



INTERSECTION CONTROL EVALUATION (ICE) POLICY

APPENDIX D. Example TE Study with Intersection Control Evaluation

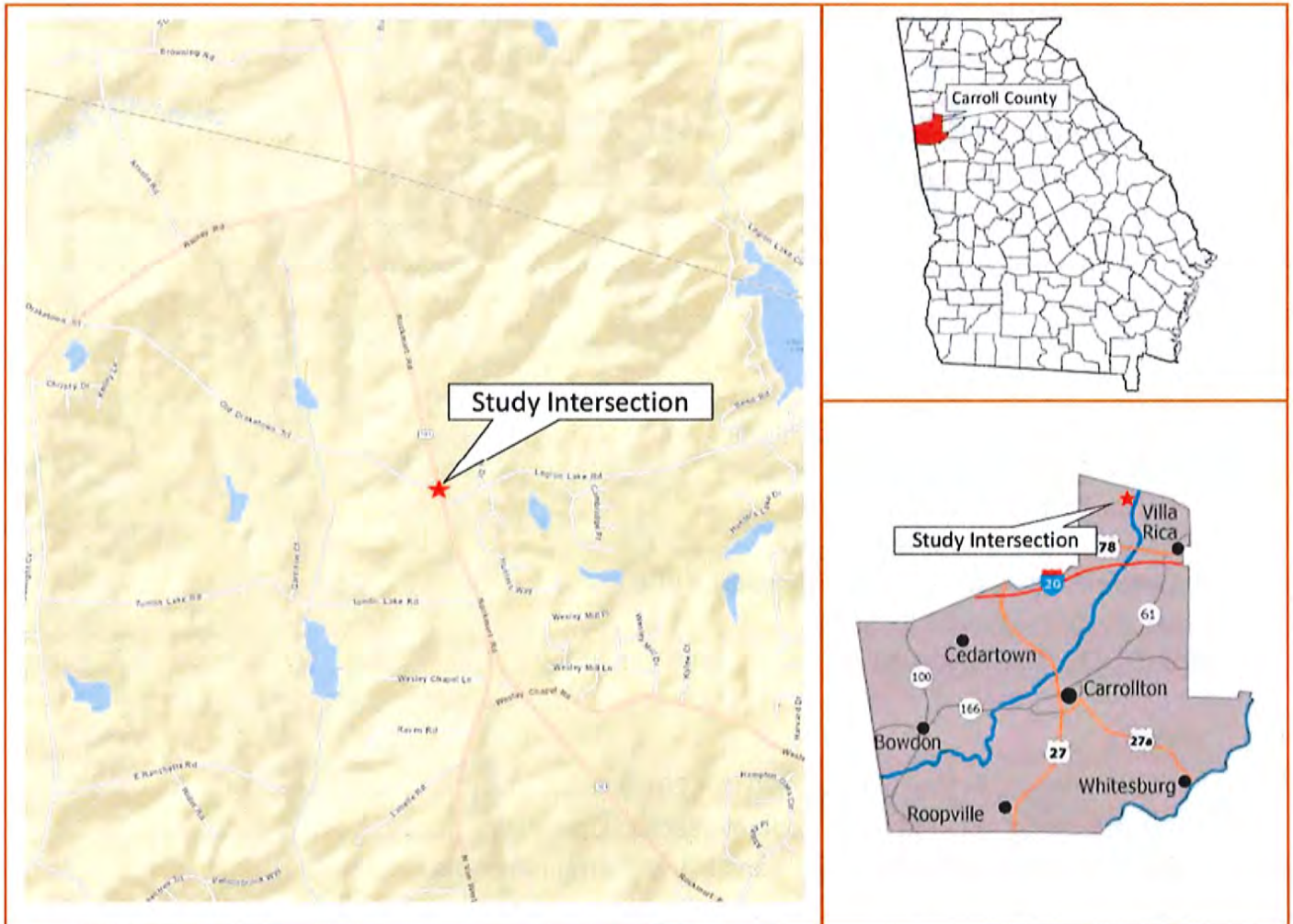
Exhibit D-1: SR 101 @ Old Draketown Trail, Carroll County

Exhibit D-2: SR 140 @ Avery Road, Cherokee County

Exhibit D-1:
SR 101 @ Old Draketown Trail, Carroll County

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA
TRAFFIC ENGINEERING STUDY

May 2017



PRIMARY ROUTE: SR 101 (Rockmart Road)

SECONDARY ROUTE: Old Draketown Trail

MILEPOINT: 5.27

GDOT DISTRICT: 6

CONGRESSIONAL DISTRICT 3

COUNTY: Carroll

CITY: Temple

PREPARED BY: ARCADIS



TABLE OF CONTENTS

Study Request	1
Reason For Investigation	1
Project Location	1
Field Visit	1
Crash Analysis	2
Operational Analysis	3
Traffic Volume Counts:.....	3
Signal Warrant Analysis:	3
Intersection Control Evaluation (ICE).....	3
Crash Reduction Factors	4
Expected Operational Results	4
Benefit-Cost Analysis.....	5
Conclusion	5

Appendix A: Crash Data

Appendix B: intersection Crash Diagram

Appendix C: Traffic Data

Appendix D: Traffic Analysis

Appendix E: Signal Warrant Analysis

Appendix F: Intersection Control Evaluation (ICE)

Appendix G: Alternative Sketches

Appendix H: Cost Estimates

TABLES

Table 1: Intersection Crash History [2013 – 2015].....	2
Table 2: Existing AM / PM Peak Hour Intersection Operations	3
Table 3: Summary of Current Conditions Signal Warrant Analysis	3
Table 4: Crash Reduction	4
Table 5: Operational Analysis Results	4
Table 6: Benefit / Cost Ratio Analysis Results.....	5

STUDY REQUEST: This study was requested by GDOT District 6 Traffic Operations (Grant Waldrop)

REASON FOR INVESTIGATION: SR 101 at Old Draketown Trail intersection has experienced 2.3 crashes per year from 2013-2015. Per the Highway Safety Manual (1) methodology, intersections with similar characteristics typically experience 2.1 crashes per year. Also, this intersection has experienced severe crashes resulting in multiple injuries and a fatality.

PROJECT LOCATION: SR 101 is a two-lane road with a posted speed of 55 MPH. It is classified as an Urban Minor Arterial that connects northern Carroll County and western Paulding County to I-20. There are few signalized intersections along this roadway, with the nearest signal to this intersection being 5 miles to the south. Old Draketown Trail is a two-lane local road with a posted speed of 45 MPH that connects Rainey Road to SR 101. There are no signalized intersections on Old Draketown Trail. **Figure 1** provides aerial view of the intersection geometrics.

Figure 1: Aerial Map of Study Intersection



FIELD VISIT

A field visit was conducted on Tuesday, November 15, 2016. The site visit observed the current site conditions as well as identifying and documenting conditions that could effect safety and operations. Field visit observations included:

- **Intersection control:** Currently SR 101 is free flow, and Old Draketown Trail is stop controlled. The pavement shows signs of wearing and cracking. Other Modes of Transportation: No other modes of transportation were noticed in the project vicinity.
- **Horizontal/Vertical Grades:** There is a steep gradient on the east side Old Draketown Trail approaching SR 101 inside of the clear zone. There is no guardrail at this location or at any location near the intersection. Old Draketown Trail intersects SR 101 at a 55-degree skew that can make turning more difficult.
- **Intersection Delay / Queuing:** There was no major delay or queuing issues at the intersection. The absences of a northbound left turn lane caused some vehicles to stop in the through travel lane to await a gap to turn left. This causes minor delay for northbound vehicles, and leads to a greater risk of rear-end crashes.

- Sight Distance / Vegetation Concerns: There is an adequate sight-triangle of vision for all approaches. There is a vertical crest on SR 101 just south of this intersection that impacts the visibility of northbound vehicles. There is no vegetation that could obstruct views.
- Pavement/Signs/Striping Conditions: The pavement and marking appeared adequate with only normal wear. There is a standard stop sign on the Old Draketown approach in good condition but a portion of the stop bar has worn off.
- Pedestrian Accommodations: There are no pedestrian accommodations provided at the intersection nor signs of significant pedestrian activity (no beaten path). There were two pedestrians observed during the site visit crossing the Old Draketown Trail approach. No other pedestrians were observed during the 12-hour traffic count.
- Lighting: There is no street lighting at the intersection.
- Parking: There is no on-street parking accommodations near the intersection.
- Potential Environmental Impacts: There is no appearance of any environmental concerns at this intersection.
- Other Modes of Transportation: There are no bus stops near this rural intersection

CRASH ANALYSIS

Crash data for over the most recent three-year period for which data is available was collected from GEARS. The number and types of crashes are provided in tabular form in **Appendix A** and **Table 1** below presents a comparison of crash rates, injury rates, and fatality rates along the study area. A crash diagram of all crashes occurring at this intersection is included in **Appendix B**.

Table 1: Intersection Crash History [2011 – 2013]

Collision Type	Year			
	2013	2014	2015	Total
Angle	-	-	-	-
Head On	-	-	-	-
Rear End	1	2	2	5
Sideswipe	-	-	-	-
Not a Collision with Motor Vehicle	-	-	2	2
Unknown	-	-	-	-
Total Crashes	1	2	4	7
Total Non-Fatal Injuries	-	-	-	-
Total Fatalities	-	-	-	-
Average Crashes (per year)				2.3
HSM Predicted Crashes (per year)				2.1
Average Daily Traffic (ADT)	9,350	9,350	9,350	
Crash Rate (per 100 MEV)	29	59	117	
Non-Fatality Injury Rate (per 100 MEV)	-	-	-	
Fatality Rate (per 100 MEV)	-	-	-	

ADT = average daily traffic; MEV = million entering vehicles

In the past five years, there have been seven crashes reported at SR 101 and Old Draketown Trail. Five of the crashes were rear end collisions and two involved running off roadway (attempting to avoid rear ending another vehicle). There were no injuries, nor fatalities involved in the reported crashes.

The study intersection has had an average of 2.3 crashes per year from 2013-2015. According to Highway Safety Manual (HSM) methodology, intersections with similar geometric, traffic control, and traffic volume characteristics typically experience 2.1 crashes per year.

OPERATIONAL ANALYSIS

Traffic Volume Counts:

A 12-hour intersection turning movement count was collected on Thursday, September 29, 2016. All cars, trucks or other motorized vehicles passing through the intersection were counted between the hours of 6:30AM and 6:30PM, broken into 15-minute intervals to determine peak morning, mid-day and afternoon peak hours. The percentage of trucks on each intersection leg was also reported. As a permanent count station is not available near of the intersection, the 12-hour data was used to project Average Daily Traffic (ADT) for each of the approach roadways. Queue length observations were made for critical movements during the AM and PM peak periods. The traffic volume counts collected and ADT reports and/or projections are included in **Appendix C**.

Existing Operations:

The intersection geometries, volumes and control specifics were inputs to a Synchro 9 model analysis of existing conditions that was calibrated to observed queuing conditions. The Synchro model reports for existing intersection conditions are include in **Appendix D** and the results are summarized in **Table 2** below.

Table 2: Existing AM / PM Peak Hour Intersection Operations

Intersection	Peak Period	Overall Delay/LOS	V/C Ratio	Eastbound Delay	Eastbound LOS	Westbound Delay	Westbound LOS	Northbound Delay	Northbound LOS	Southbound Delay	Southbound LOS	ICU (%/LOS)
SR 101 at Old Draketown Trail	AM	11.2 / B	0.24	11.2	B	N/A	N/A	1.4	A	0.00	A	0.44 / A
	PM	10.6 / B	0.24	10.6	B	N/A	N/A	2.5	A	0.0	A	0.54 / A

Note: LOS for unsignalized intersection is based on maximum side street approach delay

Signal Warrant Analysis:

The Manual of Uniform Traffic Control Devices 2009 Edition (MUTCD) is the established source for evaluating warrants for installing a traffic signal. The MUTCD established nine traffic signal warrants that define minimum conditions under which signal installations may be justified. Installation of a traffic signal can improve the overall safety and/or operation of an intersection but should be considered only when deemed necessary by analysis combined with engineering judgement, and less restrictive solutions have been considered.

A signal warrant analysis was evaluated based on the existing 12-hour turning movement counts that were used as inputs into the analysis model. The full warrants report is included in **Appendix E** and the results summarized in **Table 3** below.

Table 3: Summary of Current Conditions Signal Warrant Analysis

Intersection	Warrant 1a	Warrant 1b	Warrant 2	Warrant 3	Warrant 4	Warrant 5	Warrant 6	Warrant 7	Warrant 8	Warrant 9
SR 101 at Old Draketown Trail	No	No	No	No	n/a	n/a	n/a	n/a	n/a	n/a

Based on the warrant analysis conducted combined with good engineering judgement, a signal is not warranted for this intersection.

INTERSECTION CONTROL EVALUATION (ICE)

GDOT's Intersection Control Evaluation (ICE) policies were developed to further leverage safety advancements as part of intersection improvements. The ICE process consists of 2 distinct stages. A Stage 1 evaluation identifies potential Intersection Control Types that may provide safety benefits. Stage 2 further evaluates those alternatives inclusive of safety, operations, cost, environmental

impacts and project support. The Stage 1 screening and Stage 2 ranking results are documented in **Appendix F**. Sketches of each Stage 2 alternative are included in **Appendix G**.

1. **Conventional (Minor Route Stop):** Old Draketown Trail is currently an offset tee pair with Legion Lake Road. Installing A northbound left turn lane would reduce the total amount of crashes as well as the occurrences of crashes that lead to injuries. As the left turn taper would extend to the SR 101 / Legion Lake Road intersection, it is recommended that the left turn lane should be extended through the Legion Lake Road intersection (providing back-to-back left turns) so that southbound left turns onto Legion Lake Road can be moved out of the southbound SR101 travel lane. The ICE level two screening showed that this was the best option when looking at cost, safety, operations, environmental, and political implications.

A realignment of Legion Lake Road to intersect with Old Draketown Road would reduce the number of conflict points on SR101. However, the cost and impacts of the realignment would be considerable and the safety gain would not be more than the provision of a left turn bay as previously identified. Lastly, The addition of guardrail at the intersection would improve safety for vehicles running off the roadway.

2. **Single Lane Roundabout:** A single lane roundabout was analyzed using GDOT's Roundabout Analysis Tool spreadsheet with and without a northbound bypass lane. With such low right turn volume bypass lanes were determined not to be needed at this intersection.
3. **Conventional Signalized:** Intersection volumes do not meet signal warrants and thus a signalized intersection is not recommended.

Crash Reduction Factors

The Crash Reduction Factors used in the ICE Stage 2 analysis were determined from the FHWA's CMF Clearinghouse website (<http://www.cmfclearinghouse.org/>) and are provided in **Table 4** below:

Table 4: Crash Reduction Factors

Safety Countermeasure	PDO	Injury/Fatal
Turn Lane Improvements	49%	55%
Intersection Realignment	13%	N/A
Single Lane Roundabout	71%	87%
New guardrail embankment	3%*	55%*

*Running off road only crashes.

EXPECTED OPERATIONAL RESULTS

For all alternatives considered in the Stage 2 analysis, the intersection delay and LOS was determined with the intersection control improvements made and the results are summarized in **Table 5**. All of the alternatives considered provide equal or improved intersection operating conditions compared to existing conditions.

Table 5: Operational Analysis Results

Approach	Existing Stop Control		Turn Lane Improvements		Roadway Realignment		Single Lane Roundabout	
	AM	PM	AM	PM	AM	PM	AM	PM
EB	11.2 - B	10.6 - A	11.2 - B	10.6 - A	11.2 - B	10.6 - A	5 - A	4 - A
WB	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NB	1.4 - A	2.5 - A	1.2 - A	1.8 - A	1.4 - A	2.5 - A	4 - A	6 - A
SB	0.0 - A	0.0 - A	0.0 - A	0.0 - A	0.0 - A	0.0 - A	5 - A	5 - A
Overall	11.2 - B	10.6 - A	11.2 - B	10.6 - A	11.2 - B	10.6 - A	-	-

Note: LOS for unsignalized intersection is based on maximum side street approach delay

BENEFIT-COST ANALYSIS

A summary of the Safety Benefit / Cost of the studied alternatives are presented in **Table 6**. The Turn Lane Improvements and Intersection Realignment alternatives are shown because the two projects will be combined and was analyzed to have the highest ICE Stage 2 score, as shown in **Appendix F**. A summary of the cost estimate development details is included in **Appendix H**.

Table 6: Benefit / Cost Ratio Analysis Results

Safety Countermeasure	Project Cost	B/C Ratio
Turn Lane Improvements	\$435,673	18.38
Intersection Realignment	\$195,097	0.17

CONCLUSION

The intersection of SR 101 and Old Draketown Trail experiences more crashes than the HSM methodology predicts, and there has been one intersection fatality. Potential solutions including the installation of a northbound left turn lane, replacing the intersection with a roundabout, and other minor intersection modifications showed a possible reduction in expected crashes.


Recommendations

A list of short, mid-term and long-term safety project recommendations are identified in **Table 7**. The result of the long-term project is expected to reduce the number of overall crashes to 1.0 crashes per year, and to have a 55 percent reduction of injury crashes. If the skew cannot be reasonably corrected, the northbound turn lane should be still be installed, resulting in a projected decrease of 1.2 crashes per year.

Table 7: Intersection Safety Improvement Recommendations

Short Term	Mid Term	Long Term
<ul style="list-style-type: none">• Refresh paint or provide thermoplastic on the Old Draketown Road stop bar• Install additional intersection warning signs	<ul style="list-style-type: none">• Install guardrail to reduce crashes involving vehicles running off the roadway	<ul style="list-style-type: none">• Install a northbound turn lane (extending back-to-back with a southbound left turn lane at Legion Lake Road)• Correcting the Old Draketown Trail intersection skew (by tee'ing into SR 101 at or close to 90-degrees)

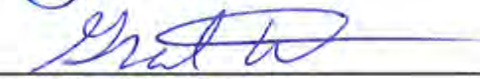
RECOMMENDED BY:


Jonathan Reid, PE, PTOE
Consultant Project Manager

DATE

6-1-17

RECOMMENDED BY:


Grant Waldrop, PE
District Traffic Engineer

DATE

6-8-17

Appendix A: Crash Data

Agency Name	Date	Time	County	Route	Injuries	Fatalities	Manner Of Collision	First Harmful Event	Light	Surface	Weight1	Weight2	Movement1	Movement2	Number Of Vehicles	Latitude	Longitude	Serious Injuries	Vehicle Injuries	Complaint Injuries	U1 Factors	U2 Factors
438573 Gap Post 00	1/7/2013	13:45:00	CARROLL	GA 101 NEAR OLD DRAKETOWN RD SR 101	0	0	Rear End	Motor Vehicle In Motion	Daylight	Dry	Passenger Car	Passenger Car	Straight	Stopped	2	33.78445	-84.96716	0	0	0	0	No Contributing Factors
4723836 Gap Post 00	1/31/2014	17:40:00	CARROLL	LEGION LAKE RD	0	0	Rear End	Motor Vehicle In Motion	Daylight	Dry	Pickup Truck	Utility Passenger Vehicle	Straight	Stopped	2	33.783103	-84.96662	0	0	0	0	No Contributing Factors
5109944 Gap Post 00	12/28/2014	1:05:00	CARROLL	GA 101 S OF LEGION LAKE RD	0	0	Not A Collision with Motor Vehicle	Ditch	Dark Night	Wet	Passenger Car		Turning Left		1	33.78309	-84.96677	0	0	0	0	No Contributing Factors
5117715 Gap Post 00	1/2/2015	10:10:00	CARROLL	GA 101	0	0	Rear End	Motor Vehicle In Motion	Daylight	Wet	Passenger Car	Passenger Car	Straight	Stopped	2	33.783767	-84.967025	0	0	0	0	No Contributing Factors
5387516 Gap Post 00	8/11/2015	16:12:00	CARROLL	LEGION LAKE RD	0	0	Rear End	Motor Vehicle In Motion	Daylight	Dry	Pickup Truck	Pickup Truck	Straight	Stopped	2	33.78313	-84.96668	0	0	0	0	No Contributing Factors
5510093 Gap Post 00	11/8/2015	4:07:00	CARROLL	GA 101	0	0	Not A Collision with Motor Vehicle	Ditch	Dark Night	Wet	Passenger Car		Turning Right		1	33.78389	-84.96702	0	0	0	0	No Contributing Factors

Appendix B: Intersection Crash Diagram

LOCATION: SR 101 @ Old Draketown Trail

CRASH PERIOD: 2013 to 2015

①

Crash Number	Crash Type	Date	Day of Week	Time of Day	Injury or Fatality?	Pavement Condition
4318573	Rear End	01/07/13	Monday	1:45 PM	---	Dry
5117725	Rear End	01/02/15	Friday	10:10 AM	---	Wet

②

Crash Number	Crash Type	Date	Day of Week	Time of Day	Injury or Fatality?	Pavement Condition
5109944	Single Vehicle	12/28/14	Sunday	1:05 AM	---	Wet

③

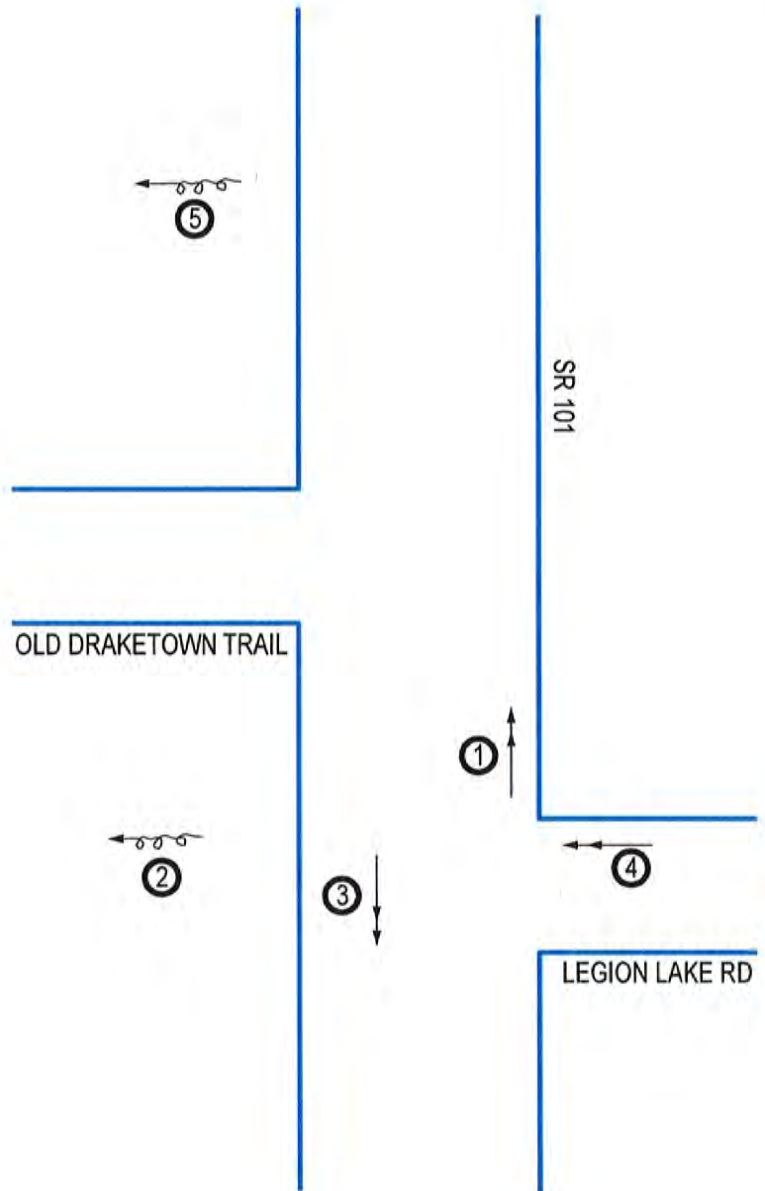
Crash Number	Crash Type	Date	Day of Week	Time of Day	Injury or Fatality?	Pavement Condition
3676514	Rear End	04/11/14	Friday	8:21 PM	Injury	Dry

④

Crash Number	Crash Type	Date	Day of Week	Time of Day	Injury or Fatality?	Pavement Condition
4723036	Rear End	01/31/14	Friday	5:40 PM	---	Dry
5387516	Rear End	08/11/15	Tuesday	4:12 PM	---	Dry

⑤

Crash Number	Crash Type	Date	Day of Week	Time of Day	Injury or Fatality?	Pavement Condition
5510093	Single Vehicle	11/08/15	Sunday	4:07 AM	---	Wet



SYMBOLS

- ← Moving Vehicle
- ←→→ Backing Vehicle
- ← - - Non-Involved Vehicle
- * - - Pedestrian
- ▬ Parked Vehicle
- Fixed Object

TYPES OF CRASHES

- ←← Rear End
- Head On
- ↘ Side Swipe
- ←○○ Out of Control
- ↘ Left Turn
- ↑ Right Angle

Appendix C: Traffic Data

All Traffic Data Services

1 SR 101 & Old Draketown Trail AM
Thursday, September 29, 2016

Peak Hour
05:00 PM - 06:00 PM
Peak 15-Minutes
05:15 PM - 05:30 PM

Traffic Counts - All Vehicles

Time	Old Draketown Trail						SR 101						SR 101						Rolling Hour						
	Eastbound						Westbound						Northbound							Southbound					
	U-Turn	Left	Thru	Right	RTOR	U-Turn	Left	Thru	Right	RTOR	U-Turn	Left	Thru	Right	RTOR	U-Turn	Left	Thru		Right	RTOR	Total			
6:30 AM	0	1	0	22	0	0	0	0	0	0	0	4	35	0	0	0	0	0	82	0	0	144			
6:45 AM	0	0	0	28	0	0	0	0	0	0	0	8	38	0	0	0	0	0	78	0	0	152			
7:00 AM	0	0	0	22	0	0	0	0	0	0	0	5	37	0	0	0	0	0	74	0	0	138			
7:15 AM	0	0	0	20	0	0	0	0	0	0	0	14	42	0	0	0	0	0	95	0	0	171			
7:30 AM	0	1	0	17	0	0	0	0	0	0	0	4	37	0	0	0	0	0	96	0	0	155			
7:45 AM	0	0	0	21	0	0	0	0	0	0	0	6	49	0	0	0	0	0	84	0	0	160			
8:00 AM	0	0	0	15	0	0	0	0	0	0	0	2	38	0	0	0	0	0	75	0	0	130			
8:15 AM	0	0	0	21	0	0	0	0	0	0	0	9	33	0	0	0	0	0	69	1	0	133			
8:30 AM	0	0	0	15	0	0	0	0	0	0	0	8	30	0	0	0	0	0	39	2	0	94			
8:45 AM	0	0	0	10	0	0	0	0	0	0	0	6	31	0	0	0	0	0	49	0	0	96			
9:00 AM	0	0	0	15	0	0	0	0	0	0	0	4	23	0	0	0	0	0	42	0	0	84			
9:15 AM	0	1	0	14	0	0	0	0	0	0	0	9	24	0	0	0	0	0	55	0	0	103			
9:30 AM	0	0	0	9	0	0	0	0	0	0	0	4	35	0	0	0	0	0	31	0	0	79			
9:45 AM	0	0	0	8	0	0	0	0	0	0	0	4	30	0	0	0	0	0	64	1	0	107			
10:00 AM	0	0	0	12	0	0	0	0	0	0	0	12	28	0	0	0	0	0	49	0	0	101			
10:15 AM	0	0	0	8	0	0	0	0	0	0	0	6	35	0	0	0	0	0	36	2	0	87			
10:30 AM	0	0	0	13	0	0	0	0	0	0	0	7	41	0	0	0	0	0	48	0	0	109			
10:45 AM	0	1	0	9	0	0	0	0	0	0	0	8	25	0	0	0	0	0	39	3	0	85			
11:00 AM	0	1	0	6	0	0	0	0	0	0	0	6	33	0	0	0	0	0	42	1	0	89			
11:15 AM	0	2	0	12	0	0	0	0	0	0	0	5	38	0	0	0	0	0	44	4	0	105			
11:30 AM	0	0	0	9	0	0	0	0	0	0	0	12	37	0	0	0	0	0	31	0	0	89			
11:45 AM	0	3	0	8	0	0	0	0	0	0	0	12	47	0	0	0	0	0	41	1	0	112			
12:00 PM	0	1	0	9	0	0	0	0	0	0	0	4	49	0	0	0	0	0	40	0	0	103			
12:15 PM	0	0	0	6	0	0	0	0	0	0	0	6	46	0	0	0	0	0	39	2	0	99			
12:30 PM	0	0	0	8	0	0	0	0	0	0	0	13	29	0	0	0	0	0	47	1	0	98			
12:45 PM	0	0	0	5	0	0	0	0	0	0	0	5	49	0	0	0	0	0	32	0	0	91			
1:00 PM	0	0	0	12	0	0	0	0	0	0	0	5	40	0	0	0	0	0	29	0	0	86			
1:15 PM	0	0	0	15	0	0	0	0	0	0	0	13	44	0	0	0	0	0	53	0	0	125			
1:30 PM	0	0	0	15	0	0	0	0	0	0	0	8	36	0	0	0	0	0	47	2	0	108			
1:45 PM	0	0	0	8	0	0	0	0	0	0	0	14	55	0	0	0	0	0	51	1	0	129			
2:00 PM	0	0	0	11	0	0	0	0	0	0	0	5	38	0	0	0	0	0	37	0	0	91			
2:15 PM	0	1	0	7	0	0	0	0	0	0	0	6	51	0	0	0	0	0	65	2	0	132			
2:30 PM	0	2	0	9	0	0	0	0	0	0	0	13	55	0	0	0	0	0	48	2	0	129			
2:45 PM	0	0	0	11	0	0	0	0	0	0	0	17	51	0	0	0	0	0	57	1	0	137			
3:00 PM	0	2	0	12	0	0	0	0	0	0	0	17	46	0	0	0	0	0	39	2	0	118			
3:15 PM	0	1	0	9	0	0	0	0	0	0	0	15	67	0	0	0	0	0	53	2	0	147			
3:30 PM	0	2	0	10	0	0	0	0	0	0	0	20	64	0	0	0	0	0	52	0	0	148			
3:45 PM	0	3	0	14	0	0	0	0	0	0	0	15	75	0	0	0	0	0	53	3	0	163			

[illegible]

Pedestrians

[illegible]

3:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Hour Summary	1	1	2	0	0	0	0	0	0	0	0	0	0	0	1	1			

Appendix D: Traffic Analysis

HCM 2010 TWSC
3: SR 101 & Old Draketown Trail

11/21/2016

Intersection

Int Delay, s/veh 1.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	1	80	29	165	349	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	1	87	32	179	379	0

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	621	379	379 0
Stage 1	379	-	- -
Stage 2	242	-	- -
Critical Hdwy	6.42	6.22	4.12 -
Critical Hdwy Stg 1	5.42	-	- -
Critical Hdwy Stg 2	5.42	-	- -
Follow-up Hdwy	3.518	3.318	2.218 -
Pot Cap-1 Maneuver	451	668	1179 -
Stage 1	692	-	- -
Stage 2	798	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	437	668	1179 -
Mov Cap-2 Maneuver	437	-	- -
Stage 1	692	-	- -
Stage 2	774	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	11.2	1.2	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1179	-	664	-	-
HCM Lane V/C Ratio	0.027	-	0.133	-	-
HCM Control Delay (s)	8.1	0	11.2	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0.1	-	0.5	-	-

Intersection	
Int Delay, s/veh	1.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	1	55	86	390	279	8
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	110	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	67	82	79	97	91	55
Heavy Vehicles, %	2	2	3	3	2	2
Mvmt Flow	1	67	109	402	307	15

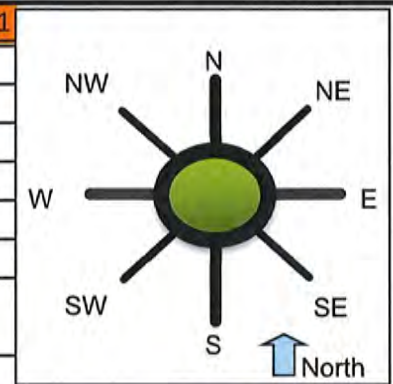
Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	934	314	321
Stage 1	314	-	-
Stage 2	620	-	-
Critical Hdwy	6.42	6.22	4.13
Critical Hdwy Stg 1	5.42	-	-
Critical Hdwy Stg 2	5.42	-	-
Follow-up Hdwy	3.518	3.318	2.227
Pot Cap-1 Maneuver	295	726	1233
Stage 1	741	-	-
Stage 2	536	-	-
Platoon blocked, %			-
Mov Cap-1 Maneuver	269	726	1233
Mov Cap-2 Maneuver	269	-	-
Stage 1	741	-	-
Stage 2	489	-	-

Approach	EB	NB	SB
HCM Control Delay, s	10.7	1.7	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1233	-	700	-	-
HCM Lane V/C Ratio	0.088	-	0.098	-	-
HCM Control Delay (s)	8.2	-	10.7	-	-
HCM Lane LOS	A	-	B	-	-
HCM 95th %tile Q(veh)	0.3	-	0.3	-	-

General & Site Information v 4.1

Analyst: Selma Hasancevic
Agency/Co: Arcadis
Date:
Project or PI#:
Year, Peak Hour: 2016, 7 AM
County/District: Carroll
Intersection: SR 101 at Old Draketown Trail
Name:



Volumes Entry Legs (FROM)

	N (1)	NE (2)	E (3)	SE (4)	S (5)	SW (6)	W (7)	NW (8)
--	-------	--------	-------	--------	-------	--------	-------	--------

Exit Legs (TO)	N (1), vph					165		1	
	NE (2), vph								
	E (3), vph								
	SE (4), vph								
	S (5), vph	349						80	
	SW (6), vph								
	W (7), vph					29			
	NW (8), vph								
Output	Total Vehicles	349	0	0	0	194	0	81	0

Volume Characteristics	N	NE	E	SE	S	SW	W	NW
% Cars	98.3%	100.0%	100.0%	100.0%	97.1%	100.0%	98.2%	100.0%
% Heavy Vehicles	1.7%	0.0%	0.0%	0.0%	2.9%	0.0%	1.8%	0.0%
% Bicycle	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
# of Pedestrians (ped/hr)	0	0	0	0	0	0	0	0
PHF	0.91	0.95	0.95	0.95	0.93	0.95	0.83	0.95
F _{HV}	0.983	1.000	1.000	1.000	0.972	1.000	0.982	1.000
F _{ped}	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Entry/Conflicting Flows	N	NE	E	SE	S	SW	W	NW
Flow to Leg # N (1), pcu/h	0	0	0	0	183	0	1	0
NE (2), pcu/h	0	0	0	0	0	0	0	0
E (3), pcu/h	0	0	0	0	0	0	0	0
SE (4), pcu/h	0	0	0	0	0	0	0	0
S (5), pcu/h	390	0	0	0	0	0	98	0
SW (6), pcu/h	0	0	0	0	0	0	0	0
W (7), pcu/h	0	0	0	0	32	0	0	0
NW (8), pcu/h	0	0	0	0	0	0	0	0
Entry flow, pcu/h	390	0	0	0	215	0	99	0
Conflicting flow, pcu/h	32	0	0	0	1	0	390	0

Results: Approach Measures of Effectiveness

HCM 6th Edition	N	NE	E	SE	S	SW	W	NW
Entry Capacity, vph	1313	NA	NA	NA	1339	NA	911	NA
Entry Flow Rates, vph	384	NA	NA	NA	209	NA	98	NA
V/C ratio	0.29				0.16		0.11	
Control Delay, sec/pcu	5				4		5	
LOS	A				A		A	
95th % Queue (ft)	31				14		9	

Notes:

v 4.0

Unit Legend:

vph = vehicles per hour

PHF = peak hour factor

F_{HV} = heavy vehicle factor

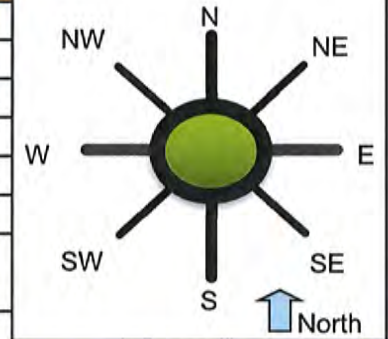
pcu = passenger car unit

Bypass Lane Merge Point Analysis (if applicable)

Bypass Characteristics	Bypass #1	Bypass #2	Bypass #3	Bypass #4	Bypass #5	Bypass #6
Select Entry Leg from Bypass (FROM)						
Select Exit Leg for Bypass (TO)						
Does the bypass have a dedicated receiving lane?						
Volumes						
Right Turn Volume removed from Entry Leg						
Volume Characteristics (for entry leg)						
PHF						
F _{HV}						
F _{ped}						
NOTE: Volume Characteristics for Exit Leg are already taken into account						
Entry/Conflicting Flows						
Entry Flow, pcu/hr						
Conflicting Flow, pcu/hr						
Bypass Lane Results (HCM 6th Edition)						
Entry Capacity of Bypass, vph						
Flow Rates of Exiting Traffic, vph						
V/C ratio						
Control Delay, s/veh						
LOS						
95th % Queue (ft)						
Approach w/Bypass Delay, s/veh						
Approach w/Bypass LOS						

General & Site Information v 4.1

Analyst: Selma Hasancevic
Agency/Co: Arcadis
Date:
Project or PI#:
Year, Peak Hour: 2016, 3 PM
County/District: Carroll
Intersection: SR 101 at Old Draketown Trail
Name:



Volumes		Entry Legs (FROM)							
		N (1)	NE (2)	E (3)	SE (4)	S (5)	SW (6)	W (7)	NW (8)
Exit Legs (TO)	N (1), vph					390		1	
	NE (2), vph								
	E (3), vph								
	SE (4), vph								
	S (5), vph	279						55	
	SW (6), vph								
	W (7), vph	8				86			
	NW (8), vph								
Output	Total Vehicles	287	0	0	0	476	0	56	0

Volume Characteristics	N	NE	E	SE	S	SW	W	NW
% Cars	98.3%	100.0%	100.0%	100.0%	97.1%	100.0%	98.2%	100.0%
% Heavy Vehicles	1.7%	0.0%	0.0%	0.0%	2.9%	0.0%	1.8%	0.0%
% Bicycle	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
# of Pedestrians (ped/hr)	0	0	0	0	0	0	0	0
PHF	0.91	0.95	0.95	0.95	0.93	0.95	0.83	0.95
F _{HV}	0.983	1.000	1.000	1.000	0.972	1.000	0.982	1.000
F _{ped}	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Entry/Conflicting Flows	N	NE	E	SE	S	SW	W	NW
Flow to Leg # N (1), pcu/h	0	0	0	0	432	0	1	0
NE (2), pcu/h	0	0	0	0	0	0	0	0
E (3), pcu/h	0	0	0	0	0	0	0	0
SE (4), pcu/h	0	0	0	0	0	0	0	0
S (5), pcu/h	312	0	0	0	0	0	67	0
SW (6), pcu/h	0	0	0	0	0	0	0	0
W (7), pcu/h	9	0	0	0	95	0	0	0
NW (8), pcu/h	0	0	0	0	0	0	0	0
Entry flow, pcu/h	321	0	0	0	527	0	69	0
Conflicting flow, pcu/h	95	0	0	0	1	0	312	0

Results: Approach Measures of Effectiveness								
HCM 6th Edition	N	NE	E	SE	S	SW	W	NW
Entry Capacity, vph	1231	NA	NA	NA	1339	NA	986	NA
Entry Flow Rates, vph	315	NA	NA	NA	512	NA	67	NA
V/C ratio	0.26				0.38		0.07	
Control Delay, sec/pcu	5				6		4	
LOS	A				A		A	
95th % Queue (ft)	26				47		6	

Notes: v 4.0

Unit Legend:
vph = vehicles per hour
PHF = peak hour factor
F_{HV} = heavy vehicle factor
pcu = passenger car unit

Bypass Lane Merge Point Analysis (if applicable)						
Bypass Characteristics	Bypass #1	Bypass #2	Bypass #3	Bypass #4	Bypass #5	Bypass #6
Select Entry Leg from Bypass (FROM)						
Select Exit Leg for Bypass (TO)						
Does the bypass have a dedicated receiving lane?						
Volumes						
Right Turn Volume removed from Entry Leg						
Volume Characteristics (for entry leg)						
PHF						
F _{HV}						
F _{ped}						
NOTE: Volume Characteristics for Exit Leg are already taken into account						
Entry/Conflicting Flows						
Entry Flow, pcu/hr						
Conflicting Flow, pcu/hr						
Bypass Lane Results (HCM 6th Edition)						
Entry Capacity of Bypass, vph						
Flow Rates of Exiting Traffic, vph						
V/C ratio						
Control Delay, s/veh						
LOS						
95th % Queue (ft)						
Approach w/Bypass Delay, s/veh						
Approach w/Bypass LOS						

Appendix E: Signal Warrant Analysis

Warrants Summary															
Information															
Analyst							Intersection								
Agency/Co							SR 101 @ Old Draketown Trail								
Date Performed							Jurisdiction								
11/8/2016							GDOT								
Project ID							Units								
							U.S. Customary								
East/West Street							Time Period Analyzed								
Old Draketown Trail							PM								
File Name							North/South Street								
Warrants Analysis							SR 101								
							Major Street								
							North-South								
Project Description															
General										Roadway Network					
Major Street Speed (mph)		55		<input checked="" type="checkbox"/>		Population < 10,000				Two Major Routes		<input type="checkbox"/>			
Nearest Signal (ft)		0		<input type="checkbox"/>		Coordinated Signal System				Weekend Count		<input type="checkbox"/>			
Crashes (per year)		3		<input type="checkbox"/>		Adequate Trials of Alternatives				5-yr Growth Factor		0			
Geometry and Traffic				EB			WB			NB			SB		
				LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N				1	0	0	0	0	0	0	1	0	0	1	0
Lane usage				L	LR					LT			TR		
Vehicle Volume Averages (vph)				2	0	43	0	0	0	38	185	0	0	198	3
Peds (ped/h) / Gaps (gaps/h)				--	/	--	--	/	--	--	/	--	--	/	--
Delay (s/veh) / (veh-hr)				--	/	--	--	/	--	--	/	--	--	/	--
Warrant 1: Eight-Hour Vehicular Volume													<input type="checkbox"/>		
1 A. Minimum Vehicular Volumes (Both major approaches --and-- higher minor approach) --or--													<input type="checkbox"/>		
1 B. Interruption of Continuous Traffic (Both major approaches --and-- higher minor approach) --or--													<input type="checkbox"/>		
1 80% Vehicular --and-- Interruption Volumes (Both major approaches --and-- higher minor approach)													<input type="checkbox"/>		
Warrant 2: Four-Hour Vehicular Volume													<input type="checkbox"/>		
2 A. Four-Hour Vehicular Volumes (Both major approaches --and-- higher minor approach)													<input type="checkbox"/>		
Warrant 3: Peak Hour													<input type="checkbox"/>		
3 A. Peak-Hour Conditions (Minor delay --and-- minor volume --and-- total volume) --or--													<input type="checkbox"/>		
3 B. Peak- Hour Vehicular Volumes (Both major approaches --and-- higher minor approach)													<input type="checkbox"/>		
Warrant 4: Pedestrian Volume													<input type="checkbox"/>		
4 A. Pedestrian Volumes (Four hours --or-- one hour) --and--													<input type="checkbox"/>		
4 B. Gaps Same Period (Four hours --or-- one hour)													<input type="checkbox"/>		
Warrant 5: School Crossing													<input type="checkbox"/>		
5. Student Volumes --and--													<input type="checkbox"/>		
5. Gaps Same Period													<input type="checkbox"/>		
Warrant 6: Coordinated Signal System													<input type="checkbox"/>		
6. Degree of Platooning (Predominant direction or both directions)													<input type="checkbox"/>		
Warrant 7: Crash Experience													<input type="checkbox"/>		
7 A. Adequate trials of alternatives, observance and enforcement failed --and--													<input type="checkbox"/>		
7 B. Reported crashes susceptible to correction by signal (12-month period) --and--													<input type="checkbox"/>		

7 C. 80% Volumes for Warrants 1A, 1B --or-- 4 are satisfied	<input type="checkbox"/>
---	--------------------------

Warrant 8: Roadway Network	<input type="checkbox"/>
8 A. Weekday Volume (Peak hour total --and-- projected warrants 1, 2 or 3) --or--	<input type="checkbox"/>
8 B. Weekend Volume (Five hours total)	<input type="checkbox"/>

Appendix F: Intersection Control Evaluation (ICE)

GDOT PI # (or N/A) **N/A** County: **Carroll** Requested By: **District Engineer** Date: **4/19/2017**
 Major (State) Route: **SR 101** GDOT District: **6 - Cartersville** Area Type: **Rural**
 Crossing Route: **Old Draketown Trail** Prepared By: **Arcadis** Analyst: **T. Galloway**
 Project Purpose: **Improve intersection safety** Project ID: **3005**

Introduction In 2005, SAFETEA-LU established the Highway Safety Improvement Program (HSIP) and mandated that each State prepare a Strategic Highway Safety Plan (SHSP) by which to prioritize safety funding investments. Intersections quickly became a common component of a majority of States' SHSP emphasis areas and HSIP project lists, including in Georgia's SHSP. Intersection Control Evaluation (ICE) policies and procedures represent a traceable and transparent procedure to streamline the evaluation of intersection control alternatives, and to further leverage the safety advancements noted above for intersection improvements beyond just the safety program. As approximately one-third of all traffic fatalities and roughly 75% of all traffic crashes in Georgia occur at or adjacent to intersections, the Georgia SHSP includes an emphasis on enhancing intersection safety in order to advance toward the Toward Zero Deaths vision embraced by the Georgia Governor's Office of Highway Safety. This ICE tool was developed to support the ICE policy and help ensure that intersection investments across the entire Georgia highway system are selected, prioritized and implemented with defensible benefits for safety toward those ends.

Tool Goal The goal of this ICE tool is to provide a simplified and consistent way of using traffic, safety, cost, environmental impact and political support data to assess and quantify intersection control improvement benefits and aid decision making by the Department in a manner that provides traceability, transparency, consistency and accountability when identifying and selecting an intersection control solution that both meets the project purpose and reflects the overall best value in terms of specific performance-based criteria.

Requirements An ICE is **required** for any intersection improvement (e.g., a new intersection, an intersection modification, widening/reconstruction or corridor project, or work accomplished through a driveway or encroachment permit that affects an intersection) where **1)** the intersection includes at least one roadway designated as a State Route (State Highway System) or as part of the National Highway System; and/or **2)** the intersection will be designed or constructed using State or Federal funding. In certain circumstances where an ICE would otherwise be required, the requirement **may** be waived based on appropriate evidence presented with a written request. Please see the "Waiver" tab to understand the criteria that may make a project waiver eligible and learn how to submit a waiver request to the Department. An ICE is **not required** when the proposed work involved does not include any major changes to an intersection that would substantially alter the character of the intersection; for instance, a project limited only to "mill and fill" pavement resurfacing with no change to intersection geometry or control, or routine traffic signal timing (not to include adding a phase) and equipment maintenance.

Two-Stage Process A complete ICE process consists of two (2) distinct stages, and it is expected that the respective level of effort for completing both stages of ICE will correspond to the magnitude and complexity of the intersection. The Stage 1 and Stage 2 ICE forms are designed to keep data inputs at a minimum, requiring limited data entry and drop-down menu fields. All fields shaded in grey have drop down menu choices and all fields shaded in blue require a text response. All other cells in the worksheet are locked to prohibit the entering or editing of data.

Stage 1: Screening Decision Record Stage 1 is conducted as early in the project development process as possible and is intended to inform which alternatives are worthy of further evaluation in Stage 2. A Stage 1 evaluation normally requires sufficient analysis or subject matter expertise to estimate the preliminary footprint of the intersection to determine whether or not an alternative is practical to implement. Users should use good engineering judgement in responding to seven policy questions by selecting "Yes" or "No" in the drop-down boxes and alternatives should not be summarily eliminating without due consideration. Reasons for eliminating or advancing an alternative should be documented in the rightmost column with heading: "Screening Decision Justification".

Stage 2: Alternative Selection Decision Record Stage 2 involves a more detailed and familiar evaluation of alternatives identified in Stage 1 in order to support the selection of a preferred alternative that may be advanced to detailed design. Based on the Concept Development Process outlined by the PDP Manual, Stage 2 would begin after the Initial Concept Meeting for corridor improvements and projects consisting of multiple intersections. The data entry is similar in process to Stage 1 but is more robust, requiring separate analysis of each alternative to determine cost, impacts, operations, safety and project support. A separate "Instructions" tab is provided to provide guidance to the user on data entry values and parameters. Once all the data is entered, a score and ranking of each alternative is calculated and reported on the bottom line of the worksheet to inform on the best intersection treatment to select as the preferred alternative.

Documentation A complete ICE document consists of the combination of the outputs from both Stage 1 and Stage 2 along with supporting documentation, to be included in the approved project Concept Report (or equivalent) or as a stand-alone document.

GDOT PI #	N/A	<p>1 Does alternative address the project need in a balanced manner and in scale with the project?</p> <p>2 Does alternative improve safety performance in terms of reducing severe crashes?</p> <p>3 Does alternative incorporate convenience and accessibility for pedestrians and/or bicyclists?</p> <p>4 Does alternative improve (or preserve) traffic operations (congestion, delay, reliability, etc.)?</p> <p>5 Does alternative appear feasible given the site characteristics, constraints and location context?</p> <p>6 Does alternative appear feasible with respect to other project factors?</p> <p>7 Overall feasible alternative (select alternative for further evaluation in Stage 2)?</p>							
Major Route:	SR 101								
Minor Route:	Old Draketown Trail								
Prepared by:	Arcadis								
Analyst:	T. Galloway								
Date Completed:	4/19/2017								
<p>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.</p> <p>Note: No more than 5 alternatives may be selected and evaluated in Stage 2.</p>									
Intersection Alternative:		Screening Decision Justification:							
Unsignalized	Conventional (Minor Stop)	No	No	No	Yes	Yes	Yes	No	Existing Condition
	Conventional (All-Way Stop)	No	Yes	No	Yes	No	No	No	Low side street volume
	Mini Roundabout	No	Yes	No	No	No	No	No	High speed mainline
	Single Lane Roundabout	Yes	Yes	No	No	No	No	Yes	Potential solution to evaluate
	Multilane Roundabout	No	No	No	No	No	No	No	All single lane approaches
	RCUT (unsignalized)	No	No	No	No	No	No	No	Significant impacts to improve from undivided to divided roadway
	RIRO w/downstream U-Turn	No	No	No	No	No	No	No	Significant thru volumes / insufficient ROW on mainline
	Unsignalized High-T	No	No	No	No	No	No	No	Low volume
	Offset-Tee Pair	No	No	No	No	No	No	No	No thru vehicles
	Other Unsignalized (provide description):	Yes	Yes	No	Yes	Yes	Yes	Yes	Fix Intersection skew
Other Unsignalized (provide description):	Yes	Yes	No	Yes	Yes	Yes	Yes	Add Left Turn Lane	
Signalized Intersections	Traffic Signal	No	No	No	No	No	No	No	Does not meet signal warrants
	Median U-Turn (Indirect Left)	No	No	No	No	No	No	No	N/A - Does not meet signal warrants
	RCUT (signalized)	No	No	No	No	No	No	No	N/A - Does not meet signal warrants
	Displaced Left Turn (CFI)	No	No	No	No	No	No	No	N/A - Does not meet signal warrants
	Continuous Green-Tee (Hight-T)	No	No	No	No	No	No	No	N/A - Does not meet signal warrants
	Jughandle (Any Corner)	No	No	No	No	No	No	No	N/A - Does not meet signal warrants
	Quadrant Roadway (Any Corner)	No	No	No	No	No	No	No	N/A - Does not meet signal warrants
	Diverging Diamond (Ramp Terminals)	No	No	No	No	No	No	No	N/A - Does not meet signal warrants
	Single Point Interch (Ramp Terminals)	No	No	No	No	No	No	No	N/A - Not an interchange
	Other Signalized (provide description):	No	No	No	No	No	No	No	N/A - Not an interchange
	Other Signalized (provide description):	No	No	No	No	No	No	No	Write in control type / improvements



GDOT ICE STAGE 2: ALTERNATIVE SELECTION DECISION RECORD

Version 1.8
Revised 4/14/2017

Project Information

GDOT PI # (or N/A) N/A

GDOT District: 6 - Cartersville

Date: 4/19/2017

County: Carroll

Area Type: Rural

Agency/Firm: Arcadis

Project Location: SR 101 @ Old Draketown Trail

Analyst: T. Galloway

Existing Intersection Control: Conventional (Minor Stop)

Type of Analysis: Safety Funded Project

Existing Conditions

Intersection meets Signal warrants?	No
Intersection meets AWSC warrants?	No
Traffic Analysis Software	Synchro 9
Existing Pk Hr Intersection Delay*	2.2
Existing Intersection V/C ratio*	0.19
Design Year	2017
Design Year Intersection Delay*	2.2
Design Year V/C Ratio*	0.19

* = worst case AM/PM results

Crash Data:

Crash Type	3 most recent years of intersection crash data	Crash Severity		
		PDO	Injuries	Fatalities
Angle		0	0	0
Head-On		0	0	0
Rear End		4	0	0
Sideswipe - same		0	0	0
Sideswipe - opposite		0	0	0
Not Collision w/Motor Veh		2	0	0
TOTALS:		6	0	0

Alternatives Analysis

Proposed Control Type/Improvement

Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Single Lane Roundabout	Fix Intersection skew	Add Left Turn Lane	N/A	N/A

Project Cost

Construction Cost	\$644,002	\$113,542	\$338,325		
ROW Cost	\$32,200	\$10,191	\$12,766		
Environmental Cost	\$0	\$0	\$0		
Reimbursable Utility	\$19,161	\$5,677	\$16,916		
PE+Contingency Cost (30%)	\$208,609	\$38,823	\$110,402		
Total Cost	\$903,972	\$168,233	\$478,409		

Traffic Operations

Design Yr Intersection Delay	5.5	2.2	1.8		
Design Yr V/C Ratio	0.31	0.19	0.24		
Traffic Analysis Software	GDOT RND Tool 4.0	Synchro 9	Synchro 9		

Safety Analysis

Predefined CRF: PDO	71%	0%	0%		
Predefined CRF: Fatal/Inj	87%	0%	0%		
User Defined CRF: PDO		13%	49%		
User Defined CRF: Fatal/Inj		0%	55%		
User Defined CRF Source (if applicable):		CMF Clearinghouse # 5188	CMF Clearinghouse #s 4703 / 4704 / 5188		

Environmental Impacts

Historic District/Property	None	None	None	None	
Archaeology Resources	None	None	None	None	
Graveyard	None	None	None	None	
Stream	None	None	None	None	
Underground Tank/Hazmat	None	None	None	None	
Park Land	None	None	None	None	
Environmental Justice Community	None	None	None	None	
Wooded Area	None	None	None	None	
Wetland	None	None	None	None	

Political Factors

If environmental impact is highlighted **RED**, provide justification impact won't jeopardize project delivery on ENV worksheet tab.

Local Citizen Support	Neutral	Neutral	Supportive	Neutral	
Local Government Support	Neutral	Neutral	Strong	Neutral	
GDOT District Office Support	Neutral	Neutral	Supportive	Neutral	
GDOT Central Office Support	Neutral	Neutral	Supportive	Neutral	

Final ICE Stage 2 Score

Rank of Control Type Alternatives:

7.4	6.5	7.8	-	-
2	3	1	-	-

Note: Stage 2 score is not shown (shown as "-") if signal or AWS is selected as control type but signal or AWS warrants are not met

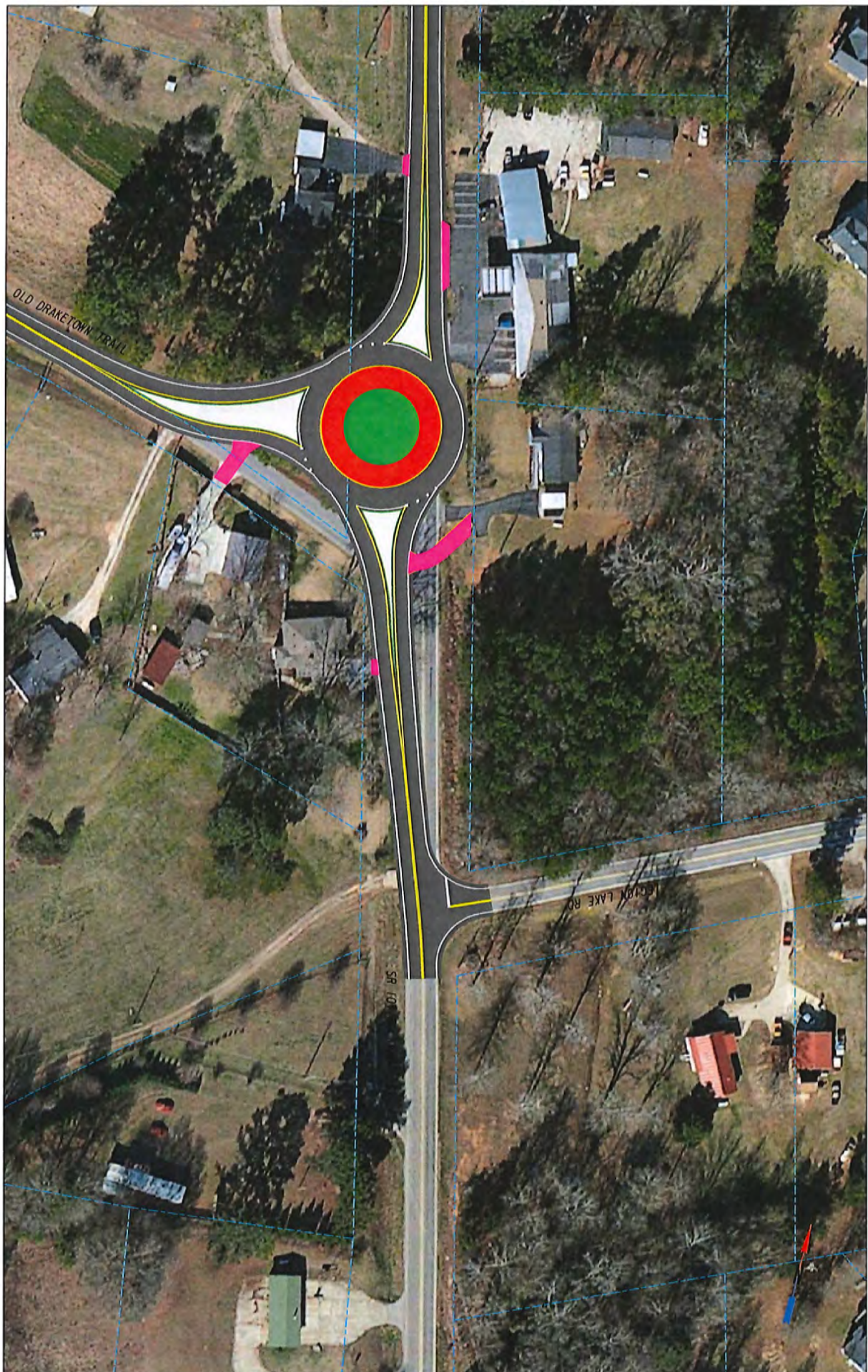
Provide any additional general comments or explain analysis inputs (as necessary):

No comments.

Appendix G: Alternative Sketches







Appendix H: Cost Estimates

Planning Level Project Cost Estimation

Project Identification

Description	Add Left Turn Lane	Proj. Type
From/To Limit		District
Notes		3
SR 101	0.15 miles	
Old Draktown Trail	0.03 miles	
	total	0.18
Cost Summary Incl. Contingency		
Preliminary Engineering	\$ 67,665	
Reimbursable Utility	\$ 16,916	
Right-of-Way	\$ 12,766	
Construction	\$ 338,325	
Total	\$ 435,673	

Construction Costs

Average Per Lane-Mile Components	Unit Cost	Miles	Add Lanes	Lane-Miles	Cost
Surface Str. New Cst. base & pave	\$410,000	0.03	2.00	0.06	\$24,600
SR or High volume Rd widening	\$500,000	0.10	1.00	0.1	\$50,000
Surface Street Overlay	\$64,000	0.18	2.00	0.36	\$23,040
Concrete Widening (Ramps)	\$843,744			0	\$0
Cross Streets widening	\$307,500			0	\$0
Cross Street Overlay	\$20,000				\$0
Traffic Control	\$150,000	0.18	1.00		\$27,000
Typical Driveways	\$75,000	0.01	3.00		\$2,250
Typical E & S Control Temp&Perm	\$150,000	0.18	2.00		\$54,000
Typical Earthwork	\$500,000	0.15	0.50		\$37,500
Typical Drainage - Urban Section	\$255,000				\$0
Curb & Gutter both sides (mile)	\$264,000				\$0
Typical Drainage - Rural Section	\$150,000	0.18	1.00		\$27,000
Signing & Marking	\$50,000	0.18	2.00		\$18,000
Typical Clear & Grub-120 ft wide	\$109,091				\$0
Typical Guardrail Type W	\$212,000				\$0
20ft. Raised median +C&G (mile)	\$968,000				\$0
Median landscaping	\$100,000				\$0
Sidewalks 5 ft. ea. side (mile)	\$294,000				\$0
ADA Ramps	\$1,500				\$0
Subtotal					\$263,390

Additional Per Mile Components	Unit Cost	Length	Factor	Cost
Add Major Earthwork (mile)	\$350,000			\$0
Add Major Drainage (mile)	\$150,000			\$0
Add Major Grade changes (mile)	\$350,000			\$0
Major alignment corrections (mile)	\$750,000	0.03	2.00	\$45,000
Maint of Traffic difficulty (mile)	\$200,000			\$0
Temporary Barrier	\$30			\$0
Concrete Island + C&G (SY)	\$60			\$0
Add guardrail Type T (mile)	\$423,000			\$0
Paved Shoulders, 4 ft. 2 sides(mile)	\$100,000			\$0
blank	\$0			\$0
blank	\$0			\$0
Blankway, 4 feet, both side (mile)	\$333,333			\$0
Add driveways (mile)	\$75,000			\$0
Cl. B Conc. Base or pvmt widening	\$792,000			\$0
Special E&S control	\$300,000			\$0
Subtotal				\$45,000

Individual Components	Unit Cost	Length (ft)	Width (ft)	Ht (ft)	Cost
Truck Apron	\$506,880				\$0
Cone Header Crub. TP 7 both sides (r	\$126,720				\$0
Cone Header Crub. TP 9 both sides (r	\$147,840				\$0
Retaining Walls - Gravity 0 - 5' (LF)	\$60	0			\$0
Retaining Walls-Gravity 5'-max (LF)	\$120	0			\$0
Retaining Walls-Special Design(SF)	\$60	0			\$0
Bridges - widen (SF)	\$100	0	0	0	\$0
Bridges - widen (SF)	\$100	0	0	0	\$0
Bridges - replace (SF)	\$120	0	0	0	\$0
Bridges - replace (SF)	\$120	0	0	0	\$0
Bridges - detour (SF)	\$60	0	0	0	\$0
Bridge Removal (SF)	\$25	0	0	0	\$0
Cofferdams (ea)	\$20,000	0			\$0
Box Culverts (SF)	\$95	0	0		\$0
Box Culverts (SF)	\$95	0	0		\$0
Large cross drains (LF)	\$80	0			\$0
Replace cross drains (LF)	\$120	0			\$0
Sediment/ detention ponds (ea)	\$30,000	0			\$0
Pavement patching (Sq yd)	\$30	0	1.00		\$0
Bus Stop Relocation	\$50,000	0			\$0
Traffic Signalization / Upgrade (ea)	\$125,000				\$0
Subtotal					\$308,390
Total Construction Cost					\$308,390
Percent of Total					78%

Right-of-Way Costs

Area Type	Unit cost/ac	Miles	Width (ft)	Acres	Cost
Urban					
Residential Property	\$800,000	0	0	0.00	\$0
Residential Easement	\$240,000	0	0	0.00	\$0
Commercial Property	\$1,200,000	0	0	0.00	\$0
Commercial Easement	\$360,000	0	0	0.00	\$0
Suburban/Rural					
Residential Property	\$20,000	0.1	30	0.36	\$7,273
Residential Easement	\$180,000	0	0	0.00	\$0
Commercial Property	\$800,000	0	0	0.00	\$0
Commercial Easement	\$240,000	0	0	0.00	\$0
Displacements					
Residential	\$250,000	0	1.00		\$0
Commercial	\$1,000,000	0	0		\$0
Damages	\$0	0	1.00		\$0
Total Right-of-Way Cost					\$11,636
3%					\$349,974

Reimbursable Utility Costs

5%	Total Reimbursable Utility Cost \$	15,420
3.88%		

Preliminary Engineering Costs

20%	Total Preliminary Engineering Cost	\$67,678
15.53%		

Contingency Costs

10%	Total Contingency Cost	\$36,549
	Total (PE+Util.+ROW+CST)	\$397,124
	Grand Total	\$435,673

Safety Benefits

Recommendation	CMF ID	Ek	R	r	Rp	rp
Left turn lane	253	0.135	0.55	0.45	0.49	0.51
Skew	5188	0.087	0.00	1.00	0.13	0.87

Description	Symbol	Value
Reduction Factor (F, I)	R	0.55
Reduction Factor (PDO)	Rp	0.5563
Capital Recovery Factor	Ek	0.135
Initial Improvement Cost	Ci	\$ 435,672

Accident Data	Symbol	Value
PDO	P	1.8
Fatalities	F	0.2
Injuries	I	0.8

Weighted cost of fatal and injury collisions

$$Q = \$ 2,584,400$$

$$\text{Annual Benefit: } \$ 1,448,757$$

$$\text{Annual Cost: } \$ 78,816$$

$$\text{Annual B/C Ratio: } 18.38$$

Design Life Benefit

$$B = \$ 6,908,658$$

Design Life Cost

$$C = \$ 375,847$$

Design Life Benefit/Cost Ratio

$$B/C = 18.38$$

Planning Level Project Cost Estimation

Project Identification

Description	SR 101 @ Old Drakestown Trail Safety	Proj. Type	3
From/To Limit		District	
Notes			
SR 101	0.00 miles		
Old Drakestown Trail	0.03 miles		
	total		0.03

Cost Summary Incl. Contingency	
Preliminary Engineering	\$ 65,687
Reimbursable Utility	\$ 5,677
Right-of-Way	\$ 10,191
Construction	\$ 113,542
Total	\$ 195,097

Construction Costs

Average Per Lane-Mile Components	Unit Cost	Miles	Add Lanes	Lane-Miles	Cost
Surface Str. New Cst. base & pave	\$410,000	0.03	2.00	0.06	\$24,600
SR or High volume Rd widening	\$500,000			0	\$0
Surface Street Overlay	\$64,000	0.03	2.00	0.06	\$3,840
Concrete Widening (Ramps)	\$843,744			0	\$0
Cross Streets widening	\$307,500			0	\$0
Cross Street Overlay	\$20,000				\$0
Traffic Control	\$150,000	0.03	1.00		\$4,500
Typical Driveways	\$75,000				\$0
Typical E & S Control Temp&Perm	\$150,000	0.03	2.00		\$9,000
Typical Earthwork	\$500,000	0.03	2.00		\$30,000
Typical Drainage - Urban Section	\$255,000				\$0
Curb & Gutter both sides (mile)	\$264,000	0.03	1.00		\$4,500
Typical Drainage - Rural Section	\$150,000	0.03	1.00		\$1,500
Signing & Marking	\$50,000	0.03	1.00		\$3,273
Typical Clear & Grub-120 ft wide	\$109,091	0.03	1.00		\$0
Typical Guardrail Type W	\$212,000				\$0
20ft. Raised median +C&G (mile)	\$968,000				\$0
Median landscaping	\$100,000				\$0
Sidewalks 5 ft. ea. side (mile)	\$294,000				\$0
ADA Ramps	\$1,500				\$0
Subtotal					\$81,213

Additional Per Mile Components	Unit Cost	Length	Factor	Cost
Add'l Major Earthwork (mile)	\$350,000			\$0
Add'l Major Drainage (mile)	\$150,000			\$0
Add'l Major Grade changes (mile)	\$350,000			\$0
Major alignment corrections (mile)	\$750,000	0.03	1.00	\$22,500
Maint of Traffic difficulty (mile)	\$200,000			\$0
Temporary Barrier	\$30			\$0
Concrete Island + C&G (SY)	\$60			\$0
Add'l guardrail Type T (mile)	\$423,000			\$0
Paved Shoulders, 4 ft, 2 sides(mile)	\$100,000			\$0
blank	\$0			\$0
blank	\$0			\$0
Bikeway, 4 feet, both side (mile)	\$333,333			\$0
Add'l driveways (mile)	\$75,000			\$0
Ci. B Conc. Base or pvmt widening	\$792,000			\$0
Special E&S control	\$300,000			\$0
Subtotal				\$22,500

Individual Components	Unit Cost	Length (ft)	Width (ft)	Ht (ft)	Cost
Truck Apron	\$506,880				\$0
Cone Header Crub, TP 7 both sides (r	\$126,720				\$0
Cone Header Crub, TP 9 both sides (r	\$147,840				\$0
Retaining Walls - Gravity 0 - 5' (LF)	\$60	0			\$0
Retaining Walls-Gravity 5-max (LF)	\$120	0			\$0
Retaining Walls-Special Design(SF)	\$60	0			\$0
Bridges - widen (SF)	\$100	0	0	0	\$0
Bridges - widen (SF)	\$100	0	0	0	\$0
Bridges - replace (SF)	\$120	0	0	0	\$0
Bridges - replace (SF)	\$120	0	0	0	\$0
Bridges - detour (SF)	\$60	0	0	0	\$0
Bridge Removal (SF)	\$25	0	0	0	\$0
Cofferdams (ea)	\$20,000	0			\$0
Box Culverts (SF)	\$95	0	0	0	\$0
Box Culverts (SF)	\$95	0	0	0	\$0
Large cross drains (LF)	\$80	0			\$0
Replace cross drains (LF)	\$120	0			\$0
Sediment/ detention ponds (ea)	\$30,000	0			\$0
Pavement patching (Sq yd)	\$30	0			\$0
Bus Stop Relocation	\$50,000	0			\$0
Traffic Signalization / Upgrade (ea)	\$125,000				\$0
Subtotal					\$0
Total Construction Cost					\$103,713
Percent of Total					58%

Right-of-Way Costs

Area Type	Unit cost/ac	Miles	Width (ft)	Acres	Cost
Urban					
Residential Property	\$800,000	0	0	0.00	\$0
Residential Easement	\$240,000	0	0	0.00	\$0
Commercial Property	\$1,200,000	0	0	0.00	\$0
Commercial Easement	\$360,000	0	0	0.00	\$0
Suburban/Rural					
Residential Property	\$20,000	0.08	30	0.29	\$5,818
Residential Easement	\$180,000	0	0	0.00	\$0
Commercial Property	\$800,000	0	0	0.00	\$0
Commercial Easment	\$240,000	0	0	0.00	\$0

Displacements	Number	factor	ROW multiplier	Cost
Residential	0	1.00		\$0
Commercial	0	0		\$0
Damages	0	1.00		\$0
Total Right-of-Way Cost			1.6	\$9,309
			5%	

Reimbursable Utility Costs

5%	Total Reimbursable Utility Cost \$	5,186
		2.91%

Preliminary Engineering Costs

20%	Total Preliminary Engineering Cost	\$60,000
		33.67%

Contingency Costs

10%	Total Contingency Cost	\$16,890
	Total (PE+Util.+ROW+CST)	\$178,207
	Grand Total	\$195,097

Safety Benefits

Recommendation	CMF ID	Ek	R	r	Rp	rp
Skew	5188	0.087	0.00	1.00	0.13	0.87

Description	Symbol	Value
Reduction Factor (F, I)	R	0
Reduction Factor (PDO)	Rp	0.13
Capital Recovery Factor	Ek	0.087
Initial Improvement Cost	Ci	\$ 195,097

Accident Data	Symbol	Value
PDO	P	1.8
Fatalities	F	0.2
Injuries	I	0.8

Weighted cost of fatal and injury collisions

$$Q = \$ 2,584,400$$

$$\text{Annual Benefit:} \quad \$ 6,388$$

$$\text{Annual Cost:} \quad \$ 36,973$$

$$\text{Annual B/C Ratio:} \quad 0.17$$

Design Life Benefit

$$B = \$ 30,463$$

Design Life Cost

$$C = \$ 176,315$$

Design Life Benefit/Cost Ratio

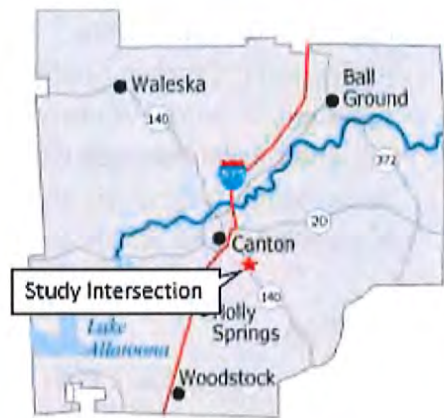
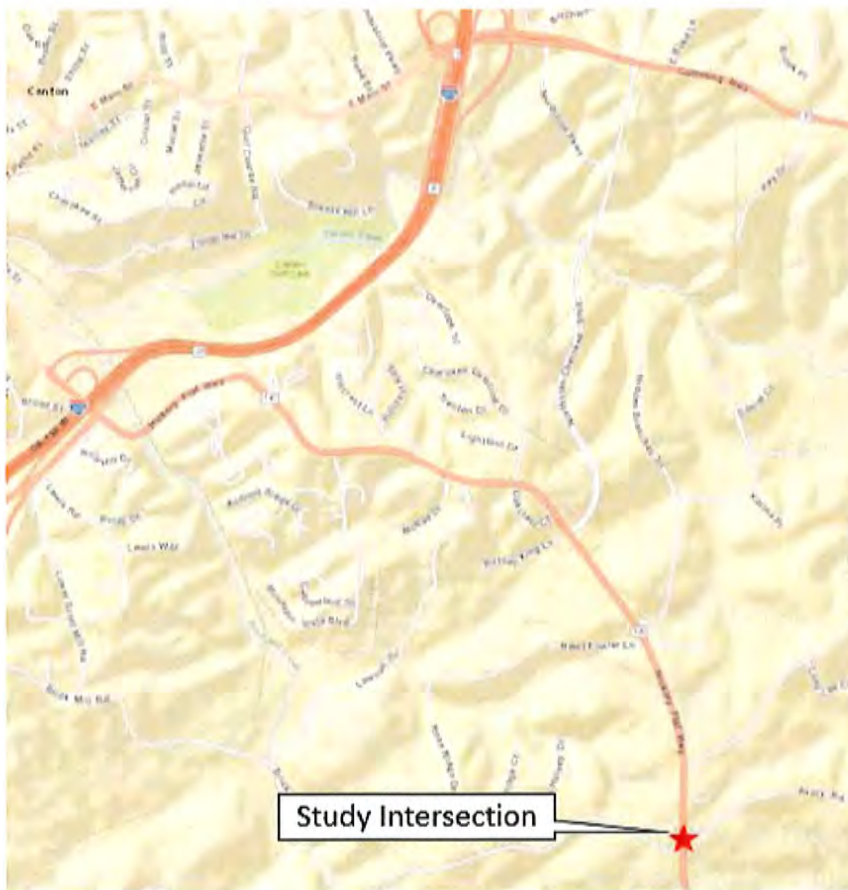
$$B/C = 0.17$$

Exhibit D-2:
SR 140 @ Avery Road, Cherokee County

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

TRAFFIC ENGINEERING STUDY

May 2017



PRIMARY ROUTE: SR 140
SECONDARY ROUTE: Avery Road
MILEPOINT: 18.99
GDOT DISTRICT: 6
CONGRESSIONAL DISTRICT 11
COUNTY: Cherokee
CITY: Canton
PREPARED BY: ARCADIS



TABLE OF CONTENTS

Study Request	1
Reason For Investigation	1
Project Location	1
Field Visit	1
Crash Analysis	2
Operational Analysis	3
Traffic Volume Counts:.....	3
Signal Warrant Analysis:	3
Intersection Control Evaluation (ICE).....	3
Crash Reduction Factors	4
Expected Operational Results	4
Benefit-Cost Analysis	4
Conclusion	5

Appendix A: Crash Data

Appendix B: intersection Crash Diagram

Appendix C: Traffic Data

Appendix D: Synchro Analysis

Appendix E: Signal Warrant Analysis

Appendix F: Intersection Control Evaluation (ICE)

Appendix G: Alternative Sketches

Appendix H: Cost Estimates

TABLES

Table 1: Intersection Crash History [2013 – 2015].....	2
Table 2: Existing AM / PM Peak Hour Intersection Operations	3
Table 3: Summary of Current Conditions Signal Warrant Analysis	3
Table 4: Crash Reduction Factors	4
Table 5: Operational Analysis Results	4
Table 6: Benefit / Cost Ratio Analysis Results.....	4

STUDY REQUEST: This study was requested by GDOT District 6 Traffic Operations (Grant Waldrop)

REASON FOR INVESTIGATION: SR 140 @ Avery Road intersection has experienced 5.3 crashes per year from 2013-2015 resulting. Per the Highway Safety Manual (1) methodology, intersections with similar characteristics typically experience 3.2 crashes per year. Also, this intersection has experienced severe crashes resulting in nine injuries and a fatality.

PROJECT LOCATION: SR 140 is a two-lane road with a posted speed of 50 MPH. It is classified as an Urban Minor Arterial that connects Canton with North Fulton County. The nearest signal to this intersection 800 feet to the north at Scott Road. Avery Road is a two-lane local road with a posted speed of 30 MPH. There are no signalized intersections on Avery Road. **Figure 1** provides aerial view of the intersection geometrics.

Figure 1:Aerial Map of Study Intersection



FIELD VISIT

A field visit was conducted on Tuesday, February 14, 2017. The site visit observed the current site conditions as well as identifying and documenting conditions that could affect safety and operations. Field visit observations included:

- **Intersection control:** Currently SR 140 is free flow, and Avery Road is stop controlled. The pavement shows signs of wearing and cracking. Other Modes of Transportation: No other modes of transportation were noticed in the project vicinity.
- **Horizontal/Vertical Grades:** SR 140 has vertical crest just south of the intersection with Avery Road. SR 140 also has a slight vertical crest just to the north of the intersection with Avery Road. Avery Road has a sharp horizontal curve leading up to the intersection, and sits lower than the SR 140 roadway.
- **Intersection Delay / Queuing:** There was no major delay or queuing issues at the intersection. The absence of a southbound left turn lane caused some vehicles to stop in the through

travel lane to await a gap to turn left. This causes minor delay for southbound vehicles, and leads to a greater risk of rear-end crashes.

- Sight Distance / Vegetation Concerns: Avery Road has sight distance issue due to the vertical crest curves, and sitting lower than SR 140. When driving on SR 140 Avery Road is hard to see due to these issues as well.
- Pavement/Signs/Striping Conditions: The pavement and marking appeared adequate with only normal wear. There is a standard stop sign on the Avery Road approach in good condition.
- Pedestrian Accommodations: There are no pedestrian accommodations provided at the intersection nor signs of significant pedestrian activity (no beaten path). No pedestrians were observed during the 12-hour traffic count.
- Lighting: There is no street lighting at the intersection.
- Parking: There is no on-street parking accommodations near the intersection.
- Potential Environmental Impacts: There is no appearance of any environmental concerns at this intersection.
- Other Modes of Transportation: There are no bus stops near this rural intersection

CRASH ANALYSIS

Crash data for over the most recent five-year period for which data is available was collected from GEARS. The number and types of crashes are provided in tabular form in **Appendix A** and **Table 1** below presents a comparison of crash rates, injury rates, and fatality rates along the study area. A crash diagram of all crashes occurring at this intersection is included in **Appendix B**.

Table 1: Intersection Crash History [2013 – 2015]

Collision Type	Year			
	2013	2014	2015	Total
Angle	-	-	2	2
Head On	1	-	(1)	2
Rear End	5	4	3	12
Sideswipe	-	-	-	-
Not a Collision with Motor Vehicle	-	-	-	-
Unknown	-	-	-	-
Total Crashes	6	4	6	16
Total Non-Fatal Injuries	2	2	5	9
Total Fatalities	-	-	1	1
Average Crashes (per year)				5.3
HSM Predicted Crashes (per year)				3.2
Average Daily Traffic (ADT)	15,000	15,000	15,000	
Crash Rate (per 100 MEV)	110	73	110	
Non-Fatality Injury Rate (per 100 MEV)	36	36	91	
Fatality Rate (per 100 MEV)	-	-	18	

ADT = average daily traffic; MEV = million entering vehicles; (x) = fatality

In the past three years, there have been sixteen crashes reported at SR 140 and Avery Road. Twelve of the crashes were rear end collisions, two were head on collisions (attempting to avoid rear ending another vehicle), and two angle crashes. Only one fatality was reported in 2015 in a head-on collision. Most of the crashes were due to southbound vehicles blocking southbound traffic in an attempt to turn left onto Avery Road. When driving southbound on SR 140 Avery Road sits lower than the roadway, and is hard to see until you are at the intersection. This leads to many vehicles braking without notice, and getting rear-ended by vehicles behind them.

The study intersection has had an average of 5.3 crashes per year from 2013-2015. Per the Highway Safety Manual (HSM) methodology, intersections with similar geometric, traffic control, and traffic volume characteristics typically experience 3.2 crashes per year.

OPERATIONAL ANALYSIS

Traffic Volume Counts:

A 12-hour intersection turning movement count was collected on Thursday, September 29, 2016. All cars, trucks or other motorized vehicles passing through the intersection were counted between the hours of 6:30AM and 6:30PM, broken into 15-minute intervals to determine peak morning, mid-day and afternoon peak hours. The percentage of trucks on each intersection leg was also reported. As a permanent count station is not available near of the intersection, the 12-hour data was used to project Average Daily Traffic (ADT) for each of the approach roadways. Queue length observations were made for critical movements during the AM and PM peak periods. The traffic volume counts collected and ADT reports and/or projections are included in **Appendix C**.

Existing Operations:

The intersection geometries, volumes and control specifics were inputs to a Synchro 9 model analysis of existing conditions that was calibrated to observed queuing conditions. The Synchro model reports for existing intersection conditions are include in **Appendix D** and the results are summarized in **Table 2** below.

Table 2: Existing AM / PM Peak Hour Intersection Operations

Intersection	Peak Period	Overall Delay/LOS	V/C Ratio	Eastbound Delay	Eastbound LOS	Westbound Delay	Westbound LOS	Northbound Delay	Northbound LOS	Southbound Delay	Southbound LOS	ICU (%/LOS)
SR 140 @ Avery Road	AM	1.8 / A	0.47	N/A	N/A	28.2	D	0.0	A	1.8	A	0.88 / E
	PM	3.7 / A	0.62	N/A	N/A	50.3	F	0.0	A	3.1	A	1.06 / G

Note: LOS for unsignalized intersection is based on maximum side street approach delay

Signal Warrant Analysis:

The Manual of Uniform Traffic Control Devices 2009 Edition (MUTCD) is the established source for evaluating warrants for installing a traffic signal. The MUTCD established nine traffic signal warrants that define minimum conditions under which signal installations may be justified. Installation of a traffic signal can improve the overall safety and/or operation of an intersection but should be considered only when deemed necessary by analysis combined with engineering judgement, and less restrictive solutions have been considered.

A signal warrant analysis was evaluated based on the existing 12-hour turning movement counts that were used as inputs into the analysis model. A 100% right turn reduction was applied to complete the signal warrant. The full warrants report is included in **Appendix E** and the results summarized in **Table 3** below.

Table 3: Summary of Current Conditions Signal Warrant Analysis

Intersection	Warrant 1a	Warrant 1b	Warrant 2	Warrant 3	Warrant 4	Warrant 5	Warrant 6	Warrant 7	Warrant 8	Warrant 9
SR 140 @ Avery Road	No	No	No	No	n/a	n/a	n/a	n/a	n/a	n/a

Based on the warrant analysis conducted combined with good engineering judgement, a signal is not warranted for this intersection.

INTERSECTION CONTROL EVALUATION (ICE)

GDOT's Intersection Control Evaluation (ICE) policies were developed to further leverage safety advancements as part of intersection improvements. The ICE process consists of 2 distinct stages. A Stage 1 evaluation identifies potential Intersection Control Types that may provide safety benefits.

Stage 2 further evaluates those alternatives inclusive of safety, operations, cost, environmental impacts and project support. The Stage 1 screening and Stage 2 ranking results are documented in **Appendix F**. Sketches of each Stage 2 alternative are included in **Appendix G**.

1. **Conventional (Minor Route Stop):** Installing a southbound left turn lane would reduce the total amount of crashes as well as the occurrences of crashes that lead to injuries. In addition, install intersection ahead warning signs on both southbound and northbound approaches.
2. **Single Lane Roundabout:** A single lane roundabout was analyzed using GDOT's Roundabout Analysis Tool spreadsheet with and without a northbound bypass lane. With such low right turn volume bypass lanes were determined not to be needed at this intersection.
3. **Conventional Signalized:** Intersection volumes do not meet signal warrants and thus a signalized intersection is not recommended.

Crash Reduction Factors

The Crash Reduction Factors used in the ICE Stage 2 analysis were determined from the FHWA's CMF Clearinghouse website (<http://www.cmfclearinghouse.org/>) and are provided in **Table 4** below:

Table 4: Crash Reduction Factors

Safety Countermeasure	PDO	Injury/Fatal
Turn Lane Improvements	44%	55%
Single Lane Roundabout	71%	87%

EXPECTED OPERATIONAL RESULTS

For all alternatives considered in the Stage 2 analysis, the intersection delay and LOS was determined with the intersection control improvements made and the results are summarized in **Table 5**. All of the alternatives considered provide equal or improved intersection operating conditions compared to existing conditions.

Table 5: Operational Analysis Results

Approach	Existing Stop Control		Turn Lane Improvements		Single Lane Roundabout	
	AM	PM	AM	PM	AM	PM
WB	28.2 - D	50.3 - F	28.2 - D	50.3 - F	7 - A	10 - A
NB	0.0 - A	0.0 - A	0.0 - A	0.0 - A	8 - A	13 - B
SB	1.8 - A	3.1 - A	0.8 - A	1.0 - A	10 - A	13 - B
Overall	3.1 - B	4.4 - A	2.7 - B	3.5 - A	-	-

BENEFIT-COST ANALYSIS

A summary of the Safety Benefit / Cost of the studied alternatives are presented in **Table 6**. Only the Turn Lane Improvements alternative is shown because this alternative was analyzed to have a higher ICE Stage 2 score than the Roundabout, as shown in **Appendix F**. A summary of the cost estimate development details is included in **Appendix H**.

Table 6: Benefit / Cost Ratio Analysis Results

Safety Countermeasure	Project Cost	B/C Ratio
Turn Lane Improvements	\$288,254	55.75

CONCLUSION

The intersection of SR 140 @ Avery Road experiences more crashes than the HSM methodology predicts, and there has been one intersection fatality. Potential solutions including the installation of a northbound left turn lane, replacing the intersection with a roundabout, and other minor intersection modifications showed a possible reduction in expected crashes.


Recommendations

A list of short, mid-term and long-term safety project recommendations are identified in **Table 7**. The result of the long-term project is expected to reduce the number of overall crashes by 44% a year, and to have a 55 percent reduction of injury/fatal crashes. Intersection ahead signs should be installed because of sight distance issue due to crest hills near the intersection.

Table 7: Intersection Safety Improvement Recommendations

Short Term	Long Term
<ul style="list-style-type: none">• Install additional intersection warning signs	<ul style="list-style-type: none">• Install a southbound left turn lane


RECOMMENDED BY:


Jonathan Reid, PE, PTOE
Consultant Project Manager

DATE

6-1-17

RECOMMENDED BY:


Grant Waldrop, PE
District Traffic Engineer

DATE

6-8-17

Appendix A: Crash Data

Appendix B: intersection Crash Diagram

LOCATION: SR 140 @ Avery Road

CRASH PERIOD: 2013 to 2015

①

Crash Number	Crash Type	Date	Day of Week	Time of Day	Injury or Fatality	Pavement Condition
4359711	Rear End	2/18/2013	Monday	6:53 PM	Injury	Dry
4364037	Rear End	2/22/2013	Friday	4:35 PM	---	Wet
4641174	Rear End	11/14/2013	Thursday	7:25 AM	---	Dry
4597385	Rear End	10/4/2013	Friday	2:11 PM	---	Dry
4897156	Rear End	7/3/2014	Thursday	3:27 PM	---	Dry
5013429	Rear End	10/10/2014	Friday	3:08 AM	Injury	Dry
5034165	Rear End	10/29/2014	Wednesday	5:15 PM	---	Dry
5248595	Rear End	4/10/2015	Friday	7:54 AM	Injury	Wet
5470268	Rear End	10/15/2015	Thursday	9:30 PM	---	Dry
5515496	Rear End	11/18/2015	Wednesday	8:00 AM	---	Wet

②

Crash Number	Crash Type	Date	Day of Week	Time of Day	Injury or Fatality	Pavement Condition
4508363	Rear End	7/19/2013	Friday	5:39 PM	---	Dry
5058049	Rear End	11/20/2014	Thursday	2:20 PM	---	Dry

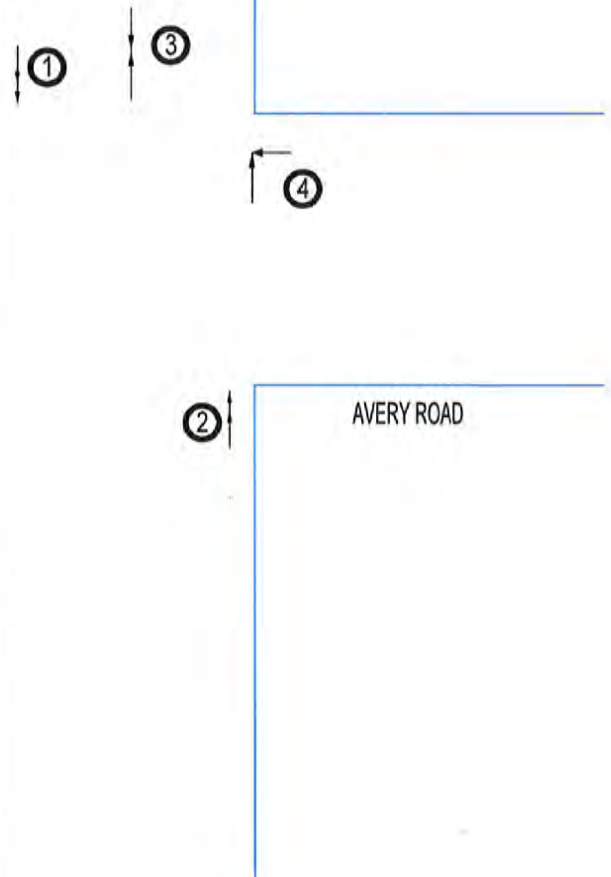
③

Crash Number	Crash Type	Date	Day of Week	Time of Day	Injury or Fatality	Pavement Condition
4424987	Head On	4/22/2013	Monday	11:30 AM	Injury	Dry
5448822	Head On	9/28/2015	Monday	12:16 PM	Fatality	Wet

④

Crash Number	Crash Type	Date	Day of Week	Time of Day	Injury or Fatality	Pavement Condition
5368882	Angle	7/24/2015	Friday	3:52 PM	---	Dry
5412868	Angle	9/2/2015	Wednesday	9:20 PM	Injury	Dry

SR 140



SYMBOLS

- ← Moving Vehicle
- ← → → Backing Vehicle
- ← - - Non-Involved Vehicle
- x - - Pedestrian
- ▬ Parked Vehicle
- Fixed Object

TYPES OF CRASHES

- ← ← Rear End
- → Head On
- ↙ ↘ Side Swipe
- ← ○ ○ Out of Control
- ↗ Angle

Appendix C: Traffic Data

Time	Eastbound					Westbound					Northbound					Southbound					Total
	U-Turn	Left	Thru	Right	RTOR	U-Turn	Left	Thru	Right	RTOR	U-Turn	Left	Thru	Right	RTOR	U-Turn	Left	Thru	Right	RTOR	
Articulated Trucks																					
6:30 AM	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	3
6:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	1	0	0	4
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	2
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	6
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	3
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
8:30 AM	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2
9:00 AM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
9:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
9:30 AM	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	2	0	0	5
9:45 AM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	2
10:00 AM	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
10:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	1	0	0	4
10:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	3
10:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	1	0	0	6

	11:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	2
	11:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	3
	11:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	3
	11:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	3
	12:00 PM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0	0	4
	12:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
	12:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	5
	12:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2
	1:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3
	1:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	4
	1:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2
	2:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
	2:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	3
	2:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	4
	3:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
	3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3
	3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2
	3:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
	4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3
	4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
	4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	2
	5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
	5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
	5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
	6:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
	6:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
	12-Hour Summary	0	0	0	0	0	0	1	0	3	0	0	0	0	52	1	0	0	0	1	56	0	0	114
Lights	6:30 AM	0	0	0	0	0	0	2	0	9	0	0	0	0	80	3	0	0	9	127	0	0	230	
	6:45 AM	0	0	0	0	0	0	3	0	9	0	0	0	0	87	7	0	0	5	164	0	0	275	
	7:00 AM	0	0	0	0	0	0	8	0	12	0	0	0	0	95	6	0	0	15	125	0	0	261	
	7:15 AM	0	0	0	0	0	0	6	0	26	0	0	0	0	111	7	0	0	14	164	0	0	328	
	7:30 AM	0	0	0	0	0	0	7	0	15	0	0	0	0	189	10	0	0	17	174	0	0	412	
	7:45 AM	0	0	0	0	0	0	7	0	33	0	0	0	0	194	10	0	0	12	123	0	0	379	
	8:00 AM	0	0	0	0	0	0	9	0	15	0	0	0	0	135	3	0	0	9	135	0	0	306	
	8:15 AM	0	0	0	0	0	0	5	0	15	0	0	0	0	125	10	0	0	9	122	0	0	286	
	8:30 AM	0	0	0	0	0	0	4	0	20	0	0	0	0	126	8	0	0	11	138	0	0	307	
	8:45 AM	0	0	0	0	0	0	5	0	20	0	0	0	0	127	2	0	0	5	126	0	0	285	
	9:00 AM	0	0	0	0	0	0	6	0	10	0	0	0	0	156	7	0	0	11	125	0	0	315	
	9:15 AM	0	0	0	0	0	0	4	0	14	0	0	0	0	123	2	0	0	6	109	0	0	258	
	9:30 AM	0	0	0	0	0	0	5	0	11	0	0	0	0	116	3	0	0	6	85	0	0	226	
	9:45 AM	0	0	0	0	0	0	1	0	9	0	0	0	0	109	4	0	0	7	115	0	0	245	
	10:00 AM	0	0	0	0	0	0	3	0	8	0	0	0	0	117	6	0	0	5	100	0	0	239	
	10:15 AM	0	0	0	0	0	0	5	0	7	0	0	0	0	130	4	0	0	7	99	0	0	252	
	10:30 AM	0	0	0	0	0	0	4	0	7	0	0	0	0	115	3	0	0	4	124	0	0	257	
	10:45 AM	0	0	0	0	0	0	3	0	8	0	0	0	0	118	5	0	0	3	120	0	0	257	
	11:00 AM	0	0	0	0	0	0	0	0	4	0	0	0	0	108	3	0	0	7	102	0	0	224	
	11:15 AM	0	0	0	0	0	0	2	0	8	0	0	0	0	106	0	0	0	6	101	0	0	223	
	11:30 AM	0	0	0	0	0	0	6	0	7	0	0	0	0	115	0	0	0	4	132	0	0	264	
	11:45 AM	0	0	0	0	0	0	2	0	6	0	0	0	0	127	2	0	0	6	125	0	0	268	
	12:00 PM	0	0	0	0	0	0	7	0	7	0	0	0	0	124	3	0	0	6	137	0	0	284	
	12:15 PM	0	0	0	0	0	0	0	0	2	0	0	0	0	132	3	0	0	3	117	0	0	257	
	12:30 PM	0	0	0	0	0	0	2	0	7	0	0	0	0	129	4	0	0	5	129	0	0	276	
	12:45 PM	0	0	0	0	0	0	4	0	6	0	0	0	0	128	8	0	0	5	129	0	0	280	
	1:00 PM	0	0	0	0	0	0	4	0	6	0	0	0	0	140	3	0	0	5	131	0	0	289	
	1:15 PM	0	0	0	0	0	0	1	0	10	0	0	0	0	125	6	0	0	10	122	0	0	274	
	1:30 PM	0	0	0	0	0	0	3	0	9	0	0	0	0	100	7	0	0	6	159	0	0	284	
	1:45 PM	0	0	0	0	0	0	4	0	15	0	0	0	0	117	2	0	0	3	155	0	0	296	
	2:00 PM	0	0	0	0	0	0	5	0	11	0	0	0	0	139	5	0	0	15	149	0	0	324	
	2:15 PM	0	0	0	0	0	0	1	0	8	0	0	0	0	127	4	0	0	8	164	0	0	312	
	2:30 PM	0	0	0	0	0	0	8	0	6	0	0	0	0	138	4	0	0	6	151	0	0	313	
	2:45 PM	0	0	0	0	0	0	5	0	13	0	0	0	0	140	3	0	0	8	147	0	0	316	
	3:00 PM	0	0	0	0	0	0	2	0	6	0	0	0	0	152	4	0	0	17	128	0	0	309	
	3:15 PM	0	0	0	0	0	0	2	0	10	0	0	0	0	144	8	0	0	10	144	0	0	318	
	3:30 PM	0	0	0	0	0	0	3	0	11	0	0	0	0	181	11	0	0	17	146	0	0	369	
	3:45 PM	0	0	0	0	0	0	7	0	11	0	0	0	0	136	6	0	0	12	175	0	0	347	
	4:00 PM	0	0	0	0	0	0	6	0	9	0	0	0	0	199	8	0	0	10	138	0	0	370	
	4:15 PM	0	0	0	0	0	0	13	0	15	0	0	0	0	185	6	0	0	11	165	0	0	395	
	4:30 PM	0	0	0	0	0	0	5	0	17	0	0	0	0	199	9	0	0	15	160	0	0	405	
	4:45 PM	0	0	0	0	0	0	6	0	23	0	0	0	0	211	13	0	0	19	152	0	0	424	
	5:00 PM	0	0	0	0	0	0	5	0	19	0	0	0	0	215	10	0	0	19	218	0	0	486	
	5:15 PM	0	0	0	0	0	0	2	0	18	0	0	0	0	212	10	0	0	18	192	0	0	452	
	5:30 PM	0	0	0	0	0	0	7	0	29	0	0	0	0	219	7	0	0	22	176	0	0	460	
	5:45 PM	0	0	0	0	0	0	5	0	20	0	0	0	0	191	6	0	0	18	154	0	0	394	
	6:00 PM	0	0	0	0	0	0	5	0	22	0	0	0	0	196	10	0	0	20	146	0	0	399	
	6:15 PM	0	0	0	0	0	0	3	0	21	0	0	0	0	182	6	0	0	12	151				




11:45 AM	0	0	0	0	0	0	0	0	1	0	0	0	2	1	0	0	2	0	0	6
12:00 PM	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	3	0	0	6
12:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	5	0	0	9
12:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	4
12:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	3
1:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	4
1:15 PM	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	6	0	0	9
1:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
1:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	6	0	0	10
2:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	5
2:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	3	0	0	8
2:30 PM	0	0	0	0	0	0	1	0	1	0	0	0	2	1	0	0	6	0	0	11
2:45 PM	0	0	0	0	0	0	1	0	0	0	0	0	3	1	0	0	6	0	0	11
3:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	3	0	0	6
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	2	0	0	6
3:30 PM	0	0	0	0	0	0	0	0	1	0	0	0	4	1	0	0	4	0	0	10
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	6	0	0	8
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	3
4:15 PM	0	0	0	0	0	0	1	0	0	0	0	0	7	1	0	0	3	0	0	12
4:30 PM	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	4	0	0	5
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	3	0	0	5
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
5:30 PM	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2	0	0	4
5:45 PM	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	2	0	0	5
6:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	3
6:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	3	0	6
12-Hour Summary	0	0	0	0	0	0	4	0	11	0	0	0	145	19	0	0	4	160	0	343

Time	Avery Rd				SR 140			SR 140			Total
	Westbound				Northbound			Southbound			
	U-Turn	Left	Thru	Right	U-Turn	Thru	Right	U-Turn	Left	Thru	
7:00AM		28	0	90	0	614	35	0	59	622	1,448
8:00AM		24	0	70	0	540	25	0	34	545	1,238
9:00AM		16	0	44	0	530	16	0	30	448	1,084
10:00AM		15	0	31	0	500	19	0	20	458	1,043
11:00AM		10	0	26	0	470	7	0	23	474	1,010
12:00PM		14	0	23	0	524	18	0	19	534	1,132
1:00PM		12	0	41	0	493	20	0	24	585	1,175
2:00PM		21	0	39	0	561	20	0	38	632	1,311
3:00PM		14	0	39	0	627	32	0	56	613	1,381
4:00PM		31	0	65	0	807	38	0	55	630	1,626
5:00PM		19	0	88	0	841	34	0	77	748	1,807

Appendix D: Traffic Analysis

Intersection

Int Delay, s/veh 2.8

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	28	90	614	35	59	622
Future Vol, veh/h	28	90	614	35	59	622
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	30	98	667	38	64	676




Major/Minor	Minor1	Major1	Major2
Conflicting Flow All	1490	686	0
Stage 1	686	-	-
Stage 2	804	-	-
Critical Hdwy	6.42	6.22	4.12
Critical Hdwy Stg 1	5.42	-	-
Critical Hdwy Stg 2	5.42	-	-
Follow-up Hdwy	3.518	3.318	2.218
Pot Cap-1 Maneuver	136	447	893
Stage 1	500	-	-
Stage 2	440	-	-
Platoon blocked, %			
Mov Cap-1 Maneuver	120	447	893
Mov Cap-2 Maneuver	120	-	-
Stage 1	500	-	-
Stage 2	389	-	-

Approach	WB	NB	SB
HCM Control Delay, s	29.7	0	0.8
HCM LOS	D		

Minor Lane/Major Mvmt	NBT	NBRWBLn1	SBL	SBT
Capacity (veh/h)	-	- 271	893	-
HCM Lane V/C Ratio	-	- 0.473	0.072	-
HCM Control Delay (s)	-	- 29.7	9.3	0
HCM Lane LOS	-	- D	A	A
HCM 95th %tile Q(veh)	-	- 2.4	0.2	-

Intersection

Int Delay, s/veh 3.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	19	88	841	34	77	748
Future Vol, veh/h	19	88	841	34	77	748
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	21	96	914	37	84	813

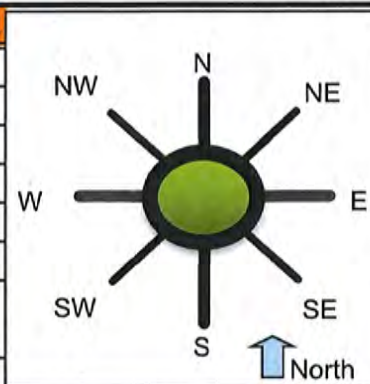
Major/Minor	Minor1	Major1	Major2
Conflicting Flow All	1913	933	0
Stage 1	933	-	-
Stage 2	980	-	-
Critical Hdwy	6.42	6.22	4.12
Critical Hdwy Stg 1	5.42	-	-
Critical Hdwy Stg 2	5.42	-	-
Follow-up Hdwy	3.518	3.318	2.218
Pot Cap-1 Maneuver	75	323	722
Stage 1	383	-	-
Stage 2	364	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	59	323	722
Mov Cap-2 Maneuver	59	-	-
Stage 1	383	-	-
Stage 2	287	-	-

Approach	WB	NB	SB
HCM Control Delay, s	55.6	0	1
HCM LOS	F		

Minor Lane/Major Mvmt	NBT	NBRWBLn1	SBL	SBT
Capacity (veh/h)	-	- 180	722	-
HCM Lane V/C Ratio	-	- 0.646	0.116	-
HCM Control Delay (s)	-	- 55.6	10.6	0
HCM Lane LOS	-	- F	B	A
HCM 95th %tile Q(veh)	-	- 3.7	0.4	-

General & Site Information v 4.1

Analyst: Selma Hasancevic
 Agency/Co: Arcadis
 Date: _____
 Project or PI#: _____
 Year, Peak Hour: _____
 County/District: Cherokee/11
 Intersection: SR 140 at Avery Road
 Name: _____



Volumes Entry Legs (FROM)

	N (1)	NE (2)	E (3)	SE (4)	S (5)	SW (6)	W (7)	NW (8)
--	-------	--------	-------	--------	-------	--------	-------	--------

Exit Legs (TO)	N (1), vph			90		614		
	NE (2), vph							
	E (3), vph	59			35			
	SE (4), vph							
	S (5), vph	622		28				
	SW (6), vph							
	W (7), vph							
	NW (8), vph							
Output	Total Vehicles	681	0	118	0	649	0	0

Volume Characteristics	N	NE	E	SE	S	SW	W	NW
% Cars	98.9%	100.0%	99.1%	100.0%	99.3%	100.0%	100.0%	100.0%
% Heavy Vehicles	1.1%	0.0%	0.9%	0.0%	0.7%	0.0%	0.0%	0.0%
% Bicycle	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
# of Pedestrians (ped/hr)	0	0	0	0	0	0	0	0
PHF	0.86	0.95	0.76	0.95	0.99	0.95	0.95	0.95
F _{HV}	0.989	1.000	0.991	1.000	0.993	1.000	1.000	1.000
F _{ped}	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Entry/Conflicting Flows	N	NE	E	SE	S	SW	W	NW
Flow to Leg # N (1), pcu/h	0	0	119	0	625	0	0	0
NE (2), pcu/h	0	0	0	0	0	0	0	0
E (3), pcu/h	69	0	0	0	36	0	0	0
SE (4), pcu/h	0	0	0	0	0	0	0	0
S (5), pcu/h	731	0	37	0	0	0	0	0
SW (6), pcu/h	0	0	0	0	0	0	0	0
W (7), pcu/h	0	0	0	0	0	0	0	0
NW (8), pcu/h	0	0	0	0	0	0	0	0
Entry flow, pcu/h	801	0	157	0	660	0	0	0
Conflicting flow, pcu/h	37	0	625	0	69	0	0	0

Results: Approach Measures of Effectiveness								
HCM 6th Edition	N	NE	E	SE	S	SW	W	NW
Entry Capacity, vph	1314	NA	723	NA	1277	NA	NA	NA
Entry Flow Rates, vph	792	NA	155	NA	656	NA	NA	NA
V/C ratio	0.60		0.21		0.51			
Control Delay, sec/pcu	10		7		8			
LOS	A		A		A			
95th % Queue (ft)	108		20		77			

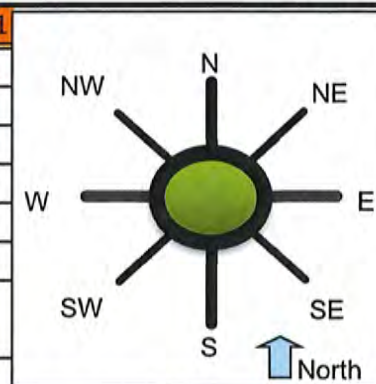
Notes: v 4.0

Unit Legend:
vph = vehicles per hour
PHF = peak hour factor
F_{HV} = heavy vehicle factor
pcu = passenger car unit

Bypass Lane Merge Point Analysis (if applicable)						
Bypass Characteristics	Bypass #1	Bypass #2	Bypass #3	Bypass #4	Bypass #5	Bypass #6
Select Entry Leg from Bypass (FROM)						
Select Exit Leg for Bypass (TO)						
Does the bypass have a dedicated receiving lane?						
Volumes						
Right Turn Volume removed from Entry Leg						
Volume Characteristics (for entry leg)						
PHF						
F _{HV}						
F _{ped}						
NOTE: Volume Characteristics for Exit Leg are already taken into account						
Entry/Conflicting Flows						
Entry Flow, pcu/hr						
Conflicting Flow, pcu/hr						
Bypass Lane Results (HCM 6th Edition)						
Entry Capacity of Bypass, vph						
Flow Rates of Exiting Traffic, vph						
V/C ratio						
Control Delay, s/veh						
LOS						
95th % Queue (ft)						
Approach w/Bypass Delay, s/veh						
Approach w/Bypass LOS						

General & Site Information v 4.1

Analyst: Selma Hasancevic
 Agency/Co: Arcadis
 Date: _____
 Project or PI#: _____
 Year, Peak Hour: _____
 County/District: Cherokee, 11
 Intersection: SR 140 at Avery Rd
 Name: _____



Volumes Entry Legs (FROM)

	N (1)	NE (2)	E (3)	SE (4)	S (5)	SW (6)	W (7)	NW (8)
--	-------	--------	-------	--------	-------	--------	-------	--------

Exit Legs (TO)	N (1), vph			88		841		
	NE (2), vph							
	E (3), vph	77				34		
	SE (4), vph							
	S (5), vph	748		19				
	SW (6), vph							
	W (7), vph							
	NW (8), vph							
Output	Total Vehicles	825	0	107	0	875	0	0

Volume Characteristics	N	NE	E	SE	S	SW	W	NW
% Cars	98.9%	100.0%	99.1%	100.0%	99.3%	100.0%	100.0%	100.0%
% Heavy Vehicles	1.1%	0.0%	0.9%	0.0%	0.7%	0.0%	0.0%	0.0%
% Bicycle	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
# of Pedestrians (ped/hr)	0	0	0	0	0	0	0	0
PHF	0.86	0.95	0.76	0.95	0.99	0.95	0.95	0.95
F _{HV}	0.989	1.000	0.991	1.000	0.993	1.000	1.000	1.000
F _{ped}	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Entry/Conflicting Flows	N	NE	E	SE	S	SW	W	NW
Flow to Leg # N (1), pcu/h	0	0	117	0	855	0	0	0
NE (2), pcu/h	0	0	0	0	0	0	0	0
E (3), pcu/h	91	0	0	0	35	0	0	0
SE (4), pcu/h	0	0	0	0	0	0	0	0
S (5), pcu/h	879	0	25	0	0	0	0	0
SW (6), pcu/h	0	0	0	0	0	0	0	0
W (7), pcu/h	0	0	0	0	0	0	0	0
NW (8), pcu/h	0	0	0	0	0	0	0	0
Entry flow, pcu/h	970	0	142	0	890	0	0	0
Conflicting flow, pcu/h	25	0	855	0	91	0	0	0

Results: Approach Measures of Effectiveness								
HCM 6th Edition	N	NE	E	SE	S	SW	W	NW
Entry Capacity, vph	1330	NA	572	NA	1250	NA	NA	NA
Entry Flow Rates, vph	959	NA	141	NA	884	NA	NA	NA
V/C ratio	0.72		0.25		0.71			
Control Delay, sec/pcu	13		10		13			
LOS	B		A		B			
95th % Queue (ft)	171		24		160			

Notes: v 4.0

Unit Legend:
vph = vehicles per hour
PHF = peak hour factor
F_{HV} = heavy vehicle factor
pcu = passenger car unit

Bypass Lane Merge Point Analysis (if applicable)						
Bypass Characteristics	Bypass #1	Bypass #2	Bypass #3	Bypass #4	Bypass #5	Bypass #6
Select Entry Leg from Bypass (FROM)						
Select Exit Leg for Bypass (TO)						
Does the bypass have a dedicated receiving lane?						
Volumes						
Right Turn Volume removed from Entry Leg						
Volume Characteristics (for entry leg)						
PHF						
F _{HV}						
F _{ped}						
NOTE: Volume Characteristics for Exit Leg are already taken into account						
Entry/Conflicting Flows						
Entry Flow, pcu/hr						
Conflicting Flow, pcu/hr						
Bypass Lane Results (HCM 6th Edition)						
Entry Capacity of Bypass, vph						
Flow Rates of Exiting Traffic, vph						
V/C ratio						
Control Delay, s/veh						
LOS						
95th % Queue (ft)						
Approach w/Bypass Delay, s/veh						
Approach w/Bypass LOS						

Appendix E: Signal Warrant Analysis

Analyst: Arcadis
 Agency: Arcadis
 Date: 2/8/2017
 Project ID: Safetyr
 EW Street: Avery Road

Intersection: SR 140 @ Avery Road
 Jurisdiction: GDOT
 Units: U.S. Customary
 Analysis Year: 2016
 NS Street: SR 140

General Information

Major St. Speed (mph): 50
 Nearest Signal (ft): 800
 Crashes per Yr: 5

Population: Less than 10000
 Coordinated Signal System: N

School Crossing

Students in Highest Hour: 0
 Adequate Gaps in Period: 0
 Minutes in Period: 0

Roadway Network

Two Major Routes: 0
 Weekend Count: 0
 5-yr Growth Factor: 0

Geometry and Traffic

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	0	0	0	0	0	0	1	0	0	1	0
LaneUsage					LR			TR			LT	

Results

Warrant 1: Eight-Hour Vehicular Volume []
 1 A. Minimum Vehicular Volumes []
 1 B. Interruption of Continuous Traffic []
 1 80% Vehicular --and-- Interruption Volumes []

Warrant 2: Four-Hour Vehicular Volume []
 2 A. Four-Hour Vehicular Volumes []

Warrant 3: Peak Hour []
 3 A. Peak-Hour Conditions []
 3 B. Peak-Hour Vehicular Volume Hours Met []

Warrant 4: Pedestrian Volume []
 4 A. Pedestrian Volumes []
 4 B. Gaps Same Period []

Warrant 5: School Crossing []
 5 A. Student Volumes []
 5 B. Gaps Same Period []

Warrant 6: Coordinated Signal System []
 6 Degree of Platooning []

Warrant 7: Crash Experience []
 7 A. Adequate trials of alternatives []

Warrant 8: Roadway Network	[]
8 A. Weekday Volume	[]
8 B. Weekend Volume	[]

	Major	Minor	Total	Delay	1A	1A	1B	1B	2	3A	3B
Hours	Volume	Volume	Volume	(Veh-hr)	70%	56%	70%	56%	70%	70%	70%
07-08	1295	28	1323	0.0	No	No	No	No	No	No	No
08-09	1119	24	1143	0.0	No	No	No	No	No	No	No
09-10	1008	16	1024	0.0	No	No	No	No	No	No	No
10-11	978	15	993	0.0	No	No	No	No	No	No	No
11-12	967	10	977	0.0	No	No	No	No	No	No	No
12-13	1077	14	1091	0.0	No	No	No	No	No	No	No
13-14	1102	12	1114	0.0	No	No	No	No	No	No	No
14-15	1231	21	1252	0.0	No	No	No	No	No	No	No
15-16	1296	14	1310	0.0	No	No	No	No	No	No	No
16-17	1492	31	1523	0.0	No	No	No	No	No	No	No
17-18	1666	19	1685	0.0	No	No	No	No	No	No	No
18-19	0	0	0	0.0	No	No	No	No	No	No	No
Total	13231	204	13435		0	0	0	0	0	0	0

[illegible][illegible][illegible]

[illegible]

Appendix F: Intersection Control Evaluation (ICE)



INTERSECTION CONTROL EVALUATION (ICE) TOOL

Version 1.8
Revised 4/14/2017

GDOT PI # (or N/A): **N/A** County: **Carroll** Requested By: **District Engineer** Date: **4/19/2017**
 Major (State) Route: **SR 140** GDOT District: **6 - Cartersville** Area Type: **Rural**
 Crossing Route: **Avery Road** Prepared By: **Arcadis** Analyst: **T. Galloway**
 Project Purpose: **Improve intersection safety** Project ID: **3006**

Introduction In 2005, SAFETEA-LU established the Highway Safety Improvement Program (HSIP) and mandated that each State prepare a Strategic Highway Safety Plan (SHSP) by which to prioritize safety funding investments. Intersections quickly became a common component of a majority of States' SHSP emphasis areas and HSIP project lists, including in Georgia's SHSP. Intersection Control Evaluation (ICE) policies and procedures represent a traceable and transparent procedure to streamline the evaluation of intersection control alternatives, and to further leverage the safety advancements noted above for intersection improvements beyond just the safety program. As approximately one-third of all traffic fatalities and roughly 75% of all traffic crashes in Georgia occur at or adjacent to intersections, the Georgia SHSP includes an emphasis on enhancing intersection safety in order to advance toward the Toward Zero Deaths vision embraced by the Georgia Governor's Office of Highway Safety. This ICE tool was developed to support the ICE policy and help ensure that intersection investments across the entire Georgia highway system are selected, prioritized and implemented with defensible benefits for safety toward those ends.

Tool Goal The goal of this ICE tool is to provide a simplified and consistent way of using traffic, safety, cost, environmental impact and political support data to assess and quantify intersection control improvement benefits and aid decision making by the Department in a manner that provides traceability, transparency, consistency and accountability when identifying and selecting an intersection control solution that both meets the project purpose and reflects the overall best value in terms of specific performance-based criteria.

Requirements An ICE is **required** for any intersection improvement (e.g., a new intersection, an intersection modification, widening/reconstruction or corridor project, or work accomplished through a driveway or encroachment permit that affects an intersection) where **1)** the intersection includes at least one roadway designated as a State Route (State Highway System) or as part of the National Highway System; and/or **2)** the intersection will be designed or constructed using State or Federal funding. In certain circumstances where an ICE would otherwise be required, the requirement **may** be waived based on appropriate evidence presented with a written request. Please see the "Waiver" tab to understand the criteria that may make a project waiver eligible and learn how to submit a waiver request to the Department. An ICE is **not required** when the proposed work involved does not include any major changes to an intersection that would substantially alter the character of the intersection; for instance, a project limited only to "mill and fill" pavement resurfacing with no change to intersection geometry or control, or routine traffic signal timing (not to include adding a phase) and equipment maintenance.

Two-Stage Process A complete ICE process consists of two (2) distinct stages, and it is expected that the respective level of effort for completing both stages of ICE will correspond to the magnitude and complexity of the intersection. The Stage 1 and Stage 2 ICE forms are designed to keep data inputs at a minimum, requiring limited data entry and drop-down menu fields. All fields shaded in grey have drop down menu choices and all fields shaded in blue require a text response. All other cells in the worksheet are locked to prohibit the entering or editing of data.

Stage 1: Stage 1 is conducted as early in the project development process as possible and is intended to inform which alternatives are worthy of further evaluation in Stage 2. A Stage 1 evaluation normally requires sufficient analysis or subject matter expertise to estimate the preliminary footprint of the intersection to determine whether or not an alternative is practical to implement. Users should use good engineering judgement in responding to seven policy questions by selecting "Yes" or "No" in the drop-down boxes and alternatives should not be summarily eliminating without due consideration. Reasons for eliminating or advancing an alternative should be documented in the rightmost column with heading: "Screening Decision Justification".

Stage 2: Stage 2 involves a more detailed and familiar evaluation of alternatives identified in Stage 1 in order to support the selection of a preferred alternative that may be advanced to detailed design. Based on the Concept Development Process outlined by the PDP Manual, Stage 2 would begin after the Initial Concept Meeting for corridor improvements and projects consisting of multiple intersections. The data entry is similar in process to Stage 1 but is more robust, requiring separate analysis of each alternative to determine cost, impacts, operations, safety and project support. A separate "Instructions" tab is provided to provide guidance to the user on data entry values and parameters. Once all the data is entered, a score and ranking of each alternative is calculated and reported on the bottom line of the worksheet to inform on the best intersection treatment to select as the preferred alternative.

Documentation A complete ICE document consists of the combination of the outputs from both Stage 1 and Stage 2 along with supporting documentation, to be included in the approved project Concept Report (or equivalent) or as a stand-alone document.

GDOT PI #	N/A	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 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, constraints and 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)?							
Major Route:	SR 140								
Minor Route:	Avery Road								
Prepared by:	Arcadis								
Analyst:	T. Galloway								
Date Completed:	4/19/2017								
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. Note: No more than 5 alternatives may selected and evaluated in Stage 2.									
Intersection Alternative:		Screening Decision Justification:							
Unsignalized	Conventional (Minor Stop)	Yes	Yes	No	Yes	Yes	Yes	Yes	Addition of left turn lane
	Conventional (All-Way Stop)	No	Yes	No	No	Yes	No	No	Low side street volume
	Mini Roundabout	No	No	No	No	No	No	No	High speed mainline
	Single Lane Roundabout	Yes	Yes	No	No	Yes	No	Yes	Potential solution to evaluate
	Multilane Roundabout	No	No	No	No	No	No	No	All single lane approaches
	RCUT (unsignalized)	No	No	No	No	No	No	No	Significant impacts to improve from undivided to divided roadway
	RIRO w/downstream U-Turn	No	No	No	No	No	No	No	Significant thru volumes / insufficient ROW on mainline
	Unsignalized High-T	No	No	No	No	No	No	No	Low volume
	Offset-Tee Pair	No	No	No	No	No	No	No	No thru vehicles
	Other Unsignalized (provide description):	No	No	No	No	No	No	No	
Other Unsignalized (provide description):	No	No	No	No	No	No	No		
Signalized Intersections	Traffic Signal	No	No	No	No	No	No	No	N/A - Does not meet signal warrants
	Median U-Turn (Indirect Left)	No	No	No	No	No	No	No	N/A - Does not meet signal warrants
	RCUT (signalized)	No	No	No	No	No	No	No	N/A - Does not meet signal warrants
	Displaced Left Turn (CFI)	No	No	No	No	No	No	No	N/A - Does not meet signal warrants
	Continuous Green-Tee (Hight-T)	No	No	No	No	No	No	No	N/A - Does not meet signal warrants
	Jughandle (Any Corner)	No	No	No	No	No	No	No	N/A - Does not meet signal warrants
	Quadrant Roadway (Any Corner)	No	No	No	No	No	No	No	N/A - Does not meet signal warrants
	Diverging Diamond (Ramp Terminals)	No	No	No	No	No	No	No	N/A - Not an interchange
	Single Point Interch (Ramp Terminals)	No	No	No	No	No	No	No	N/A - Not an interchange
	Other Signalized (provide description):	No	No	No	No	No	No	No	Write in control type / improvements
Other Signalized (provide description):	No	No	No	No	No	No	No	Write in control type / improvements	



GDOT ICE STAGE 2: ALTERNATIVE SELECTION DECISION RECORD

Version 1.8
Revised 4/14/2017

Project Information

GDOT PI # (or N/A) N/A

County: Carroll

Project Location: SR 140 @ Avery Road

GDOT District: 6 - Cartersville

Area Type: Rural

Date: 4/19/2017

Agency/Firm: Arcadis

Analyst: T. Galloway

Existing Intersection Control: Conventional (Minor Stop)

Type of Analysis: Safety Funded Project

Existing Conditions

Intersection meets Signal warrants?

No

Intersection meets AWSC warrants?

No

Traffic Analysis Software

Synchro 9

Existing Pk Hr Intersection Delay*

2.2

Existing Intersection V/C ratio*

0.19

Design Year

2017

Design Year Intersection Delay*

2.2

Design Year V/C Ratio*

0.19

* = worst case AM/PM results

Crash Data:

3 most recent years of
intersection crash data

Crash Severity

	PDO	Injuries	Fatalities
Angle	1	1	0
Head-On	0	1	1
Rear End	9	3	0
Sideswipe - same	0	0	0
Sideswipe - opposite	0	0	0
Not Collision w/Motor Veh	0	0	0
TOTALS:	10	5	1

Crash Type

All
TWC
lane

Alternatives Analysis

Proposed Control Type/Improvement

Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Conventional (Minor Stop)	Single Lane Roundabout	N/A	N/A	N/A

Project Cost

Construction Cost	\$200,966	\$587,770		
ROW Cost	\$11,478	\$22,979		
Environmental Cost	\$0	\$0		
Reimbursable Utility	\$10,048	\$33,731		
PE+Contingency Cost (30%)	\$66,748	\$193,344		
Total Cost	\$289,240	\$837,824		

Traffic Operations

Design Yr Intersection Delay	3.5	12.8		
Design Yr V/C Ratio	0.67	0.68		
Traffic Analysis Software	Synchro 9	GDOT RND Tool 4.0		

Safety Analysis

Predefined CRF: PDO	0%	71%		
Predefined CRF: Fatal/Inj	0%	87%		
User Defined CRF: PDO	44%			
User Defined CRF: Fatal/Inj	55%			
User Defined CRF Source (if applicable):	CMF Clearinghouse #s 4703 / 4704			

Environmental Impacts

Historic District/Property	None	None	None	None
Archaeology Resources	None	None	None	None
Graveyard	None	None	None	None
Stream	None	None	None	None
Underground Tank/Hazmat	None	None	None	None
Park Land	None	None	None	None
Environmental Justice Community	None	None	None	None
Wooded Area	None	None	None	None
Wetland	None	None	None	None

Political Factors

If environmental impact is highlighted **RED**, provide justification impact won't jeopardize project delivery on ENV worksheet tab.

Local Citizen Support	Neutral	Neutral	Neutral	Neutral
Local Government Support	Neutral	Neutral	Neutral	Neutral
GDOT District Office Support	Neutral	Neutral	Neutral	Neutral
GDOT Central Office Support	Neutral	Neutral	Neutral	Neutral

Final ICE Stage 2 Score

7.4

7.3

-

-

-

Rank of Control Type Alternatives:

1

2

-

-

-

Provide any additional general comments or explain analysis inputs (as necessary):

Note: Stage 2 score is not shown (shown as "-") if signal or AWS is selected as control type but signal or AWS warrants are not met

No comments.

Appendix G: Alternative Sketches





Appendix H: Cost Estimates

Planning Level Project Cost Estimation

Project Identification

Description	SR 140 @ Avery Road	Proj. Type	3
From/To Limit		District	
Notes			
SR 140	0.12 miles	total	0.12

Cost Summary Incl. Contingency	
Preliminary Engineering	\$ 65,761
Reimbursable Utility	\$ 10,048
Right-of-Way	\$ 11,478
Construction	\$ 200,966
Total	\$ 288,254

Construction Costs

Average Per Lane-Mile Components	Unit Cost	Miles	Add Lanes	Lane-Miles	Cost
Surface Str. New Cst. base & pave	\$410,000				\$0
SR or High volume Rd widening	\$500,000	0.12	0.75	0.09	\$45,000
Surface Street Overlay	\$64,000	0.12	2.00	0.24	\$15,360
Concrete Widening (Ramps)	\$843,744			0	\$0
Cross Streets widening	\$307,500			0	\$0
Cross Street Overlay	\$20,000				\$0
Traffic Control	\$150,000	0.12	1.00		\$18,000
Typical Driveways	\$75,000				\$0
Typical E & S Control Temp&Perm	\$150,000	0.12	1.00		\$18,000
Typical Earthwork	\$500,000	0.12	1.00		\$60,000
Typical Drainage - Urban Section	\$255,000				\$0
Curb & Gutter both sides (mile)	\$264,000	0.12	1.00		\$18,000
Typical Drainage - Rural Section	\$150,000	0.12	1.50		\$9,000
Signing & Marking	\$50,000				\$0
Typical Clear & Grub-120 ft wide	\$109,091				\$0
Typical Guardrail Type W	\$212,000				\$0
20ft. Raised median +C&G (mile)	\$968,000				\$0
Median landscaping	\$100,000				\$0
Sidewalks 5 ft. ea side (mile)	\$294,000				\$0
ADA Ramps	\$1,500				\$0
Subtotal					\$183,360

Additional Per Mile Components	Unit Cost	Length	factor	Cost
Add'l Major Earthwork (mile)	\$350,000			\$0
Add'l Major Drainage (mile)	\$150,000			\$0
Add'l Major Grade changes (mile)	\$350,000			\$0
Major alignment corrections (mile)	\$750,000			\$0
Maint of Traffic difficulty (mile)	\$200,000			\$0
Temporary Barrier	\$30			\$0
Concrete Island + C&G (SY)	\$60			\$0
Add'l guardrail Type T (mile)	\$423,000			\$0
Paved Shoulders, 4 ft. 2 sides(mile)	\$100,000			\$0
blank	\$0			\$0
blank	\$0			\$0
Bikeway, 4 feet, both side (mile)	\$333,333			\$0
Add'l driveways (mile)	\$75,000			\$0
Cl. B Conc. Base or prvnt widening	\$792,000			\$0
Special E&S control	\$300,000			\$0
Subtotal				\$0

Individual Components	Unit Cost	Length (ft)	Width (ft)	Ht (ft)	Cost
Truck Apron	\$506,880				\$0
Conc Header Crub. TP 7 both sides (r	\$126,720				\$0
Conc Header Crub. TP 9 both sides (r	\$147,840				\$0
Retaining Walls - Gravity 0 - 5' (LF)	\$60				\$0
Retaining Walls-Gravity 5'-max (LF)	\$120				\$0
Retaining Walls-Special Design(SF)	\$60				\$0
Bridges - widen (SF)	\$100				\$0
Bridges - widen (SF)	\$100				\$0
Bridges - replace (SF)	\$120				\$0
Bridges - replace (SF)	\$120				\$0
Bridges - detour (SF)	\$60				\$0
Bridge Removal (SF)	\$25				\$0
Cofferdams (ea)	\$20,000				\$0
Box Culverts (SF)	\$95				\$0
Box Culverts (SF)	\$95				\$0
Large cross drains (LF)	\$80				\$0
Replace cross drains (LF)	\$120				\$0
Sediment/ detention ponds (ea)	\$30,000				\$0
Pavement patching (Sq yd)	\$30				\$0
Bus Stop Relocation	\$50,000				\$0
Traffic Signalization / Upgrade (ea)	\$125,000				\$0
Subtotal					\$0
Total Construction Cost					\$183,360
Percent of Total					70%

Right-of-Way Costs

Area Type	Unit cost/ac	Miles	Width (ft)	Acres	Cost
Urban					
Residential Property	\$800,000	0	0	0.00	\$0
Residential Easement	\$240,000	0	0	0.00	\$0
Commercial Property	\$1,200,000	0	0	0.00	\$0
Commercial Easement	\$360,000	0	0	0.00	\$0
Suburban/Rural					
Residential Property	\$30,000	0.07	15	0.13	\$3,818
Residential Easement	\$15,000	0.1	15	0.18	\$2,727
Commercial Property	\$800,000	0	0	0.00	\$0
Commercial Easement	\$240,000	0	0	0.00	\$0

Displacements	Number	factor	ROW multiplier	Cost
Residential	0	1.00		\$0
Commercial	0	0		\$0
Damages	0	1.00		\$0
Total Right-of-Way Cost			1.6	\$10,473
			4%	

Reimbursable Utility Costs

5%	Total Reimbursable Utility Cost \$	9,168
3.49%		

Preliminary Engineering Costs

20%	Total Preliminary Engineering Cost	\$60,000
22.81%		

Contingency Costs

10%	Total Contingency Cost	\$25,253
	Total (PE+Util.+ROW+CST)	\$263,001
	Grand Total	\$288,254

Safety Benefits

Recommendation	Ek	R	r	Rp	rp
Left turn lane	0.135	0.55	0.45	0.44	0.56

Description	Symbol	Value
Reduction Factor (F, I)	R	0.55
Reduction Factor (PDO)	Rp	0.44
Capital Recovery Factor	Ek	0.135
Initial Improvement Cost	Ci	\$ 288,254

Accident Data	Symbol	Value
PDO	P	3.3
Fatalities	F	0.3
Injuries	I	3.0

Weighted cost of fatal and injury collisions

$$Q = \$ 1,769,877$$

$$\text{Annual Benefit: } \$ 3,284,381$$

$$\text{Annual Cost: } \$ 58,914$$

$$\text{Annual B/C Ratio: } 55.75$$

Design Life Benefit

$$B = \$ 15,662,167$$

Design Life Cost

$$C = \$ 280,943$$

Design Life Benefit/Cost Ratio

$$B/C = 55.75$$