A Study of Driver Behavior at Access Points with Restricted Left Turn Movements: Case Studies in Alabama

by

Caleb Rogers

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Approved by

Huaguo Zhou, Chair, Professor of Civil Engineering
Rod Turochy, Professor of Civil Engineering
Jeffrey LaMondia, Associate Professor of Civil Engineering

ABSTRACT

Past studies showed that left turn movement at unsignalizd intersection caused over 40% crashes. To improve intersection safety, transportation agencies often use access management strategies to eliminate left turns for reducing number of conflicts. One common access management technical used in Alabama is to install channelized island to create right-in and right-out driveways. However, without median treatments, this technique alone may not be able to prevent left turns from driveways. This thesis applied a simple before and after method and a cross sectional comparison method to study the effectiveness of right-in and right-out channelizing island on reducing left turns.

An illegal left turn is when a vehicle turns left out of an access onto a major roadway, when they are supposed to turn right only. The objective of this study is to study driver behaviors, such as undesirable movements at access points with restricted left turn design. Seven unsignalized intersections with restricted left-turn designs in Auburn, AL were selected for this study. 72-hour traffic video data were collected at each location. The undesirable movements were recorded for analysis of driver behavior. The descriptive statistical data analysis showed that there were. A cross sectional analysis suggests traffic signage and median types have an impact on driver behavior. The results recommended that channelized islands alone at driveways cannot restrict left-turn movements. It should work together with a raised median, enhanced signage and pavement marking to restrict left turns and make right-turn only intersections safer.

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LIST OF ABBREVIATIONS

ALDOT – Alabama Department of Transportation

AADT – Average Annual Daily Traffic

DNE – Do Not Enter

FDOT – Florida Department of Transportation

HSM – Highway Safety Manual

LOS – Level of Service

MUTCD – Manual on Uniform Traffic Control Devices

PET – Post Encroachment Time

TWLTL – Two-Way Left Turn Lane

WWD – Wrong Way Driver

CHAPTER 1

INTRODUCTION

Restricted left turn design has been widely implemented by transportation agencies to reduce left-turn related conflicts and crashes at unsignalized intersections. An illegal left turn is when a vehicle turns left out of an access onto a roadway when they are designated to turn right only. There have been numerous studies *(1-5)* in the past to study the safety and operational effects of using a right turn followed by U-turns to replace the direct left-turn movements. Most of these studies *(1,2)* analyzed the crash data or traffic conflict data before and after the improvements. However, few studies investigated driver behavior at restricted left-turn access points. Some of these behaviors reflect public perception or acceptance of this type of design. Engineers have developed detailed design guidelines on how to apply different geometric design elements and traffic control devices to restrict left-turn movements and provide an alternative for them. For example, a raised channelized island is often installed on minor roads to direct traffic into turning right. A "Right Turn Only" sign is required to convey to motorists the need to turn right instead of left in coming out of an access point. The lane-use arrows are recommended for providing additional guidance to the driver (*6*). Sometimes, a "Do Not Enter" (DNE) sign is used to keep traffic from driving the wrong side of the channelized island.

Furthermore, the objective of this study is to determine driving behavior at restricted left-turn access points through case studies in Alabama. Seven locations were selected to represent three different general types of intersections in Alabama. A 72-hour traffic video was collected at each location. Driver behavior data (illegal left-turns), wrong-way movements, and traffic conflicts data were recorded by manually watching these videos. They were then analyzed to evaluate how the access control strategies affect driver behavior at this type of intersection.

CHAPTER 2

RESEARCH OBJECTIVES

Some access management manuals do not have countermeasures to reduce illegal left turns at unsignalized accesses on roadways. Thus, the objectives of this research are to:

- Provide countermeasures to reduce illegal left turns at unsignalized accesses on roadways.
- Provide countermeasures for reducing the number of times a motorist drives on the wrong side of a channelizing island at unsignalized accesses on roadways.
- Determine the scope of the illegal left turns
- Reduce the number of conflicts, as illustrated in **Figure 1** and **Figure 2**

As can be seen in **Figure 1,** there are a total of 9 conflict points at a three-way intersection. These are reduced when there are restricted left turn designs, as seen in **Figure 2**. Left turn crashes tend to be more severe because they involve a T-bone type of impact.

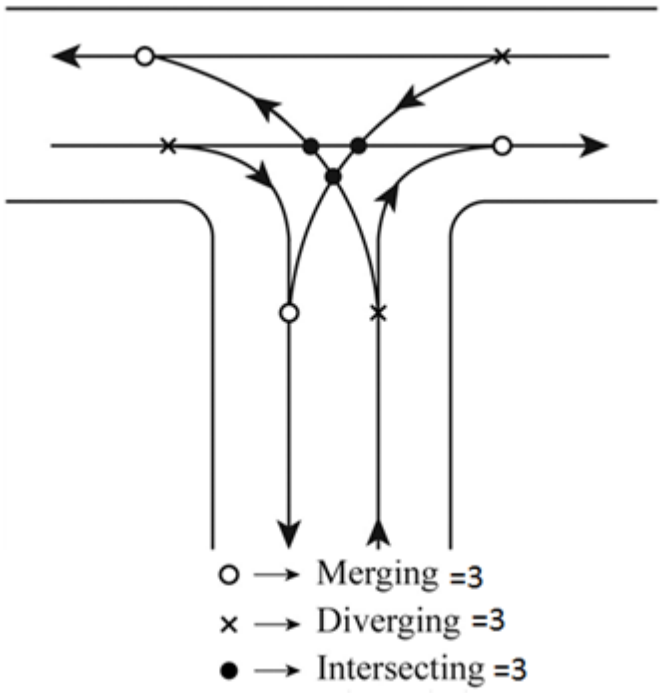


Figure 1 Three-leg Intersection with No Restrictions (7)

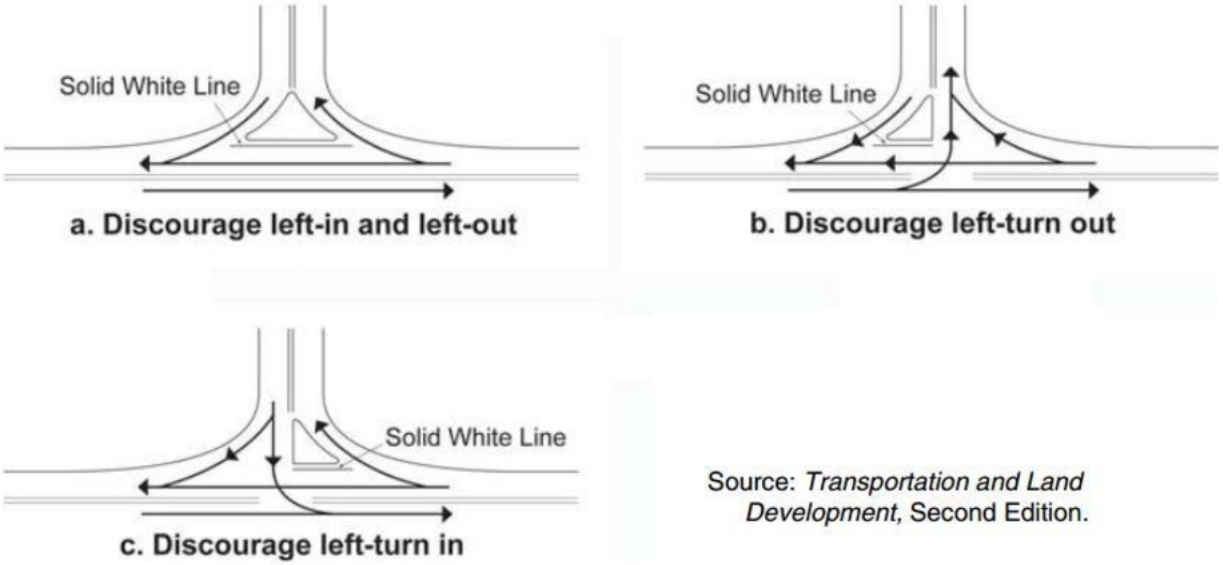


Figure 2 Various Conditions and Conflict Points for Three-leg Intersections (8)

CHAPTER 3

LITERATURE REVIEW

Field review results indicated that there are many restricted left-turn access designs using the raised channelized island on minor roads in Alabama. Some of them are on the undivided highways and applied in urban areas. Besides the restricted raised median that prevents traffic flow across the major road, channelized island, and traffic control devices (signs and pavement markings) are used to restrict the left-turns from the minor roads. Currently, there are no specific design guidelines in the ALDOT Access Management Manual *(9)* on where and how restricted left-turns should be installed. Some other states' access management manuals *(1,2, 10-19)* provided more guidelines on how to use the raised median for a restricted left-turn design. For example, the FDOT Median Design Handbook states that, “restrictive medians and well-designed median openings are also a key component of access management. Raised or restrictive medians are paved or landscaped areas that separate vehicular traffic. The documented benefits of raised medians are so significant that FDOT requires a raised or restrictive median on divided roadways with a design speed of 45 mph or greater, per FDM 210 – Arterials and Collectors. Medians should be installed whenever possible on multi-lane arterial roadways”. It also included that, “directional median openings are designed to restrict certain traffic movements. The main characteristic of a directional median opening is that vehicular traffic from the cross streets cannot conduct left turns or cross the arterial. The only movements allowed are right turns onto the arterials” *(1)*. The MDOT Access Management Manual states that the number of conflict points is reduced to two after a raised concrete median is installed on the major road. Recently, the city of Auburn, Alabama has installed 8” round two-way yellow ceramic pavement markers at least at one intersection. These pavement markers serve as a restrictive median.

Regarding median design and sight distance, the South Carolina Department of Transportation's Access Management Manual discusses how sight distance influences how drivers can visually determine how to make a maneuver across the roadway from an access. Sites that do not meet the criteria for sight distance for left turning movements should have a median constructed on the main roadway to reduce conflicts and reduce illegal left turns. One of the factors influencing sight distance is the presence of vegetation or a building blocking the driver's line of sight.

The Pennsylvania Department of Transportation's Access Management Manual discusses how that grade on the major roadway influences the sight distance for motorists turning out of an access onto the roadway. The intersection sight distance equation must be satisfied for the vehicle to be allowed to turn left out of the access.

In regards to safety and crash data, the Michigan Department of Transportation's Access Management Guidebook states that "Where crash data are easily available, it can be an important element in developing an access management plan. Very often, high crash rates are associated with poor access management… Studies from across the nation have confirmed that… improved driveway design significantly reduce crash potential." In other words, reducing conflict points by restricting left movements often reduces crashes at unsignalized intersections.

The Manual on Uniform Traffic Control Devices (MUTCD) *(6)* provided guidance on using traffic signs and pavement marking to restrict left turns, including, a Right-Turn Only sign, lane use arrows, etc. Geometric design guidelines for access points (*5*) provide information on how to use channelized islands to restrict the left-turns. However, few past studies (*3,4*) investigated how these signs, pavement markings, and channelized islands affect driver behavior.

North Carolina's Department of Transportation's *Policy on Street and Driveway Access to North Carolina Highway*, considers the fact that for every 10 mile per hour of "arterial design speed for appropriate arterial width of crossing" for two lanes for a passenger vehicle to turn left it requires at least 100 feet of sight distance, 120 feet for four lanes, and 130 feet for six lanes.

According to the Clark County Area Access Management manual for Southern Nevada *(20)*, there are significant economic benefits to access management. Studies have been done in several states, including Iowa, Kansas, and Texas, that have shown that businesses are just as economically profitable, and in some cases more profitable after access management plans are implemented.

There are a higher number of illegal left turns at locations where there are no traffic control devices (*21*). This is because motorists are not aware that they are prohibited from making a left turn out of an unsignalized intersection. High number of illegal left turns means that motorists must wait in line longer to turn (*22).* Doing so results in an increase in air pollution, as well as decreasing the overall LOS of the unsignalized intersection. Driver patience also decreases the longer the queue that the motorists must wait through (*23).*

A strategy to reduce the number of times a motorist attempts an illegal left turn are to reduce the speed limit on the major road and minor road, and to add lanes to the approach on the minor road *(24).* In addition, over 50 percent of all crashes occur at intersections in urban areas and 30 percent in rural areas. Tall buildings also pose a danger to motorists attempting to make an illegal left turn.

It is 25 percent safer to eliminate an illegal left turn by adding a raised concrete median *(25).* In addition, eliminating an illegal left turn and forcing people to turn right followed by a U-

turn reduces the number of conflicts by up to almost 50 percent. Crashes were brought down by approximately 20 percent when eliminating illegal left turns. According to the HSM, crashes were reduced by the following degrees when eliminating illegal left turns at an unsignalized intersection:

- Total crashes were reduced by 14 to 51 percent
- Property Damage Only crashes were reduced by 5 to 11 percent
- Fatal and injury crashes were reduced by 31 to 36 percent
- Rear-end crashes were reduced by 9 to 16 percent
- Right Angle crashes were reduced by 33 to 36 percent

In summary, safety is significantly improved, and conflict points are reduced when illegal left turns are reduced or eliminated.

CHAPTER 4

METHODOLOGY

4.1 Study Locations

Restricted left-turns were studied during April, May, June, August, and September of 2021, as well as February of 2022 at various locations in Auburn, Alabama. Seven locations were selected to conduct the study including the grocery store entrance on the North College Street, the gas station on the Shug Jordan Parkway, Southparke Drive on South College Street, the apartment entrance on Glenn Avenue, the baseball field on Donahue Drive, the location on Wire Road, and the restaurant location on Magnolia Avenue. These locations were selected because they have restrictive left turn features and traffic control devices that prohibit left turning maneuvers. Video data was recorded by portable cameras as shown in **Figure 3**. The camera was attached to a pole and mounted on a sign or utility pole. Video footage ran for 72 hours straight and was recorded on a Monday-Thursday. Video was recorded in 30-minute increments. This was done to give a consistency to the analysis of the data. **Table 1** described the roadways involved in the study.

Figure 3 A Portable Camera used to record Illegal Left Turns

TABLE 1 Roadways studied in Auburn, Alabama

	North College Street	**Shug Jordan Parkway**	**South College Street**	**Glenn Avenue**
Roadway Classification (*26*)	Principal Arterial	Principal Arterial	Principal Arterial	Minor Arterial
Number of Lanes on Main Road	2	4	4	2
Speed Limit	50 MPH	55 MPH	45 MPH	25 MPH
Median Type	Undivided	Undivided	Divided	Undivided
Type of Intersection	Three-way	Three-way	Four-way	Three-way
Type of Traffic Control Devices Present	Channelizing Island, Only Sign, Pavement Arrow	Pavement Arrow, Channelizing Island	Channelizing Island	Channelizing Island

TABLE 1 Roadways studied in Auburn, Alabama (Cont'd)

	Donahue Drive	**Wire Road**	**Magnolia Avenue**
Roadway Classification (*26*)	Minor Arterial	Local	Minor Arterial
Number of Lanes on Main Road	2	2	3
Speed Limit	25 MPH	20 MPH	25 MPH
Median Type	Undivided	Undivided	TWLTL

Type of Intersection	Three-way	Four-way	Three-way
Type of Traffic Control Devices Present	Channelizing Island	Channelizing Island, Right Turn Only Sign, Pavement Arrow	Two Right Turn Only Signs

Location 1 – Grocery Store Entrance on North College Street

North College Street is a two-lane principal arterial having auxiliary lanes, with a speed limit of 50 miles per hour at the grocery store entrance. The grocery store entrance has one lane coming out of the store. This lane is designed for right out only traffic. Traffic coming into the store is allowed to turn in from both the north and southbound directions. Channelized island, right-turn only sign, and lane use arrows are installed on the minor road to restrict left-turns from driveways. **Figure 4** and **Figure 5** show this location from an aerial and ground view respectively.

Figure 4 Aerial view of North College Street at the Grocery Store Entrance (27)

Figure 5 Ground view of North College Street at the Grocery Store Entrance (27)

Location 2 - Gas Station on Shug Jordan Parkway

Shug Jordan Parkway is a four-lane undivided principal arterial, with a speed limit of 55 miles per hour. There is only one lane for traffic exiting the gas station. There is a channelized island encouraging people to turn right out of the gas station. There is a DNE sign and a lane use arrow on the pavement to deter people from driving on the wrong side of the channelized island. **Figure 6** and **Figure 7** show this location from an aerial and ground view respectively.

Figure 6Aerial view of Shug Jordan Parkway at the Gas Station Entrance (27)

Figure 7 Ground view of Shug Jordan Parkway at the Gas Station Entrance

Location 3 – Restaurant Entrance on South College Street

South College Street is a four-lane undivided principal arterial, with a speed limit of 45 miles per hour. The entrance at Restaurant is a right-in-right-out only access design. There is a raised concrete median separating the two directions of traffic flow on the South College Street. **Figure 8** and **Figure 9** show this location from an aerial and ground view respectively.

Figure 8 Aerial view of South College Street at Southparke Drive (27)

Figure 9 Ground view of South College Street at Southparke Drive (27)

Location 4 – Apartment Entrance on Glenn Avenue

Glenn Avenue is an east-west undivided minor arterial, with a speed limit of 25 miles per hour. The entrance to the apartment is a right-in-right-out only access design. **Figure 10** shows this location from a ground view.

Figure 10 Ground view of Glenn Avenue at the Apartment Entrance

Figure 11 Alternate Ground view of Glenn Avenue at the Apartment Entrance

Location 5 – Donahue Drive near Baseball Field

Donahue Drive is a two-lane undivided minor arterial, with a speed limit of 25 miles per hour. The exit is a right-out only access design. **Figure 12** and **Figure 13** show this location from an aerial and ground view respectively.

Figure 12 Ariel view of Donahue Drive at the Entrance near Baseball Ballfield (27)

Figure 13 Ground view of Donahue Drive at the Entrance near Baseball Ballfield

Location 6 – Entrance on Wire Road near War Eagle Way

Wire Road is a two-lane undivided local roadway, with a speed limit of 20 miles per hour. The entrance is a right-in-right-out only access design. **Figure 14** and **Figure 15** show this location from an aerial and ground view respectively.

Figure 14 Ariel view of Wire Road at the Entrance near War Eagle Way (27)

Figure 15 Ground view of Wire Road at the Entrance near War Eagle Way (27)

Figure 16 Alternate Ground view of Wire Road at the Entrance near War Eagle Way

Location 7 – Restaurant Exit on Magnolia Avenue

Magnolia Avenue is a three-lane undivided minor arterial with a two-way-left-turn-lane, with a speed limit of 25 miles per hour. The exit at the Restaurant is a right-out only access design. **Figure 17** shows this location from a ground view.

Figure 17 Ground view of Magnolia Avenue at the Restaurant Exit

Figure 18 Alternate Ground view of Magnolia Avenue at the Restaurant Exit

4.2 Data Collection

The research team installed portable traffic cameras mounted near the respective locations. The videos were recorded for 72 hours during the three weekdays (Monday to Thursday). The videos were analyzed by observing the driver behavior and their actions when approaching the restricted left turn. The total number of vehicles that approached the restricted left turn were counted as well as the number of vehicles that made an illegal left turn. This would give a ratio of the drivers that would make an illegal left turn. Other abnormalities such as driving on the wrong side of the channelized island were noted.

4.3 Data Analysis Method

The behaviors were analyzed by reviewing the videos recorded by portable traffic cameras. Driver behavior in this study was defined by the vehicles' actions that were taken at the restricted left turn. While making an illegal left turn, the driver's behavior showed vehicles yielding at the channelized island and making a large J turn to go around the channelized island and turn left, as shown in **Figure 21**. In addition, when there were no pavement markings and few signs to direct drivers, there were behaviors of driving on the wrong side of the channelized island as shown in **Figure 20**.

A before-after comparison was conducted for the Glenn Avenue location. The before condition was prior to the construction of yellow pavement markers, the after condition was after the construction of yellow pavement markers.

Please see **Table 1** for details on cross-section elements.

CHAPTER 5

RESULTS

5.1 Descriptive Statistics

From the grocery store entrance location on North College St, it was found that roughly 1 in every 3 vehicles made an illegal left turn. **Table 2** represents a sample of vehicles that approached the restricted left turn in 30-minute periods. In addition, it was also determined that 1 in 20 vehicles that made an illegal left turn made the left turn from the wrong side of the channelized island. Also, there was a close conflict in approximately 1 out of every 33 vehicles turning out of the grocery store access. A close conflict was defined when vehicles made an illegal left turn and would interfere with cars on the major road. As shown in **Figure 19**, an illegal left turn can be found at this location. In addition, in **Figure 20**, an example can be seen of a vehicle driving on the wrong side of the channelized island.

TABLE 2

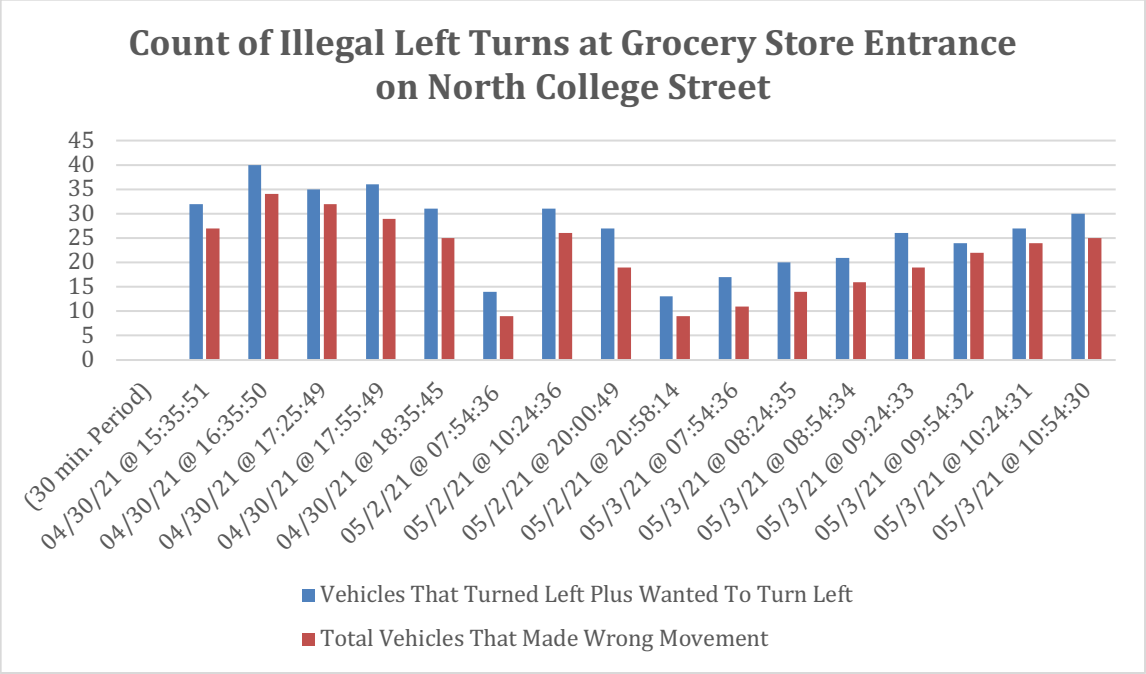


Figure 19 Illegal left turn onto N. College Street at the Grocery Store entrance location

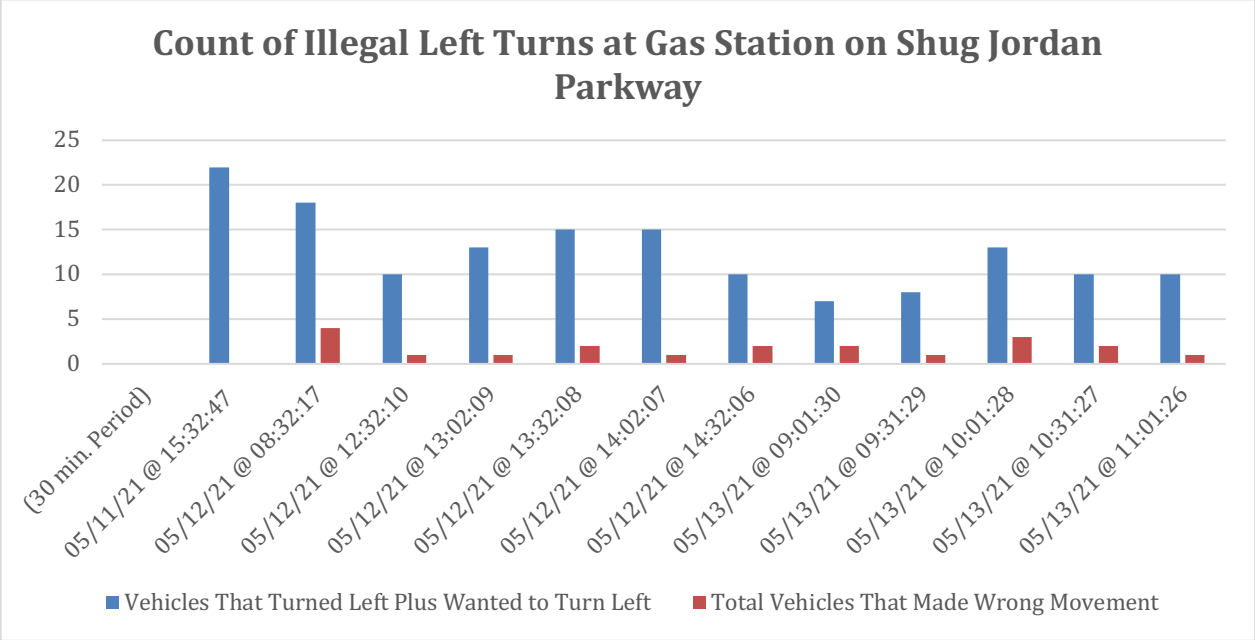
Figure 20 Vehicle on the wrong side of the channelized island at the Grocery Store entrance location

At the gas station location on Shug Jordan Parkway, it was found that approximately 1 in 15 vehicles were making an illegal left turn. **Table 3** represents the number of cars that approached the restricted left turn in 30-minute time periods. There were some cases at this location where

drivers drove over the channelized island or waited in the striped median to merge into oncoming traffic. At this location, there were no cases of driving on the wrong side of the channelized island. This is because this location has a “DNE” sign as well as pavement markings in the entrance lane. An example of an illegal left turn at this location can be seen in **Figure 21** below.

Figure 21 Illegal left turn onto Shug Jordan Parkway at the Gas Station location

TABLE 3



At Southparke Drive on South College Street, there were 1 in every 60 vehicles that made an illegal movement. Most illegal movements that were made were illegal left turns, but there were a couple cases where drivers illegally drove straight through the intersection. **Table 4** represents a sample of vehicles that approached the restricted left turn in 30-minute periods. It was observed at this location that drivers would wait in the left turn lane on South College Street to merge into oncoming traffic. It was also observed that the small concrete median installed at the major road was effective in preventing illegal left turns, but there are still points of improvement. In **Figure 22** below, an example can be seen of a vehicle making an illegal left turn and waiting in the left turn lane to yield onto South College Street.

TABLE 4

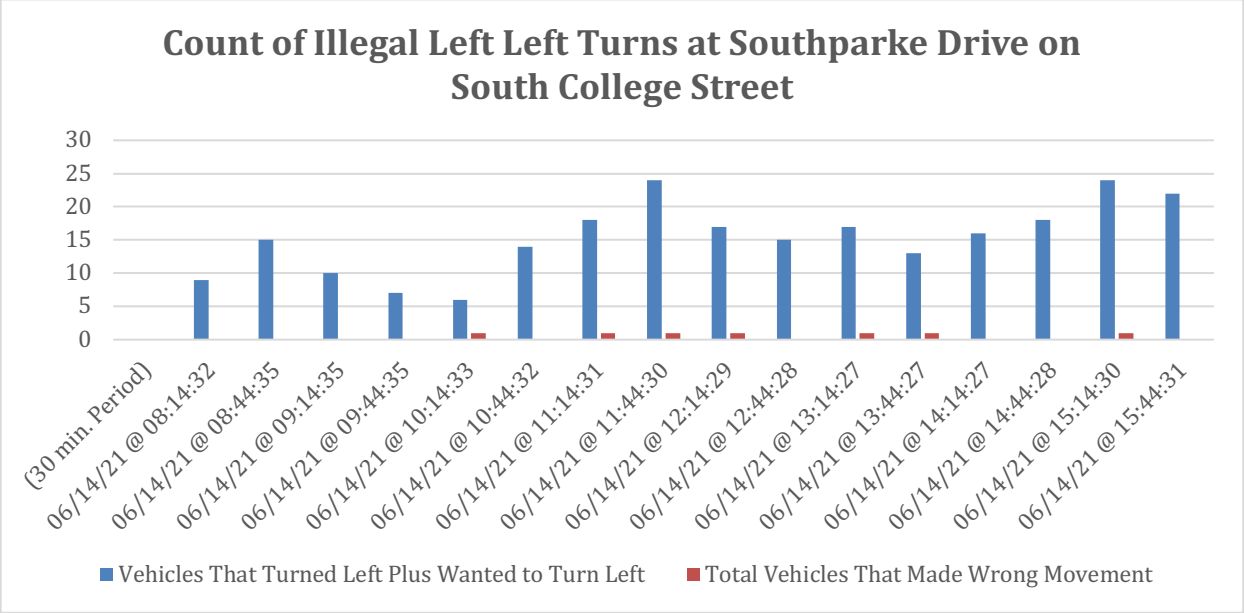


Figure 22 Illegal left turn onto South College Street at Southparke Drive

At the apartment location on Glenn Avenue, it was found that approximately 35% of vehicles were making an illegal left turn before yellow pavement markers were added. These yellow pavement markings were added as a deterrent to motorists making an illegal turn. It was found that after the yellow markers (8" round two-way yellow ceramic pavement markers) were added,

the percentage of vehicles making an illegal left turn was just 8%. **Table 5** represents the number of vehicles that approached the restricted left turn in 30-minute time periods before the makers were constructed. At this location, there were some cases of driving on the wrong side of the channelized island. **Table 6** represents the number of vehicles that approached the restricted left turn in 30-minute time periods after the makers were constructed. An example of an illegal left turn at this location before the construction of the yellow markers can be seen in **Figure 23** below. **Figure 24** is a picture of the location after the construction of the yellow markers.

TABLE 5

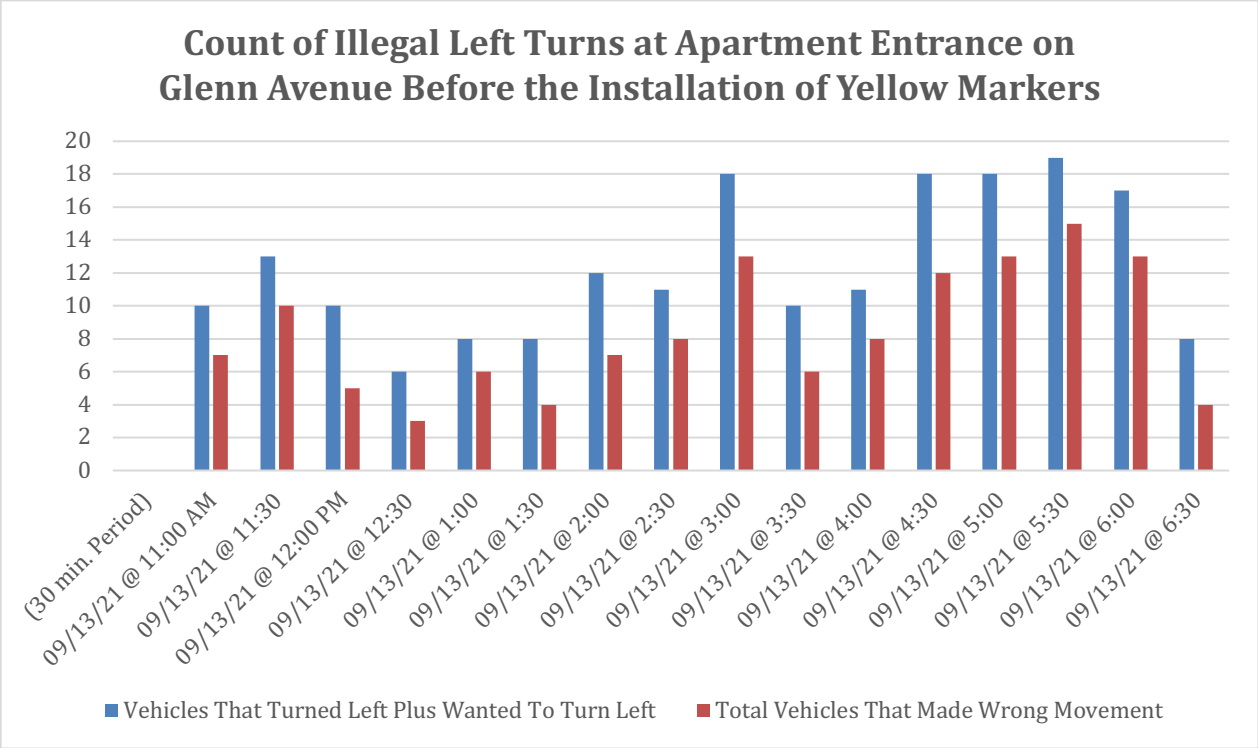


TABLE 6

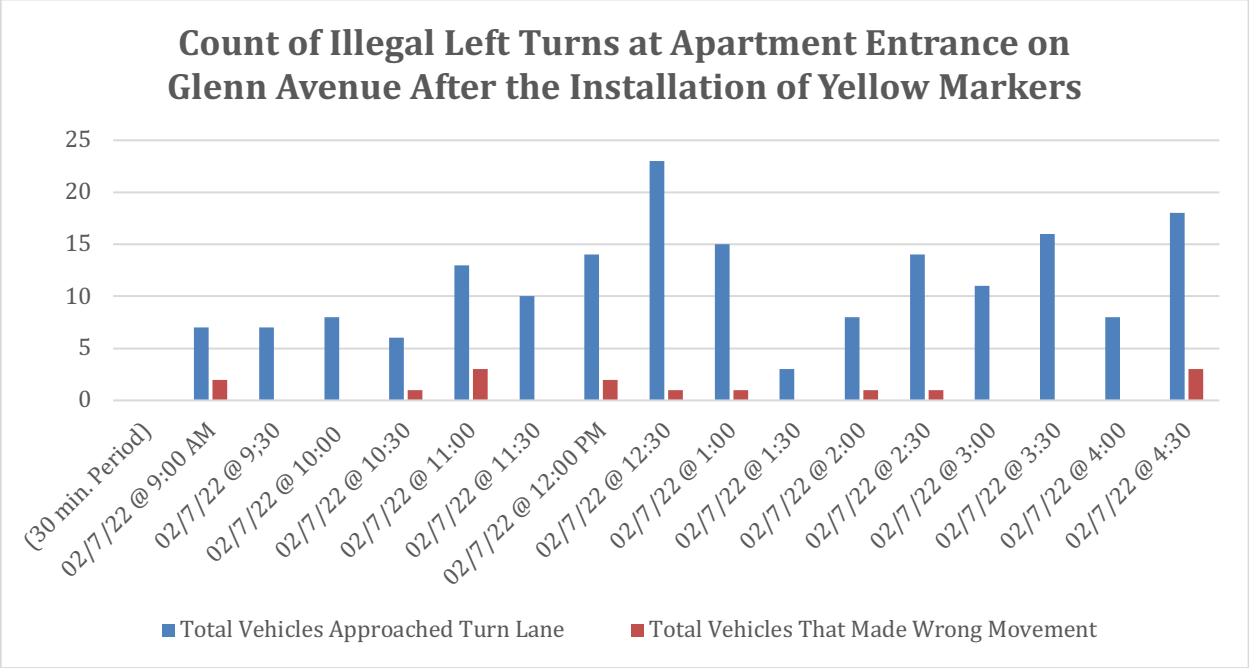


Figure 23 Illegal left turn onto Glenn Avenue at the Apartment Location

Figure 24 Glenn Avenue at Apartment Location (Note the addition of Yellow Markers)

At the baseball field location on Donahue Drive, it was found that approximately 14% of vehicles were making an illegal left turn. **Table 7** represents the number of vehicles that approached the restricted left turn in 30-minute time periods. At this location, there was at least one case of driving on the wrong side of the channelized island. An example of an illegal left turn at this location can be seen in **Figure 25** below.

TABLE 7

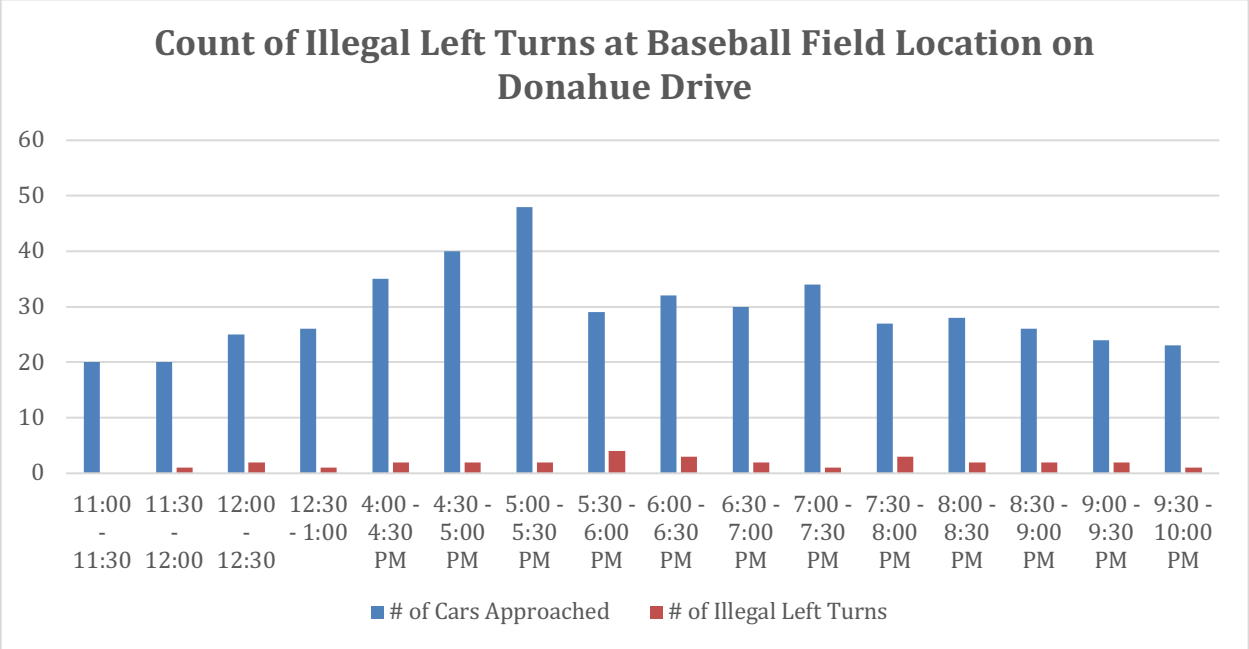


Figure 25 Illegal left turn onto Donahue Drive at the Baseball Field Location

At the location on Wire Road, it was found that approximately 1 in 23 vehicles were making an illegal left turn. **Table 8** represents the number of vehicles that approached the restricted left turn in 30-minute time periods. At this location, there was at least three cases of driving on the wrong side of the channelized island. An example of a motorist driving on the wrong side of the channelizing island at this location can be seen in **Figure 26** below.

TABLE 8

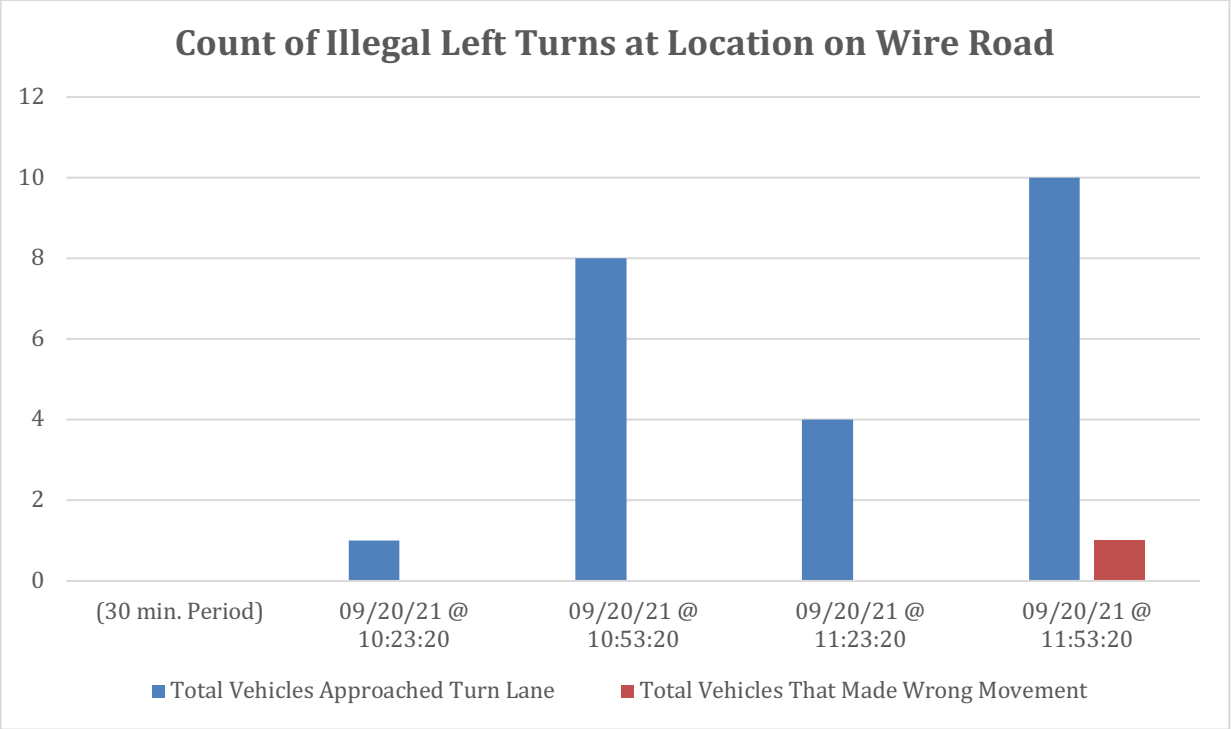


Figure 26 Motorist Driving on Wrong Side of Channelizing Island at Wire Road Location

At the location on Magnolia Avenue, it was found that approximately 4% of vehicles were making an illegal left turn. **Table 9** represents the number of vehicles that approached the restricted left turn in 30-minute time periods. An example of a motorist making an illegal left turn at this location can be seen in **Figure 27** below.

TABLE 9

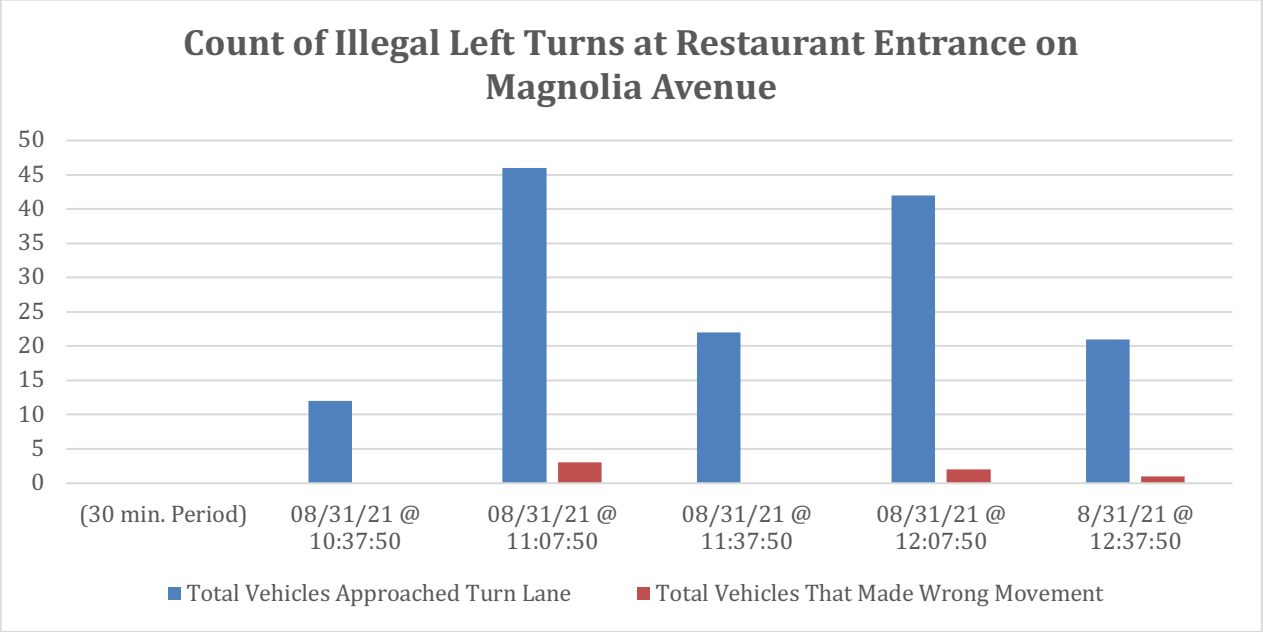
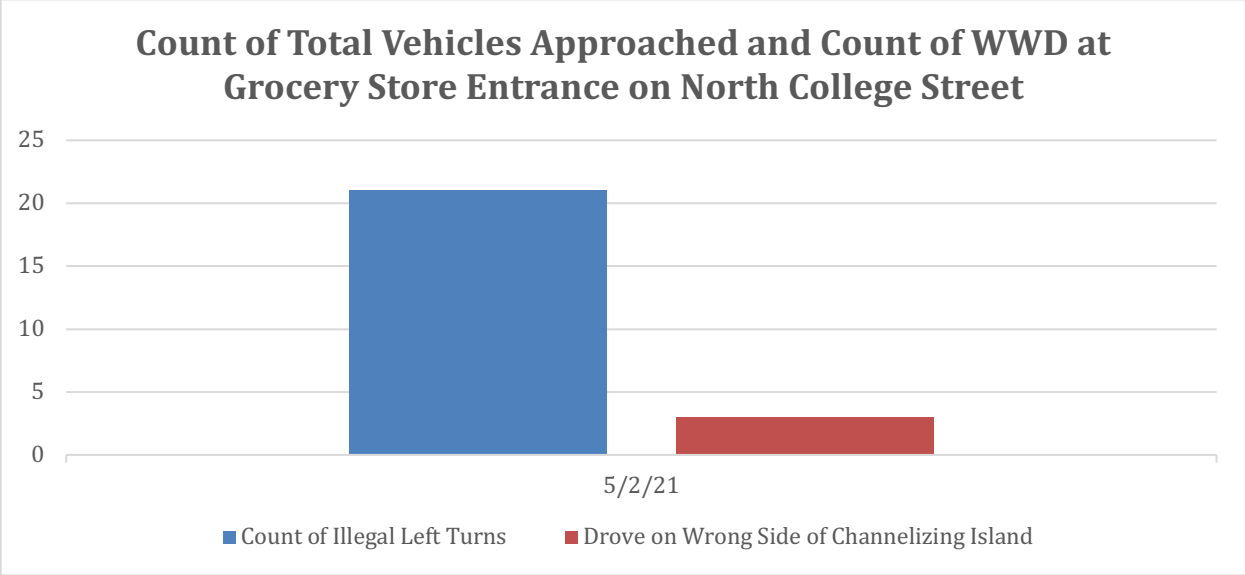


Figure 27 Illegal left turn onto Magnolia Avenue at the Restaurant Location

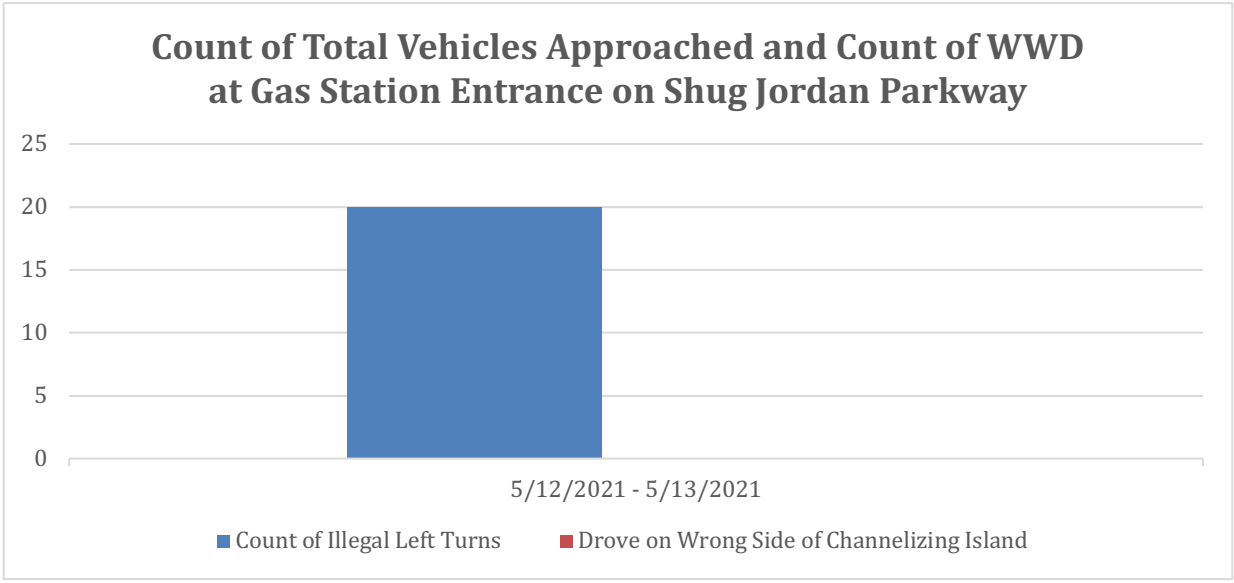
At the location on North College Street at the Grocery Store Entrance, it was found that approximately 15% of all illegal left turns were made on the wrong side of the channelizing island (see **Figure 20,** page 32). **Table 10** below represents the total number of vehicles that approached the intersection verses the number motorists who drove on the wrong side of the channelizing island.

TABLE 10



At the location on Shug Jordan Parkway at the Gas Station Entrance, it was found that approximately 0% of all illegal left turns were made on the wrong side of the channelizing island. **Table 11** below represents the total number of vehicles that approached the intersection verses the number motorists who drove on the wrong side of the channelizing island.

TABLE 11



CHAPTER 6

STATISTICAL ANALYSIS

An unrelated proportions test used to compare all three cases. An unrelated proportions test was used to analysis the data. This was done because the cross-section of the sites, the geometry of the sites, the AADT of the sites, and angle of the channelizing island did not match each other.

The following equation was used:

$$Z = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}_0\left(1-\hat{p}_0\right)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}} \quad (28)$$

p1 = proportion for sample 1

p2 = proportion for sample 2

p0 = pooled sample

n1 = sample size for sample 1

n2 = sample size for sample 2

TABLE 12 Statistical Summary

Location	Control	Ratio of Left Turns to Total Vehicle Roadway Volume	Ratio of Vehicles Making Illegal Maneuver With Control	p-value
S. College St. vs Shug Jordan Pkw.	Raised Concrete Median	13%	3%	<0.00001
N. College St. vs Shug Jordan Pkw.	DNE Sign and Pavement Arrows	14%	0%	0.04093
Magnolia Ave. before/after	Yellow Markers	68%	16%	<0.00001

To determine if the presence of a raised concrete median on a four-lane roadway significantly reduces the number of illegal left turns: the two sites that were compared were the location on Shug Jordan Parkway and the location on South College Street. These locations were compared because they are both principal arterials, they both have four lanes, and they both have a channelizing island. Shug Jordan Parkway has no raised concrete median separating the two directions of travel, while South College Street does have a raised concrete median separating the two directions of travel. The value of Z calculated was 4.4106. The value of p was less than 0.00001. This value is lower than 0.05. Thus, the presence of a raised concrete median significantly reduces the number of illegal left turns.

To determine if the presence of a DNE sign and pavement arrows significantly reduced the number of times a motorist drove on the wrong side of the channelizing island: the two sites that were compared were the location on Shug Jordan Parkway, where pavement arrows and a DNE

sign are present, and the location on North College Street, where pavement arrows and a DNE sign are not present. These locations were compared because they are both principal arterials, they both have undivided median types, and they both have channelizing islands and pavement arrows. The value of Z calculated was 1.7367. The value of p was 0.04093. Therefore, the presence of a DNE sign significantly reduces the number of times a motorist drives on the wrong side of the channelizing island.

For the presence of 8" round two-way yellow ceramic pavement markers, the two scenarios that were compared were before the addition of yellow ceramic pavement markers on Glenn Avenue at the apartment entrance, and after the addition of yellow ceramic pavement markers at the same location. The value of Z calculated was 8.2394. The value of p was less than 0.00001. This value is lower that 0.05. Thus, the result was statistically significant. Therefore, the presence of 8" round two-way yellow ceramic pavement markers significantly reduce the number of illegal left turns.

CHAPTER 7

LIMITATIONS

Limitations of the work include the collection of data at different times of the year, different times of the day, and the lack of analysis on the presence of a channelizing island. There could be different ratios of illegal left turns based on the time of year and the time of day. Also, there could be research done to determine if a sharper angle for a channelizing island decreases illegal left turns. In addition, the AADT was not collected at the different sites for the major roadway. The higher the AADT, theoretically the lower the number of illegal left turns.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

This research examined the effects of driver behavior at access points with restricted left-turn movements at seven locations in Auburn, Alabama, United States. According to the data that was collected from all seven locations, it was concluded that there are too many limitations to the data to make a definite conclusion as to what might reduce illegal left turns.

CHAPTER 9

FUTURE RESEARCH

More research could be done to study the conflicts at each location by recording the PET. In addition, more videos may be reviewed at each location to count more illegal left turns and cases of motorists driving on the wrong side of the channelizing island. Other factors contributing to the percentage of illegal left turns at the locations in this study are the average annual daily traffic on the main roadways, the queue of vehicles on the access roadway, and the angle of the channelizing island. More research could be conducted for these factors at the locations not analyzed in this study.

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