Safety Improvement
Hammond Drive at Mount Vernon Highway
Sandy Springs, Georgia

Team #5

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Team Member Contributions

The proposed project is conducted and completed by the following team members. Corresponding tasks are listed below their names.

Ulrich Sounkoua

- Conducted the sight distance analysis and intersection sight distance analysis
- Evaluated roundabout design alternative using the GDOT ICE tool v2.14
- Evaluated the Road Diet alternative
- Report compilation and review

John Lyall

- Cost analysis and corresponding spreadsheets
    - ICE cost estimation tool for single-lane roundabout
    - GDOT pay items for road diet
- Report compilation/review and conclusion

Jermaine Jones Jr.

- Presenting alternative 1
- Constructed CAD drawings
    - Existing conditions
    - Alternatives

Jonathan Buttram

- Report compilation, review and quality checked it.
- Presentation compilation and review.
- Assisted in brainstorming alternative ideas for project.
- Presented on the alternative two topic, road dieting.

Juan Almanza

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Abstract

Throughout the design of a transportation project, many characteristics must be evaluated. Utilizing crash data, site distances, basic geometry and relevant topographic features are all important aspects to be considered. While mobility and drainage are large concerns on all roadways, ultimate safety yields the most important consideration. Resulting in numerous crashes from a sight distance issue, this study aims to justify a redesign of the intersection of Hammond Drive at Mount Vernon Highway, located in Sandy Springs, Georgia.

Introduction

Located in the fifth largest city of Georgia, the Intersection of Hammond Drive at Mount Vernon Highway has been causing a lot of speeding issues recently and the issue has become one of the top priorities of the City of Sandy Springs Traffic Department. The current free right turn giving access to Hammond Drive coming from Mount Vernon Highway is one of the prime reasons that explains the speeding issue. Also, the EB traffic on Hammond Drive is faced with a high downsloping vertical curve that allows drivers to gain extra speed thus becoming a high crash hazard for anyone trying to make a left turn Mitchell Road and worse from Braemore Rd. Not only have Sandy Springs citizens have requested a design improvement, but the crash data provided below yields the fact that improvement is needed.

Problem Statement and Objective

The primary goal of this project is to improve safety. In order to complete this, creating and researching two adequate solutions is the best route to take. The first solution is installing a mini roundabout at the current intersection of Hammond Dr and Mt Vernon Hwy to reduce speed. The second alternative is to implement a road diet that will include installing a protected left turn at the intersection of Hammond Dr and Lake Forrest Dr. Lastly, alternative 3 is a “do nothing” approach to the problem.

Methodology

In order to properly and effectively produce a solution, existing conditions must be studied in order to accomplish alternatives. This is carried out by conducting several measures such as: photos, survey, future impact analysis, future and current economic impacts, and safety research. After initial research is conducted, the next step is to utilize the GDOT ICE tool to determine whether a roundabout is feasible. As for the second alternative, using Synchro to evaluate the LOS before and after installing a protected left turn on Lake Forest Drive. Comparing the two options will be the final step in determining how to execute the challenge.

Existing Conditions

The current state of Hammond Drive between Lake Forrest Drive and Mt Vernon Highway is inadequately designed for sight distance. The intersection of Hammond Drive @ Mt vernon Highway is signal controlled. An aerial image has been provided (Figure 1) to show the issue at a glance. Additionally, Figures 2-5 displays the issue from a driver perspective. Per crash data (Figure 7), many accidents happen while turning out of Mitchell Road NW and Braemore Drive NW. These crashes are mainly due to drivers not seeing each other. This issue is not only a mobility concern, but a safety problem for the present and future.

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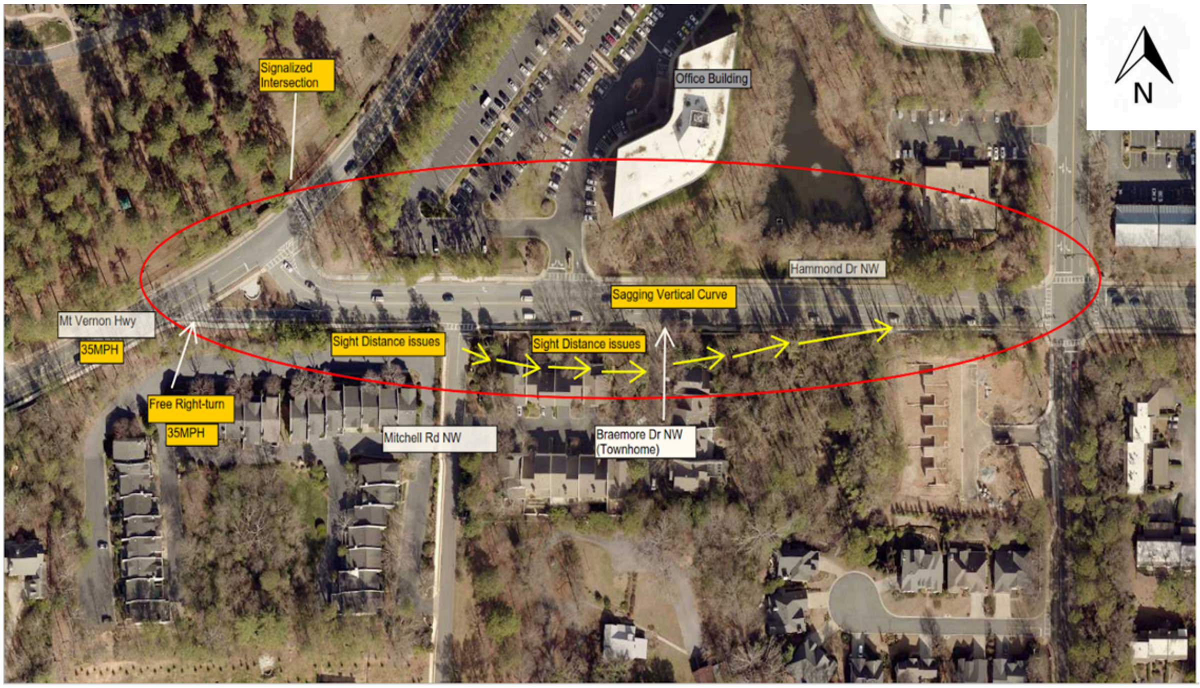

Fig. 1: Summary of issues

Fig. 2: Making a Left off Mitchell

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Fig. 3: Making a Left off Braemore Drive NW

Fig. 4: Making a Right off Braemore Drive NW

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Fig. 5: Sight Distance to the Left of Braemore

Fig. 6: Current Conditions (Created via Autodesk Infraworks.)

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Crash Data

Criteria:
Agency: Sandy Springs Police Dept.
County: FULTON
Date of Collision is between 1/1/2014 and 12/31/2017
Roadway contains Hammond Dr, Sandy Springs Circle and Mt Vernon Hwy

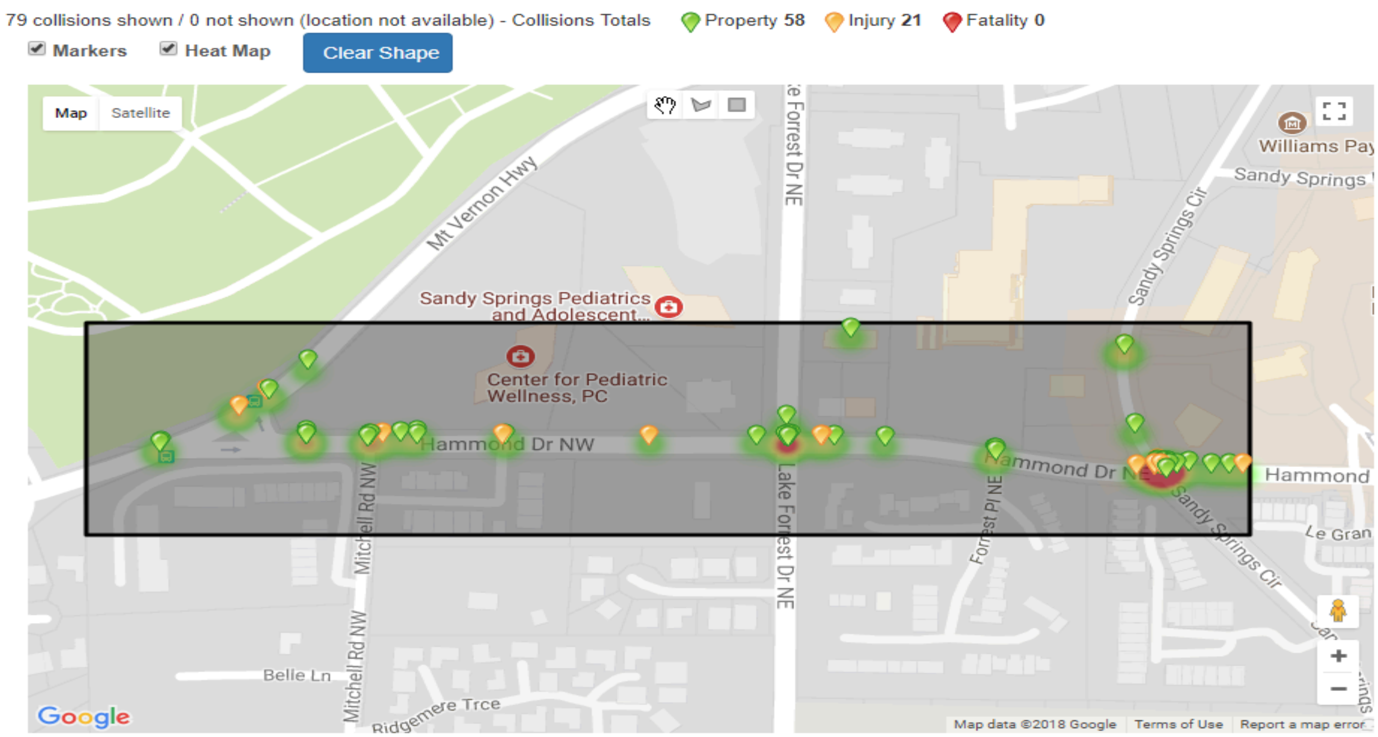

Fig. 7: Crash Data for Hammond Drive

Data Analysis - Intersection Sight Distance (ISD)

AASHTO Standards

Design Intersection Sight Distance (Case B1 – Left turn from stop)

Speed (mph) *	Stopping Sight Distance (ft.)	Design Intersection Sight Distance (ft.)
25	155	280
30	200	335
35	250	390
40	305	445
45	360	500
50	425	555
55	495	610
60	570	665
65	645	720
70	730	775
75	820	830
80	910	885

Note: The distance shown is for a stopped passenger car to turn left onto a two-lane highway with no median and grades 3 percent or less.

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Figure#: Case B1

Case B1 Left Turn from Stop if the design vehicle is a passenger car.

ISD = 1.47*Vmajor*tg with Vmajor= 35mph

tg= 7.5+0.5+0.8= 8.8 → ISD= 1.47(35 mph)(8.8s)= 452.76 ft> 390 ft required

Case B2 Right Turn from Stop if the design vehicle is a passenger car.

ISD=1.47*Vmajor*tg

tg= 6.5+0.4= 6.9 → ISD= 1.47(35 mph)(6.9s)= 355 ft > 335 required

Exhibit 9-57. Time Gap for Case B2—Right Turn from Stop and Case B3—Crossing Maneuver

Metric				US Customary			
		Intersection sight distance for passenger cars				Intersection sight distance for passenger cars	
Design speed (km/h)	Stopping sight distance (m)	Calculated (m)	Design (m)	Design speed (mph)	Stopping sight distance (ft)	Calculated (ft)	Design (ft)
20	20	36.1	40	15	80	143.3	145
30	35	54.2	55	20	115	191.1	195
40	50	72.3	75	25	155	238.9	240
50	65	90.4	95	30	200	286.7	290
60	85	108.4	110	35	250	334.4	335
70	105	126.5	130	40	305	382.2	385
80	130	144.6	145	45	360	430.0	430
90	160	162.6	165	50	425	477.8	480
100	185	180.7	185	55	495	525.5	530
110	220	198.8	200	60	570	573.3	575
120	250	216.8	220	65	645	621.1	625
130	285	234.9	235	70	730	668.9	670
				75	820	716.6	720
				80	910	764.4	765

Note: Intersection sight distance shown is for a stopped passenger car to turn right onto or cross a two-lane highway with no median and grades 3 percent or less. For other conditions, the time gap must be adjusted and required sight distance recalculated.

Figure#: Case B2

Case 3 does not apply as we have a T-intersection.

Sight Distance

The minimum Stopping Sight Distance (SSD) is 250’ for a grade of 3% but given that we have a sagging curve with a grade of about 8%-10% we should have a greater sight distance. The Sight Distance to the Right (SDR) is adequate in this case.

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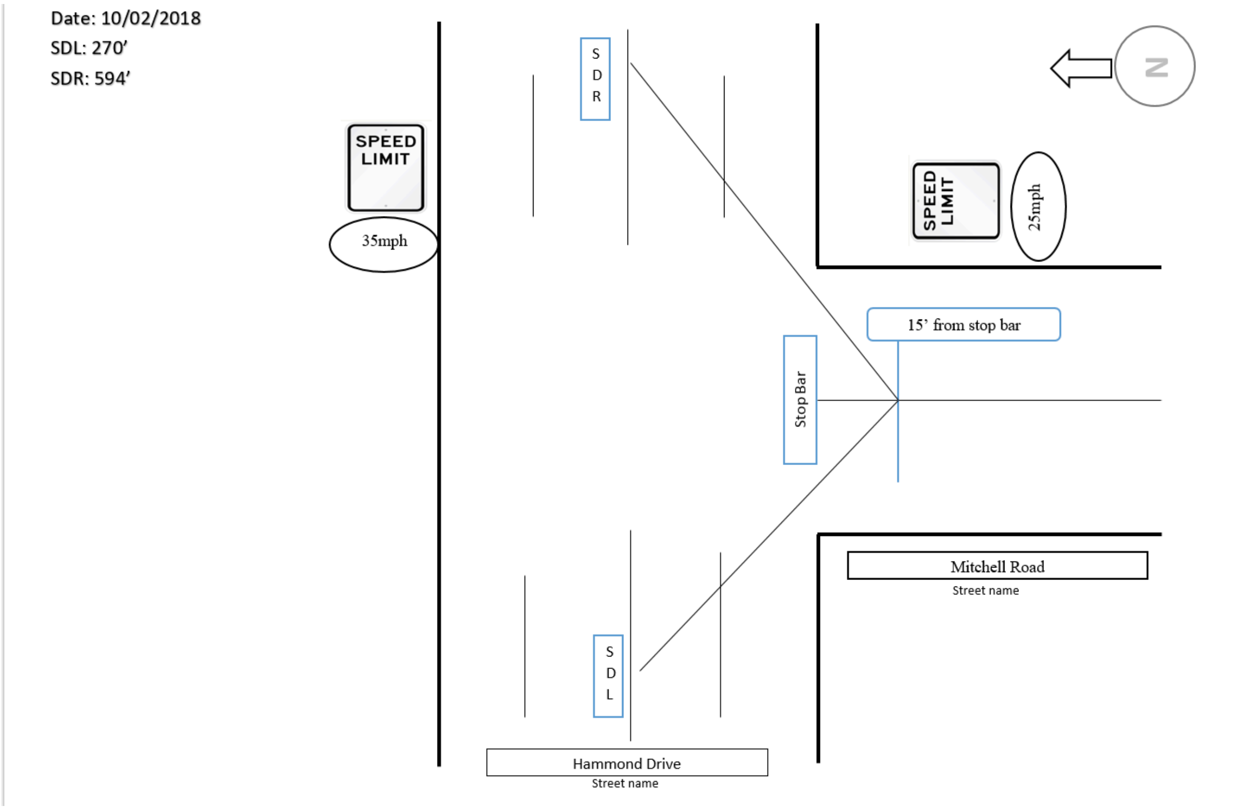


Figure 8: Site distance from Mitchell Road

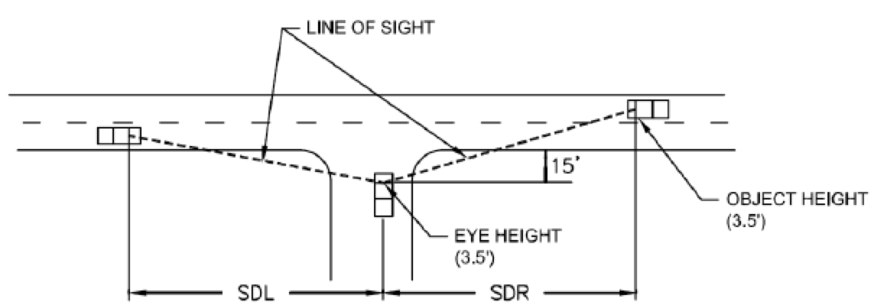
CHAPTER 3

SPACING OF DRIVEWAYS

Georgia Department of Transportation

3E SIGHT DISTANCE-without medians

Driveways should be located to provide adequate sight distance. Minimum intersection sight distance criteria are provided in Table 3-4. The line of sight establishes the boundary of a sight triangle, within which there should be no sight obstruction.
Abdul to revise table



ARTERIAL SPEED, MPH	SIGHT DISTANCE (FEET)						
	2 Lane	3 Lanes		4 Lanes		5 Lanes	
	SDL=SDR	SDL	SDR	SDL	SDR	SDL	SDR
30	335	310	355	335	375	355	400
35	390	365	415	390	440	415	465
40	445	415	475	445	500	475	530
45	500	465	530	500	565	530	600
50	555	515	590	555	625	590	665
55	610	570	650	610	690	650	730
60	665	620	710	665	750	710	795
65	720	670	765	720	815	765	860

Figure 9: Adequate site distance illustration.

The measured sight distance to the left (SDL) is 270 ft <390 ft required → Not adequate.
The measured SDR is adequate.

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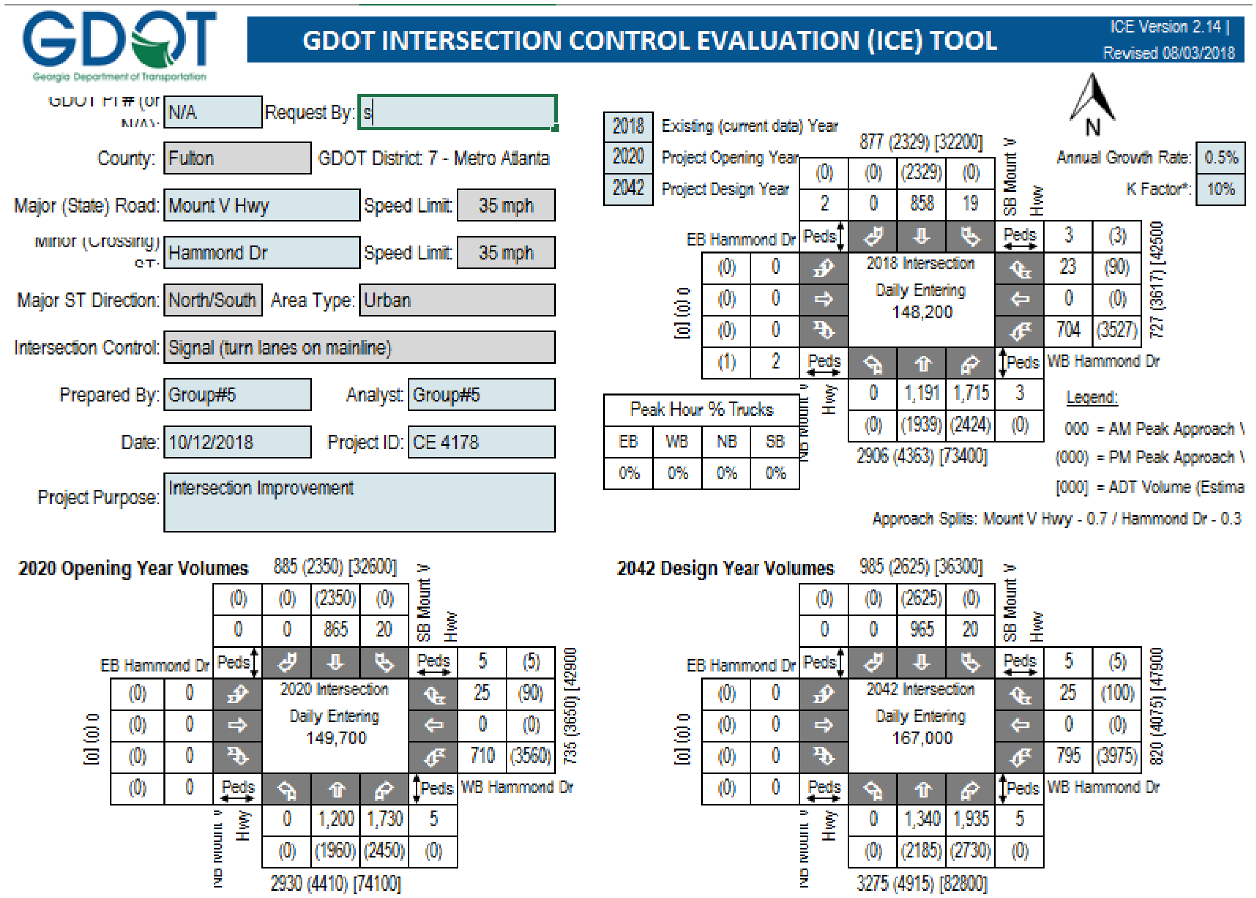
Analysis

Alternative analysis using the GDOT ICE tool V2.14



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Existing Year Volume Inputs

	EB Hammond Dr			WB Hammond Dr			NB Mount V Hwy			SB Mount V Hwy		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
AM Peak Hour:	0	0	0	704	0	23	0	1,191	1,715	19	858	0
PM Peak Hour:	(0)	(0)	(0)	(3527)	(0)	(90)	(0)	(1939)	(2424)	(0)	(2329)	(0)

	Eastbound		Westbound		Northbound		Southbound	
Peak Hour Truck %:	0.0%		0.0%		0.1%		0.3%	
AM (PM) Ped X-ings:	2	(1)	3	(3)	3	(0)	2	(0)

* K Factor = proportion of annual average daily traffic occurring in the peak hour

Open Yr Volume Override

	EB Hammond Dr			WB Hammond Dr			NB Mount V Hwy			SB Mount V Hwy		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
AM Peak Hour:	0	0	0	0	0	0	0	0	0	0	0	0
PM Peak Hour:	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)

	EB		WB		NB		SB	
AM (PM) Ped X-ings:	0	(0)	0	(0)	0	(0)	0	(0)

Design Yr Volume Override

	EB Hammond Dr			WB Hammond Dr			NB Mount V Hwy			SB Mount V Hwy		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
AM Peak Hour:	0	0	0	0	0	0	0	0	0	0	0	0
PM Peak Hour:	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)

	EB		WB		NB		SB	
AM (PM) Ped X-ings:	0	(0)	0	(0)	0	(0)	0	(0)

ADT Volume Override

	Exist Year	Open Year	Design
EB Hammond Dr	0	0	0
WB Hammond Dr	0	0	0
NB Mount V Hwy	0	0	0
SB Mount V Hwy	0	0	0

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GDOT

GDOT ICE STAGE 1: SCREENING DECISION RECORD

ICE Version 2.14 | Revised 08/03/2018

GDOT PI #	N/A
Project Location:	Mount V Hwy @ Hammond Dr
Prepared by:	Group#5
Analyst	Group#5
Date:	10/12/2018

Note: Up to 5 alternatives may be selected and evaluated; Use this ICE Stage 1 to screen 5 or fewer alternatives to evaluate in Stage 2

Answer "Yes" or "No" to each policy question for each control type to identify which alternatives should be evaluated in the Stage 2 Decision Record; enter justification in the rightmost column

	Intersection Alternative (see "Intersections" tab for detailed description of intersection/interchange type)	1. Does alternative address the project need in a balanced manner and in scale with the project?	2. Does alternative improve safety performance in terms of reducing severe crashes?	3. Does alternative incorporate safety, convenience and accessibility for pedestrians and/or bicyclists?	4. Does alternative improve (or preserve) traffic operations (congestion, delay, reliability, etc.)?	5. Does alternative appear feasible given the site characteristics, constrains & location context?	6. Does alternative appear feasible with respect to other project factors?	7. Overall feasible alternative (select alternative for further evaluation in Stage 2)?	**Screening Decision**
Unsignalized Intersections	Conventional (Minor Stop)	No	No	No	No	No	No	No	
	Conventional (All-Way Stop)	No	No	No	No	No	No	No	
	Mini Roundabout	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
	Single Lane Roundabout	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
	Multilane Roundabout	No	No	No	No	No	No	No	
	RCUT (stop control)	No	No	No	No	No	No	No	
	RIRO w/down stream U-Turn	No	No	No	No	No	No	No	
	High-T (unsignalized)	No	No	No	No	No	No	No	
	Offset-T Intersections	No	No	No	No	No	No	No	
	Diamond Interch (Stop Control)	No	No	No	No	No	No	No	
	Diamond Interch (RAB Control)	No	No	No	No	No	No	No	ROW restrictions
	No LT Lane Improvements No RT Lane Improvements	No	No	No	No	No	No	No	
	Other unignalized (provide description):	No	No	No	No	No	No	No	
	Traffic Signal	No	No	No	No	No	No	No	Existing
	Median U-Turn (Indirect Left)	No	No	No	No	No	No	No	
Signalized Intersections	RCUT (signalized)	No	No	No	No	No	No	No	
	Displaced Left Turn (CFI)	No	No	No	No	No	No	No	
	Continuous Green-T	No	No	No	No	No	No	No	
	Jughandle	No	No	No	No	No	No	No	
	Quadrant Roadway	No	No	No	No	No	No	No	
	Diamond Interch (Signal Control)	No	No	No	No	No	No	No	
	Diverging Diamond	No	No	No	No	No	No	No	
	Single Point Interchange	No	No	No	No	No	No	No	
	No LT Lane Improvements No RT Lane Improvements	No	No	No	No	No	No	No	
	Other Signalized (provide description):	No	No	No	No	No	No	No	

= Intersection type selected for more detailed analysis in Stage 2 Alternative Selection Decision Record

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GDOT

GDOT ICE STAGE 2: ALTERNATIVE SELECTION DECISION RECORD

ICE Version 2.14 | Revised 08/03/2018

GDOT PI # (or N/A)	N/A	GDOT District:	7 - Metro Atlanta	Date:	10/12/2018
County:	Fulton	Area Type:	Urban	Agency/Firm:	Group#5
Project Location:	Mount V Hwy @ Hammond Dr			Analyst:	Group#5
Existing Intersection Control:	Signal (turn lanes on mainline)			Type of Analysis:	Safety Funded Project

Opening / Design Year Traffic Operations

Intersection meets signal/AWS warrants?	None	
Traffic Analysis Measure of Effectiveness	Intersection Delay	
Traffic Analysis Software Used	--select one--	
Analysis Time Period	AM Peak Hr	PM Peak Hr
2020 Opening Yr No-Build Peak Hr Intersection	0.0 sec	0.0 sec
2020 Opening Yr No-Build Peak Hr Intersection V/C	0.00	0.00
2042 Design Yr No-Build Peak Hr Intersection Delay	0.0 sec	0.0 sec
2042 Design Yr No-Build Peak Hr Intersection V/C	0.00	0.00

Complete Streets Warrants Met?

- ☑ PEDESTRIANS
- ☑ BICYCLES
- ☑ TRANSIT

Crash Data: Enter 5 most recent years of intersection crash data	Crash Severity			
Crash Type	PDO	Injury Crash*	Fatal Crash*	
Angle	0	0	0	#DIV/0!
Head-On	0	0	0	#DIV/0!
Rear End	0	0	0	#DIV/0!
Sideswipe - same	0	0	0	#DIV/0!
Sideswipe - opposite	0	0	0	#DIV/0!
Not Collision w/Motor Veh	0	0	0	#DIV/0!
TOTALS:	0	0	0	0

* Number of crashes resulting in injuries / fatalities, not number of persons

Alternatives Analysis:	Alternative 1		Alternative 2		Alternative 3	Alternative 4	Alternative 5
Proposed Control Type/Improvement	Mini Roundabout		Single Lane Roundabout		N/A	N/A	N/A
Project Cost: (From CostEst Worksheet)	*Additional description here*		*Additional description here*				
Construction Cost	$90,000		$479,000				
ROW Cost	$377,000		$966,000				
Environmental Cost	$0		$0				
Reimbursable Utility Cost	$3,000		$14,000				
Design & Contingency Cost	$33,000		$133,000				
Cost Adjustment (justification req'd)			0%				
Total Cost	$503,000		$1,592,000				
Traffic Operations:							
Traffic Analysis Software Used	--select one--		--select one--				
Analysis Period	AM Peak Hr	PM Peak Hr	AM Peak Hr	PM Peak Hr			
2042 Design Yr Build Intersection Delay	0.0 sec	0.0 sec	0.0 sec	0.0 sec			
2042 Design Yr Build Intersection V/C	0.00	0.00	0.00	0.00			
Safety Analysis:							
Predefined CRF: PDO	#N/A		24%				
Predefined CRF: Fatal/Inj	#N/A		71%				
Predefined CRF Source:	#N/A		FHWA Clearinghouse #s 225 / 4255				
User Defined CRF: PDO							
User Defined CRF: Fatal/Inj							
User Defined CRF Source (write in if applicable):							

Environmental Impacts:[1]					
Historic District/Property	None	None			
Archaeology Resources	None	None			
Graveyard	**Significant**	None			
Stream	None	None			
Underground Tank/Hazmat	None	None			
Park Land	None	None			
EJ Community	None	None			
Wooded Area	Minimal	None			
Wetland	None	None			
	*Note: If environmental impact is significant (**RED**), provide justification impact won't jeopardize project delivery using "Env" worksheet*				
Stakeholder Posture:	*[1] Environmental impacts are only preliminary estimates; detailed environmental impact documentation will be included with project*				
Local Community Support	Strong	Strong			
GDOT Support	Neutral	Neutral			
Final ICE Stage 2 Score:	**#N/A**	**2.2**			
Rank of Control Type Alternatives:	**#N/A**	**#N/A**			
	Note: Stage 2 score is not given (shown as "-") if signal or AWS is selected as control type but respective warrants are not met				
Provide additional comments and/or explain any unique analysis inputs, or results (as necessary):					

The single lane roundabout resulted in a score of 2.2 while a mini-roundabout is not feasible due to environmental issues. Thus, the mini-roundabout should no longer be considered a viable option.

Alternative #1

The first alternative is to design a single lane roundabout at the current intersection of Hammond Drive and Mt Vernon Highway.

Figure 10: Roundabout model for Alternative 1 (Created via Autodesk InfraWorks)

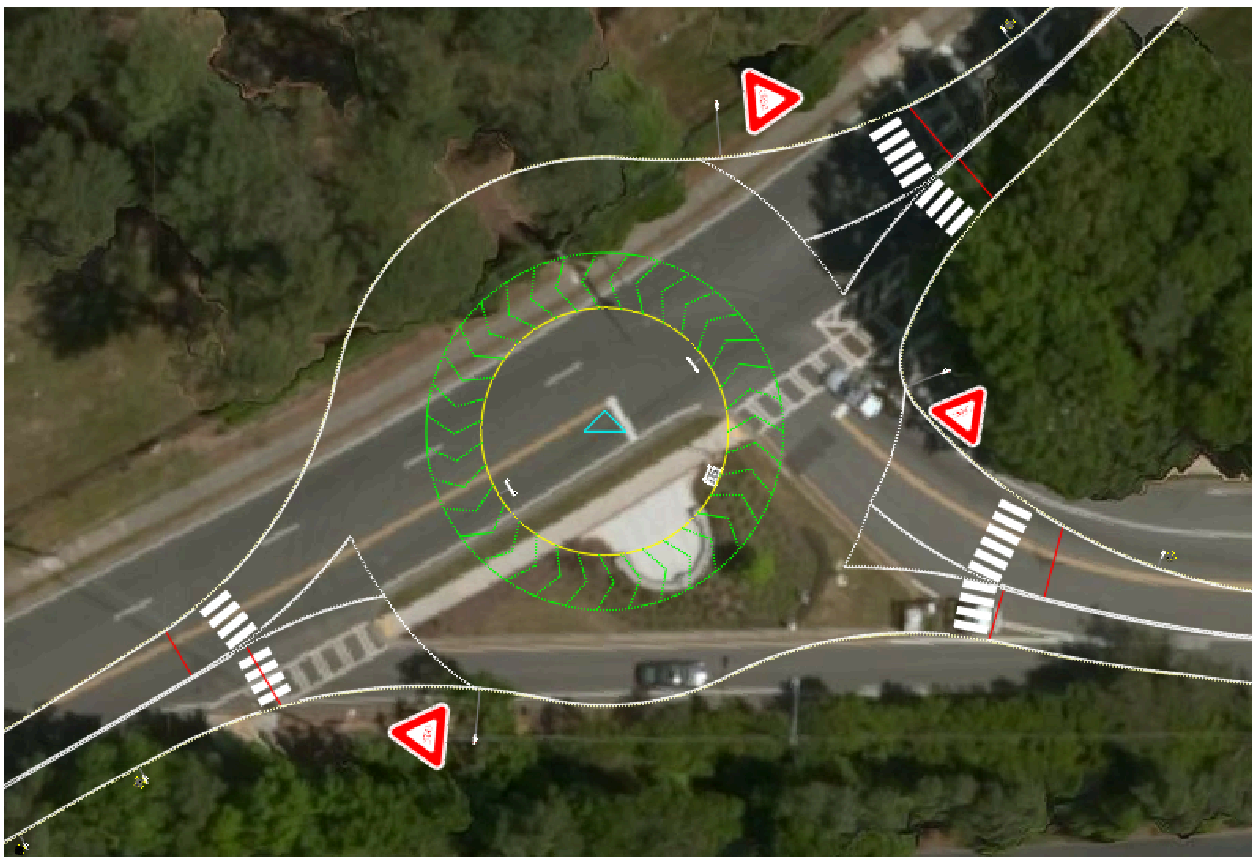

Figure 11: Roundabout design overlaying the current design of Mt Vernon Hwy and Hammond Dr. (Created via Autodesk Infraworks and exported to Autodesk Civil 3D)

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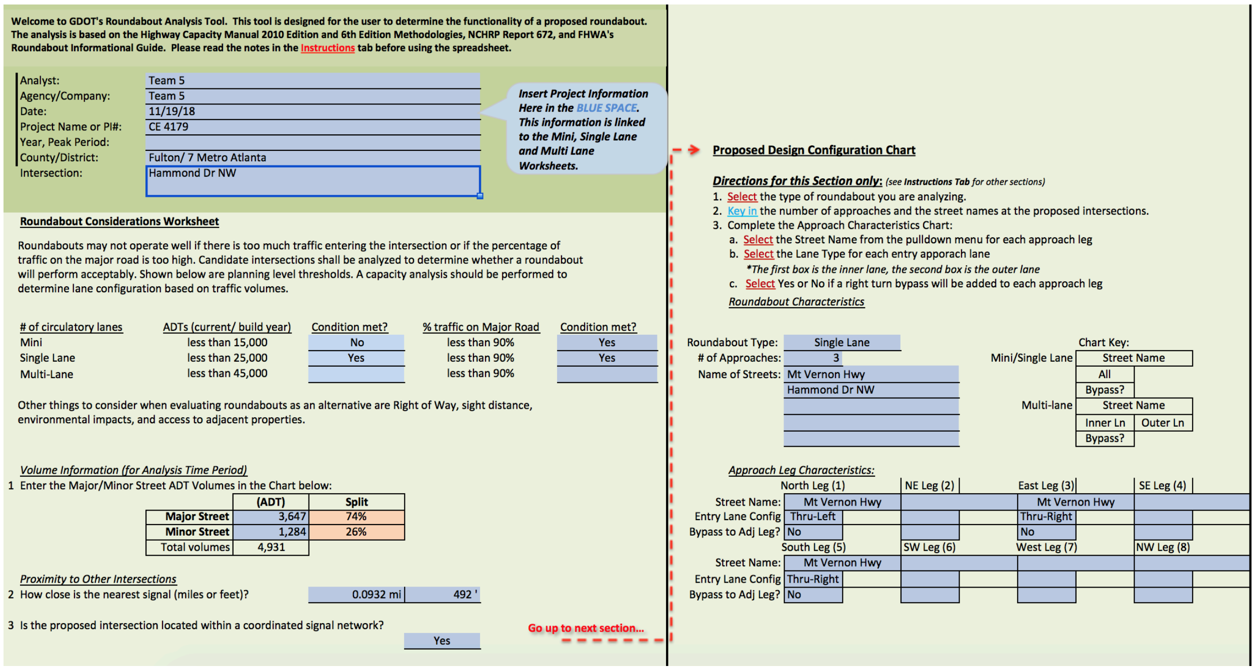
Welcome to GDOT's Roundabout Analysis Tool. This tool is designed for the user to determine the functionality of a proposed roundabout. The analysis is based on the Highway Capacity Manual 2010 Edition and 6th Edition Methodologies, NCHRP Report 672, and FHWA's Roundabout Informational Guide. Please read the notes in the Instructions tab before using the spreadsheet.

Analyst:	Team 5
Agency/Company:	Team 5
Date:	11/19/18
Project Name or PI#:	CE 4179
Year, Peak Period:	
County/District:	Fulton/ 7 Metro Atlanta
Intersection:	Hammond Dr NW

Insert Project Information Here in the BLUE SPACE. This information is linked to the Mini, Single Lane and Multi Lane Worksheets.

Roundabout Considerations Worksheet

Roundabouts may not operate well if there is too much traffic entering the intersection or if the percentage of traffic on the major road is too high. Candidate intersections shall be analyzed to determine whether a roundabout will perform acceptably. Shown below are planning level thresholds. A capacity analysis should be performed to determine lane configuration based on traffic volumes.

# of circulatory lanes	ADTs (current/ build year)	Condition met?	% traffic on Major Road	Condition met?
Mini	less than 15,000	No	less than 90%	Yes
Single Lane	less than 25,000	Yes	less than 90%	Yes
Multi-Lane	less than 45,000		less than 90%	

Other things to consider when evaluating roundabouts as an alternative are Right of Way, sight distance, environmental impacts, and access to adjacent properties.

Volume Information (for Analysis Time Period)

1 Enter the Major/Minor Street ADT Volumes in the Chart below:

	(ADT)	Split
Major Street	3,647	74%
Minor Street	1,284	26%
Total volumes	4,931	

Proximity to Other Intersections

2 How close is the nearest signal (miles or feet)? 0.0932 mi 492 '

3 Is the proposed intersection located within a coordinated signal network? Yes

Go up to next section...

Proposed Design Configuration Chart

Directions for this Section only: *(see Instructions Tab for other sections)*

1. Select the type of roundabout you are analyzing.
2. Key in the number of approaches and the street names at the proposed intersections.
3. Complete the Approach Characteristics Chart:
   a. Select the Street Name from the pulldown menu for each approach leg
   b. Select the Lane Type for each entry approach lane
   **The first box is the inner lane, the second box is the outer lane*
   c. Select Yes or No if a right turn bypass will be added to each approach leg

Roundabout Characteristics

Roundabout Type: Single Lane
\# of Approaches: 3
Name of Streets: Mt Vernon Hwy; Hammond Dr NW

Chart Key:
Mini/Single Lane: Street Name / All / Bypass?
Multi-lane: Street Name / Inner Ln / Outer Ln / Bypass?

Approach Leg Characteristics:

	North Leg (1)	NE Leg (2)	East Leg (3)	SE Leg (4)
Street Name:	Mt Vernon Hwy		Mt Vernon Hwy	
Entry Lane Config	Thru-Left		Thru-Right	
Bypass to Adj Leg?	No		No	

	South Leg (5)	SW Leg (6)	West Leg (7)	NW Leg (8)
Street Name:	Mt Vernon Hwy			
Entry Lane Config	Thru-Right			
Bypass to Adj Leg?	No			

Figure #. GDOT's Roundabout Analysis Tool

Table 1: Single Lane Roundabout vehicle flow information

Results: Approach Measures of Effectiveness								
HCM 6th Edition	**N**	**NE**	**E**	**SE**	**S**	**SW**	**W**	**NW**
Entry Capacity, vph	362	NA	421	NA	NA	115	NA	NA
Entry Flow Rates, vph	1126	NA	1352	NA	NA	2713	NA	NA
V/C ratio	**3.11**		**3.21**			**23.63**		
Control Delay, sec/pcu	**979**		**1021**			**10252**		
LOS	F		F			F		
95th % Queue (ft)	**2494**		**3014**			**8196**		
Notes:								v 4.0
						Unit Legend:		
						vph = vehicles per hour		
						PHF = peak hour factor		
						F_{HV} = heavy vehicle factor		
						pcu = passenger car unit		

Using the GDOT Roundabout Analysis Tool V4.1 it has been found that placing a Mini Roundabout or a Single Lane Roundabout would lead to a LOS (F). The existing LOS is B therefore a Single Lane Roundabout or Mini Roundabout would not be a better alternative to the existing intersection.

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Cost Analysis: Single Lane Roundabout

Project Information

Location:	Mount V Hwy @ Hammond Dr	County:	Fulton	Date:	10/12/2018
GDOT PI # (or N/A):	N/A	Area Type:	Urban	Agency/Firm:	Group#5
Existing Intersection Control:	Signal (turn lanes on mainlin	GDOT District:	7 - Metro Atlanta	Analyst:	Group#5
Type of Analysis:	Conventional Non-Safety Funded Project			Major Street Direction:	North/South

Table 1: Existing Conditions

	NB Mount V Hwy			SB Mount V Hwy			EB Hammond Dr			WB Hammond Dr		
Movement	Left Turn	Thru	Right Turn	Left Turn	Thru	Right Turn	Left Turn	Thru	Right Turn	Left Turn	Thru	Right Turn
Number of Lanes	0	1	1	1	1	0	0	0	0	1	0	1
Lane Widths*	0'	12'	12'	12'	12'	0'	0'	0'	0'	12'	0'	12'
Bay Length**	0'		0'	110'		0'	0'		0'	0'		0'
Median Width		0'			0'			0'			0'	
Right-of-Way	24'						30'					

Table 2: Proposed Conditions

	Single Lane Roundabout	N/A	N/A	N/A	N/A
Proposed Pavement Type	F.D. Asphalt	None	None	None	None
Reimbursable Utility:	Moderate	Moderate	Moderate	Moderate	Moderate
# of Driveway(s) Impacted	0	0	0	0	0
Modify/Replace Traffic Signal	2	0	0	0	0
Lighting Poles (ea)	0	0	0	0	0
Flashing Beacons (ea)	0	0	0	0	0
RFB/PHB Ped Crossings (ea)	3	0	0	0	0
New/Replace Sidewalks (LF)	450'	0'	0'	0'	0'
New/Replace Cross Drains (LF)	0'	0'	0'	0'	0'
New/Replace Guardrail (LF)	0'	0'	0'	0'	0'
New Retaining Wall (LF)	0'	0'	0'	0'	0'
Bridge:New/Widen/Replace (sqft)	0	0	0	0	0
Add'l ROW/Easements/Demolition	$134,696	$0	$0	$0	$0

Site Context

Topography:	Level
Traffic Mgmt Plan:	Maintain Traffic
Project Size:	Single Intersection

Cost Multipliers

Grading Complete:	15%
Reimbursable Utility:	5%
Traffic Control:	20%
Project Size:	0%
Prelim Engineering:	15%
Project Contingency:	20%

Intersections

Signal Poles	Mast Arm
Design Vehicle	WB-67
Existing Interchange?	No

Roundabouts

Inscribed DIA - Mini	
Inscribed DIA - Single	120
Inscribed DIA - Multi	
Circulating Lane Width	12

ROW Costs

Prevalent ROW Type:	Mixed (Average)
ROW Cost/Acre:	$1,028,213
ROW Multiplier:	1.6

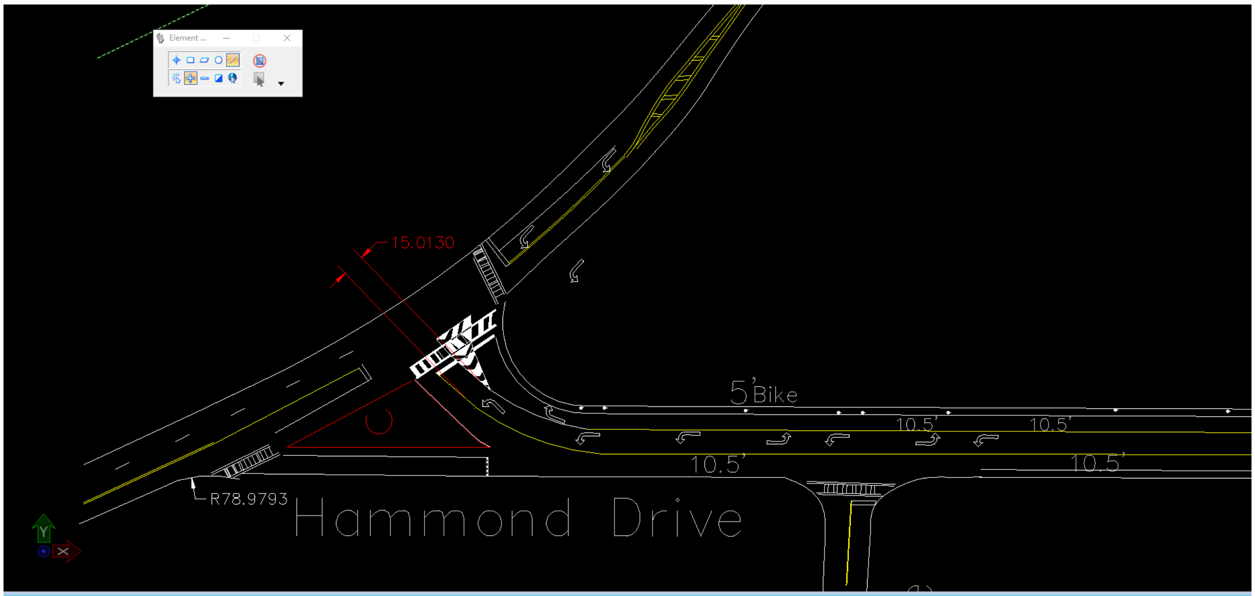
Table 3: Control Type Cost Breakdown

Pay Item	Per Ln Mi Unit Cost	Unit Cost	Single Lane Roundabout Quantity	Single Lane Roundabout Cost	N/A Quantity	N/A Cost	N/A Quantity	N/A Cost	N/A Quantity	N/A Cost	N/A Quantity	N/A Cost
New Construction (Base & Pave)	$500K/LM	$9.47/sqft	19,672	$322,088	#N/A	#N/A						
Roadway Mill and Overlay	$64K/LM	$1.21/sqft	0	$0	#N/A	#N/A						
Urban C&G/Drainage - both sides	441-6720	$19.08/LF	2000	$65,979	#N/A	#N/A						
Rural Typ Drainage - both sides	$150K/LM	$2.84/LF	0	$0	#N/A	#N/A						
Concrete Island (sqyd)	n/a	$51.58/syd	360	$32,105	#N/A	#N/A						
Median Landscaping	$100K/LM	$1.89/LF	3000	$9,824	#N/A	#N/A						
Typical Driveways Impacted (ea)	n/a	$7,500 ea	0	$0	#N/A	#N/A						
Typical E&S Control Temp/Perm	$150K/LM	$34.09/LF	1000	$45,341	#N/A	#N/A						
Roundabout Truck Apron (sqft)	n/a	$10.25/sqft	4776	$84,633	#N/A	#N/A						
Signing & Marking	$0	$22.73/LF	1,000	$30,231	#N/A	#N/A						
Flashing Beacon (ea)	n/a	$20,000 ea	0	$0	#N/A	#N/A						
New Traffic Signal (Mast Arms)	674-1000	$182,575ea	2	$485,650	#N/A	#N/A						
Lighting (per pole)	n/a	$5,607 ea	0	$0	#N/A	#N/A						
Signalized Ped Crossings (ea)	n/a	$19,637 ea	3	$78,352	#N/A	#N/A						
6' Sidewalk (LF)	n/a	$49.23/LF	450	$29,464	#N/A	#N/A						
New/replace cross drains (LF)	n/a	$41.31/LF	0	$0	#N/A	#N/A						
Typical Guardrail (LF)	n/a	$65.56/LF	0	$0	#N/A	#N/A						
Retaining Wall (LF)	n/a	$808.52/LF	0	$0	#N/A	#N/A						
Bridge widen/replace (SF)	n/a	$210/sqft	0	$0	#N/A	#N/A						
Env Costs (from Stage 2 impacts)	n/a	n/a	0	$0	#N/A	#N/A						
Grading Complete - 15%	n/a	n/a		$354,212		#N/A						
Traffic Control - 20%	n/a	n/a		$314,855		#N/A						
Reimbrusable Utility	n/a	n/a		$59,183		#N/A						
Preliminary Engineering - 15%	n/a	n/a		$236,141		#N/A						
Contigency - 20%	n/a	n/a		$314,855		#N/A						
ROW Cost/Acre: Mixed (Average)	n/a	#########		$301,194		#N/A						
Add'l ROW / Displacement / Demo	n/a	n/a		$134,696		#N/A						
ROW Multiplier - 1.6	n/a	n/a		$261,534		#N/A						
Project Scale Reduction - 0.0%	n/a	n/a		$0		#N/A						
Grand Total Costs				**$3,160,000**		**#N/A**						

Table 2: Cost Analysis for Alternative 1

Alternative #2

The second alternative is to implement a road diet and a protected left turn at the intersection of Hammond Drive and Lake Forrest Drive.



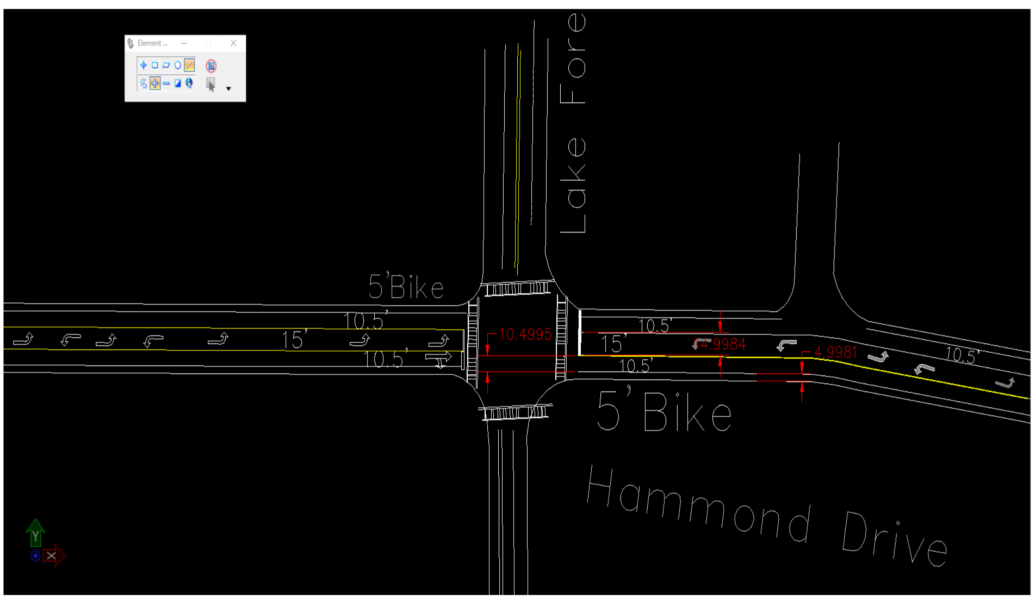


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Table 2: Left Turn warrant analysis for Lake Forrest Dr @ Hammond Dr

Intersection	Movement	Volume		Cross Product	
		AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
Hammond Dr. and Lake Forrest Dr.	EBTH	582	621	36,666	47,817
	WBL	126	154		
	WBTH	219	611	438	2,444
	EBL	4	8		
	NBTH	150	187	375	7,480
	SBL	5	80		
	SBTH	254	192	8,255	7,584
	NBL	65	79		

Leading left turn phase = 125 VPH or crossproduct of 50,000 VPH — Leading left turn phase denoted by: (dark grey)

Lagging left turn phase = 75 VPH or crossproduct of 30,000 VPH — Lagging left turn phase denoted by: (light grey)

NOTE:

The AM Peak Hour is 7:45 AM to 8:45 AM and PM Peak Hour is 5:00 PM to 6:00 PM

The total Peak Hour Volumes are summed across the 4 15 minute intervals

Table 3: AM

	Delay (Sec)	LOS	Approach LOS	Approach delay
NBL	15.4	B	A	9.2
NBT	0.0	-		
NBR	12.9	B		
SBL	14.0	B	B	10.3
SBT	0.0	-		
SBR	12.8	B		
EBL	17.4	B	C	23.4
EBT	0.0	-		
EBR	17.7	B		
WBL	15.4	C	C	24.7
WBT	0.0	-		
WBR	12.9	B		
Intersection	16.6		B	

Table 4: PM

	Delay (Sec)	LOS	Approach LOS	Approach delay
NBL	0.8	A	B	14.1
NBT	0.0	-		
NBR	0.8	A		
SBL	1.0	A	B	13.7
SBT	0.0	-		
SBR	0.6	A		
EBL	15.0	B	B	16.4
EBT	0.0	-		
EBR	15.2	B		
WBL	37.0	D	D	36.4
WBT	0.0	-		
WBR	18.5	B		
Intersection	14.3	B		

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Table 6: PM- LEFT TURN

	Delay (Sec)	LOS	Approach LOS	Approach delay
NBL	11.0	B		
NBT	0.0	-		
NBR	10.2	B		
SBL	13.8	B		
SBT	0.0	-		
SBR	8.8	A		
EBL	18.2	B		
EBT	0.0	-		
EBR	85.6	F		
WBL	41.5	D		
WBT	0.0	-		
WBR	28.5	C		
Intersection	41.6		D	

Table 7: AM LEFT TURN

	Delay (Sec)	LOS	Approach LOS	Approach delay
NBL	11.3	B		
NBT	0.0	-	B	20.1
NBR	9.1	A		
SBL	10.3	B		
SBT	0.0	-	C	19.4
SBR	9.1	A		
EBL	15.5	B		
EBT	0.0	-	C	80.4
EBR	69.0	F		
WBL	26.8	C		
WBT	0.0	-	B	30.2
WBR	15.4	B		
Intersection	36.2		D	

Table 8: FINAL SHEET

Intersection Capacity Analysis

Intersection	Approach/ Movement	Existing								Protected Left turn							
		AM Peak				PM Peak				AM Peak				PM Peak			
		Delay	LOS	Approach delay	Approach LOS	Delay	LOS	Approach delay	Approach LOS	Delay	LOS	Approach delay	Approach LOS	Delay	LOS	Approach delay	Approach LOS
Hammond Drive @ Lake Forrest	NBL	15.4	B	9.2	A	0.8	A	B	14.1	11.3	B	B	20.1	11.0	B		
	NBT	0.0	-			0.0	-			0.0	-			0.0	-		
	NBR	12.9	B			0.8	A			9.1	A			10.2	B		
	SBL	14.0	B	10.3	B	1.0	A	B	13.7	10.3	B	C	19.4	13.8	B		
	SBT	0.0	-			0.0	-			0.0	-			0.0	-		
	SBR	12.8	B			0.6	A			9.1	A			8.8	A		
	EBL	17.4	B	23.4	C	15.0	B	B	16.4	15.5	B	C	80.4	18.2	B		
	EBT	0.0	-			0.0	-			0.0	-			0.0	-		
	EBR	17.7	B			15.2	B			69.0	F			85.6	F		
	WBL	15.4	C	24.7	C	37.0	D	D	36.4	26.8	C	B	30.2	41.5	D		
	WBT	0.0	-			0.0	-			0.0	-			0.0	-		
	WBR	12.9	B			18.5	B			15.4	B			28.5	C		
	Overall			16.6	B			14.3	B			36.2	D			41.6	D

Analyzing the results in the table above, it is noticed that the LOS after the installation of a protected left turn is D while the existing LOS is B. It can be concluded that the road diet with a protected left-turn is not a practical or recommended solution to implement. However , giving that the traffic volume on the eastbound left turn is really small implementing a permissive left turn for the EBLT and a Protected and Permissive for the WBLT would solve the delay issue.

Cost Analysis: Road Diet

The following cost analysis was performed using the Georgia Department of Transportation Item Mean Summary from January 2013.

Table 9: Cost Analysis of Alternative #2

Item Code	Item Description	Quantity	UM	Unit Cost	Total Cost
153-1300	FIELD ENGINEERS OFFICE TP 3	1	EA	$ 2,251.10	$ 2,251.10
652-0094	PAVEMENT MARKING, SYMBOL, TP 4	4	EA	$ 50.09	$ 200.36
652-0110	PAVEMENT MARKING, ARROW, TP 1	4	EA	$ 50.24	$ 200.96
652-0120	PAVEMENT MARKING, ARROW, TP 2	7	EA	$ 49.50	$ 346.50
652-2501	SOLID TRAFFIC STRIPE, 5 IN, WHITE	0.193	LM	$ 379.51	$ 73.25
652-2502	SOLID TRAFFIC STRIPE, 5 IN, YELLOW	0.432	LM	$ 383.10	$ 165.50
652-3501	SKIP TRAFFIC STRIPE, 5 IN, WHITE	0.019	LM	$ 281.57	$ 5.35
652-3502	SKIP TRAFFIC STRIPE, 5 IN, YELLOW	0.432	GLM	$ 252.90	$ 109.25
652-5701	SOLID TRAF STRIPE, 24 IN, WHITE	10	LF	$ 2.03	$ 20.30
653-0220	THERMOPLASTIC PVMT MARKING, WORD, TP 2	1	EA	$ 87.50	$ 87.50
656-5000	REMOVE EXIST TRAF MARKINGS-	2	EA	$ 16.00	$ 32.00
				∑	$ 3,492.07

Pavement Design

Using the GDOT Pavement Design Tool v2.0 the following pavement dimensions were obtained for a Full-Depth Flexible Pavement Design.

Table 10: Flexible Pavement Design Analysis

Flexible Pavement Design Analysis

PI Number	0004178	**County(s)**	Cobb
Project Number		**Design Name**	Group 5
Project Description	Polytechnic Lane		

Traffic Data (AADTs are one-way)						**Miscellaneous Data**	
Initial Design Year	2018	**Initial AADT, VPD**	4,931	**24 Hour Truck %**	1.00	**Lanes in one direction**	2
Final Design Year	2038	**Final AADT, VPD**	7,000	**SU Truck %**	0.00	**Curb & Gutter/Barrier**	No
		Mean AADT, VPD	5,966	**MU Truck %**	1.00		

Design Data					
Lane Distribution Factor (%)	74.00	**Soil Support Value**	2.00	**Single Unit ESAL**	0.40
Terminal Serviceability Index	2.50	**Regional Factor**	1.80	**Multiple Unit ESAL**	2.00
		User Defined 18-KIP ESAL	0.00	**Calculated 18-KIP ESAL**	2.00
Non-Standard Value Comment					

Design Loading (Calculated 18-KIP ESAL)					
Mean AADT, VPD	**LDF (%)**	**Vehicle Type**	**Volume (%)**	**ESAL Factor**	**Daily ESAL**
5,966	74.00	Single Unit Truck	0.00	0.40	0
		Multi Unit Truck	1.00	2.00	89
				Total Daily ESALs	89
				Total Design Period ESALs	649,700

Proposed Flexible Full Depth Pavement Structure				
Course	**Material**	**Thickness (inches)**	**Structural Coefficient**	**Structural Value**
Course 1	12.5 mm Superpave	2.50	0.4400	1.10
Course 2	19 mm Superpave	2.00	0.4400	0.88
		1.00	0.3000	0.30
Course 3	25 mm Superpave	3.50	0.3000	1.05
Course 4	Graded Aggregate Base	7.00	0.1600	1.12

Required SN 4.61 **Proposed pavement is 3.53% Underdesigned** **Proposed SN** 4.45

Table 11: Criteria For Use of Asphaltic Concrete Layer and Mix Types

CRITERIA FOR USE OF ASPHALTIC CONCRETE LAYER AND MIX TYPES
(Using Base Year Two-Way ADT)

	PAY ITEM	Base Year Two-Way ADT	MIX TYPE	LAYER THICKNESS AND/OR SPREAD RATE Customary, (Metric)			REMARKS
				(Minimum)	USE	(Maximum)	
Drainage	400-3206	>25,000	12.5 mm OGFC	85 lbs/yd^2, (47 kg/m^2)	**90 lbs/yd^2, (50 kg/m^2)**	95 lbs/yd^2, (53 kg/m^2)	For High ADT State Routes with speed limits ≥ 55 mph.
Drainage	400-3624	N/A	12.5 mm PEM	110 lbs/yd^2, (60 kg/m^2)	**135 lbs/yd^2, (75 kg/m^2)**	165 lbs/yd^2, (90 kg/m^2)	For Interstate Routes.
Surface**	402-3814	<800	4.75 mm	¾", 85 lbs/yd^2, (19 mm, 45 kg/m^2)	**7/8", 90 lbs/yd^2, (22 mm, 50 kg/m^2)**	1-1/8", 125 lbs/yd^2, (28 mm, 70 kg/m^2)	For State and Off-system Routes with low truck traffic volume (< 100 trucks per day).
Surface**	402-3816	800 to 1000					
Surface**	402-3100	<800	9.5 mm Type I Superpave	7/8", 90 lbs/yd^2, (22 mm, 50 kg/m^2)	**1-¼"*, 135 lbs/yd^2, (32 mm, 75 kg/m^2)**	1-¼", 135 lbs/yd^2, (32 mm, 75 kg/m^2)	For State and Off-system Routes * **For Off-system Routes only USE:** 1-1/8", 125 lbs/yd^2, (28 mm, 70 kg/m^2)
Surface**	402-3101	800 to 2000					
Surface**	402-3102	2000 to 4000	9.5 mm Type II Superpave	1-1/8", 125 lbs/yd^2, (28 mm, 70 kg/m^2)	**1-¼", 135 lbs/yd^2, (32 mm, 75 kg/m^2)**	1-½", 165 lbs/yd^2, (38 mm, 90 kg/m^2)	For State and Off-system Routes.
Surface**	402-3103	4000 to 10,000					
Surface**	402-3130	10,000 to 25,000	12.5 mm Superpave	1-3/8", 150 lbs/yd^2, (35mm, 80 kg/m^2)	**1-½", 165 lbs/yd^2, (38 mm, 90 kg/m^2)**	2-½", 275 lbs/yd^2, (64 mm, 150 kg/m^2)	For State Routes and for shoulders of Interstate Routes.
Surface**	402-4510	25,000 to 50,000	12.5 mm Superpave w/polymer Modified AC	1-3/8", 150 lbs/yd^2, (35mm, 80 kg/m^2)	**1-½", 165 lbs/yd^2, (38 mm, 90 kg/m^2)**	2-½", 275 lbs/yd^2, (64 mm, 150 kg/m^2)	For High ADT State Routes, all Interstate Routes; and all Interstate Ramps.
Surface**	402-3600	>50,000	12.5 mm SMA	1-3/8", 150 lbs/yd^2, (35mm, 80 kg/m^2)	**1-½", 165 lbs/yd^2, (38 mm, 90 kg/m^2)**	3", 330 lbs/yd^2, (75mm, 180 kg/m^2)	For Interstate Routes and for State Routes when recommended by OMR. **OMR may recommend 2-inch lift 12.5 mm SMA on Interstates.**

2.4 Flexible Pavement

Note: The project location determines base layer selection.

2.4.1 Graded Aggregate Base Layers

GAB can be placed in a single layer or multiple layers depending upon its thickness; layers not to exceed 8 inches and not to exceed 2 layers. Layer Coefficients may be in the range of 0.12 to 0.16

Figure 12: GDOT Pavement Design Manual

Table 13: Earthworks Using Pavement Design

Roundabout Radius	Roundabout Area
50 ft.	907.92 Cu. Yd

Course	Volume (Cu.Yd)
Surface	68.09
Base	81.71
Subbase	95.33
Subgrade	190.66
Total	435.79

Alternative #3 Do Nothing

This alternative is explained below in the conclusion.

Conclusion

Sandy Springs, Georgia is an area that is ever growing and will always need improvements. Safety, mobility, and cost effectiveness are all important considerations when improving traffic flow. Due to the fact that there have been numerous accounts from citizens complaining about the sight distance issue on Hammond Drive, a redesign is necessary. All of the alternatives for this project present many positives and negatives, which need to be considered.

The first alternative includes designing a single-lane roundabout to reduce the speed of oncoming traffic to Hammond Drive. The design promotes safety and appearance, but lacks heavily in cost effectiveness. Noting that the cost of the roundabout would be over $2M and the traffic that would result during construction, conclusively deem this design inefficient.

The third option consists of doing nothing. While this is the cheapest cost, it does not necessarily improve safety or mobility. This option could prove viable in a sense that it wouldn't hurt or set back anything, however it could risk more potential crashes.

The second alternative consists of a road diet spanning across Hammond Drive. Taking AASHTO Standards into consideration, this design is the most viable. Accidents would be reduced and traffic mobility would be greatly improved. The relatively low construction and maintenance cost while improving safety conclusively justifies this design.

References

-Georgene M. Geary, P.E., State Materials and Research Engineer, “Pavement Design”, *DEPARTMENT OF TRANSPORtATION STATE OF GEORGIA,* March 18, 2011

-”GDOT Pavement Design Tool User Guide”, *Georgia Department of Transportation Office of Design Policy and Support Engineering Support & Services,* July 15, 2013

-AASHTO “7th Edition Highway & Street Design “Green Book””, 2018

-”GDOT Pavement Design Manual”, *Georgia Department Office of Materials and Research,* December 6,2005

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Appendix

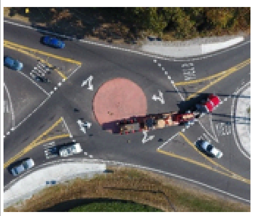
GDOT Georgia Department of Transportation

INTERSECTION CONTROL TYPE DESCRIPTIONS

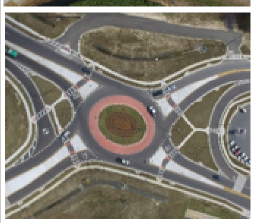
Click on intersection images for additional resource publications ICE Version 2.14 | Revised 08/03/2018

Unsignalized At-Grade Intersections

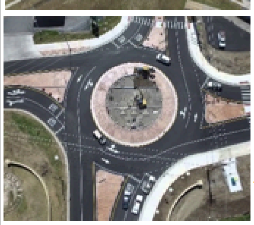
Conventional Minor Street or All-Way Stop: At minor street stop (2-way stop) intersections, vehicles on minor street stop and give right-of-way to major street. At all-way stop (AWS) intersections, all vehicles must stop and take turns entering the intersection. Both (4-leg) intersection types have 32 baseline conflict points and have limited operational and safety benefits as traffic volumes become significant.



Mini Roundabouts: Roundabout type characterized by a small diameter and traversable central island; offers most of the benefits of single-lane roundabouts with added benefit of a smaller footprint; best suited to lower-speed environments and where environmental constraints preclude use of a larger roundabout with a raised central island. Mini-roundabouts are emerging in U.S. in states including MD, MI and GA.

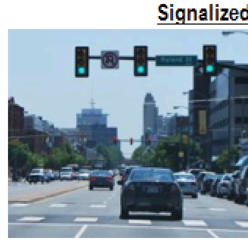


Single-Lane Roundabouts: Form of circular intersection in which traffic travels counterclockwise around a central island and in which entering traffic must yield to circulating traffic. Circulating traffic has priority with entries controlled by yield. Geometry slows all traffic into and thru the roundabout. At a 4-leg roundabout there are 8 baseline conflict points.
Also known as: Modern Roundabout

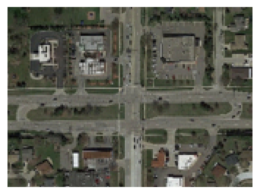


Multilane Roundabouts: Share same circulatory travel and yield-at-entry in single-lane roundabouts, but include multiple entry and circulatory lanes for one or more approaches that must accommodate vehicles traveling side by side. Important design features include proper entry path alignment and geometry, signing and marking that allows entry to exit paths without forcing a lane change in the circle.

Signalized At-Grade Intersections

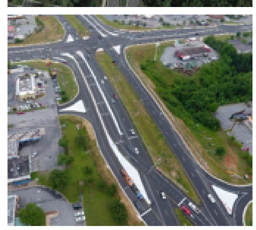


Signalized Intersection: The most common type of signalized intersection with high driver familiarity. Signal could be simple two-phase or more complex 8-phase to serve vehicular demand. Left turns can be permitted or protected (or combination of both). At a conventional 4-leg intersection there are 32 baseline conflict points.



Median U-Turn: Left turn movements otherwise occurring at the main intersection are made via U-turns in the median, preceding or following right turns. U-turns may be only on major roadway or on both major and minor roadways. A conventional MUT has 16 baseline conflict points and has shown significant operational and safety benefits.
Also known as: Indirect Left, Michigan Left, MUT

Signalized RCUT: Similar to the Median U-turn but features break in cross-street traffic that allows signals on opposite directions to operate independently. Left turns can make directly turns onto the minor road but minor road thru and left turn movements are made using the directional U-turn crossovers. An RCUT has 14 baseline conflict points (over 3 intersections).
Also known as: Superstreet



Displaced Left-Turn (DLT): Left turn traffic crosses opposing lanes in advance of main intersection and are stored in additional lanes. At main intersection, thru and left turns can be made simultaneously during same signal phase. A full DLT (both routes) has 28 baseline conflict points; a partial DLT (one route) has 30 baseline conflict points.
Also known as: Continuous Flow Intersection

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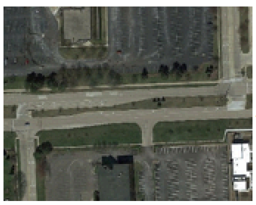
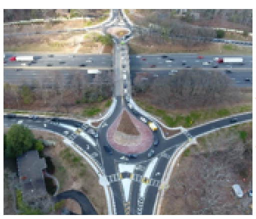
RIRO w/Downstream U-Turn: Redirects minor street thru & left turn movements as right-turns followed by a U-turn via directional median crossover (+/- 500 feet from main intersection). Major street lefts are also made indirectly, passing the crossing street and using the same U-turn crossovers in the median. Minor street intersections are reduced to right-in/right-out movements making this the safest intersection type.

Unsignalized High-T: Unsignalized 3-leg intersection features raised channelization to separate "top" thru movement from turning lanes at intersection, allowing the through movement to operate continuously. A high-T intersection has 9 baseline conflict points, the same as a conventional 3-leg.
<u>Also known as:</u> "Seagull" intersection



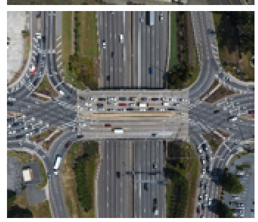
Offset-Tee Intersection: Creates an offset of minor street approaches to form 2 intersections with the major roadway separated by some distance (between 300' and 500'). Through movements on the minor street "jog" using the major street (right-turns followed by left-turns or vice versa). The Offset-T has a total of 18 baseline conflict points (over two intersections).
<u>Also known as:</u> Paired Intersection



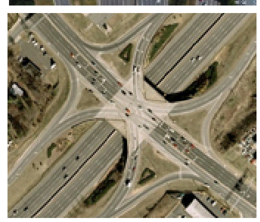
Double Roundabout Interchange: Use of single or dual lane roundabouts at traditional diamond interchange ramp terminals. The use of roundabouts requires only through lanes on the bridge (no turn lane storage lanes) and the elimination of signal control at the ramp terminals. There are a total of 16 baseline conflict points (over two intersections).
<u>Also known as:</u> Teardrop Interchange

Jughandle: Much like an at-grade diamond interchange, ramps on the major street diverge from the right side in advance of a cross street intersection, removing the left turn movement from directly at the cross-street intersection. Major street left turns are made at minor, stop-controlled intersections on the cross-street. Left turns from the cross-street remain as direct movements at the main intersection.

Quadrant Roadway: Left turns are removed from the main intersection via an additional roadway in one intersection quadrant. Left-turn movements are routed from the arterial and cross-street (using unique turning paths for each approach) onto the quadrant roadway to complete the left turn movement at the quadrant roadway "minor" T-intersections. A Quadrant Roadway has 28 baseline conflict points (over 3 intersections).



Diverging Diamond Interchange (DDI): All traffic crosses over to left side of road at first ramp terminal intersection before crossing back over at second ramp terminal. Crossover movements allow left turns to be made unopposed. A DDI has a total 14 baseline conflict points (over two intersections) and has shown both operational and safety benefits.
<u>Also known as:</u> Double Crossover Diamond



Single Point Urban Diamond (SPUI): Free-flow major street thru movements are provided by creating a separate, signalized intersection of major street turning movements with the cross-street on a separate grade, creating an intersection either under or over the priority thru roadway. Right turns are made at unsignalized ramps separated from the main intersection.