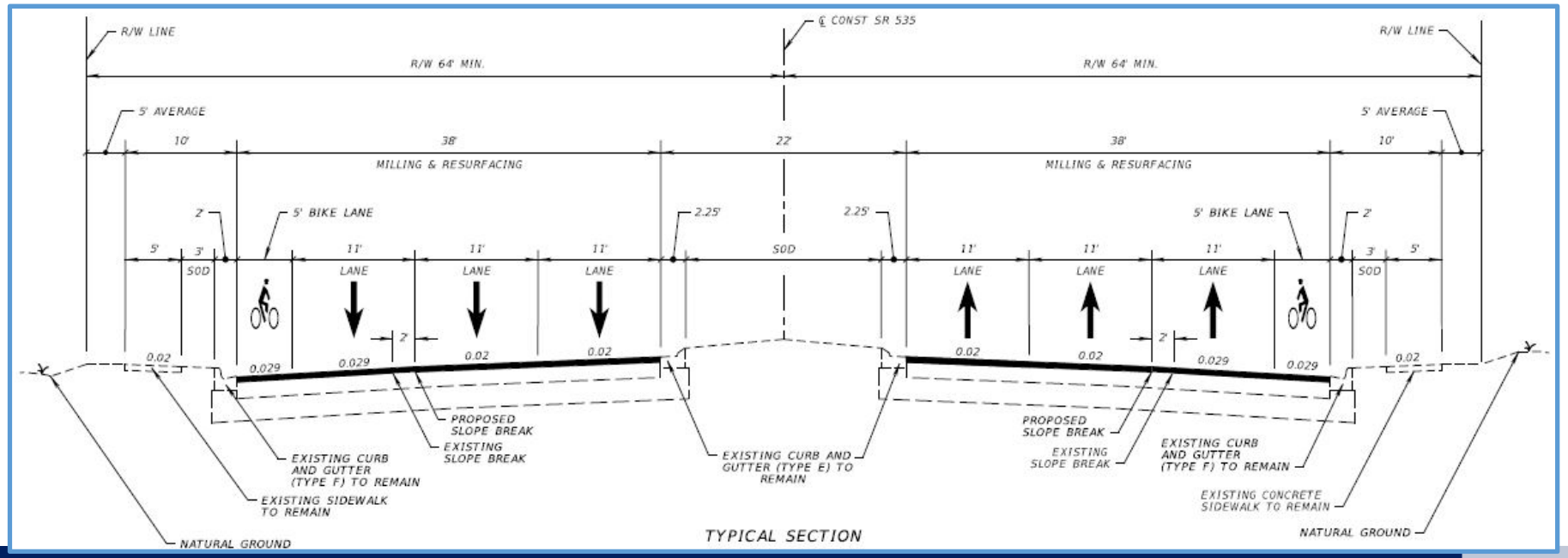
Resolution					
To be filled out by FDOT District Traffic Operations Engineer and District Design Engineer					
Project Determination	Identified Control Strategy Approved				
Comments					
DTOE Name		Signature		Date	
DDE Name		Signature		Date	

SR 535 PROJECT FOLLOW UP

FDOT

SR 535/MEADOW CREEK DRIVE PROJECT FOLLOW-UP

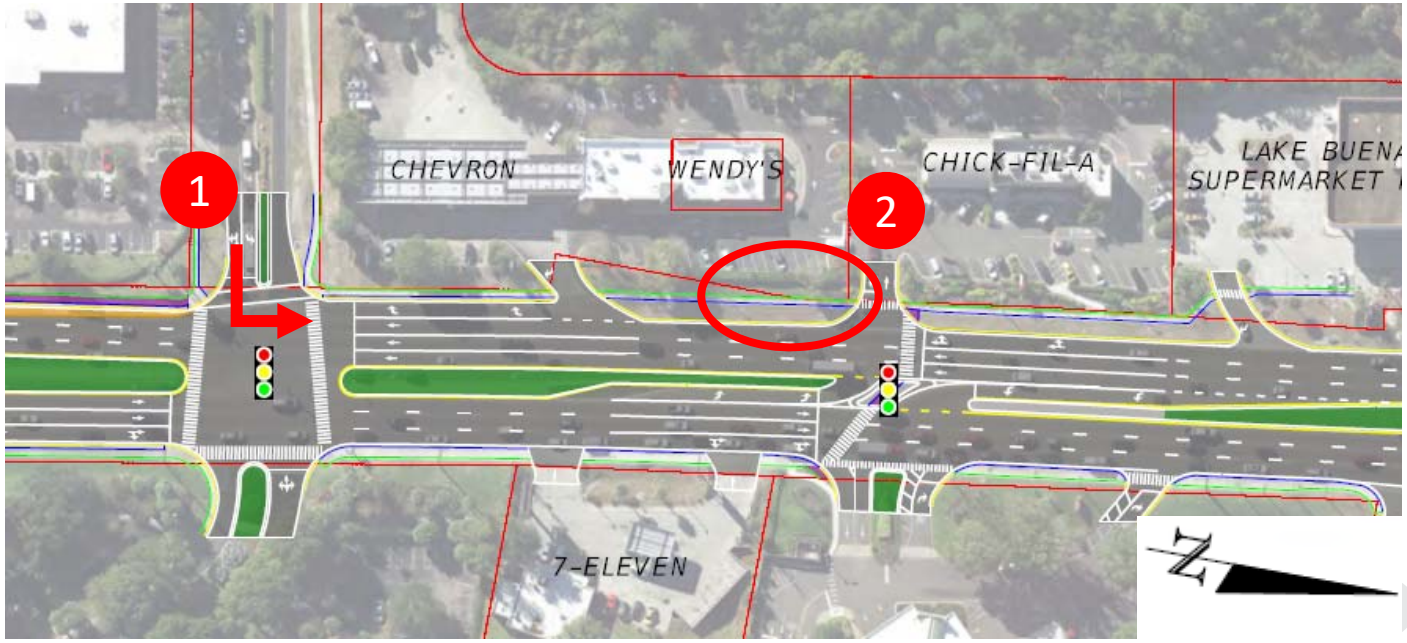
- Recommendations from Planning Study (RCUTs along corridor) went into Concept Development Study
- Concept Study reviewed RCUT and PMUT configurations
- Opportunity to include RCUT in ongoing 3R design project
  - Similar limits of the Concept Development Study
  - Feasibility of incorporating innovative intersection concepts into 3R were evaluated



SR 535/MEADOW CREEK DRIVE PROJECT FOLLOW-UP

- Additional engineering considerations for RCUT/PMUT were identified and reviewed with D5 Traffic Ops staff

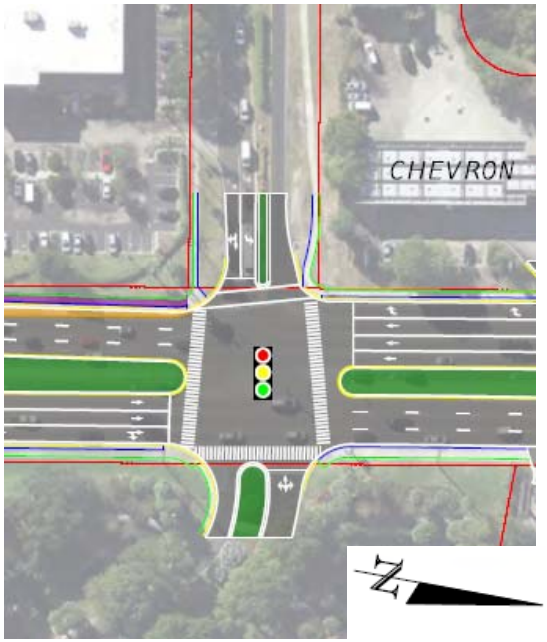
1. History of left turn crashes with peds in north leg crosswalk – PMUT would still allow these lefts
2. PMUT would force NB left turning trucks to U-turn at downstream directional median, needing ROW



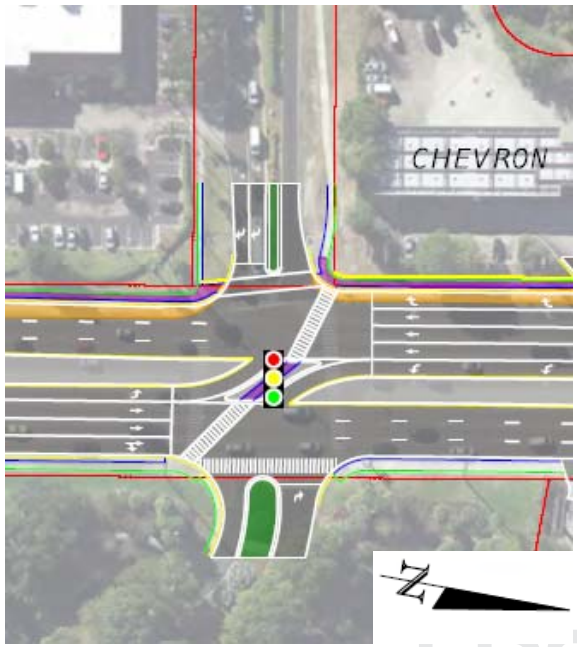
SR 535/MEADOW CREEK DRIVE PROJECT FOLLOW-UP

- Additional engineering considerations for RCUT/PMUT were identified and reviewed with D5 Traffic Ops staff

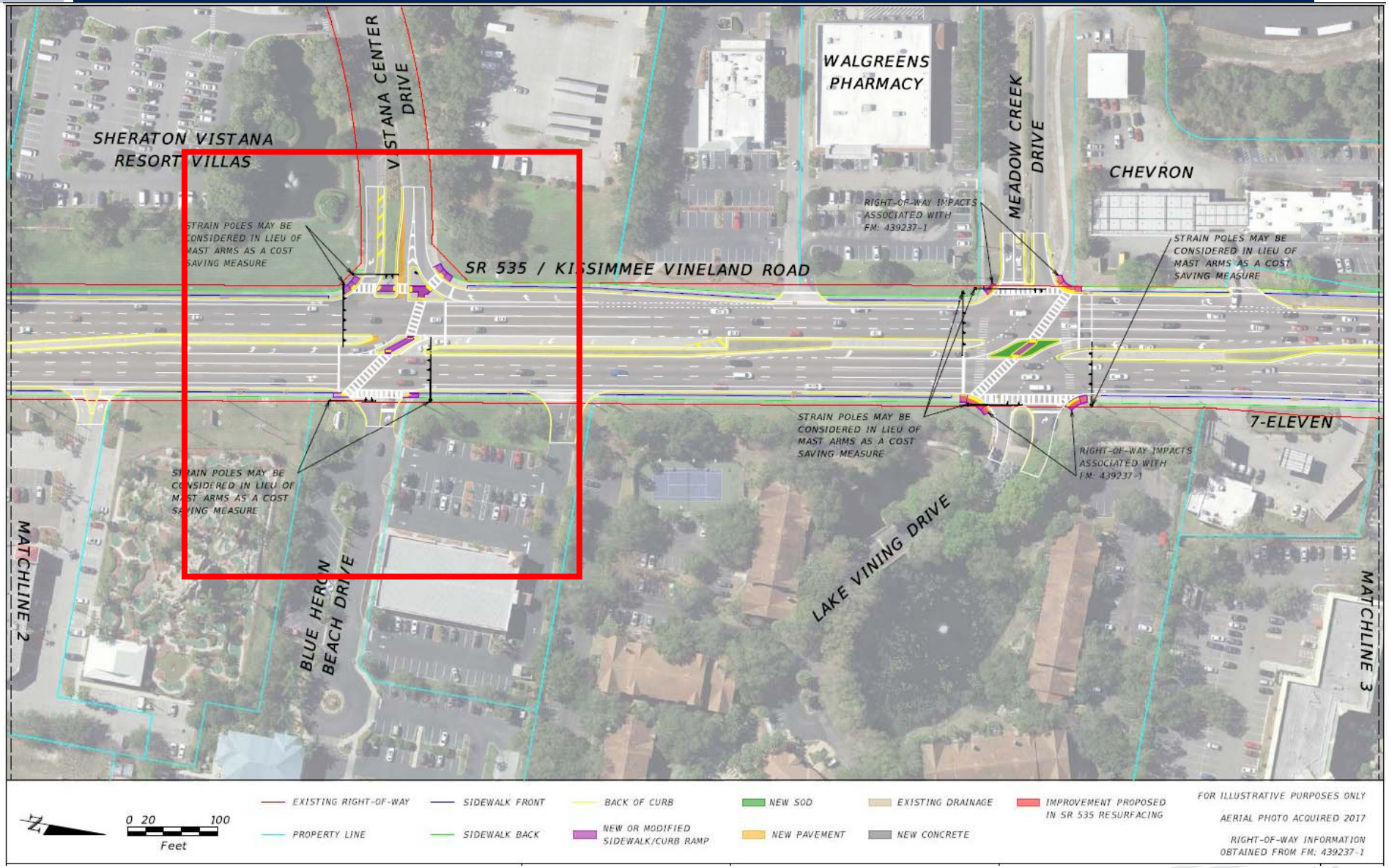
Drivers would still try NB/SB left turns in PMUT if not designed properly



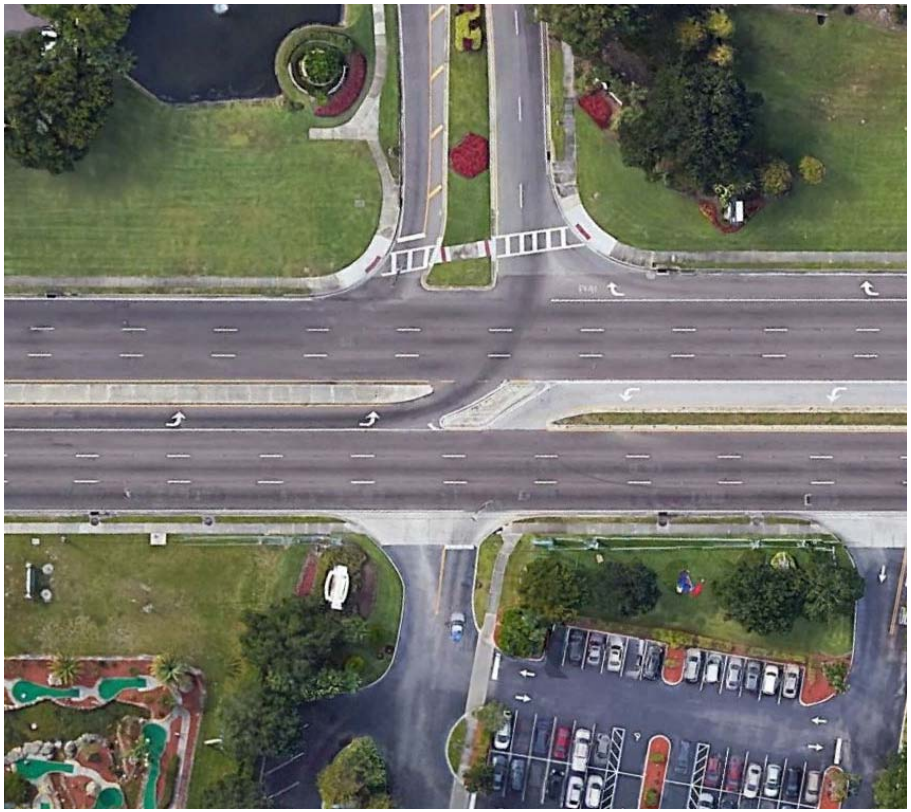
RCUT aligns with driver expectancy more than PMUT

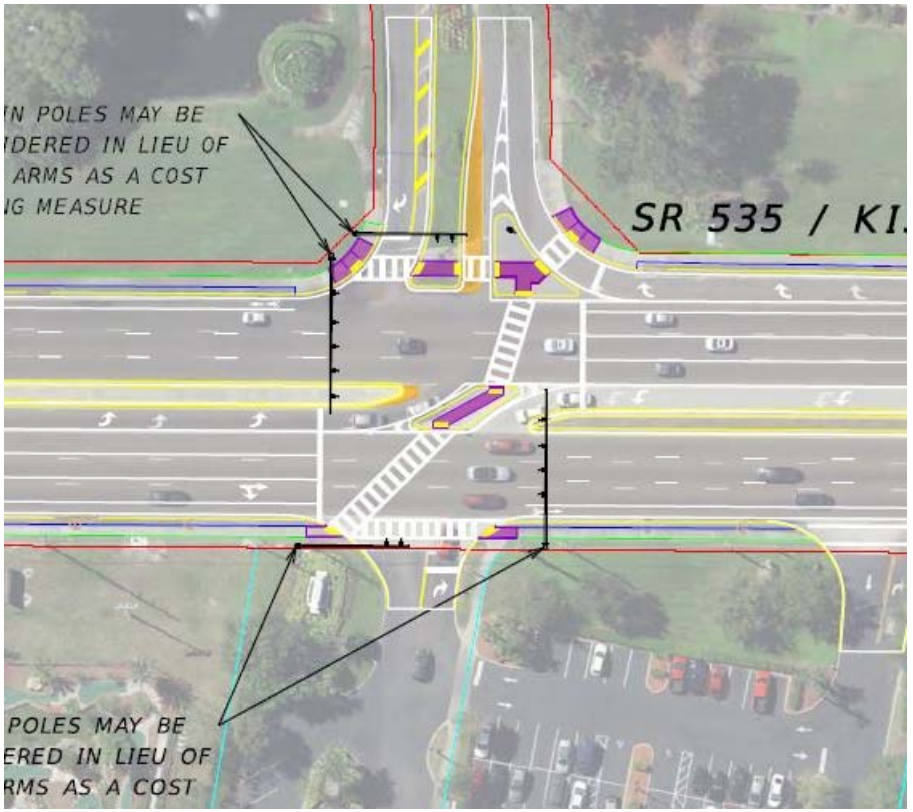


SR 535/MEADOW CREEK DRIVE PROJECT FOLLOW-UP

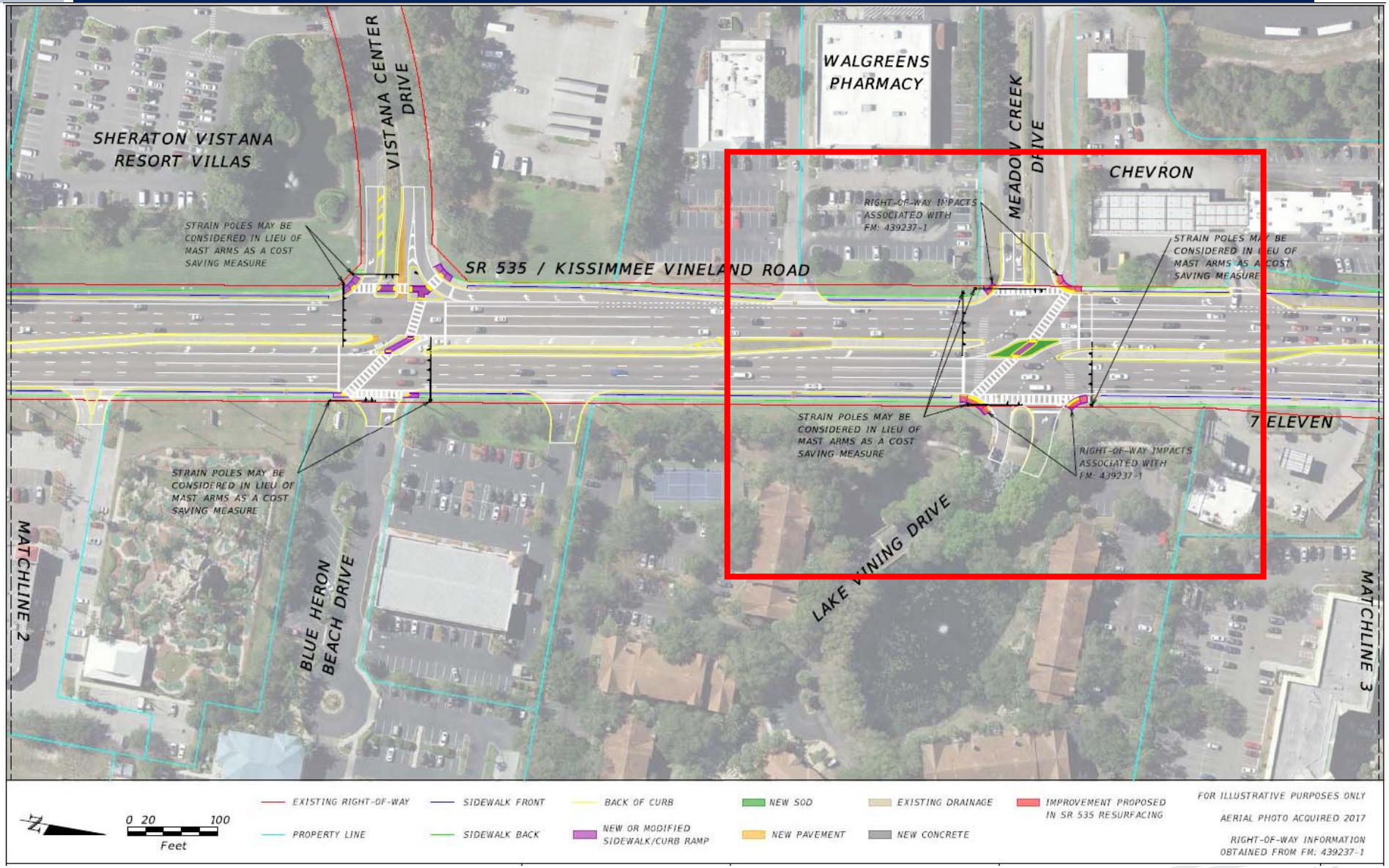


SR 535/MEADOW CREEK DRIVE PROJECT FOLLOW-UP

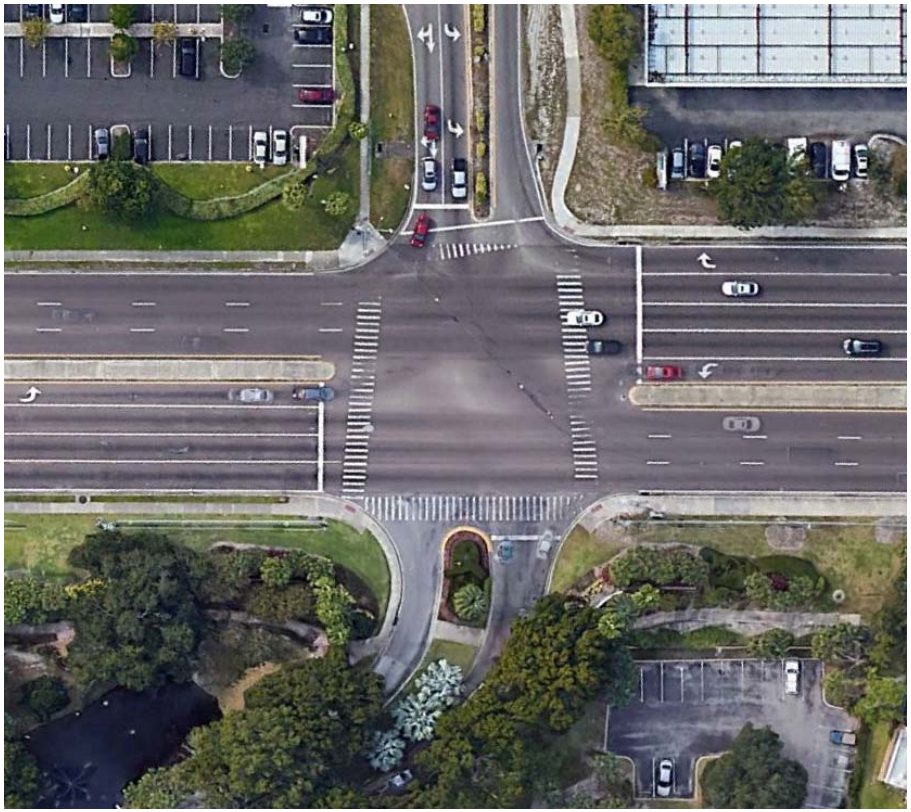


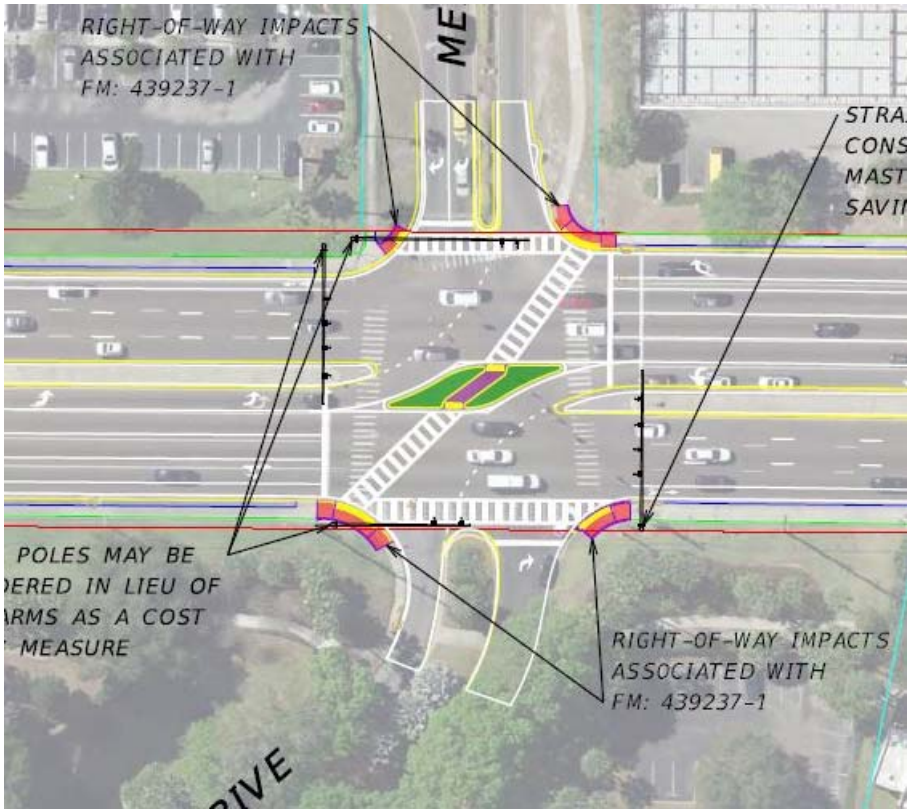


SR 535/MEADOW CREEK DRIVE PROJECT FOLLOW-UP

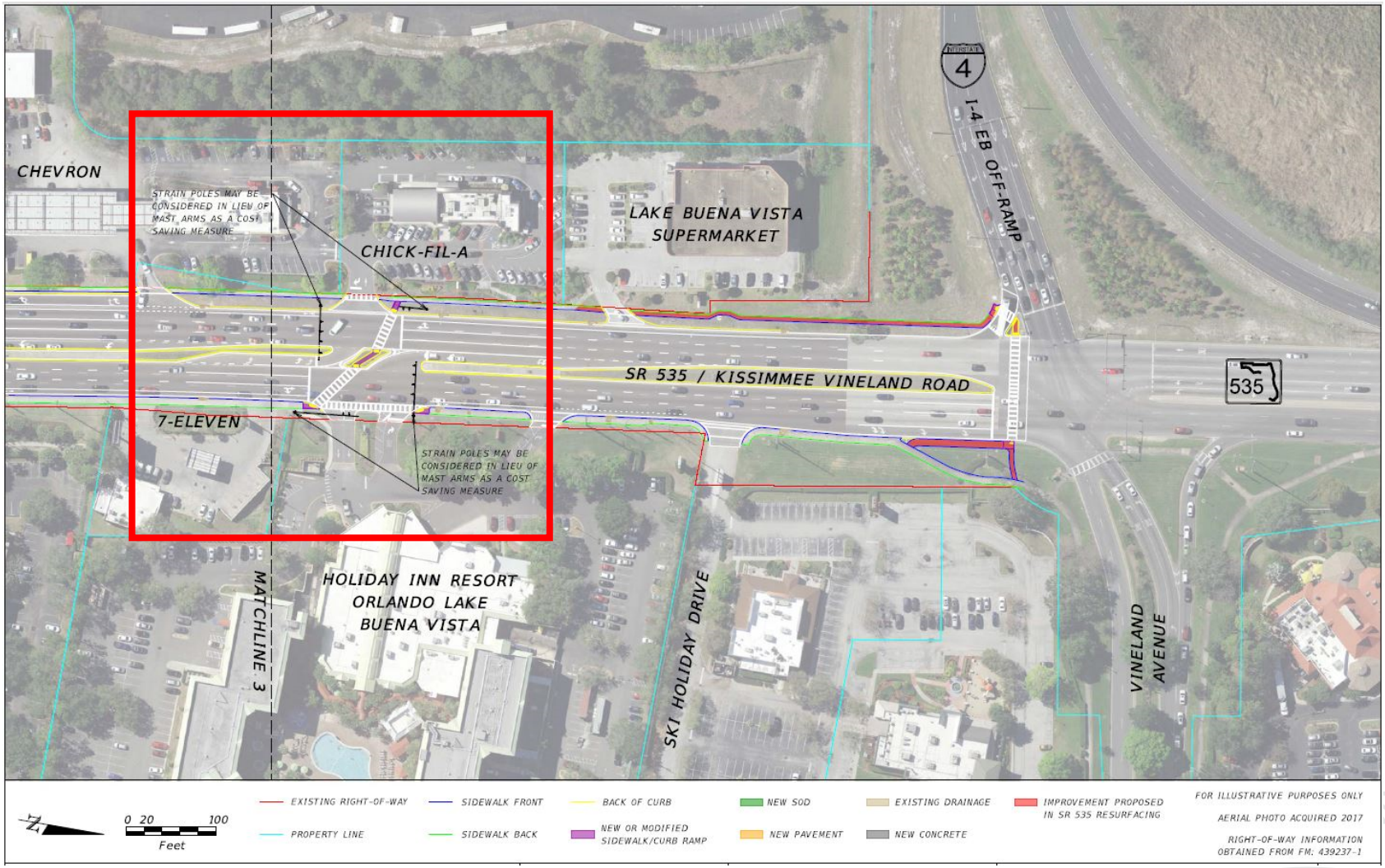


SR 535/MEADOW CREEK DRIVE PROJECT FOLLOW-UP

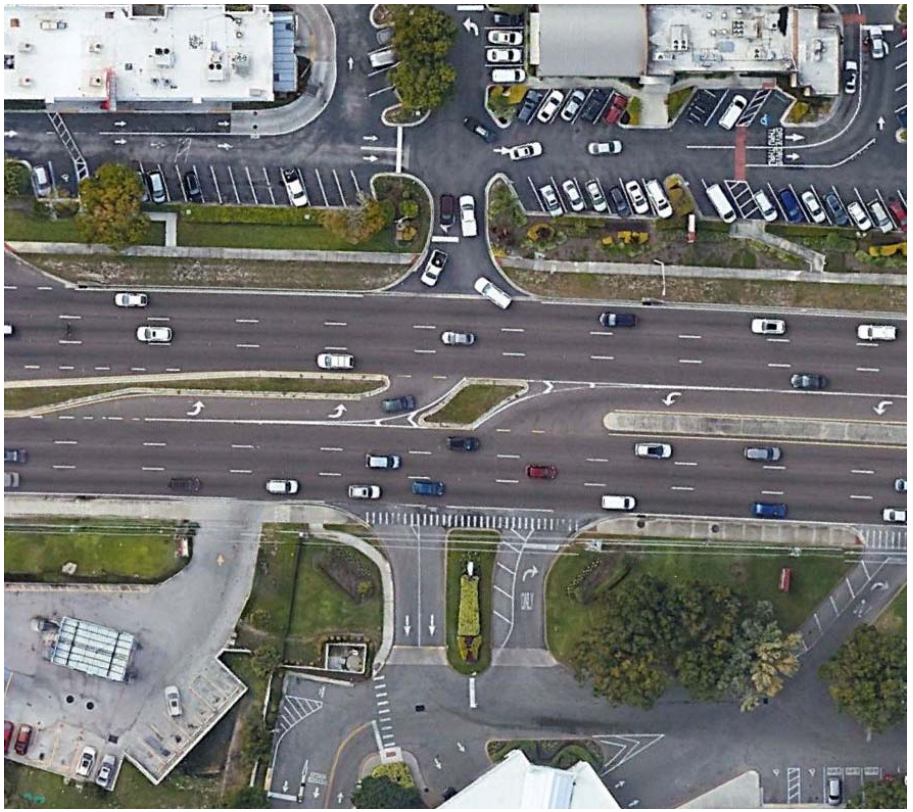


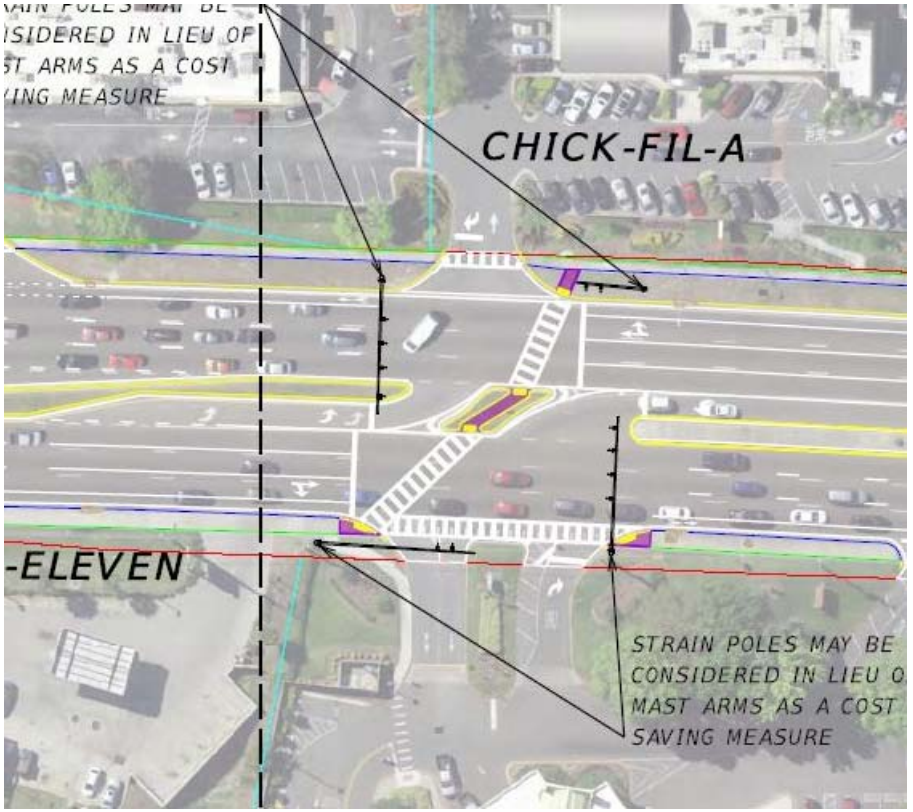


SR 535/MEADOW CREEK DRIVE PROJECT FOLLOW-UP



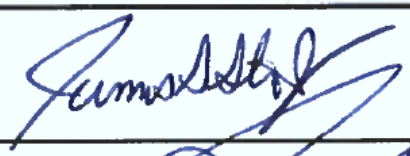
SR 535/MEADOW CREEK DRIVE PROJECT FOLLOW-UP





SR 535/MEADOW CREEK DRIVE PROJECT FOLLOW-UP

- FDOT D5 DTOE and DDE signed Stage 1 and 2

Resolution					
To be filled out by FDOT District Traffic Operations Engineer and District Design Engineer					
Project Determination	Multiple Viable Alternatives Identified: Continue to Stage 2				
Comments					
DTOE Name	James S. Stroz, Jr., P.E.	Signature		Date	12/3/18
DDE Name	Mario Bizzi PE	Signature		Date	12/4/18

- SR 535/Meadow Creek Drive RCUT included in 3R project, construction letting September 2020


DISCUSSION & QUESTIONS
FDOT