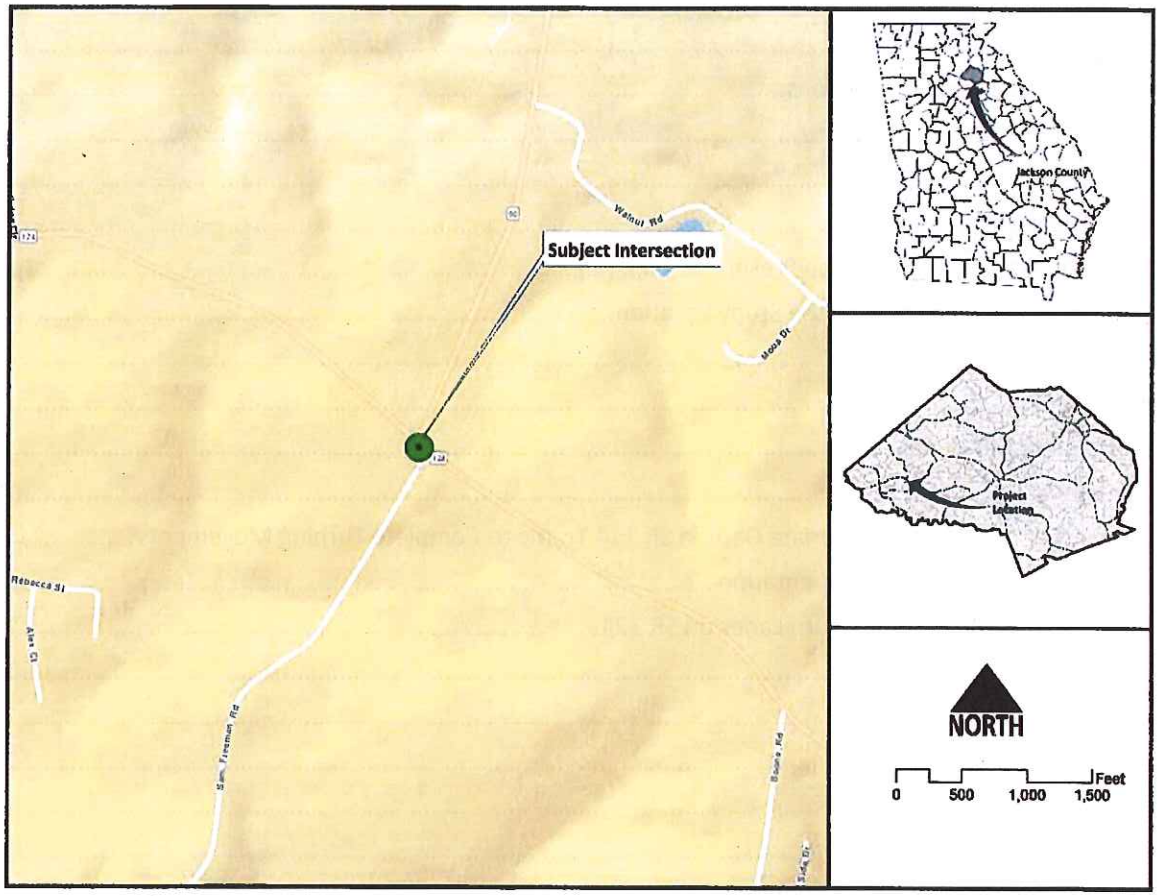
Traffic Engineering Study

State Route 124 at State Route 60/Sam Freeman Road
Jackson County, Georgia



Requested by: Georgia Department of Transportation, District 1

Date Prepared: June 8, 2018

Prepared by: ATKINS
Member of the SNC-Lavalin Group

GEORGIA REGISTERED No. PE042725 PROFESSIONAL ENGINEER TRAVIS L. BREWER

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Highway safety improvement projects are intended to increase safety performance by minimizing or eliminating risk to roadway users. Identification of locations within a highway system that present potential higher risk to roadway users is a critical component of achieving the Georgia Department of Transportation's (GDOT) ultimate goal of zero fatalities and injuries on Georgia's roadways. The unsignalized intersection located at State Route (SR) 60 and SR 124 represents one such opportunity, particularly due to the relatively high speeds and unusual layout. In order to improve safety, mobility, and non-motorized road user connectivity, GDOT commissioned Atkins to complete this traffic engineering study.

Project Location

The identified intersection is located in western Jackson County (**Figure 1**), where SR 60 intersects SR 124, just east of the town of Braselton, Georgia.

Reason for Investigation

This intersection is being investigated due its unusual intersection layout and crash history.

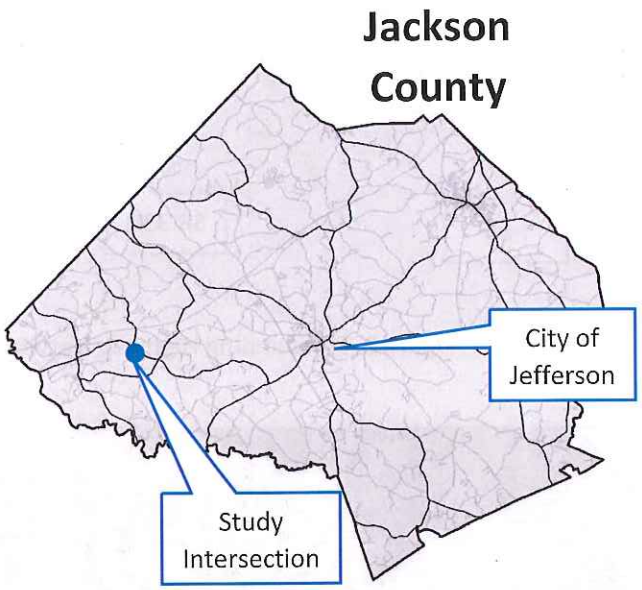


Figure 1. Study Location in Jackson County, GA

LOCATION DESCRIPTION

The study location is essentially two minor stop-controlled T-intersections almost 100 feet away from each other. The majority of the T-intersection is to the northwest where SR 60 intersects SR 124. The smaller portion of the T-intersection is to the southeast where Sam Freeman Road intersects SR 124. SR 124 can be used to travel west towards I-85 or east towards the City of Jefferson. SR 60 can be used to travel north towards the City of Gainesville. Sam Freeman Road gives access to some of the rural residences, but can also be used for travel between SR 124 and SR 332 to the south. Every roadway of the study intersection is two way and has two lanes. SR 60 has the only exclusive turn lane as a right-turn only lane. **Figure 2** shows a map of the surrounding traffic system adjacent to the SR 60 and SR 124 intersection and **Figure 3** shows the satellite imagery.

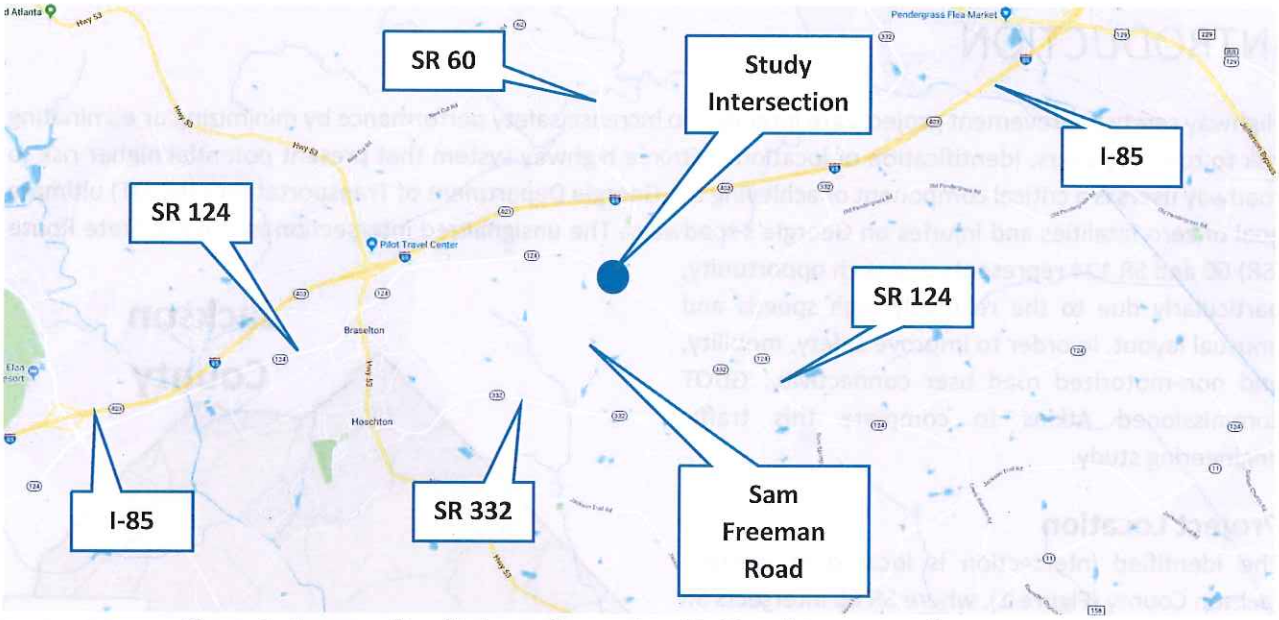


Figure 2. Surrounding Highway Network – SR 60 and SR 124 Study Intersection

Figure 3. Satellite Imagery – SR 60 at SR 124 Study Intersection

EXISTING CONDITIONS/FIELD VISIT

Atkins collected a variety of traffic engineering data specific to the project location, including historical traffic and crash data and current traffic counts as well as geometric and other roadway characteristics. Atkins also conducted a site visit on April 5th, 2018, to collect site condition data and observe the project corridor in operation.

Historical and Current Traffic Volumes

Annual average daily traffic (AADT) counts from the online GDOT database were collected specific to SR 60 and SR 124 from 2012 and 2016. The closest count station along SR 124 is located approximately 0.88 miles west, just west of McEver Lane, where the observed AADT for 2016 was 10,400. The closest count station along SR 60 is located approximately 2.27 miles north, just north of Brooks Road, where the estimated AADT for 2016 was 3,020. It should be noted, as the count station on SR 60 is so far away, traffic from other sources are likely to enter the roadway as well as leave the roadway creating a variance from what the count would be if observed from closer to the subject intersection. It should also be noted that because of Sam Freeman Road's nature to only serve local traffic and its limited length, there are no count stations along it that can provide historical data. **Table 1** summarized these counts.

Table 1. Historical AADT Volumes Adjacent to SR 124 at SR 60 Study Intersection, GDOT Online Database

Year	SR 124 (ST# 1570266)		SR 124 (ST# 1570268)		SR 60 (ST# 1570298)	
	AADT	Percent Trucks	AADT	Percent Trucks	AADT	Percent Trucks
2012	8,210	-	8,730	3.71	2,690	6.35
2013	8,390	-	9,590	3.71	2,680	6.35
2014	9,810	-	9,590	3.71	2,810	6.34
2015	10,200	-	9,740	3.71	2,920	6.35
2016	10,400	-	9,970	3.71	3,020	5.36
Average	9,402	-	9,524	3.71	2,824	6.15

Historical traffic volumes along SR 124 adjacent to the study intersection have steadily increased over the last five years. On average, SR 124 served approximately 9,402 vehicles per day (vpd), while SR 60 served 2,824 vpd during the five-year study period. Truck volumes represent approximately six percent of all traffic along SR 60. Because the station along SR 124 did not have truck volumes recorded, a second station along SR 124, 0.9 miles to the east (just east of Olde Wick Trail), was identified. The truck volumes along SR 124 at this station were estimated at approximately four percent. To perform subsequent operation analyses, Atkins also performed 12-hour turning movement counts and 24-hour classification counts at the study location in April 2017. **Table 2** provides a summary of the morning (AM) and evening (PM) peak hour periods as well as the total 24-hour count. Full details can be found **Appendix E**.

Table 2. Total Entering Volumes at SR 124 and SR 60 Intersection – April 2017

Time Period	Major Route (SR 124)			Minor Route (SR 60)/Sam Freeman Road			Entering Intersection Total
	EB	WB	Total	NB	SB	Total	
AM Peak Hour (7:00 to 8:00)	397	848	1,245	14	195	209	1,454
PM Peak Hour (5:00 to 6:00)	741	460	1,201	12	279	291	1,492
Average Daily	**6,420**	**6,855**	**13,275**	**169**	**2,369**	**2,538**	**15,813**

The AM peak hour occurs between 7:00 and 8:00 a.m. with a total approach volume of 1,454 vehicles per hour. The PM peak hour occurred between 5:00 and 6:00 p.m. with a total approach volume of 1,492 vehicles per hour. Overall, the SR 60 and SR 124 intersection served 15,813 daily vehicles during the 24-hour classification count, roughly 18 percent greater than the combined 2016 AADT values obtained from one SR 124 count station and the SR 60 count station. This disparity between the volumes can be attributed to the various neighborhoods and other side streets that would add vehicular traffic. The approach with the greatest volume of traffic was the westbound approach on SR 124 with 6,855 vehicles across the day. **Figure 4** summarizes the 24-hour classification count by time of day for each approach of the study intersection.

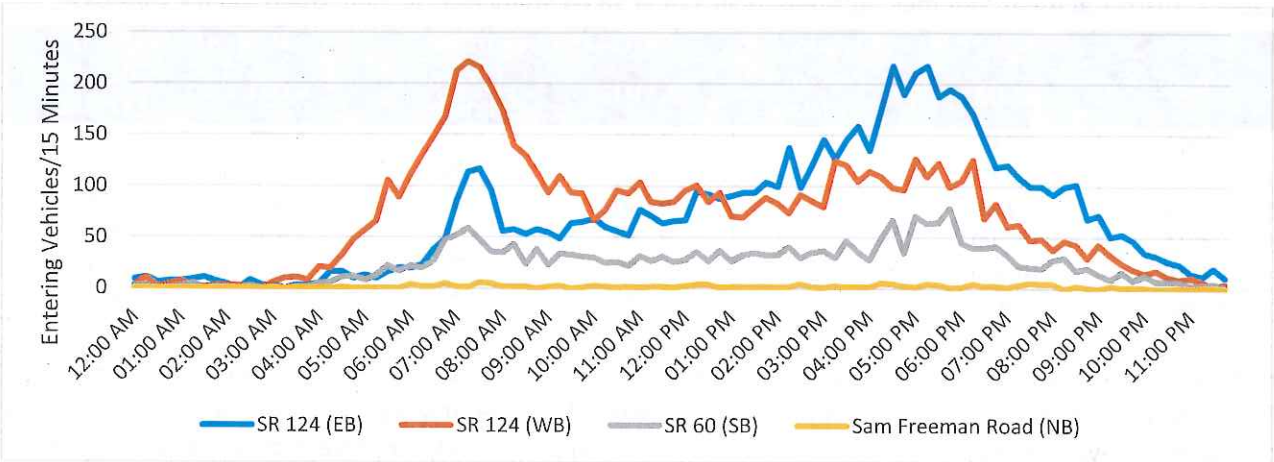


Figure 4. Entering Approach Volumes by Time of Day from 24-Hour Classification Count (April 2017)

SR 124 and SR 60 both exhibit typical AM and PM peak periods, with heavier volume flow westbound in the morning towards the nearest I-85 interchange. Similarly, in the evening the heaviest volume of traffic is eastbound away from the same I-85 interchange. The study intersection then observes a decrease in traffic to near minimal volumes overnight.

Atkins performed traffic volume forecasts for the study intersection to reflect future projected growth. An expected annual growth rate was developed based upon historical data obtained from the GDOT traffic count locations and population growth estimates for Jackson County. Actual traffic counts collected by GDOT were given preference over the estimated traffic counts provided in the GDOT traffic count database to calculate an average annual historic growth rate. **Table 3** provides annual growth rates from each source; the average is used for estimating the future year traffic growth. While the Jackson County population shows a rate of increase of 1.9 percent, the historical counts show an increase of 4.2 percent.

Table 3. Estimated Annual Growth in Traffic Volume

GDOT Historical Counts	Jackson County Population	Average
4.2%	1.9%	3.1%

Existing Traffic Control

The two three-leg intersections currently are minor stop controlled only. Through both intersections, SR 124 is given free flow movement from both the eastbound and westbound approaches. SR 60 on the southbound approach is stop controlled apart from its right-turn only lane, which is controlled by a yield sign. Sam Freeman Road with the northbound approach is then stop controlled only.

Adjacent Signalized Intersections

The nearest adjacent signalized intersection is approximately 1.33 miles away at the intersection of SR 124 and SR 332. It should be noted that one of these roadways is the same involved with the study intersection and the other can be accessed from SR 124 via Sam Freeman Road. None of the signalized intersections in relative proximity to the study intersection are close enough to have any functional impact on the study intersection.

Vehicular Speeds

The posted speed on SR 124 is 55 miles per hour (MPH), both east and west of the study intersection. SR 60 is posted at 55 MPH. Sam Freeman Road has a posted speed limit of 45 MPH.

Sight Distance

Intersection sight distance along SR 124 was measured to be greater than 1,000 feet for both left and right turning movements on each minor stop approach (SR 60 and Sam Freeman Road). This meets the necessary requirements for intersection sight distance outlined in the American Association of State Highway and Transportation Officials Policy of Geometric Design of Highways and Streets.

Pedestrian Movements

The study intersection and adjacent unsignalized intersections do not currently have pedestrian facilities. During the field visit, there were no pedestrians or bicyclists spotted within the area of the subject intersection. It should also be noted that due to the rural nature of the area around the subject intersection, pedestrian generators are also rare.

Other Modes of Transportation Present

GDOT vehicle classification count data indicates that trucks account for approximately 3.7 percent of the total vehicular traffic along SR 124 and for approximately 6.2 percent of the total traffic along SR 60.

Planned Projects Adjacent to the Study Location

The following projects were extracted from GeoPi and are in the adjacent study location:

- PI 0007663 – SR 124 from CR 171/Josh Pirkle Road to SR 11/US129 – Proposed in 2051.

Parking

There is no on-street parking along any of the roadways involved within the study location and within the immediate area of the study intersection there are no parking lots or similar parking locations.

CRASH HISTORY

Atkins collected historical traffic crash data from the most recent five-year period (2013-2017) from the Georgia Electronic Accident Reporting System to perform a comprehensive safety analysis of the study intersection. **Table 4** provides a summary of the historical traffic crash data, including fatal, injury, and property damage only (PDO) crashes, specific to the SR 124 and SR 60 intersection. Entering traffic volumes were estimated based upon traffic counts collected by Atkins, and historical crash rates are provided in crashes per one million entering vehicles.

Table 4. Summary of Traffic Crash Data at SR 60 at SR 124 (2013-2017)

Entering Traffic Volume			Traffic Crashes				Traffic Crash Rates*			
Major	Minor	Total	Fatal	Injury	PDO	Total	Fatal	Injury	PDO	Total
13,669	2,538	16,207	0	9	31	40	0.00	0.30	1.05	1.35

**Traffic crashes per one million entering vehicles*

In total, 40 crashes occurred at the study intersection during the five-year study period, including nine injury crashes resulting in one severe injury. There were no fatal crashes or non-motorized collisions during the five-year study period. **Figure 5** shows the locations for each of these crashes.

Figure 5. Location of Traffic Crashes, SR 124 at SR 60

The higher value for the crash rates (0.30 for injury crashes and 1.35 for total crashes) can be attributed primarily to the large number of rear ends and single vehicle crashes, which each made up 35 percent of the total crashes. The higher percentage of rear ends can be attributed to how the SR 124 mainline is lacking any turning lanes. However, the higher percentage of single vehicle crashes is unusual. When exploring the crash data, multiple reasons were found as the underlying cause for these single vehicle crashes; among them, speed seemed to be the most common factor. A collision diagram for the subject intersection is provided in **Appendix C** of this report.

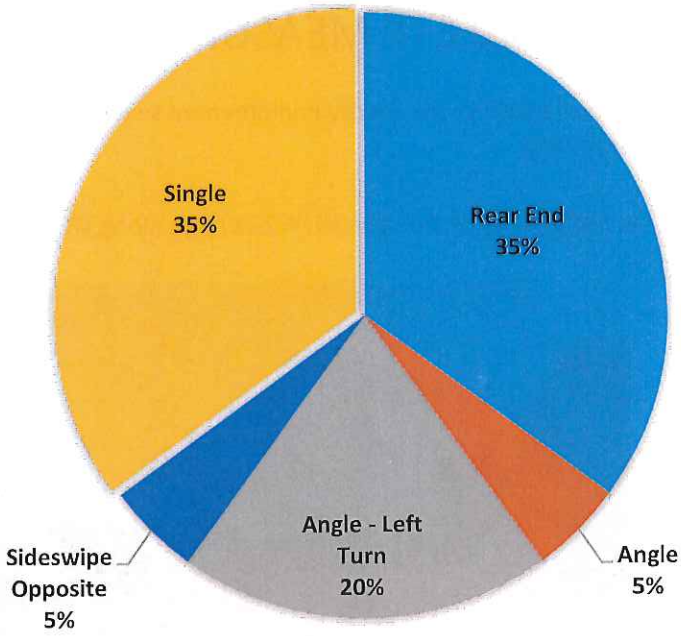


Figure 6. Distribution of Crash Types

EXISTING SAFETY MEASURES

GDOT and local agencies previously implemented several measures to improve safety performance at this location, including:

- An offset intersection ahead (W2-7L) sign along SR 124 for the eastbound approach (**Figure 7**).

Figure 7. Eastbound SR 124 approaching SR 60

- Stop-sign ahead warning signs (W3-1a) along the southbound approach on SR 60 (**Figure 8)** as well as the northbound approach on Sam Freeman Road.

Figure 8. Southbound SR 60 approaching SR 124

SAFETY ISSUES

To develop appropriate engineering countermeasures and recommendations for safety improvements, Atkins identified specific safety issues present at this location based upon the analysis of historical crash data and a site visit. Background related to the typical safety risk matrix is provided in **Appendix A.**

Safety Issue 1: Lack of Appropriate Gaps in SR 124 Traffic to Complete Turning Movements

SR 124 carries significantly greater volumes of traffic per day (13,275) than the minor approaches from SR 60 and Sam Freeman Road (2,538). Because of this, the volumes and flow of traffic may not produce the appropriate gaps for vehicles from the minor approaches to turn out or merge into. This can lead to delays, which may lead to drivers attempting to make turns without the appropriate gap in traffic. **Figure 9** shows that when evaluating the crashes that occurred at the subject intersection by time of day, there is a large peak around the PM peak time of travel. As was previously noted as well, in this PM peak time, the majority of vehicles on SR 124 are traveling eastbound, away from the nearest I-85 interchange. This would put these vehicles in the same lane that SR 60 turns left into.

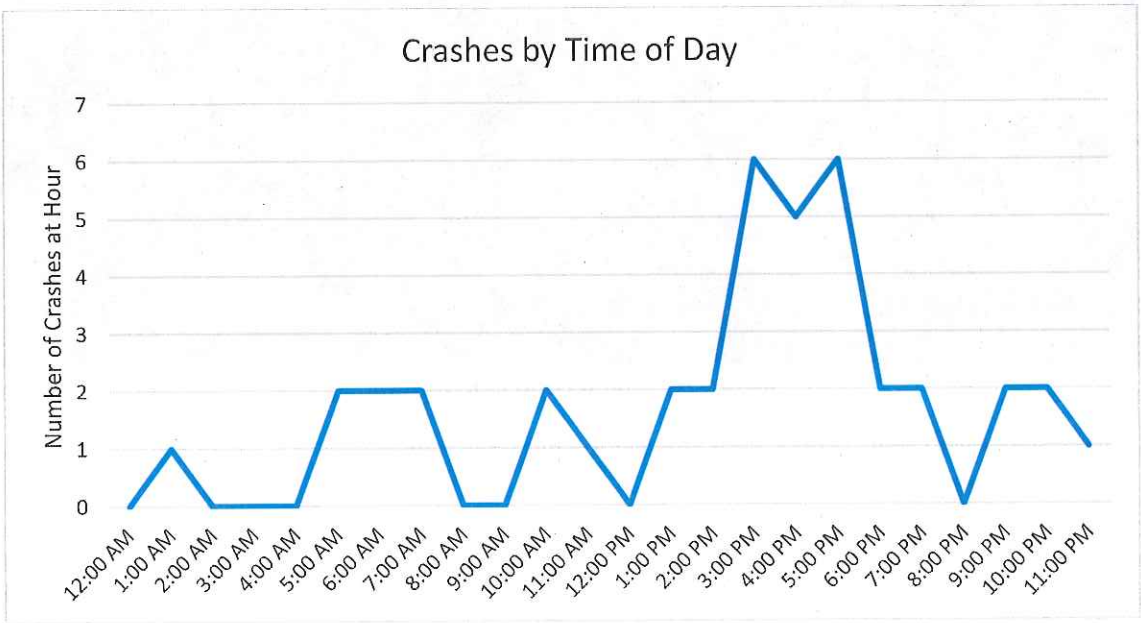


Figure 9. Crashes by Time of Day Chart

Expected Crash Types: Angle, Rear Ends
Expected Frequency: Occasional
Expected Severity: High
Risk: D

Safety Issue 2: Intersection Orientation

While it has been stated that the SR 60 and Sam Freeman Road intersections with SR 124 are their own T-intersections, they are close enough to act as one intersection. This means that vehicles from the SR 60 and Sam Freeman Road intersections provide conflict points with one another that do not occur with standard offset T-pair intersections. For these minor approaches this will raise additional questions by drivers over right-of-way, which can also lead to creating movements that other drivers did not expect.

Figure 10. Intersection Orientation

Expected Crash Types: Angle, Rear End, Sideswipe, Single Vehicle
Expected Frequency: Infrequent
Expected Severity: Moderate
Risk: B

Safety Issue 3: No Exclusive Turn Lanes on SR 124

Within the subject intersection 50 percent (7 of the 14) of the rear-end crashes that occurred were on SR 124 and related to vehicles slowing down or stopping to make a turn onto SR 60 or Sam Freeman Road. These rear ends could have otherwise been avoided had the vehicles making the turning movement been provided their own exclusive turning lanes outside of the through lanes on SR 124.

Figure 12. Vehicle Turning Left on SR 124

Expected Crash Types: Rear Ends
Expected Frequency: Occasional
Expected Severity: Moderate
Risk: C

OPERATIONAL ANALYSIS

Capacity Analysis

Appendix B provides the background for a planning level capacity analysis procedure. The acceptable AADT for a two-lane road using this methodology is 13,300. Observed AADT counts on SR 124 were 12,619 vpd west of the SR 60 intersection and 13,669 vpd was of the same roadway. Given that the latter of these values exceeds the stated threshold for two-lane roadways, SR 124 is currently operating over capacity adjacent to the study intersection. Observed AADT at SR 60 was 4,840 vpd, while Sam Freeman Road served 370 vpd; therefore, SR 60 and Sam Freeman Road are operating under capacity.

Delay

Atkins conducted a capacity analysis for the subject intersection using the traffic operations software, Synchro, version 9 and the 2010 Highway Capacity Manual (HCM).

The analysis for the subject intersection assumes that a level of service (LOS) D or better will be considered adequate (or acceptable). LOS worse than D would indicate that an intersection or approach is nearing unacceptable levels of operation and would be unable to accommodate substantial increases in traffic without significant increases in congestion and delay. The subject intersection was analyzed as a minor-street, stop-controlled intersection. **Table 5** summarizes results from the Synchro model.

Table 5. SR 124 at SR 60 – No-Build Intersection LOS Summary (HCS: TWSC)

Analysis Year	Peak Period	Delay (LOS)								Max V/C Ratio
		EB		WB		NB		SB		
2017	AM	1.8	(A)	0	(A)	35.7	(E)	80.9	(F)	0.962
	PM	0.9	(A)	0	(A)	38.7	(E)	270.7	(F)	1.620
2021	AM	1.9	(A)	0	(A)	49.3	(E)	203.8	(F)	1.555
	PM	0.9	(A)	0	(A)	56.4	(F)	>300	(F)	2.702
2041	AM	5	(A)	0	(A)	>300	(F)	>300	(F)	2.07
	PM	1.1	(A)	0	(A)	>300	(F)	>300	(F)	N/A

The southbound approach on SR 60 experiences the greatest delays, currently over eighty seconds/vehicle in the AM peak hour. This is well above the LOS F threshold with delays only getting worse in the PM peak hour and future year projections. The intersection is currently operating above capacity for a minor stop controlled intersection.

Traffic Signal Warrant Analysis

The Federal Highway Administration's (FHWA) Manual on Uniform Traffic Control Devices (MUTCD), 2009 Edition, chapter on traffic signal warrants states that the analysis of a signal warrant should include factors in the warrant that are applicable to the existing study location operation and safety. Traffic signal warrants 1 and 2 were evaluated with available traffic data. Warrant 3 was not considered as an applicable signal warrant as the MUTCD indicates that this warrant should only be applied in unusual circumstances where a large volume of traffic is discharged over a short period of time. Warrant 7 was also not considered since a trial of alternatives has not already been tested. Furthermore, the subject intersection was analyzed using one lane for the major street approaches and one lane for the minor approach.

Traffic data for this evaluation reflect a typical weekday of traffic volumes for a 24-hour period during the 2021 build year. A compounding annual growth rate of +3.1 percent was applied to the 12-hour turning movement counts collected on April 18th, 2017. From this evaluation, the study intersection meets Warrants 1 and 2 criteria as summarized in **Table 6**.

Table 6. Warrant 1 and 2 Evaluation Summary – (100% Right Turn Reduction)

Hour	Major Road Combined Volume	Minor Road Maximum Volume	Hour Meets Warrant Criteria?		
			1A (100%)	1B (100%)	2 (100%)
7:00 AM – 8:00 AM	1,369	110	○	●	●
8:00 AM – 9:00 AM	830	75	○	●	○
9:00 AM – 10:00 AM	648	69	○	○	○
10:00 AM – 11:00 AM	605	69	○	○	○
11:00 AM – 12:00 PM	675	73	○	○	○
12:00 PM – 1:00 PM	759	87	○	●	●
1:00 PM – 2:00 PM	722	88	○	○	●
2:00 PM – 3:00 PM	867	102	○	●	●
3:00 PM – 4:00 PM	1,094	107	○	●	●
4:00 PM – 5:00 PM	1,210	140	○	●	●
5:00 PM – 6:00 PM	1,310	204	●	●	●
6:00 PM – 7:00 PM	1,069	124	○	●	●
Warrant Satisfied?			**YES**		**YES**

The resulting traffic signal warrant analyses reveal that the intersection along SR 124 at SR 60 satisfies Warrant 1B in the 8-hour analysis and Warrant 2 in the 4-hour analysis. Since Warrant 1B is met, the signal is considered to be a viable countermeasure and will be carried forward for further analysis.

Roundabout Evaluation

Atkins also evaluated the feasibility of a roundabout at this location based upon the traffic count data collected as part of this study. Atkins performed analysis procedures for the roundabout using GDOT's Roundabout Analysis Tool (version 4.1). **Appendix G** provides the full details on the operational analyses. **Table 7** provides a summary of the operational analysis results. First, the roundabout was evaluated for the build year of 2021 and design year 2041 traffic assuming a single lane roundabout. Additional analyses were performed to then evaluate the intersection with a multilane roundabout.

Table 7. Roundabout Intersection LOS Summary – Single Lane

Approach	Measure of Effectiveness	Period Analyzed			
		AM		PM	
2021 Build Year (Single Lane)		GDOT	SIDRA	GDOT	SIDRA
SR 124 (Eastbound)	V/C Ratio	0.51	0.54	0.90	0.49
	Approach Delay (sec/veh)	**9**	**10**	**29**	**9.6**
	Avg. Queue Length (lane feet)	77	54	347	42
	LOS	**A**	**B**	**D**	**A**
SR 124 (Westbound)	V/C Ratio	0.89	0.93	0.52	0.53
	Approach Delay (sec/veh)	**26**	**31.7**	**9**	**9.5**
	Avg. Queue Length (lane feet)	343	269	80	51
	LOS	**D**	**D**	**A**	**A**
SR 60 (Southbound)	V/C Ratio	0.49	0.61	0.38	0.39
	Approach Delay (sec/veh)	**15**	**22.9**	**9**	**9.5**
	Avg. Queue Length (lane feet)	72	62	48	28
	LOS	**B**	**C**	**A**	**A**
Sam Freeman Road (Northbound)	V/C Ratio	0.04	0.04	0.06	0.03
	Approach Delay (sec/veh)	**6**	**6.1**	**10**	**5.8**
	Avg. Queue Length (lane feet)	3	2	4	2
	LOS	**A**	**A**	**A**	**A**
	Intersection Total:	**C**	**C**	**C**	**A**
Approach	**Measure of Effectiveness**	**Period Analyzed**			
		AM		**PM**	
2041 Design Year (Single Lane)		**GDOT**	**SIDRA**	**GDOT**	**SIDRA**
SR 124 (Eastbound)	V/C Ratio	1.03	0.95	1.96	1.77
	Approach Delay (sec/veh)	**57**	**37.7**	**448**	**364.4**
	Avg. Queue Length (lane feet)	571	300	2858	2453
	LOS	**F**	**E**	**F**	**F**
SR 124 (Westbound)	V/C Ratio	1.77	1.62	1.04	0.86
	Approach Delay (sec/veh)	**363**	**295.9**	**58**	**22.6**
	Avg. Queue Length (lane feet)	2809	2477	594	172
	LOS	**F**	**F**	**F**	**C**
SR 60 (Southbound)	V/C Ratio	1.73	0.98	1.01	0.95
	Approach Delay (sec/veh)	**371**	**67.5**	**67**	**55.9**
	Avg. Queue Length (lane feet)	860	228	392	215
	LOS	**F**	**F**	**F**	**F**
Sam Freeman Road (Northbound)	V/C Ratio	0.12	0.14	0.27	0.13
	Approach Delay (sec/veh)	**12**	**14.8**	**33**	**14.6**
	Avg. Queue Length (lane feet)	10	10	25	10
	LOS	**B**	**B**	**D**	**B**
	Intersection Total:	**F**	**F**	**F**	**F**

Under the GDOT tool, the single lane roundabout should operate at a LOS C or better when evaluated for the build year of 2021. However, when analyzing the design year of 2041, the single lane roundabout will operate at a LOS F at worst. When evaluated, it was found that by the year 2022 at earliest, the single lane roundabout would have an approach with a LOS F. For this reason, a multilane roundabout was also evaluated. As shown in **Table 8**, the multilane roundabout still functions as a LOS F at worse but with all approaches overall performing better.

Table 8. Roundabout Intersection LOS Summary – 2041 Multilane

Approach	Measure of Effectiveness	Period Analyzed			
		AM		PM	
2041 Design Year (Two-Lanes)		GDOT	SIDRA	GDOT	SIDRA
SR 124 (Eastbound)	V/C Ratio	0.49	0.44	0.91	0.84
	Approach Delay (sec/veh)	**8.9**	**8.1**	**32.4**	**24.9**
	Avg. Queue Length (lane feet)	71	34	345	144
	LOS	**A**	**A**	**D**	**C**
SR 124 (Westbound)	V/C Ratio	0.84	0.77	0.49	0.45
	Approach Delay (sec/veh)	**21.6**	**17.0**	**8.8**	**8.3**
	Avg. Queue Length (lane feet)	276	103	73	35
	LOS	**C**	**C**	**A**	**A**
SR 60 (Southbound)	V/C Ratio	1.31	1.23	0.85	0.82
	Approach Delay (sec/veh)	**185.4**	**157.8**	**32.7**	**31.0**
	Avg. Queue Length (lane feet)	613	400	255	92
	LOS	**F**	**F**	**D**	**D**
Sam Freeman Road (Northbound)	V/C Ratio	0.09	0.07	0.18	0.15
	Approach Delay (sec/veh)	**9.1**	**7.6**	**19.9**	**16.9**
	Avg. Queue Length (lane feet)	8	3	16	7
	LOS	**A**	**A**	**C**	**C**
Intersection Total:		**C**	**D**	**C**	**C**

ALTERNATIVE AND COUNTERMEASURE EVALUATION

Given the traffic safety data outlined in the preceding sections, Atkins identified several potential design alternatives and countermeasures to improve both safety and operations at the study location. These potential design alternatives and countermeasures were evaluated for further implementation.

Intersection Control Evaluation

Atkins performed a formal intersection control evaluation (ICE), which is included in **Appendix M.** The alternatives evaluated within ICE correspond to the selected safety alternatives and recommendations that were analyzed as a part of this study. Converting the intersection to a multilane roundabout ranked first, while the installation of a signal ranked second and conversion to a single lane roundabout ranked third.

Potential Safety Alternatives and Countermeasures

Table 9 summarizes the alternatives and countermeasures selected for further consideration as well as a crash modification factor (CMF) identified from the Highway Safety Manual (HSM), FHWA CMF Clearinghouse, or the GDOT ICE form. While many safety countermeasures are suggested, only those treatments with known safety performance impacts are analyzed.

Table 9. Suggested Safety Countermeasures and CMFs for SR 124 at SR 60

	Countermeasure	CMF (FI Crashes)	CMF (PDO Crashes)	Safety Issue Addressed	CMF Source
1	Install an exclusive left-turn lane on the SR 124 EB approach.	0.650	0.720	3	CMF ID: 260 & 264

2	Install an exclusive right-turn lane on the SR 124 WB approach.	0.770	0.860	3	CMF ID: 285 & 287
3	Convert the existing intersection to a modern single-lane roundabout.	0.130	0.290	1,2,3	CMF ID: 229 & 230
4	Convert the existing intersection to a modern multilane roundabout.	0.367	0.367	1,2,3	CMF ID: 4927
5	Install a traffic signal with right-turn overlap.	0.601	0.560	1,2,3	CMF ID: 325 & 7984

The installation of left-turn and right-turn lanes can help reduce the number of rear ends occurring on SR 124. This will provide these turning movements with their own independent lane away from the through lanes on SR 124 and can also help to clarify to other drivers the intended movement of these vehicles for driver awareness.

While countermeasures 1 through 3 represent low- to intermediate-cost treatments to improve safety performance at the study location, more substantial countermeasures were considered to reduce the excess annual crashes observed at this location. The conversion of the intersection to a modern single-lane roundabout will help to provide gaps for the minor approaches to enter the intersection. Roundabouts are known to assist with speed reduction thereby reducing the severity of many collisions that may occur. The multilane roundabout is similar to the single-lane roundabout with added operational benefits. Lastly, installing a signal at the intersection will help to reduce the severity of angle crashes and improve operations on the minor street approaches.

Safety Impact of Potential Alternatives and Countermeasures

While the suggested countermeasures are proven safety treatments that have been shown in prior research to reduce traffic crashes, not all treatments may be feasible or cost-effective at this location based upon further study. Therefore, it is important to consider several combinations of the evaluated treatments that may be selected for implementation. **Table 10** summarizes the estimated impacts on expected annual crash frequencies for various safety treatment combinations.

Table 10. Annual Safety Impact of Proposed Safety Countermeasures

Safety Countermeasure Combination	Combined CMFs		Expected Crashes without Treatment		Expected Crashes with Treatment		Annual Reduction	
	FI	PDO	FI	PDO	FI	PDO	FI	PDO
Install exclusive left/right turn lanes on SR 124.	0.501	0.619	1.80	6.20	0.90	3.84	0.90	2.36
Convert the intersection to a modern single-lane roundabout.	0.130	0.290	1.80	6.20	0.23	1.80	1.57	4.40
Convert the intersection to a modern multilane roundabout.	0.367	0.367	1.80	6.20	0.66	2.28	1.14	3.92
Install a traffic signal with right-turn overlap.	0.601	0.560	1.80	6.20	1.08	3.47	0.72	2.73