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Evaluating Detours for a Major Construction Project in the Era of Real-Time Route Guidance

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ABSTRACT

Major road construction projects can be significant sources of traffic congestion and motorist delays. Maintaining agencies typically attempt to mitigate these impacts by designating detour routes and providing project information to motorists. This information can be conveyed through a variety of media, from traditional static and variable roadway signage placed in the field to electronic media including web sites, radio and television advertisements, call centers, text messaging, and navigation apps. In this era of real-time traffic information and in-vehicle route guidance, it is not clear to what extent this detour information is used and which messaging components are most effective. This study used the Interstate 59/20 reconstruction project in Birmingham, AL to evaluate the detour planning process and the effectiveness of the resulting detour and information strategies. The objective was to develop recommendations and best practices that can be applied to future construction projects and allow transportation agencies to allocate project resources to greatest effect. The evaluation included a review of the transportation modeling process used to project traffic diversions and designate detour routes, a survey of motorists to determine the sources of information they used to choose detour routes during construction, and a study of traffic patterns before, during, and after the project to understand if and how detour patterns changed over the course of the one-year project. The study resulted in recommendations for conducting planning studies for large roadway projects and found that factors such as transit usage assumptions, employer work policies, and roadway capacity assumptions can have significant impacts on model accuracy. The survey found that motorists used a wide variety of information sources when selecting detour routes and that they often modified those routes based on real-time data. The travel time and traffic count analysis found that detour patterns did vary over time as the transportation system reached equilibrium. It also found that actual traffic patterns during the reconstruction project did not always match responses to the motorist survey, suggesting that motorists used designated detour routes initially but adjusted them during the course of the project.

Keywords (up to 5):
Construction detours, motorist information

EXECUTIVE SUMMARY

Major road construction projects can be significant sources of traffic congestion and motorist delays. Maintaining agencies typically attempt to mitigate these impacts by designating detour routes and providing project information to motorists. This information can be conveyed through a variety of media, from traditional static and variable roadway signage placed in the field to electronic media including web sites, radio and television spots, call centers, text messaging, and navigation apps. In this era of real-time traffic information and in-vehicle route guidance, it is not clear to what extent this detour information is used and which messaging components are most effective. This study used the Interstate 59/20 reconstruction project in Birmingham, AL to evaluate the detour planning process and the effectiveness of the resulting detour and information strategies. The objective was to develop recommendations and best practices that can be applied to future construction projects and allow transportation agencies to allocate project resources to greatest effect. The evaluation included three primary components:

- A survey of motorists to determine the sources of information they used to choose detour routes during construction,
- A review of the transportation modeling process used to project traffic diversions and designate detour routes,
- A study of traffic patterns before, during, and after the project to understand if and how detour patterns changed over the course of the one-year project.

The review of the planning process found that factors such as transit usage assumptions, employer work policies, and roadway capacity assumptions can have significant impacts on model accuracy. The motorist survey found that motorists used a wide variety of information sources when selecting detour routes and that they often modified those routes based on real-time data. The travel time and traffic count analysis found that detour patterns did vary over time as the transportation system reached equilibrium, suggesting that motorists used designated detour routes initially but adjusted them during the course of the year.

One limitation of this study is that it focused primarily on local traffic. Additional analysis of origin-destination patterns would be required to determine how external trips (e.g., vehicles passing through the region) were affected by detour information. Also, a survey specific to commercial vehicles would be needed to provide insights into the impacts on truck traffic.

1.0 INTRODUCTION

Major construction projects can be significant sources of traffic congestion and motorist delays. Reduced roadway capacity and associated congestion can cause diversions onto adjacent facilities, which may or may not be able to handle the additional traffic. To address this, planners typically designate detour routes for major construction projects and may make adjustments to traffic signals and roadway geometry along these routes to handle expected increases in flow. Maintaining agencies can convey this detour information to motorists through a variety of media, including static road signs, variable message signs (VMS), highway advisory radio, project websites, and television and radio public service announcements. In the era of in-vehicle real-time route guidance, however, it is not clear to what extent this detour information is received by the public or which components are most effective. Transportation agencies may invest significant amounts of time and money to sign detour routes, adjust signal timings and roadway geometry, and conduct public information campaigns without fully understanding the information sources motorists use to choose detour routes or what the ensuing traffic impacts of those choices will be.

A case study for a construction project requiring significant detour planning was the reconstruction of Interstate 59/20 through downtown Birmingham, AL, in 2019. Under this project, a 1.5 mile segment of the interstate was completely closed to traffic for 1 year, resulting in significant traffic diversions to other interstate routes and surface streets. The interstate segment carried over 160,000 vehicles per day (vpd) prior to closure, so substantial amounts of both local and pass-through traffic needed to find alternate routes through the region. With the help of local planning agencies, the Alabama Department of Transportation (ALDOT) identified major detour routes prior to the closure and made geometric and signal timing changes at key locations to accommodate projected traffic patterns. It also made project and detour information available to the public through radio and tv advertisements, a project website that was updated daily, and a call center. ALDOT also provided daily updates on roadway and street closures to route guidance providers (such as Google Maps and Waze) to ensure that route guidance apps were using the most current route information.

This study sought to provide insights into how motorists made detour decisions and what the impacts of those decisions were in this case study. It evaluated the planning process used designate detour routes, conducted a survey of motorists to determine the sources of information they used to select detour routes, and analyzed traffic patterns before, during, and after the interstate closure to draw conclusions about motorist route choice behavior. From this analysis we developed recommendations that maintaining agencies can use when developing detour plans for future roadway construction projects.

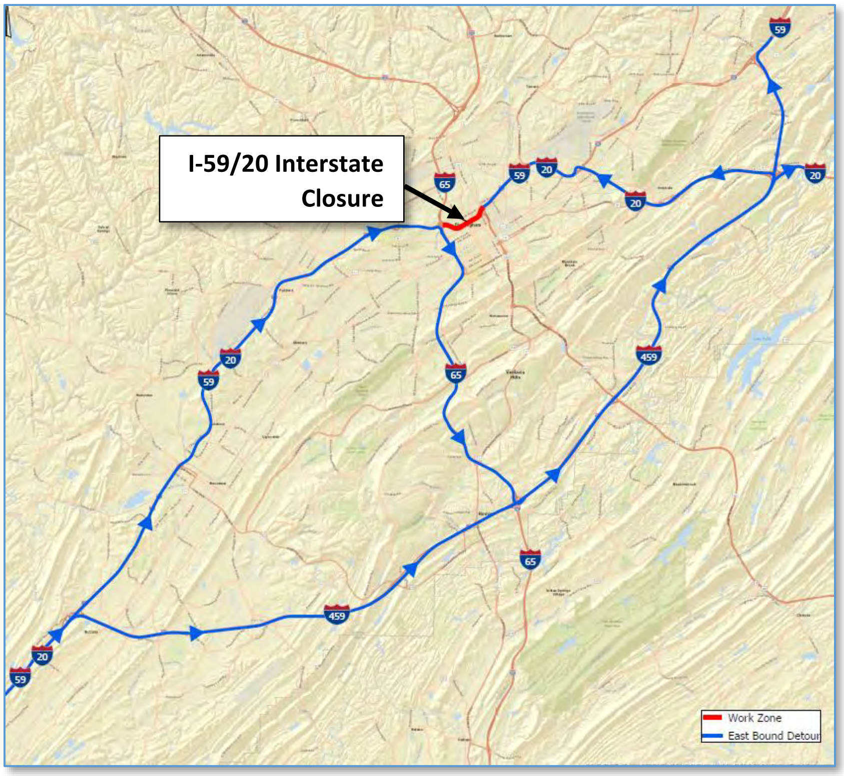


Figure 1. Location of I-59/20 reconstruction project (source: ALDOT)

Figure 2. Interstate reconstruction in February 2019 (source: ALDOT)

1.1 OBJECTIVE

The objective of this study is to better understand the information sources motorists use when selecting detour routes associated with major construction projects. The evaluation included three primary components:

- A survey of motorists to determine the sources of information they used to choose detour routes during construction,
- A review of the transportation modeling process used to project traffic diversions and designate detour routes, and
- A study of traffic patterns before, during, and after the project to understand if and how detour patterns changed over the course of the one-year project.

1.2 SCOPE

The study comprised the following tasks:

1. Conduct a literature review of research related to construction detours and motorists route choice.
2. Contact local agencies to determine the types of data available related to traffic patterns during the I-59/20 reconstruction project in Birmingham.
3. Collect traffic volume and travel time data as appropriate for periods prior to, during, and after the reconstruction project.
4. Conduct a survey of local motorists to determine what types of information they used to select a detour route.
5. Analyze available traffic date to determine how motorists detoured through the region and whether these detour patterns changed over the course of the 1-year project.
6. Analyze available traffic data and compare to the original model projections for how motorists would detour during the project. Work with the modeling consultant to determine where and why projections differed significantly from reality.
7. Develop a set of recommendations that can be applied to future large construction projects of this type. These will address modeling practices fpr defining detour routes, methods of conveying detour information to the public, and best practices for managing information during major projects.

2.0 LITERATURE REVIEW

Highway infrastructure maintenance activities and especially bridge replacement projects can be a challenge for transportation engineers. Project success depends not only design and execution, but also effective strategies to maintain traffic flow during construction. A study of the reconstruction of a major freeway overpass in Dallas, Texas (the Mockingbird Lane overpass) concluded that the success of such projects lies in the integration of bridge reconstruction sequence, constructability, and traffic control plans (O'Connor 2000).

There has been significant research related to motorist route choice models under variable traffic conditions. There seems to be far less study of how drivers respond to detour information for major construction projects and the best ways for public agencies to convey that information to motorists. Traditional detour signing is appropriate and essential for routes adjacent to construction zones, and variable message signing is appropriate to provide advance warning of major construction detours. For major construction projects with regional impacts, however, these types of information strategies are likely to be insufficient. Additional options available to transportation agencies include project websites, television and radio, social media, and call information centers. Perhaps most importantly, the prevalence of in-vehicle and smartphone phone route guidance apps allow motorists to select routes based on current traffic information and without regard to pre-defined detour routes. This type of diversion can reduce user travel times but can also create "unofficial" detour routes along roads that are not designed to carry the volume or types of detour traffic.

To gain a better understanding of how motorists select detour routes around major construction projects we reviewed literature related to motorist perceptions and route choice responses to the following information sources:

- Static and variable message signing
- Radio and television
- Project websites and social media
- Route guidance apps

2.1 Static and Variable Message Signing (VMS)

Static and variable message signs are a common means of alerting drivers to construction detours. Most available literature concerns driver responses to temporary detours necessitated by crashes, congestion, or temporary construction zones rather than long-term construction projects. Driver response to detour information appears to be closely tied to message content. A study of motorist responses to VMS content in Utah found that driver diversion rates were higher when motorists were provided detailed incident information, such as incident description, location, and estimated delay time, as opposed to general information, such as "crash ahead" or "use caution". (Sailesh 2022) The same study found that diversion rates increased with shorter distances between the incident and the VMS location, suggesting that multiple VMS installations are more effective than single ones. A similar finding relative to VMS location and diversion likelihood was found in South Korea (Kim 2014).

A study in China found that VMS diversion rates increased when heavy congestion was indicated for the primary route, as opposed to light or moderate congestion (Shen 2020). Several studies have found that response rates to VMS vary by age group, though the findings have not been consistent across studies (Peeta 2000, Gan 2013).

In the state of Indiana, an unplanned closure of a 37-mile stretch of interstate I-65 N took place for 31 days in August 2015 due to pier settlement of the Wildcat Creek Bridge of I-65 N. In consultation with Purdue University Researchers and public safety officials, the Indiana Department of Transportation (INDOT) had taken some measures to minimize the impacts. Those measures included building three temporary signals, changing one flasher operation, installing 59 signs, arranging 15 message boards, and modifying the signals on US-231 to prioritize the detour traffic for providing the best possible traffic flow on the corridor. Studies found that when the interstate reopened, the pre-detour traffic patterns returned along the diversion corridor after one week (McNamara et al., 2015).

The primary limitation of VMS is that message content is limited and therefore cannot provide detail on traffic conditions on alternate routes. Khoo and Ong (2011) also found that drivers are less likely to divert to alternate routes long in advance, as is necessary with major road closures, if traffic conditions at the VMS location are not congested. Drivers are also less willing to divert from their route if they are unfamiliar with alternate routes or lack detailed directions. The primary limitation found was that most literature concerns detours related to temporary roadway capacity restrictions, whether they be due to congestion or temporary closures. There is limited research related to driver responses to long-term roadway closures or construction.

2.2 Radio and Television

Radio has long been a primary source for traffic information. Its advantage is that it can convey real-time information on incidents and congestion without requiring that driver attention be diverted from the road. Message content can be relatively high and complex, including suggestions for diversion routes around major incidents. This can be particularly effective for localized incidents with clear and limited detour options. In cases like the I-59/20 project where the road closure had regional impacts, the suitability of radio for recommending multiple detour routes is lower.

Emerink et al. (1995) examined the impacts of both VMS and radio traffic information on driver route choice behavior. As with VMS systems, the likelihood of a driver changing their route in response to radio traffic information increased as the quality and detail of the traffic information increased. Driver familiarity with the detour route options also influenced the propensity to deviate from the planned route. The study also found that commuters seemed to be less influenced by radio and VMS information than motorists with other trip purposes.

In 2013, a survey was conducted to gather data on travelers' responses to real-time information provided in radio traffic updates and suggested detours due to the construction work of 8.2 km West Light Rail Transit (LRT) line in the downtown of the city of Calgary, Alberta, Canada (Kattan, 2013). The effects of West LRT line construction on drivers' daily commutes, including increases in travel times, mode choices, alternate route choices, and selection of sources of information on traffic conditions, were the topics of a survey questionnaire. By analyzing survey responses, it was observed that during the construction period, the percentage of respondents who reported private vehicles as their first mode choice dropped over time while the percentage of respondents who favored public transit as their first and second choices rose over time. Radio communications followed by Variable Message Signs (VMS) were selected as the most preferred medium for providing traffic updates and detours advice by the road users.

2.3 Project Websites and Social Media

A paper by Gal-Tzur examined social media usage by a range of transportation providers, including airlines, rail, ferry, and pubic agencies (Gal-Tzur et al, 2014). Common uses were to notify users of service disruptions, disruptions to a main website, or potential disruptions due to weather. Some providers also used social media to respond to user questions or complaints. Bregman and Watkins (2013) provide best practices for the use of social media by transportation agencies. Much of their work focused on the use of social media as a tool for community engagement and to solicit user input, but it also discusses the use of social media for data collection and conveying real-time system information to users. Arizona, for example, has used Twitter to provide real-time traffic information to users during extreme weather events.

Substantial research has been performed on the emerging roles of social media in emergency scenarios. Roy et al. (2021) have used a combination of traffic sensor data and Twitter data to predict evacuation demand for three separate hurricane events in Florida. Li et al. (2021) examined the uses of social media in evacuations from wildfires. Luna and Pencock (2018) found that the use of social media can enhance the spread of information both in terms of speed and reach. In fact, they concluded social media can disseminate information "faster than any other network topology."

Traffic information websites, whether they be Google Maps or public agency websites that provide traffic speed maps and cameras, are helpful for the trip planning stage. The Alabama DOT maintains the ALGO website which includes traffic information and camera views throughout the state (ALDOT 2022). Atlanta experienced dramatically increased use of its own traffic website after the 2017 bridge collapse on I-85 (Douglas 2017). The site CommuteATL logged significant increases in site traffic following the collapse and served as a clearinghouse for information consumed by public officials, smartphone app manager Waze, and the public. However, there was little found in the literature which directly measured the impact of project websites on detour selection for major projects.

2.4 Route Guidance Apps

Route guidance apps have become ubiquitous, both in the form of in-vehicle navigation systems and smartphone apps. They provide several benefits for motorist route choice:

- They can convey real-time information about the transportation network to motorists and allow them to adjust their travel route due to congestion, incidents, or construction;
- They can overcome motorist reluctance to take unfamiliar detour routes by providing turn-by-turn directions;
- They can quantify estimated time savings resulting from route changes, increasing the likelihood of motorists accepting suggested route changes.

As they relate to project detours, one concern is that users of route guidance apps may select detour routes other than those designated as primary detours. This may cause drivers to select alternate routes that are not well suited to the increased traffic volumes or are not designed to accommodate commercial vehicles and large trucks. Truck traffic on routes not designed to handle trucks can lead to damaged pavement, curbing, and utility poles. In many cases, the agency responsible for the roadway project can be held responsible for damage caused by unplanned detour traffic.

A recent STRIDE project studied the impacts of smartphone apps on vehicle routing (Guin 2021). The study led by Georgia Tech conducted a survey of navigation app users and found that they were most frequently used for first-time and infrequent trips. It also found that, when a route guidance app was used, 73% of users stated they followed the suggested routes for 80-100% of trips. Finally, the study found that users generally required a minimum 3-5 minute travel time savings on an alternate route before they would accept a suggested route diversion.

Thai et al. (2016) found that the use of route guidance apps brings both benefits and unintended consequences to the roadway network. They differentiated between routed users who had access to route guidance information and non-routed users who did not have access to real-time traffic information or routing. Non-routed users tended to select high capacity roadway segments such as freeways and major arterials because they are better known routes and easier to navigate through signage. These were opposed to low capacity road segments which are generally intended for local users and not meant to carry through traffic. The study modeled traffic conditions in Los Angeles and determined that GPS route guidance has the potential to significantly reduce gridlock by distributing trips across both high and low capacity roadway segments. However, even small reductions in traffic on high capacity roadways can result in proportionally large percentage increases in traffic on local roadways.

2.5 Summary

Across all information platforms, the willingness of motorists to divert from their originally planned route is influenced by the quality and the detail of the information provided, driver familiarity with the recommended detour routes, traffic conditions on the route where motorists receive the information, and the potential time savings involved. The literature was generally consistent in the finding that motorists were more likely to accept route detours when the information provided was detailed and reliable, regardless of the medium. Information that conveyed the magnitude of potential time savings was also positively correlated with motorist acceptance of detours. The studies, however, tended to look at the different information media in isolation. There was little found in recent literature which examined how motorists behaved when multiple sources of traffic information were available. The goal of this study is to address that subject and provide some guidance on which information sources were most likely to be used during this case study.

3.0 MOTORIST SURVEY

To address the uncertainties related to how drivers select and react to detour information from multiple sources, three primary study tasks were identified:

1. Develop and administer a survey of local motorists to determine the information sources and criteria they used to select detour routes around the interstate reconstruction project. Based on the survey, develop recommendations for disseminating detour information to motorists during large roadway projects.
2. Review the planning modeling that was used to project traffic volumes along detour routes for the I-59/20 reconstruction project. Compare forecast and actual traffic volumes during and after the reconstruction project and identify major discrepancies. Based on these comparisons, develop recommendations for future detour modeling efforts.
3. Analyze traffic volumes and travel time data collected before, during, and after the I-59/20 reconstruction to determine if and how detour patterns changed over the course of the 1-year project.

The methodology and results of the motorist survey are presented in this section. The review of the planning model and post-processing methodology are presented in Section 4. The analysis of traffic patterns before and after the interstate reconstruction project are presented in Section 5. Conclusions are summarized in Section 6.

3.1 Introduction

Long-term road construction often involves road closures that require drivers to use detour routes. In the case of the I-59/20 reconstruction project, the Alabama DOT provided detour information to motorists via a project website as well as other sources including radio and television ads, static signs, electronic variable message signs, and social media. Though the public information effort appeared to be effective, it was not clear the extent to which these various information sources were used by the public to make detour route choices and, importantly, to what extent real-time direction apps were used to select detour routes. To address this question, a motorist survey was developed and administered in the Birmingham region to document preferences and practices of local drivers related to detours. Birmingham is the largest city in Alabama with a population of 207,235 in 2020 and is the 113th largest city in the United States.

3.2 Methodology

In January 2019 the Alabama DOT began reconstruction of the 1.5 mile segment of I-59/20 through downtown Birmingham. The segment extends from I-65 to the west to the Red Mountain Expressway to the east as shown in Figure 3. This section of elevated highway had reached the end of its service life and the decision was made to demolish and rebuild it all at one time, requiring the complete closure of the segment for 1 year. The impacts of this closure were significant. Prior to reconstruction, this segment of I-59/20 carried over 160,000 vehicle per day, which included both local and through traffic. This segment of interstate is one of the primary access routes to downtown Birmingham and its closure created changes to traffic patterns across the region.

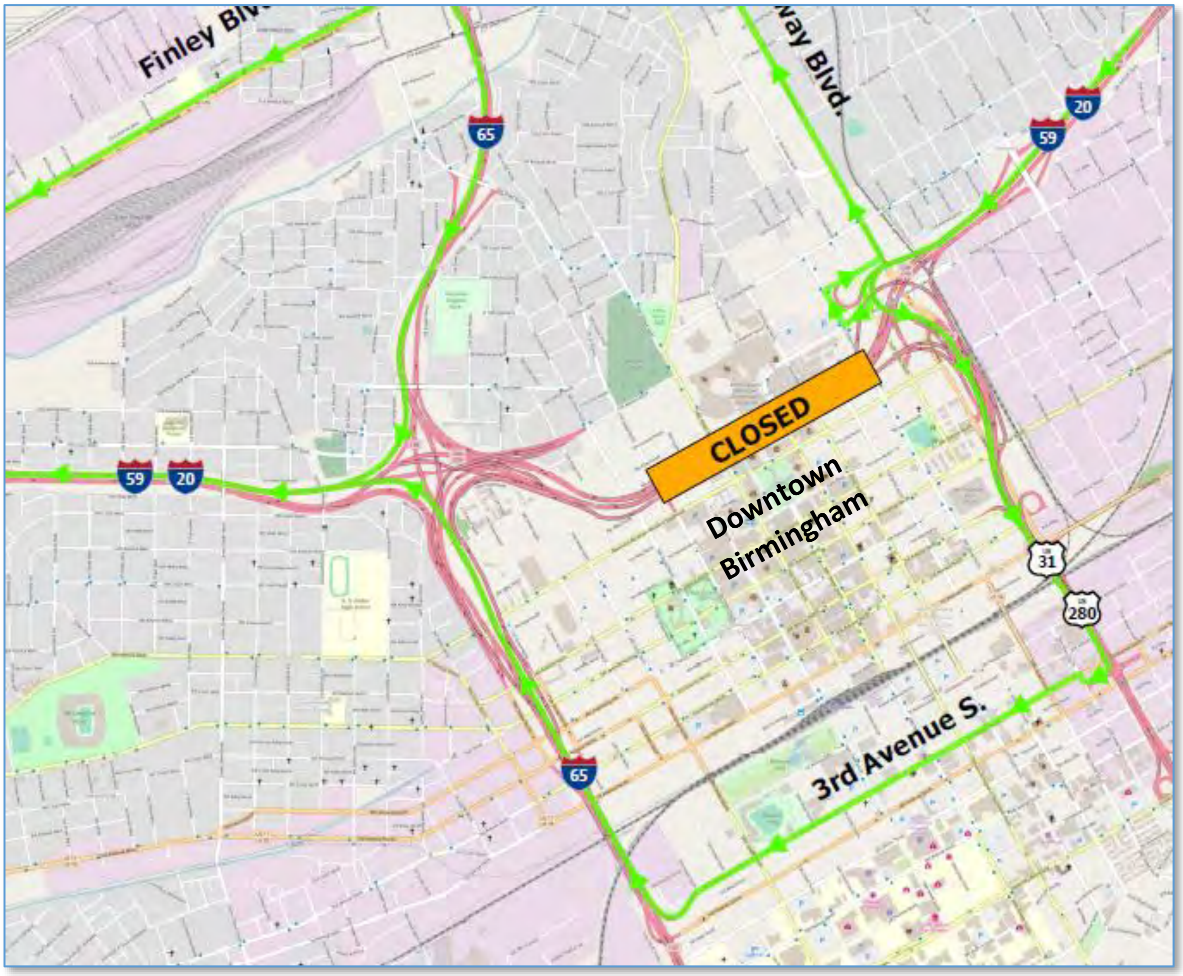


Figure 3. Location of interstate closure (source: ALDOT)

Planning for the closure began over one year prior to the actual start of construction with the hiring of a consultant to develop a planning model, identify detour routes, and estimate traffic volumes along primary detour routes. Sain Associates, Inc. collected traffic counts throughout the downtown area and refined the regional planning model developed by the Regional Planning Commission of Greater Birmingham (RPCGB) to test a variety of detour scenarios. Primary detour routes were identified and conveyed to the public by ALDOT through a range of media, including:

- Static signing along detour routes
- Variable message signs
- A project website (https://5920bridge.com/)
- Radio and television ads
- Press releases
- A public information call center
- Closure information provided directly to route guidance apps

The project website provided maps with recommended detour routes for different approaches to the downtown area. Radio and television ads alerted residents to the project and the need to detour and directed them to the project website and call center. Ads ran for several months prior to the beginning of construction. Variable message signs were provided at 6 locations along interstate routes. The goal of the motorist survey was to gain insight into the extent to which these information sources were used by motorists. More detail on actual detour routes is presented in Sections 4 and 5.

An online survey format was developed to collect information on travelers' behaviors during the period of bridge reconstruction. The Qualtrics Research Core tool was used to prepare the questionnaire as it provided a user-friendly platform. The questionnaire was modified at various stages and was pretested and fine-tuned prior to use to ensure that it was easy for responders to understand and provide answers. The questionnaire asked the motorists about their detour choice(s), information sources used in making detour route choices, impacts of detours on travel times, frequency of taking detours, discomfort associated with the detours, preferred information sources for future road construction projects, route choices at different stages of the project, home and work locations, and demographic information such as gender, age, educational qualification, and vehicle ownership, etc.

After review and approval from the UAB Institutional Review Board (IRB), the survey was distributed by Qualtrics using recommended distribution procedures. The data collection period for the survey was 10/31/2021 – 12/06/2021. The responders who participated in the survey had been living/working in the Birmingham area for the last two years (2019 - 2021). The survey was conducted in the Birmingham, AL region and a total of 320 responses have been used for data analysis. The standard sample size was estimated using the following formula:

$$n = \frac{\dfrac{z^2 \times p(1-p)}{e^2}}{1 + (\dfrac{z^2 \times p(1-p)}{e^2 N})}$$

where n is the sample size, z is the z-score for the corresponding confidence interval, e is the margin of error, N is the population size as per latest Census reports (2021), and p is the standard deviation (assumed to be equal to 0.5).

The collected data were carefully verified to ensure that respondents were from the Birmingham area by checking the residence and work locations for each response. Responses that did not pass validation tests were deleted from the database and new responses were added to replace those that were excluded. Excel was used to analyze the data, as were Qualtrics's advanced data analysis and reporting resources to generate visualizations of the results. A complete copy of the survey form is provided in Appendix B.

3.3 Survey Results

Among 320 survey participants, 57.19% were female, 42.19% were male, and 0.63% self-identified as other. Table 1 summarizes the demographic information of the survey respondents. Approximately 40% of respondents in the 35-44 years age range and the majority (~60%) of them were white. Most of the respondents (54.4%) drove a car or SUV.

Table 1: Demographic profile of survey responders

Age		Race		Education		Vehicle Type	
classification	**%**	**classification**	**%**	**classification**	**%**	**classification**	**%**
Under 18	0	White	58.4	Less than high school degree	2.81	SUV/Sedan	54.37
18 - 24	10	Black/ African American	36.7	high school graduate	22.81	Pickup/Truck	11.41
25 - 34	32.5	American Indian/ Alaska Native	2.5	some college but no degree	21.25	Motorcycle	3.4
35 - 44	39.1	Asian	1.2	Associate degree in college (2 years)	9.7	Taxi/Uber/Lyft /other similar service	8
45 - 54	12.8	Native Hawaiian/ Pacific Islander	0	Bachelor's degree in college (4 years)	20.94	Commercial vehicle	6.31
55 - 64	2.5	Other	1.2	Master's degree	14.69	Public transit	6.31
65 - 74	2.8			Doctoral Degree	2.5	Coupe	10.19
75 - 84	0.3			Professional degree	5.31		
85 or older	0						

Approximately 58% of responders reported that the bridge construction directly affected their commute to and from work while 42% said that it impacted other trip types such as shopping or school. When participants were asked whether they felt anxious about the potential impact of the bridge construction project on their travel, almost 94% responded positively (yes: 59.69% and somewhat: 34.69%) (Figure 5).

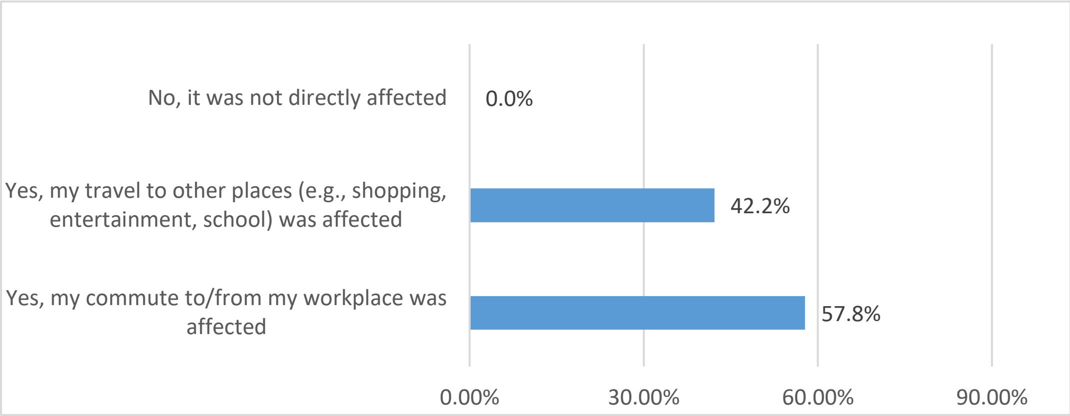


Figure 4. Was travel impacted by the reconstruction project?

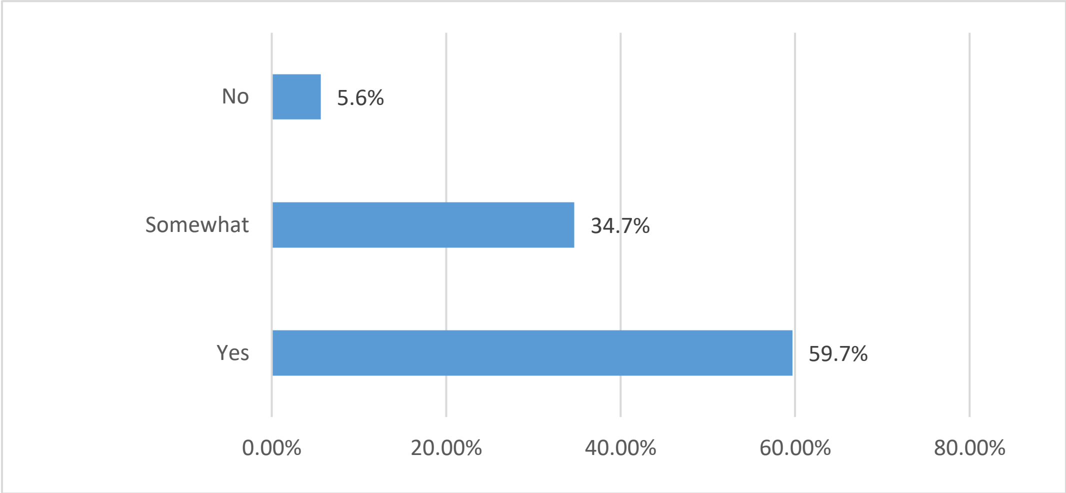


Figure 5. Were you anxious about the potential impacts of the project?

3.3.1 Participants’ Detour Responses

When asked if they had used one of the ALDOT designated detour routes for their daily commute during the reconstruction, 72% of respondents said that they had. 24% of respondents said they did have to detour but selected their own route. Only 4% said they did not have to detour during the project.

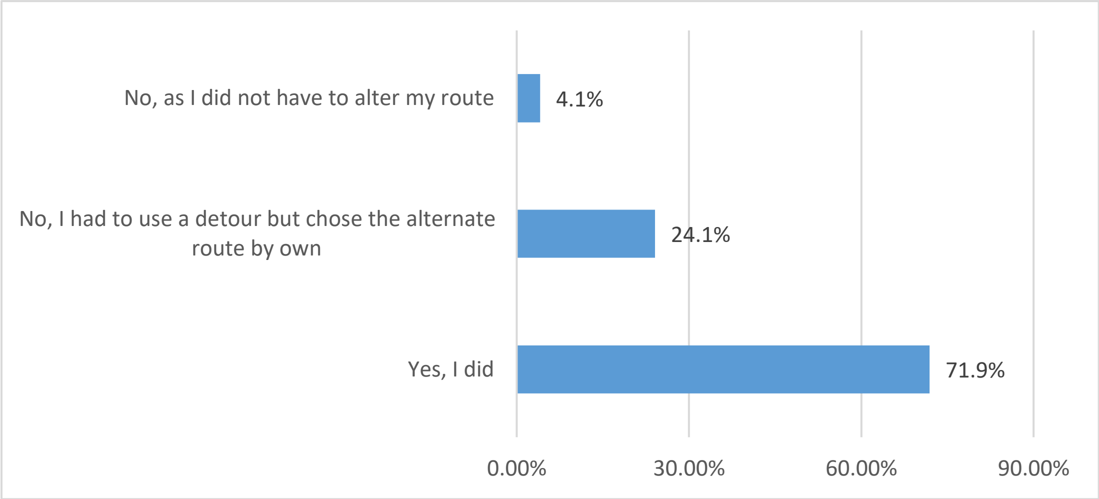


Figure 6. Did you use an ALDOT designated detour route?

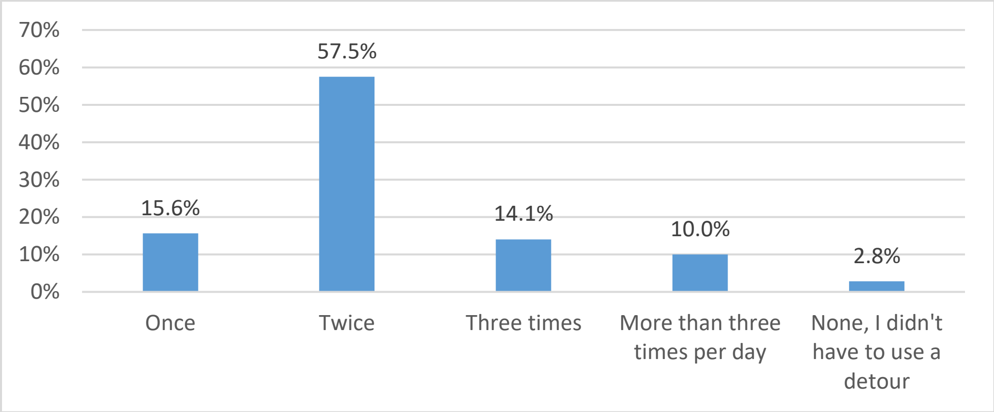


Figure 7. How many times per day did you typically need to detour?

A majority of respondents needed to detour from a previously standard route at least twice per day (Figure 7). When asked the primary source of information used to select a detour route, the most common response was a GPS navigation app such as Google Maps or Waze, accounting for nearly 25% of respondents. Television/radio traffic reports and ads were cited by another quarter of respondents. 14% of respondents said that they used the ALDOT project website to select a detour route and another 12% cited social media. The ALDOT call center was cited by just 2.5% of respondents. (Figure 8)

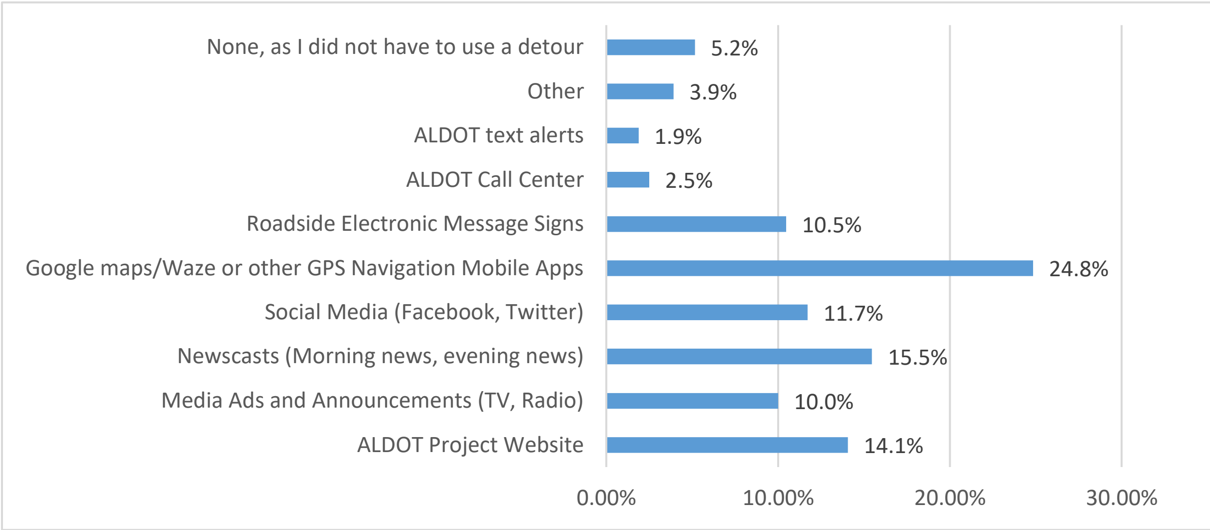


Figure 8. Primary sources of information used to select detour routes

Since most of the participants were using at least one detour per day, they were asked if the detour added more time to their travel for each direction. Analysis of their responses revealed that 17% did not experience much change on their travel times. However, 58% of the responders reported that the detour added 15 minutes to their travel time in each direction, with 21% and 5% reporting delays of about 30 minutes, and over 30 minutes respectively (Figure 9).

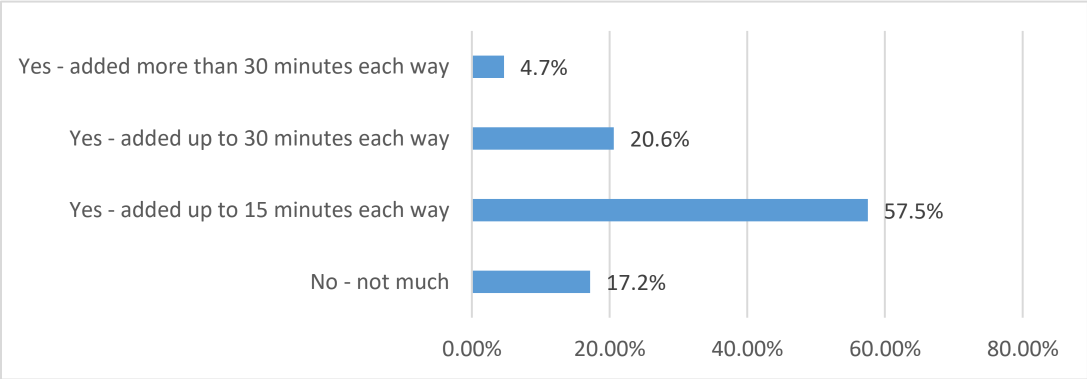


Figure 9. Impacts of detours on travel time

Participants were asked if they changed their detour routes during the reconstruction project. Approximately 45% said that they did check information sources and updated their routes accordingly. 30% said that they regularly consulted a navigation app for the best detour routes, while about 22% stated that they used mostly the same detour routes throughout the project.

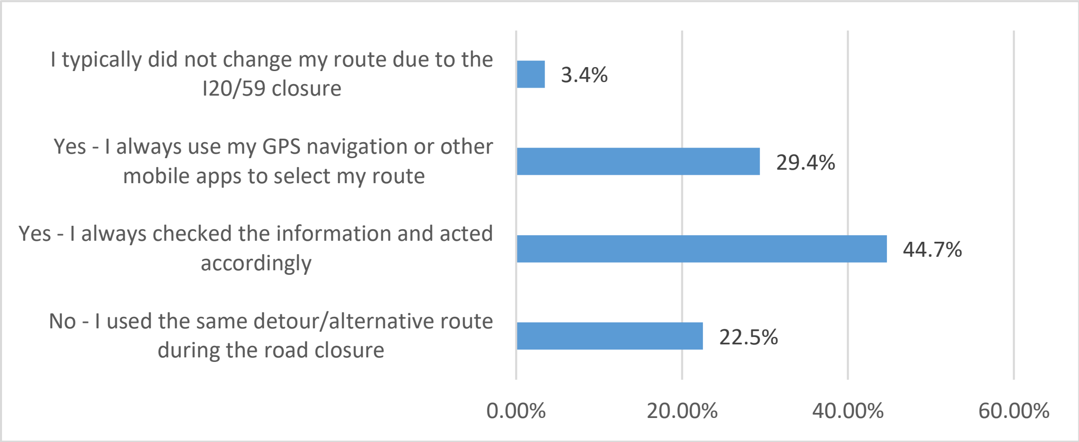


Figure 10. Did your detour routes change during the project?

Figure 11 summarizes the discomfort experienced by respondents associated with the use of detours. 17% said they managed without any problem while another 68% said they managed inconveniences reasonably well. Approximately 15% stated that the use of detours had a negative impact on their lives and/or created significant inconvenience.

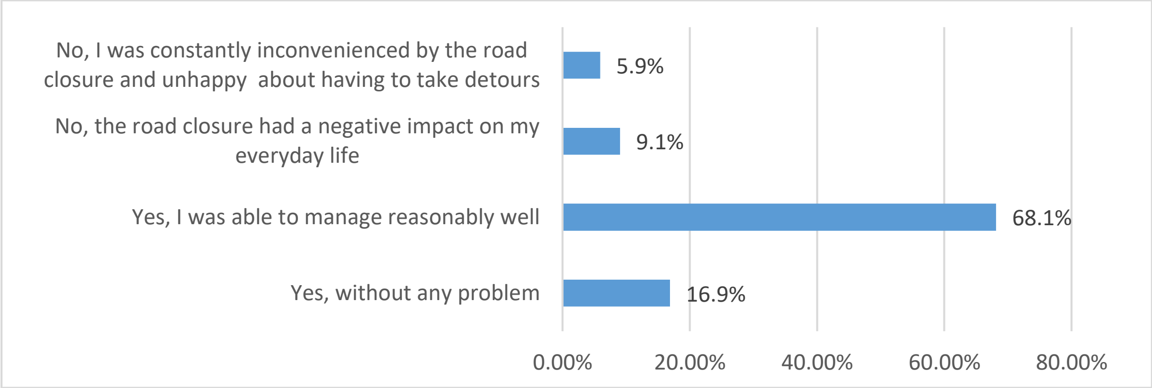


Figure 11. Discomfort associated with detours

After the completion of the project, approximately 84% of respondents said they returned to the standard routes they had been using prior to the bridge reconstruction. 14% said they continued to use their detour route and approximately 3% said their route had not changed at all (Figure 12).

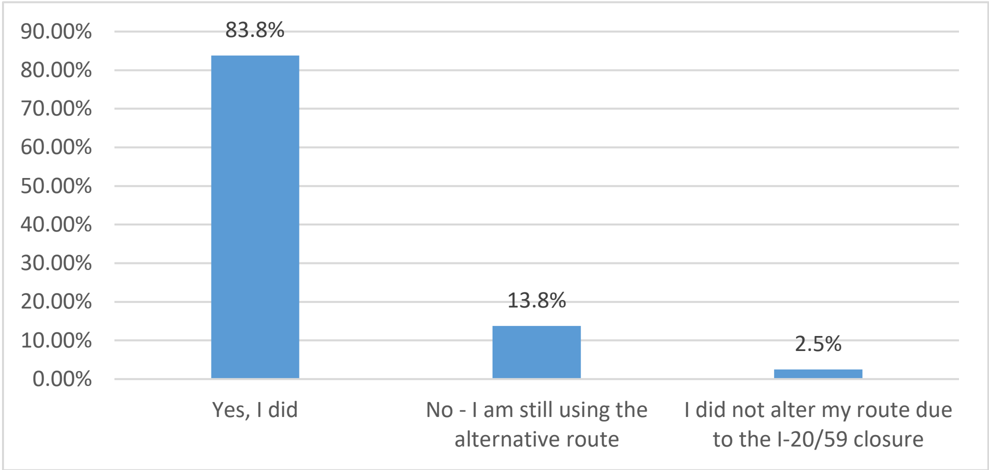


Figure 12. Did you return to your old routes upon completion of the project?

The survey participants were also asked about their preferred methods of being informed about future road construction projects and detours. 22% said they would prefer to use navigation apps such as Google Maps and Waze. 37% said they would prefer to receive information through radio and television, both through live traffic updates and informational ads. Although only a few percent of respondents said they used the ALDOT project website for the reconstruction, over 14% said they would use one in the future. Social media updates were also listed by 15% of respondents as a preferred information source. What was interesting about the responses was that no one information source was listed significantly higher than all others, meaning that highway agencies should continue to use a variety of media sources to convey information to motorists.

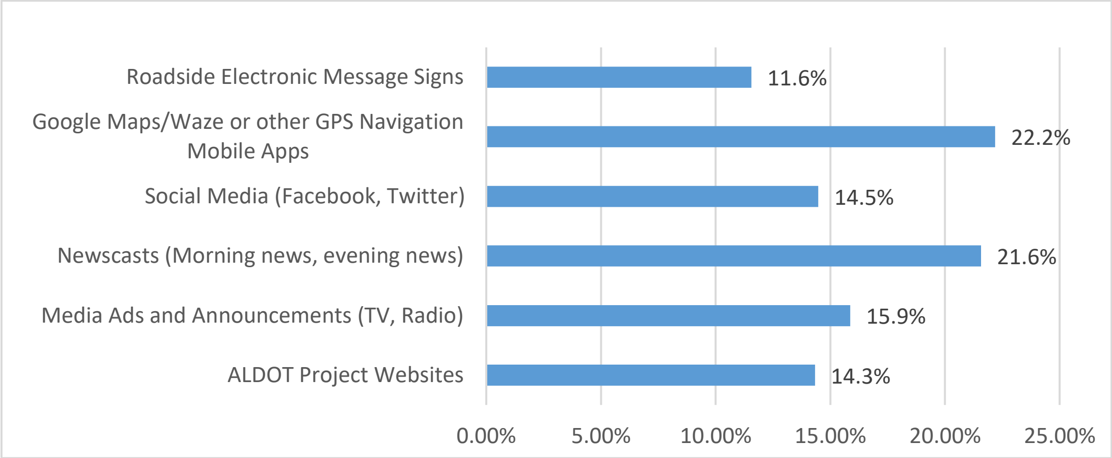


Figure 13. Preferred methods of receiving future detour information

3.3.2 Additional Analysis of Detour Users

The analysis of affected travel time (Figure 14) shows that commuting trips were more likely than other trip types to experience significant increases in travel time due to detours. This is likely because commuters typically have less flexibility to adjust the times of work trips.

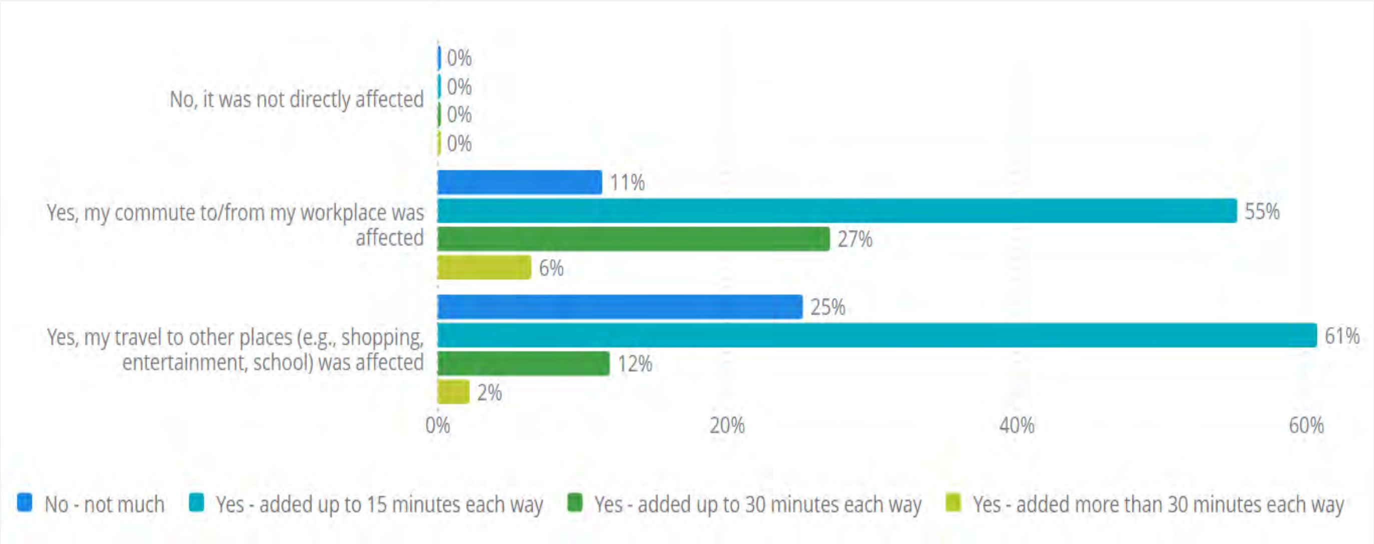


Figure 14. Detour impact on trip length by trip type

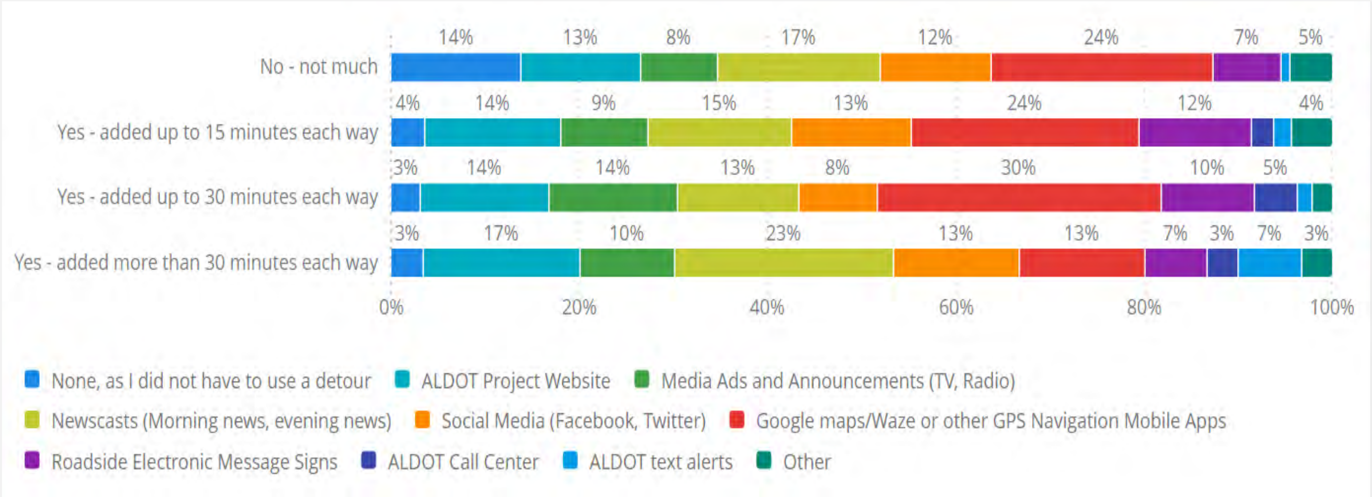


Figure 15. Travel time versus information source used to select detour route

Figure 15 provides detail on the additional travel time reported by respondents versus the primary information source used to select the detour route. Navigation apps were the most commonly used information source among those who reported 15 minutes or less additional travel time. Radio and television newscasts were the most commonly used information source among motorists who reported the longest additional travel times. Social media use was found to be similar among those who reported both the lowest and highest additional travel times. Figure 16 shows the classification of the affected travel time among the daily detour users. Most of the travelers taking a detour (once, twice, thrice and more than thrice) revealed the addition of 15 minutes in their travel each way. 22% of motorists who did not take a detour routes still reported increases in their travel times due to new traffic patterns.

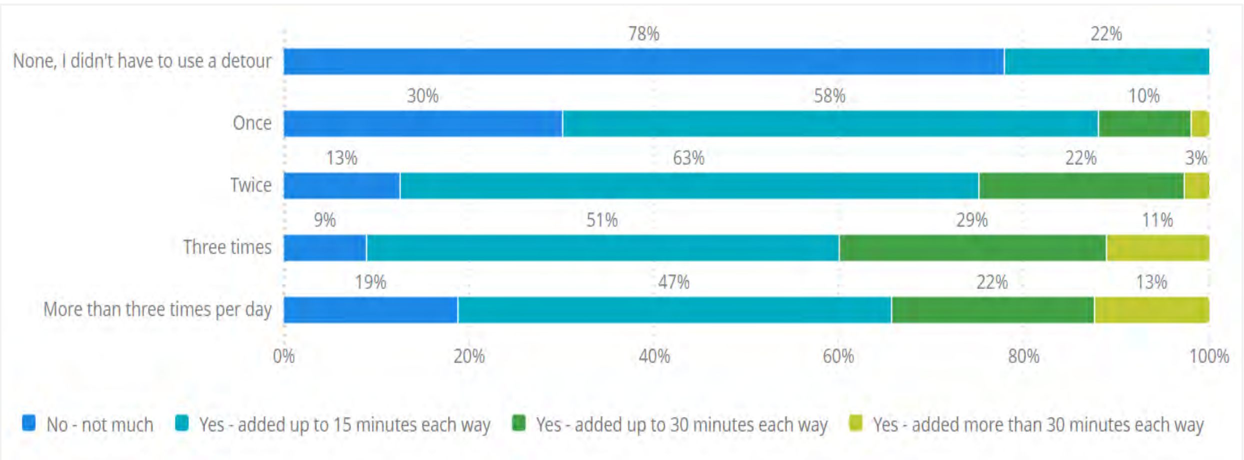


Figure 16. Additional travel time versus frequency of detours

When the detour users were asked about their preferences on receiving information/ notification for future road construction projects, the most popular choice was via navigation apps. However, radio, television, and social media were also ranked highly, highlighting the need to provide information across a variety of media platforms (Figure 17).

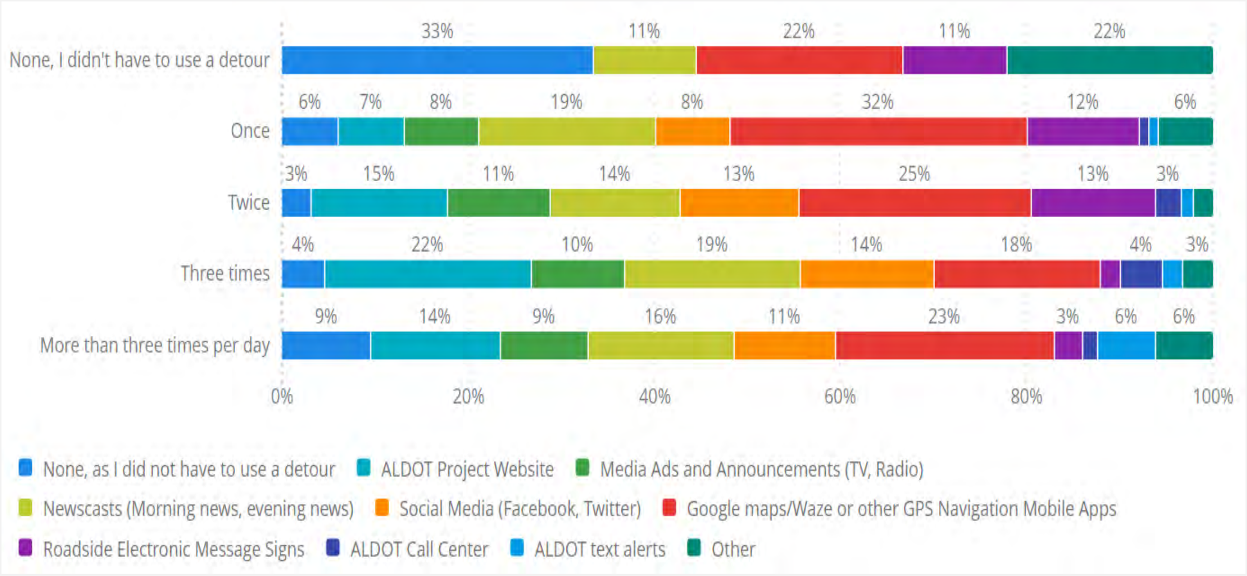


Figure 17. Information source used versus detour frequency

Detour users were asked if they used the same route every day during road construction or if they changed their route at different phases of the project. Most respondents said they consulted traffic and detour information sources throughout the project. Only a small portion of detour users (approximately 20%) stated they used the same route throughout construction (Figure 18).

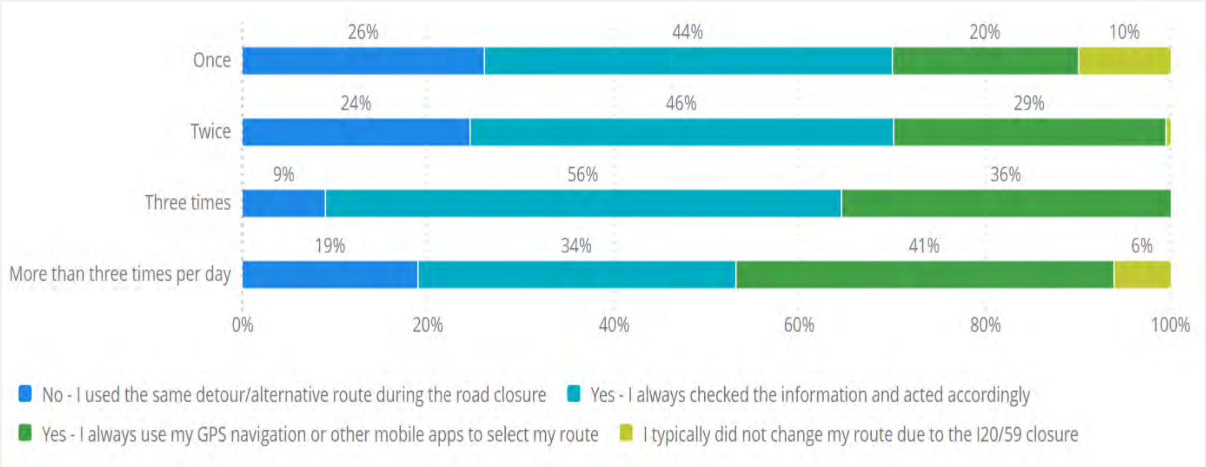


Figure 18. Use of information sources throughout the project

3.4 Summary and Conclusions

All of the survey participants reported that the interstate reconstruction project directly impacted their travel. Even the small percentage who reported that they did not have to seek a detour route said that their everyday travel was impacted by other motorists detouring to their regular travel routes and impacting travel times. Overall, 96% of respondents reported that they used detour routes either designated by ALDOT (72%) or selected on their own (24%). 58% of respondents said that they typically used a detour route twice per day, with an additional 24% reporting that they used a detour route three or more times per day. When the users were asked about the information sources used for selecting a detour route, navigation apps were the most cited (24%), followed by radio and television newscasts (15%), and the ALDOT project website (14%). Other media cited as primary sources for detour route selection includes radio and television ads (10%), social media (12%), and roadside signs (11%). Only 2.5% of respondents reported using the ALDOT call center as a primary source for detour information.

58% of respondents reported that using a detour added up to 15 minutes of travel time to their normal travel time each way, while 21% reported that using a detour added up to 30 minutes. 60% of the detour users used the detour route twice a day and ~53% of them added 15 minutes more to the travel time each way. For detour users whose trips were lengthened by 15 minutes each way, how they chose the routes varied: 24% used navigation apps, 15% used radio and television newscasts, and 14% used the ALDOT project website. For detour users whose trips were lengthened up to 30 minutes, navigation apps were more likely to be used to select their detour route than any other source and they were less likely to cite roadside signs or VMS.

After the completion of the project, approximately 84% of detour users stated they returned to their pre-construction commuting routes. When asked what information sources they would prefer to use for future road construction projects, respondents cited navigation apps (22%), radio and television newscasts (22%), media ads (16%), social media (15%), and project websites (14%). Interestingly, road signage and VMS ranked lowest among the preferred information sources at (12%).

The survey indicates that despite the prevalence of smartphones and navigation apps, motorists continue to use a wide variety of information sources to select detour routes. Navigation apps were reported to be the most popular source for traffic information and detour routing, but they were still only cited by about a quarter of respondents as the primary source of information used to select a detour route. It appears there are opportunities to expand the use of social media/ instant messaging to convey important traffic and detour information to the public, as a significant portion of respondents indicated this would be their preferred method of receiving information in the future.

This survey did have several limitations. First, it was administered online and so may not accurately represent the driver population of the region. The responses may be skewed toward motorists who are more active on the internet and social media. Second, the survey population primarily comprised area residents who were making local commutes and home-based trips. It did not include motorists who were passing through the region, as there was no simple way to locate these users. However, it appears most of these pass-through trips used interstate detours that had little impact on the downtown detour routes. Finally, the driver population was comprised primarily of non-commercial roadway users. Future surveys would need to be directed at commercial vehicle operators to determine if their information sources differ significantly from non-commercial roadway users.

4. REVIEW OF THE PLANNING MODEL

Detour planning for large and long-duration roadway projects frequently involves the use of planning models to forecast traffic volumes along the detour routes. These forecasts can help public agencies identify modifications within detour corridors to accommodate the projected increases in traffic, such as signal timing changes and geometric modifications. In the case of the I-59/20 reconstruction project, a regional planning model was used to estimate detour volumes since the interstate closure was expected to have regional impacts. Sain Associates, Inc. used the Regional Planning Commission of Greater Birmingham (RPCGB) regional planning model (CUBE Voyager) to model the interstate closure and estimate new traffic patterns. The daily volume estimates generated by the planning model were then used to develop peak hour volume estimates along the detour routes using post-processing procedures described in the National Cooperative Highway Research Program (NCHRP) publication 765.

The purpose of this study task was to review the effectiveness of both the planning model and the NCHRP 765 procedures in forecasting detour patterns and volumes. The traffic forecasts developed for the I-59/20 project study were compared to traffic counts collected during and after construction of the new I-59/20 bridge in downtown Birmingham. This task also compared the daily RPCGB model forecasts to daily volumes pulled from the ALDOT website in the study area. As the RPCGB model (like most travel demand models) is estimated from daily household surveys, it is most appropriate to compare daily volumes when evaluating model performance. The peak hour intersection forecasts were compared to the peak hour counts to evaluate the NCHRP 765 post processing procedures and identify opportunities to improve the post processing procedures.

4.1 Transportation Model Study Area

The evaluation of the planning model focused on the downtown area of Birmingham, as this was the most complex portion of the detour model. The detour routes for trips passing through the region (X-X) were largely focused on I-459 and I-65 and therefore more easily planned for. Primary detour routes identified for traffic accessing downtown or passing through the downtown area are highlighted in Figure 19. Specific intersections modeled for detour planning are highlighted in Figure 20. Specific intersections studied for this task are listed below:

2019 Study Intersections (during construction):

1. 12th Avenue N at 22nd Street N
2. Carraway Boulevard at 15th Avenue N
3. 18th Street N at Reverend Abraham Woods Jr. Boulevard
4. 18th Street N at 10th Avenue N
5. 17th Street N at 11th Avenue N
6. Carraway Boulevard at 11th Avenue N
7. Carraway Boulevard at 12th Avenue N
8. 22nd Street N at 11th Avenue N

9. 26th Street N at Carraway Boulevard
10. 31st Street N at 12th Avenue N
11. 26th Street N at Reverend Abraham Woods Jr. Boulevard
12. 25th Street N / I-59/20 Ramps at Richard Arrington Jr. Boulevard
13. 19th Street N at Reverend Abraham Woods Jr. Boulevard

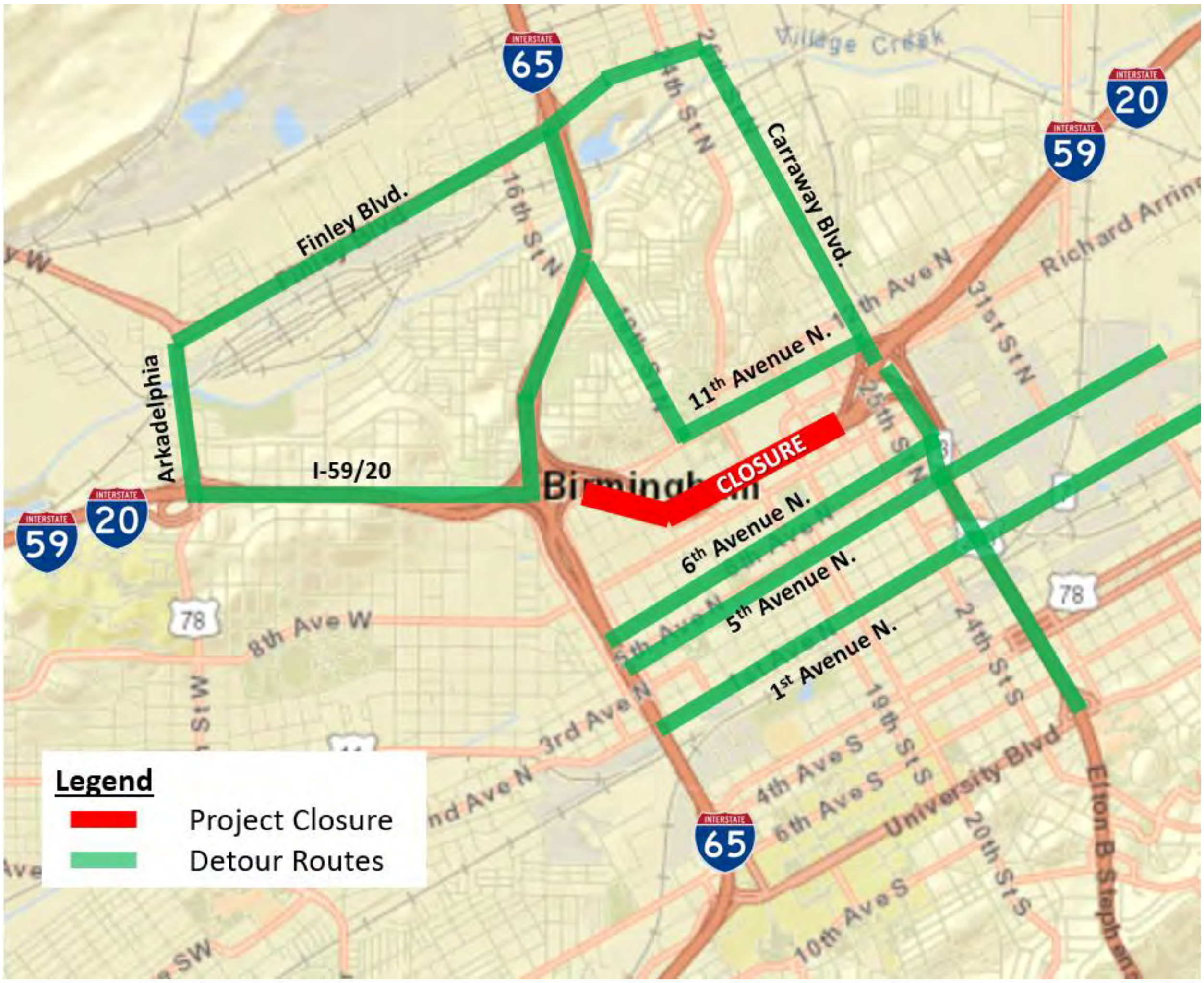


Figure 19. Project closure and primary designated downtown detour routes

2020 Study Intersections (post construction/pre-COVID):

1. Richard Arrington Jr. Boulevard at 1st Avenue N
2. 11th Avenue N / I-65 NB Exit Ramp at 3rd Avenue N
3. 22nd Street N at 5th Avenue N
4. 17th Street N at 11th Avenue N
5. 19th Street N at 11th Avenue N
6. Carraway Boulevard at 11th Avenue N
7. Carraway Boulevard at 12th Avenue N

8. 31st Street N at 12th Avenue N
9. Carraway Boulevard at 15th Avenue N
10. 26th Street N at 6th Avenue N / I-59/20 Exit Ramp
11. 26th Street N at Carraway Boulevard
12. 31st Street N at I-20 EB Ramps
13. 31st Street N at I-20 WB Ramps
14. Carraway Boulevard at Finley Boulevard
15. 22nd Street N at Richard Arrington Jr. Boulevard
16. 25th Street N at Richard Arrington Jr. Boulevard
17. 26th Street N at Reverend Abraham Woods Jr. Boulevard
18. 17th Street N at Reverend Abraham Woods Jr. Boulevard
19. 26th Street N / Carraway Boulevard at 1st Avenue N

4.2 Model Projections for Detour Volumes during Construction

Existing traffic counts were collected at all study intersections shown in Figure 20 during 2017. The Cube planning model was then used to model the closure of the I-59/20 bridge structure and associated interchanges and the subsequent impacts to downtown surface streets. Daily volume projections were developed for each study intersection, and these volumes were processed using NCHRP 765 methods to develop AM and PM peak hour traffic projections for the detour routes during construction.

The projected detour volumes were used to perform HCM capacity analysis and identify potential capacity issues on the downtown network. Summaries of the projected levels of service along the primary detour routes are shown in Figure 20. Specific findings included:

- There was the potential for significant delays at multiple intersections along Carraway Boulevard during the peak hours. It was anticipated that Carraway Boulevard would be one of the primary detour routes for motorists seeking to bypass the closure and continue either eastbound or westbound along I-59/20 or to I-65.
- It was projected that the two primary E-W detour routes, 5th Avenue North and 6th Avenue North, would be able to accommodate detour volumes at acceptable levels of service. This is because both streets were one-way and operated well below capacity.
- The original modeling study made assumptions that motorists would need to re-distribute to other undesignated detour routes during peak hours to avoid capacity bottlenecks along Carraway Boulevard and Finley Boulevard.

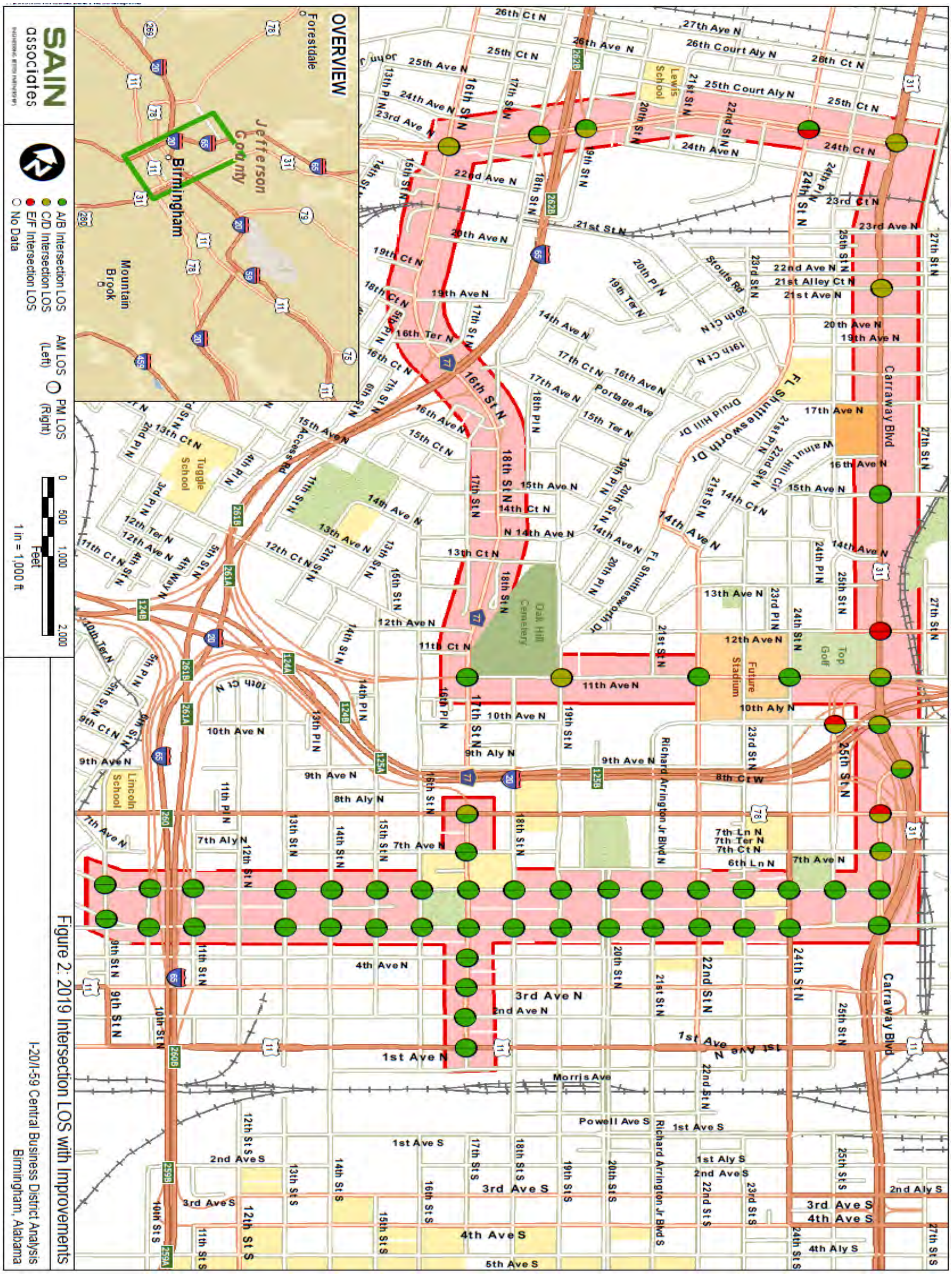


Figure 20. Projected Peak Hour LOS along key detour routes (source: Sain Associates)

Based on the capacity analysis, geometric improvements and changes to signal timing were implemented along primary detour corridors. A brief summary of improvements included:

- Modifying signal phasing and timing along Finley Boulevard to increase capacity for east-west detour movements. Also extending turn lanes at several intersections along Finley Boulevard and adding turn lanes at several others.
- Modifying signal phasing and timing along Carraway Boulevard to increase capacity for north-south detour movements. Also adding turn lanes at several intersection along Carraway Boulevard and extending turn lanes at several others.
- Providing enhanced signing along all detour routes to clarify movement priorities.
- Increasing the cycle length at major detour intersections from 80 seconds to 160 seconds during peak AM and PM periods.

Traffic counts were collected at key intersections along the designated detour routes during the interstate reconstruction in September 2019. These counts were compared to the original model projections to determine how accurate the initial detour forecasts were. The major findings from the comparisons were:

- The planning model significantly over-estimated the detour volumes along Carraway Boulevard. The projected peak hour detour volumes along Carraway Boulevard north of I-59/20 were approximately twice the actual measured detour volumes. This is significant because this was expected to be the primary detour route for traffic wishing to continue along the interstate through downtown.
- The planning model detour forecasts were also significantly higher than the measured traffic volumes along 11th Avenue North in the area immediately north of the project. In fact, model projections were 3 to 5 times greater than the measured peak hour volumes in this area, indicating that this detour route was not nearly as heavily used as anticipated.
- Projected peak period detour volumes along 5th Avenue North and 6th Avenue North were generally within 15-20% of actual counts, though the volumes generated by the planning model were generally higher than actual volumes.

4.3 Model Projections for Detour Volumes Post-Construction

The Cube planning model was also used to forecast traffic volumes post-construction, as there were several new interchange configurations associated with the reconstructed interstate. Model projections were compared to traffic counts collected during February and March 2020 (post-construction but pre-COVID shutdown). Since the original traffic projections were made for year 2025, the traffic counts collected in 2020 were factored to account for expected growth between 2020 and 2025. Note that these comparisons were not restricted to detour routes. Major findings from the volume comparisons were as follows:

- The travel demand model over-simulated Carraway Boulevard by a factor of approximately 1.5 in the post-construction conditions.
- The year 2025 forecasts were consistent with the factored post-construction counts in the area around 26th Street North.
- The travel demand model over-simulated 1st Avenue east of US-31 by a factor of approximately 1.5 for post construction conditions.
- The travel demand model over-simulated 11th Avenue North approaching the I-59/20/65 on ramps by a factor of approximately 2 for post-construction conditions.
- The travel demand model over-simulated Richard Arrington Boulevard by a factor of approximately 1.5 east of 17th Street North.
- The year 2025 forecasts were consistent with the factored post-construction counts on 11th Avenue North.
- The travel demand model year 2025 forecasts were consistent with traffic counts in the north grid/business district, particularly in the area around 1st Avenue North and 21st Street North.

The comparison of the peak hour traffic counts to forecasts illustrated the following trends:

- The travel demand model consistently over-simulated traffic volumes in the Carraway Boulevard corridor. As the intersection forecasts were developed using the model daily forecasts, the intersection forecasts along Carraway Boulevard were higher than observed counts for both construction and post-construction conditions.
- The post-construction forecasts were noticeably closer to the actual traffic counts than the construction condition forecasts.
- Generally, lower volume movements had the largest percent difference which is expected as a left turn movement with an absolute difference of 4 vehicles between the counts and the forecasts would be considered highly converged if the left turn volume were 150 vehicles; however, if there are only 5 left turns, this would lead to a significant percent difference.

4.4 Summary and Conclusions

Based on the review of the traffic counts and forecasts, it was determined that, overall, the travel demand model performed better in post-construction conditions than construction conditions which is to be expected as travel demand models are developed to reflect a typical weekday and not transient conditions as would occur during construction. During the I-59/20 bridge closure, a number of changes occurred in trip- making behavior that impacted the actual peak hour demand for the roadway network including:

- Major employers in downtown Birmingham, including the City of Birmingham, Alabama Power, UAB, and Regions temporarily adjusted their workplace policies to increase telecommuting.

- Many employers in the downtown/UAB area allowed flexible schedules during construction which shifted demand from the peak hour to other hours of the day.
- Truck traffic was re-routed on specific routes through downtown. As trucks impact traffic operations significantly at intersections, this is an important consideration for the forecasting process.

The most practical approach to address the telecommuting behavior would have been to redistribute employment from the downtown area to transportation analysis zones that are consistent with the workers home locations. Longitudinal Employer-Household Dynamics (LEHD) data or Big Data could be used to determine home locations for these workers. This simple adjustment to the demographic file would reduce the number of trips from suburban areas to the downtown/UAB area while adding some short trips in the suburban areas of the region which would be more consistent with field conditions.

The RPCGB model used in this study has a time-of-day model which could be adjusted to reflect the shifts in departure times. However, the model script estimates time of day by vehicle type based on regional productions and attractions. It would require significant adjustments to the existing time-of-day model script to isolate zones in the downtown/UAB area where construction specific time-of-day factors would be applied. Truck routes can be captured in a planning model by only allowing trucks to access the highway links in the model that are associated with specific truck routes. This is a relatively straightforward exercise that can be completed in the Cube GIS interface.

The following recommendations are presented to improve the travel demand model and NCHRP 765 post-processing procedures:

1. Conduct a full cordon study around the construction area and compare the total volume at each cordon line to the total model volumes. This exercise should be completed for construction and post-construction conditions. Big Data could be utilized for this analysis. This is the only way to identify if there are issues with the model trip generation, distribution, or a combination of both.

2. After completing the cordon study and identifying the full extent of trip generation and/or distributions issues in the model, additional screenline analysis would need to be conducted across the model region to determine if the issues are isolated to the construction area or if they persist throughout the entire region. This has significant implications in the level of effort required to adjust the model script as it is much more direct to make region-wide adjustments than adjustments specific to a construction area.

3. The fundamental challenge with intersection forecasting for detour planning is the lack of integration between the regional travel demand model and the traffic analysis tools that the intersection forecasts are fed into. As regional travel demand models do not have traffic control, the impacts of signal timing and intersection geometries are not captured. As these items directly impact the traffic flow through the intersection, integrating traffic models into the regional travel model process is a key to improving the intersection forecasting process.

   To overcome this challenge during the modeling process for this study, the travel demand modeler worked directly with the traffic engineer to manually constrain forecasts based on practical roadway capacity (accounting for bus stops, parking, pedestrians, and other urban activities not captured in the travel demand model that would impact capacity), intersection geometry, and traffic control.

4. Currently, regional travel demand model daily forecasts are post processed using NCHRP 765 procedures to capture the difference between the base year model validation and traffic counts. These refined forecasts are then used to develop growth factors for existing peak hour link volumes. The peak hour link forecasts and the existing intersection counts are then used to develop the future year intersection forecasts. This process is conducted under the assumption that travelers would not change routes based on specific intersection delays, which is not the case in the field. To best address this behavior and fully integrate the traffic modeling and travel forecasting processes, a dynamic traffic simulation could be utilized in the intersection forecasting process. Regional model trip tables can be re-estimated to reflect peak hour conditions, and the re-estimated trip tables can be assigned dynamically in the simulation model. This process would capture the impacts of traffic control and intersection geometries on future travel demand by dynamically rerouting vehicles away from the most congested intersections to less congested intersection until overall system delay is minimized.

   While this process would improve the intersection forecasting process, it is currently labor intensive from the standpoint of network coding and the dual calibration of the travel demand model trip tables and the traffic simulation model. The effort for this process would be significantly more than the current processes using a regional travel demand model, NCHRP 765 procedures, and the highway capacity traffic analysis software.

5. An immediate adjustment that could be made to the current process would be to adjust the existing k-factors used to develop the peak hour link forecasts as a function of the estimated number of employees in the study area that are projected to work from home during construction. This approach could be used for future construction projects and to evaluate scenarios such as the impacts of a pandemic.

6. It is also recommended that a detailed review of the functional class and area type be conducted for the roadway links in the vicinity of the construction zone and along all major detour routes. In the case of this study, it appears the capacities for some of the major detour routes, such as Carraway Boulevard, were set too high in the travel demand model. Adjustments to the capacity lookup tables could be made to account for unique urban forms in the vicinity of major projects, including increased transit, pedestrian, and parking activity.

7. It is important to point out that traffic counts are collected on a specific day that is assumed to be reflective of typical weekday conditions for the entire year. While this is mostly the case, there are a number of reasons that traffic counts can be erroneous, including:

   - Manual error on the part of the data collection technician
   - Incidents upstream of the manual count locations that impact traffic volumes
   - Incidents on parallel facilities that impact traffic flow on the study corridor

   Given these factors, it is important to either collect traffic counts at the same intersection for a minimum of two days on Tuesday, Wednesday, or Thursday, or use Big Data to verify if the collected traffic counts are indeed consistent with typical weekday conditions.

8. Finally, it is important to collect transit ridership data in the construction area and compare it to the ridership in the travel demand model as mode choice directly impacts the trip tables used in highway assignment.

5.0 ANALYSIS OF DETOUR PATTERNS DURING THE PROJECT

During the I-59/20 reconstruction, the Alabama Department of Transportation designated detour routes both for local traffic (downtown) and through traffic that would normally use I-59/20 to pass through the region. Traffic passing through the region was primarily directed to detour around the construction area by way of I-459 and I-65. Motorists wishing to access the downtown area were detoured onto a number of alternate routes north and south of the construction zone. The purpose of this study task was to examine traffic patterns during the reconstruction project and answer three questions:

1. Did motorists generally use the designated detour routes?
2. Did detour patterns change over the course of the one-year project?
3. After the project was completed, did traffic return to pre-construction patterns?

Using available traffic counts and travel time data collected before, during, and after the reconstruction project, we attempted to answer each of these questions.

5.1 Detour Patterns for Regional Through Traffic

The Alabama DOT designated detour routes for external traffic passing through the region. Through traffic refers to vehicles whose origin and destination lie outside the greater Birmingham area and who would normally use I-59/20 to pass through Birmingham. Figure 21 shows the ALDOT recommended detour routes for eastbound/northbound through traffic on I-59/20 and Figure 22 shows the recommended detour routes for westbound/southbound through traffic. These recommended detours were published on the ALDOT project website prior to construction. Anticipating that motorists from outside the region were not likely to have visited the project website or seen local media, variable message signs were also located in advance of key decision points entering the region.

5.1.1 Analysis of Volume Data

It was anticipated that the majority of through traffic on I-59/20 would use the I-459 detour around the south side of the city. Volume data was collected from permanent count stations along I-459, I-65, and I-59/20 for the years 2018, 2019, and 2020. Count data collected by Jefferson County on state and county routes was also compiled for the years 2018 - 2020.

Traffic counts were first analyzed along screen lines east and west of the City to determine if traffic volumes entering the Birmingham region changed in response to the interstate closure (i.e., motorists selected new routes to bypass the region). The screen lines are shown in Figures 23 and 24. The volume data indicate that average daily traffic volumes entering the Birmingham metro area from the east increased by approximately 1% from 2018 (pre-construction) to 2019 (during construction). Similarly, average daily traffic volumes entering the Birmingham metro area from the west were essentially unchanged from 2018 to 2019. Thus, it does not appear that there was any significant diversion of traffic away from the Birmingham area during the interstate closure.

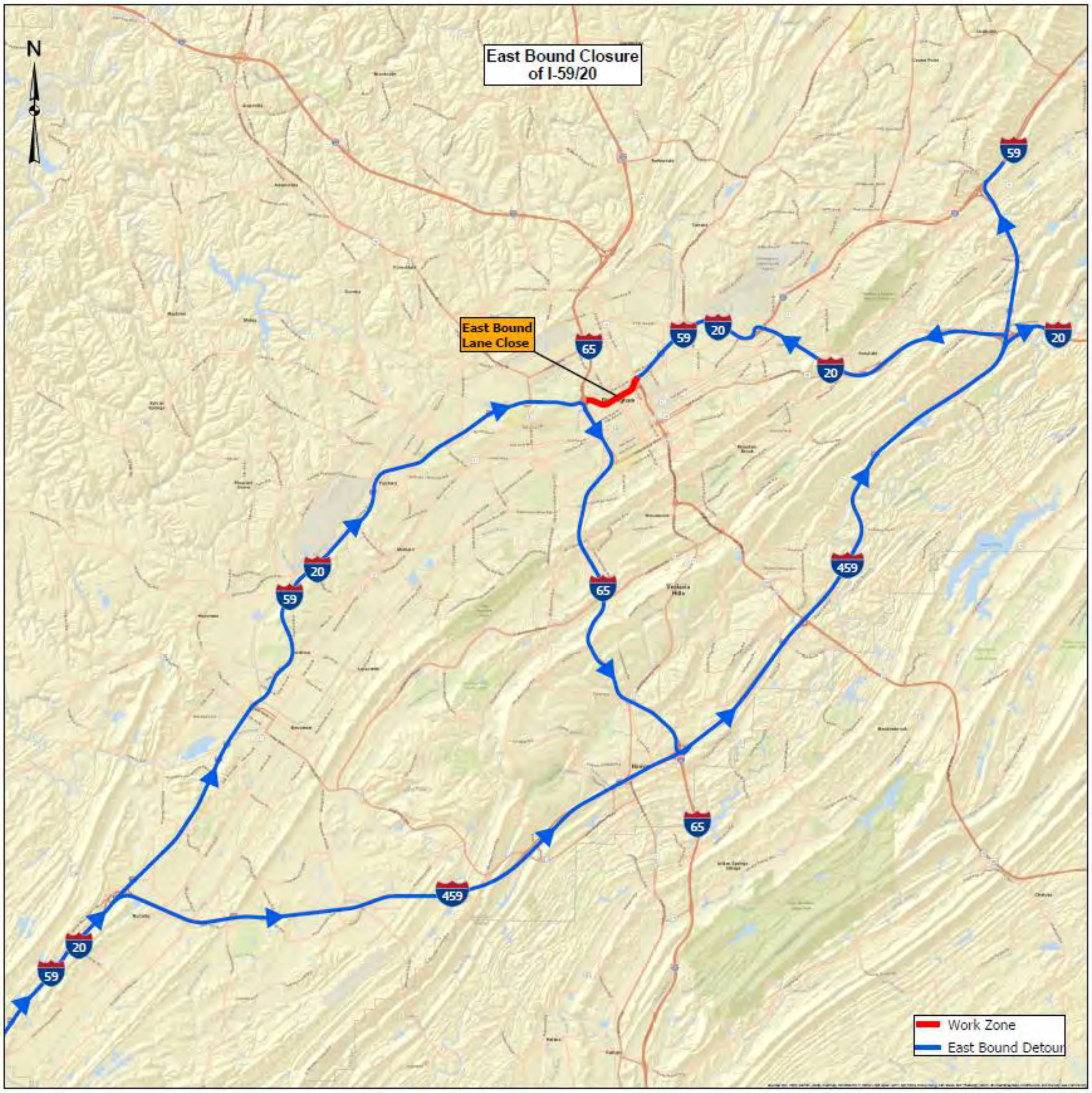


Figure 21. Recommended detour routes for eastbound through traffic (Source: ALDOT)

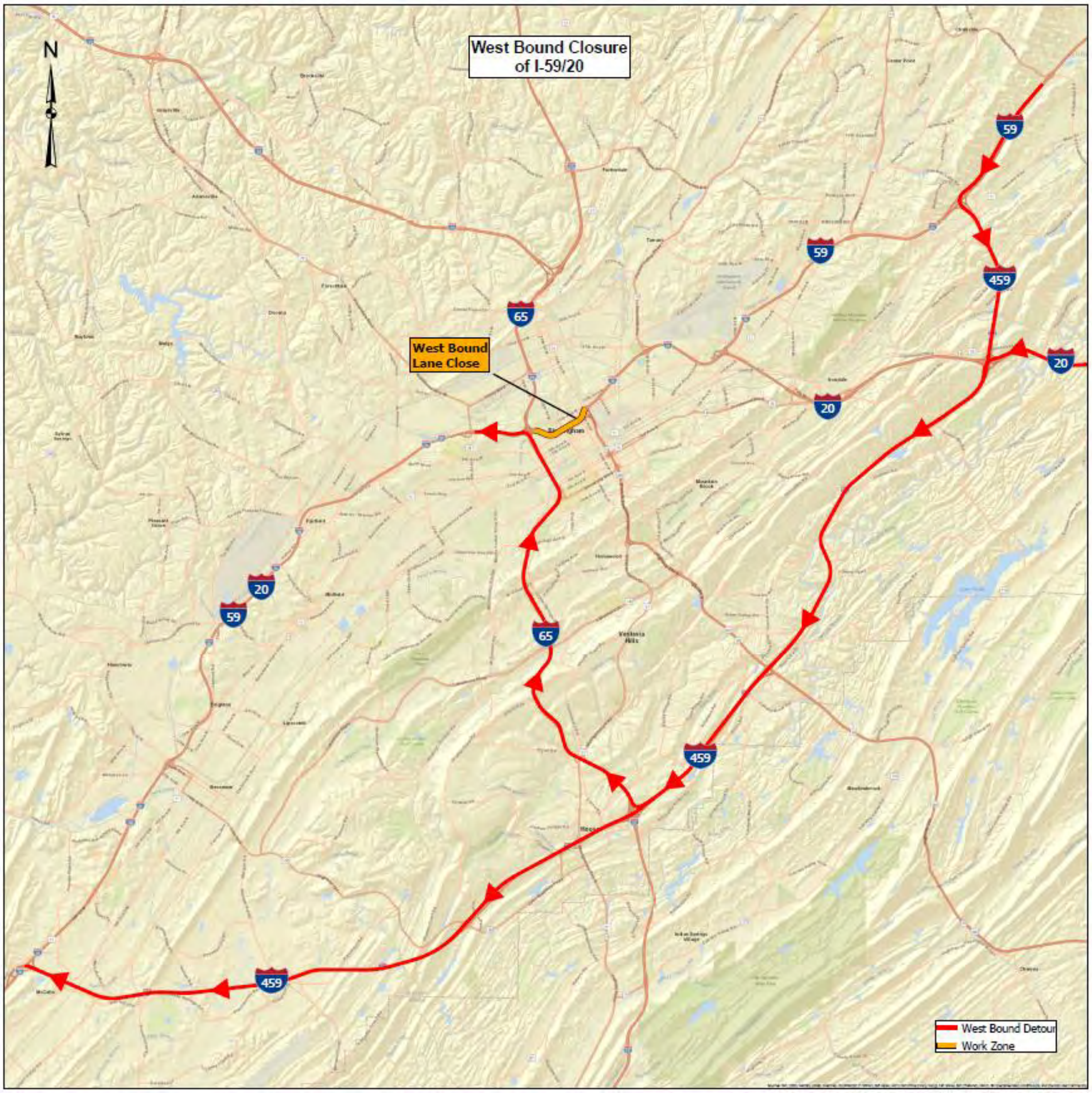


Figure 22. Recommended detour routes for westbound through traffic (Source: ALDOT)

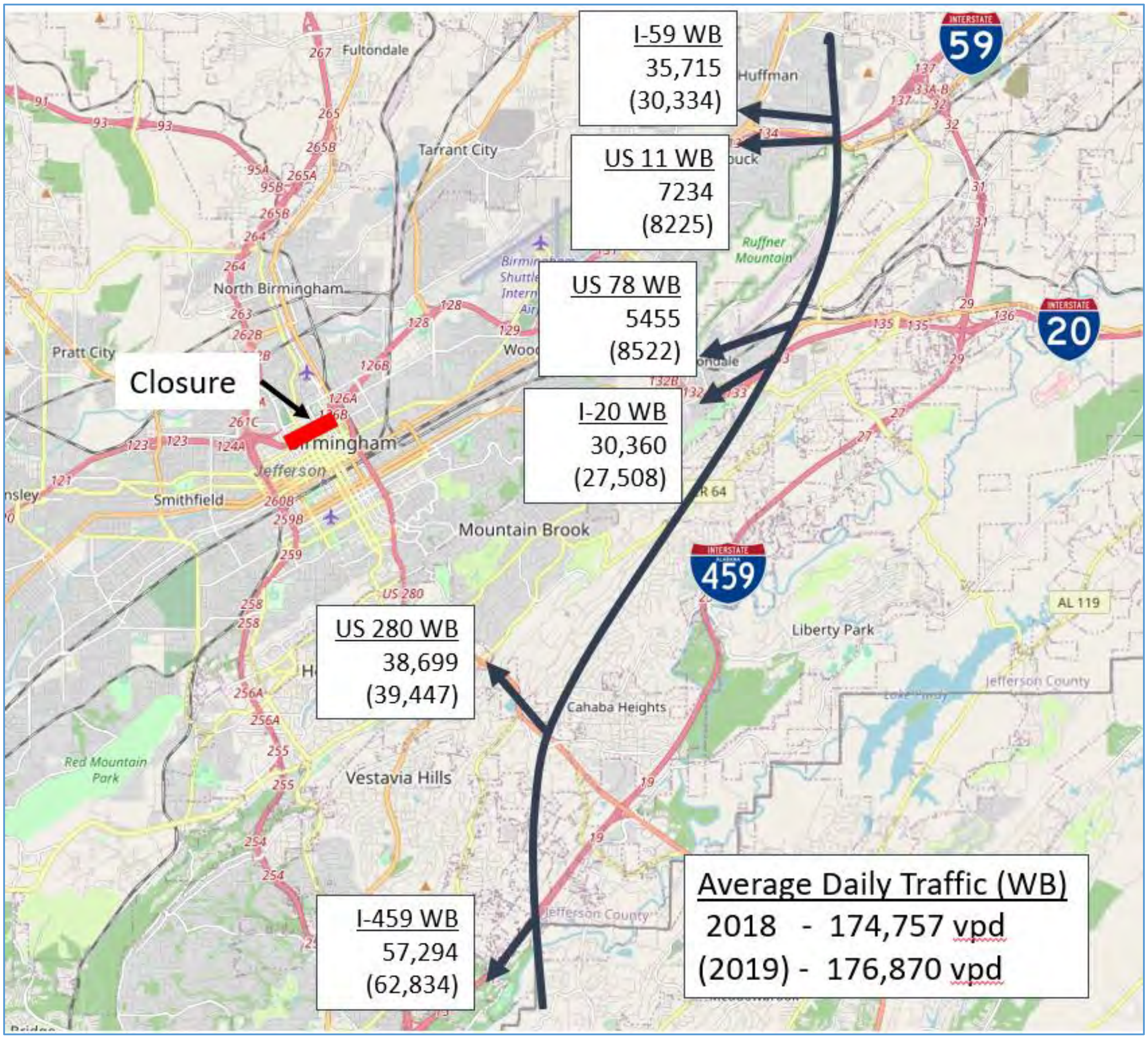


Figure 23. Eastern screen line volume comparison before and during construction

The screen line volumes indicate daily diversions of traffic from interstates I-59 and I-20 of about 8,200 vehicles. About 70% of this traffic diverted to I-459. Most of the remaining traffic diverted to either US 78 or US 11, which run parallel to I-20 and I-59. Increases in traffic on I-459 were also seen at the western screen line. WB traffic increased by approximately 5,000 vpd and eastbound traffic increased by about 4,000 vehicles per day during the reconstruction. It is assumed most of this was through traffic.

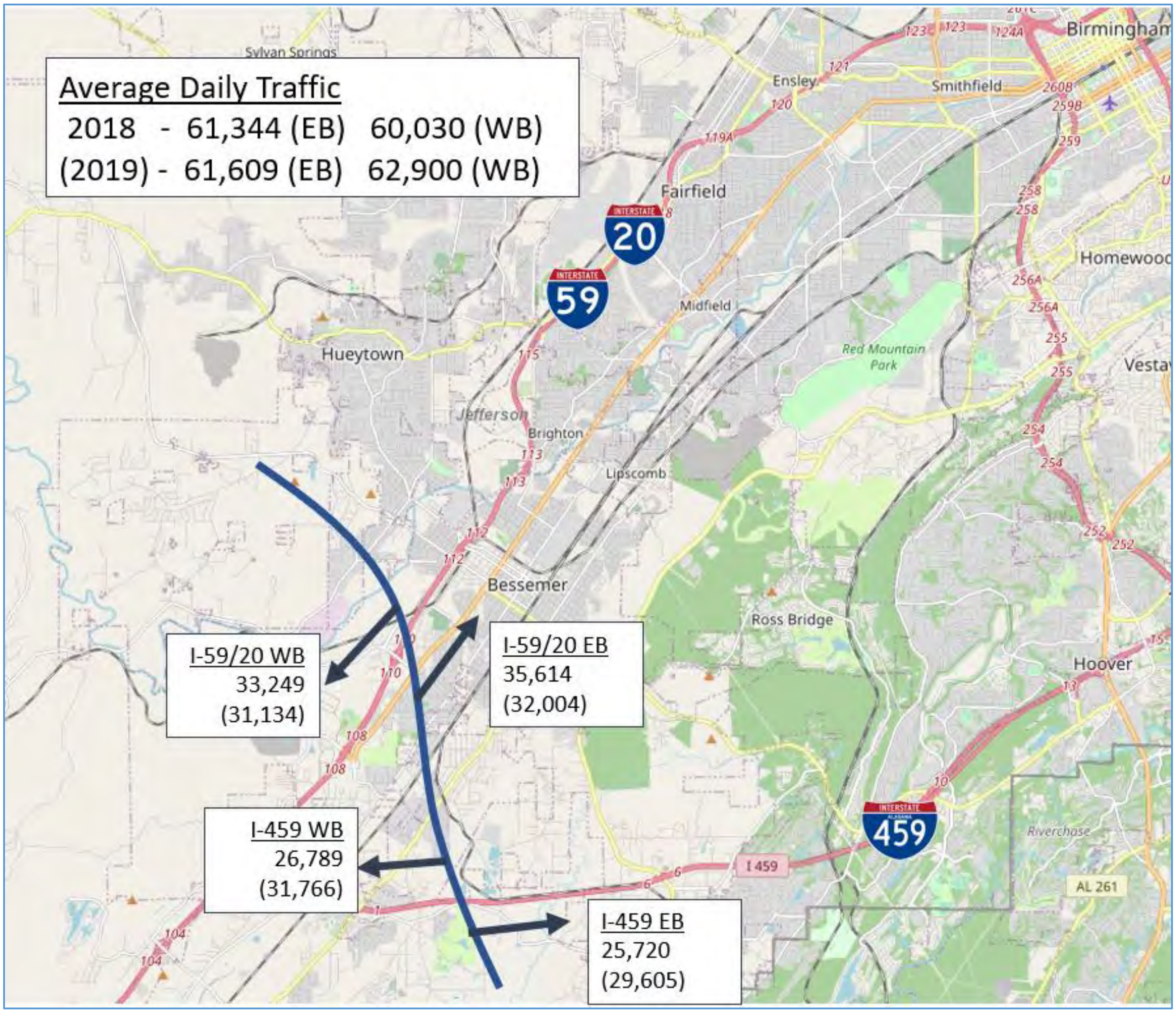


Figure 24. Western screen line volume comparison before and during construction

5.1.2 Changes in Traffic Volumes during Reconstruction

Traffic volumes along the primary detour routes were compared for before, during, and after conditions to see if diversion patterns changed during the reconstruction. Average daily traffic volumes were compared for the same months in 2018, 2019, and 2021. It should be noted that COVID shutdowns began in Birmingham in March 2020, so only January and February count data were used from 2020.

East of the reconstruction area, I-459 saw immediate increases in daily traffic volumes as seen in Figures 25 and 26. These increases remained consistent throughout the project. It should be noted, however, that volume changes were smaller in February than in March 2019 for both the SB and NB directions. This was true both in terms of absolute volumes and percentage of total traffic. This was also true along I-459 at its western junction with I-59/20 (see Figure 27).

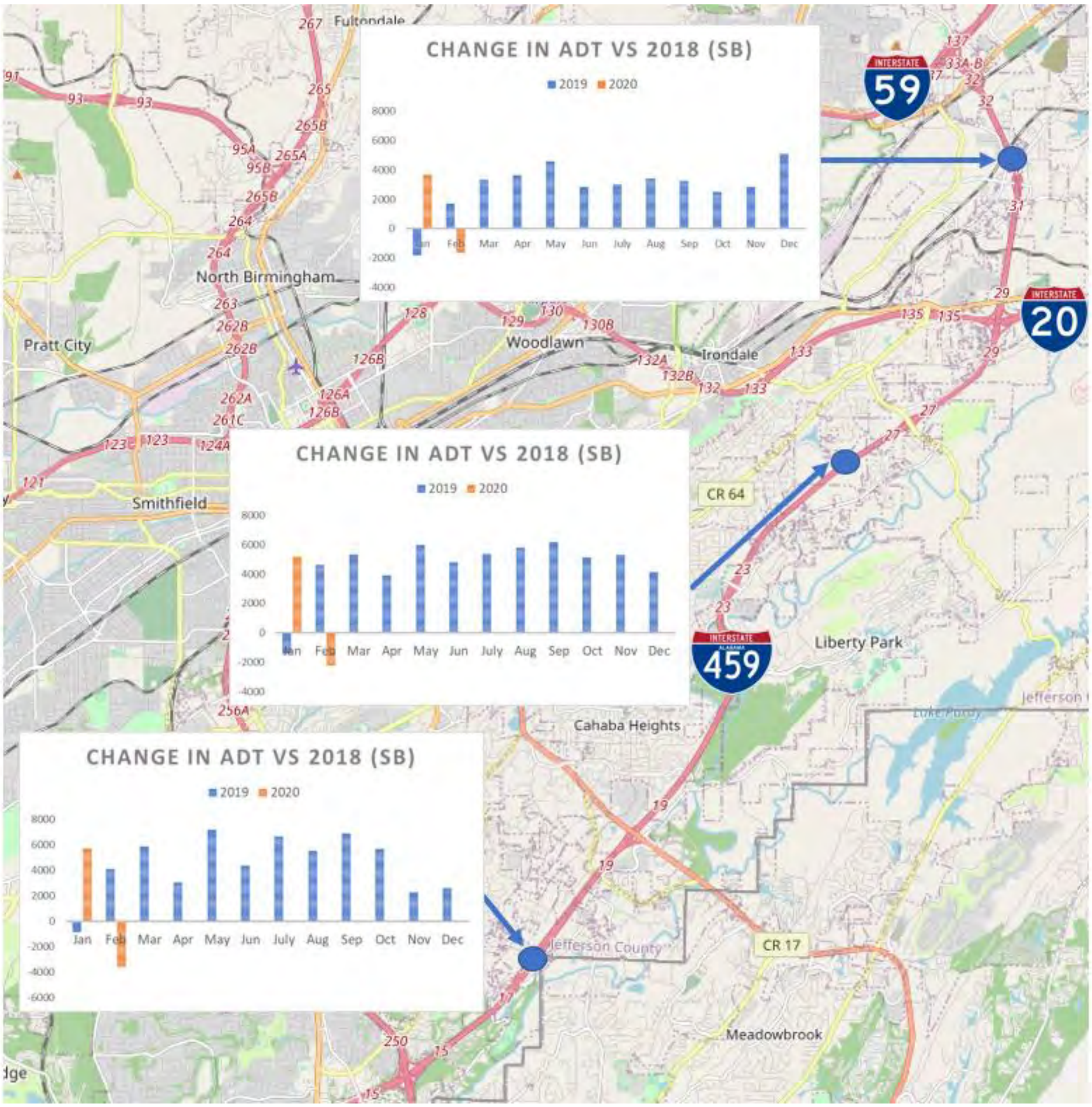


Figure 25. Change in daily traffic volumes along I-459 (SB)

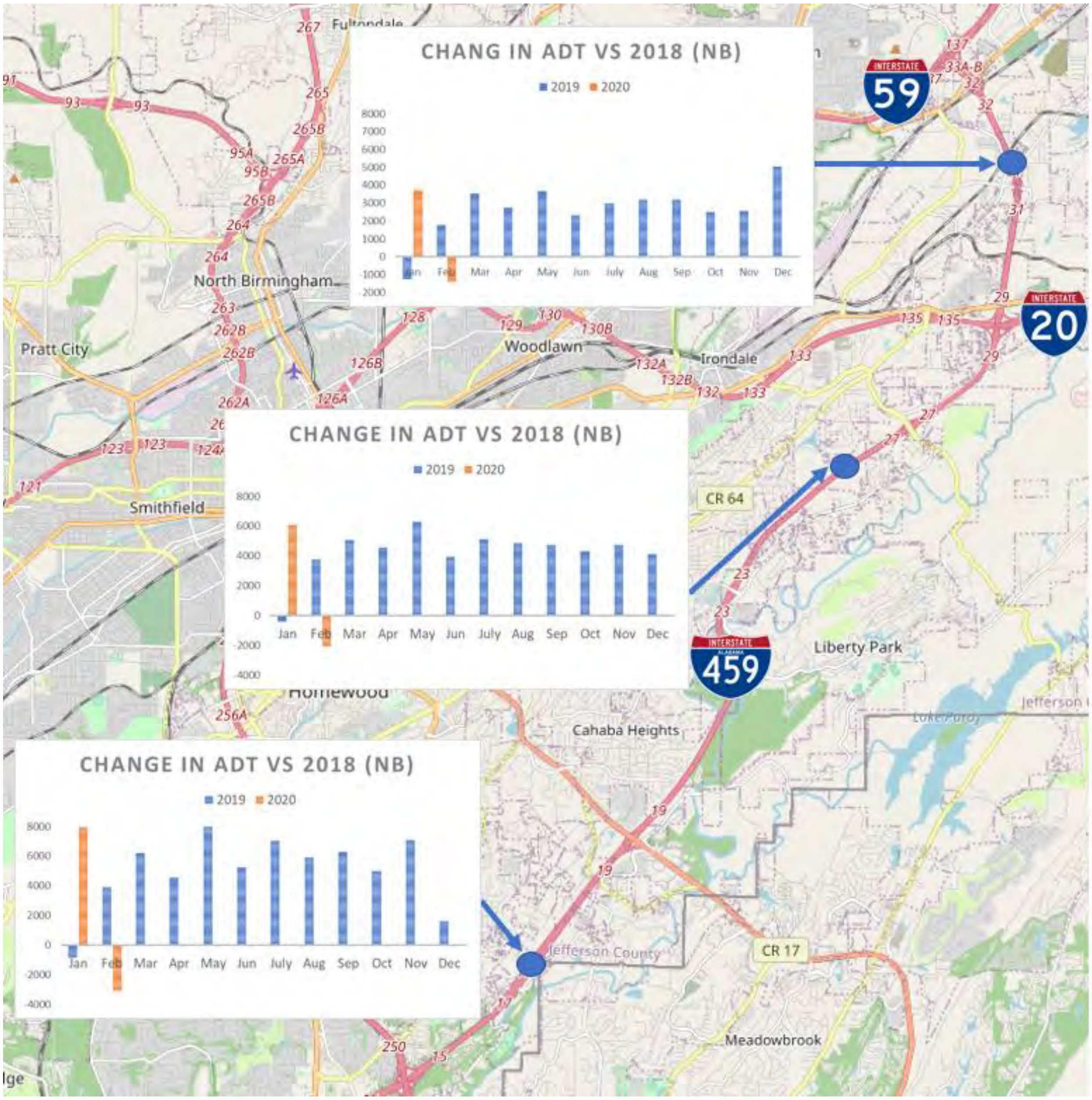


Figure 26. Change in daily traffic volumes along I-459 (NB)

This suggests that there was an increase in diversions of through traffic to I-459 from February to March 2019. In fact, ALDOT relocated VMS stations during the first month of reconstruction to provide more advance warning of the detour for through traffic and to encourage more commercial traffic to use I-459. It appears this impacted diversion rates, highlighting the importance of VMS for detour routing and the importance of correct location.

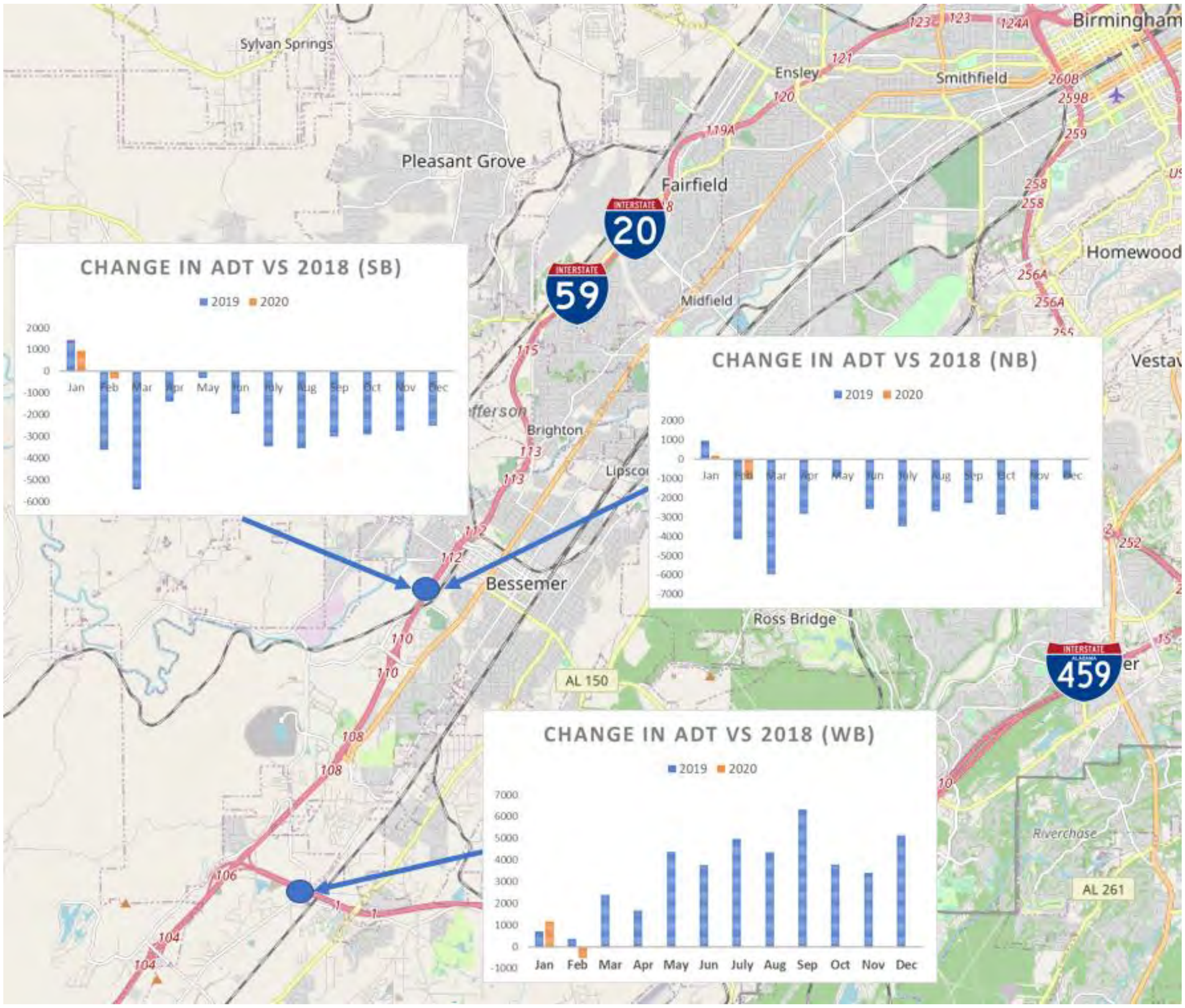


Figure 27. Change in daily traffic volumes along I-459 and I-59/20 (western end)

After the final VMS locations were determined, it appears that through traffic diversions remained consistent for the remainder of the project. This is consistent with what would be expected for through motorists relying primarily on navigation apps and VMS for route guidance around the construction project.

5.2 Detour Patterns for Local Traffic

A separate analysis was performed to determine the use of detour routes by local traffic. Because consistent count data was not available for the non-interstate roads in the study area, travel time data were used to assess the detour patterns for local traffic. The travel time data used in this study were obtained from the National Performance Management Research Data Set (NPMRDS) through the Alabama DOT and the Regional Planning Commission of Greater Birmingham.

5.2.1 Study Area

The extent of the study area is shown in Figure 28. It included all major interstate routes (I-20, I-59, I-65, and I-459) and major US routes (US 11, US 31, US 78, and US 280) affected by the closure. Tables 2 and 3 list the major roadway segments used for the analysis. It should be noted that some of the downtown surface streets were not available in the NPMRDS data set at the time of the analysis and therefore are not included here. Those downtown segments are discussed in more detail in Section 4 of this report which deals with the planning model used for detour planning. Most of the study corridors are in the jurisdiction of Jefferson County. Portions of I-65, US 31, US 280 that are beyond I-459 road fall in the domain of Shelby County. The study network was divided into 70 total roadway segments, 35 segments in the northbound/eastbound direction numbered 1 to 35, and 35 segments southbound/westbound direction numbered as 101 to 135.

5.2.2 Data Analysis

Travel Time Index (TTI) was selected as the primary performance metric used in the analysis. The TTI of a road segment is defined as the ratio of the average time required to traverse the segment to the time required to travel the same segment at free-flow speeds (FFS), as shown in the following equation:

$$\text{Travel Time Index} = \text{TTI} = \frac{\text{Average Travel Time}}{\text{Travel Time Based on Free Flow Speed}}$$

The Travel Time Index (TTI) is a measure of the degree of congestion. A TTI value greater than 1.0 can indicate the presence of congestion. The 70 roadway segments analyzed included 411 separate TMC segments. Travel time data was collected from the NPMRDS at 15 minute intervals for all 411 TMC segments during the AM peak period of 6:30 AM to 9:00 AM (10 data points) and during the PM peak period from 4:00 PM to 6:30 PM (10 data points) for each weekday of the month. Weekend and holiday data were excluded from the analysis.

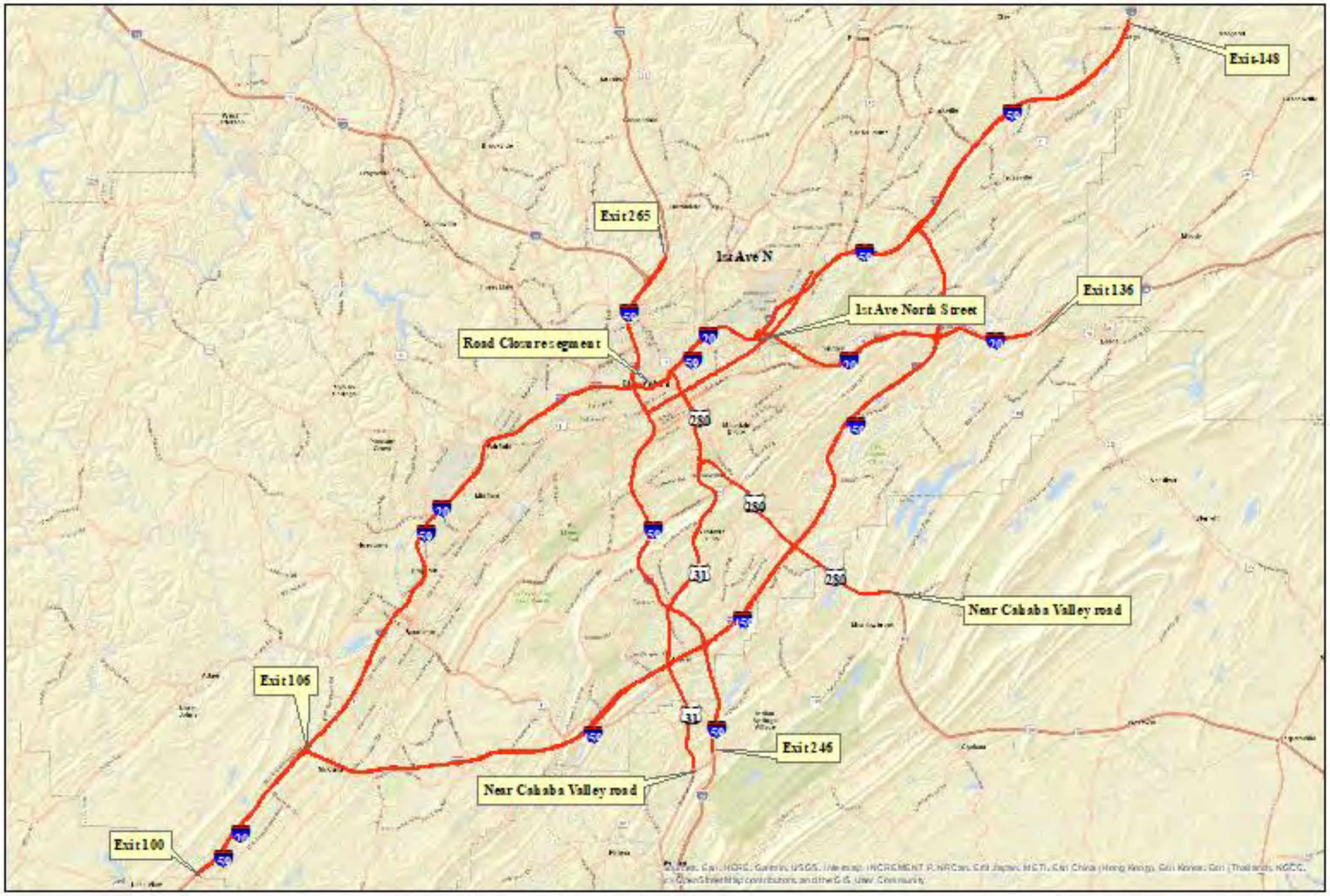


Figure 28. Study area and primary detour corridors for I-59/20 reconstruction

Table 2: List of northbound and eastbound road segments

Seg No	Corridor Name	Direction	Length (mi)	FFS (mph)	Nos of TMC	Exit No	Description
1	I-20/59	EB	5.30	70	3	100 to 106	From I-20/59 Exit 100 to I-20/59 & I-459 intersection
2	I-20/59	EB	18.60	66.38	23	106 to 124	I-20/59 & I-459 intersection to I-20/59 & I-65 intersection
3	I-20/59	EB	0.62	50	1	-	I-20/59 & I-65 intersection
4	I-20/59	EB	0.81	50	5	124 to 126	The work zone of the I-20/59 bridge replacement project
5	I-20/59	EB	4.01	53.36	8	126 to 130	I-20/59 & US-280/31 intersection to I-20 & I-59 intersection
6	I-59	NB	7.55	63.84	11	130 to 137	I-20 & I-59 intersection to I-59 & I-459 intersection
7	I-59	NB	10.38	70	8	137 to 148	I-59 & I-459 intersection towards Exit 148 on I-59 road
8	I-459	NB	13.55	68.98	8	106 to 13	from I-20/59 & I-459 intersection to I-459 & US-31 intersection
9	I-459	NB	2.51	70	3	13 to 15	I-459 & US-31 intersection to I-459/I-65 intersection
10	I-459	NB	3.54	70	3	15 to 19	I-65 &I-459 intersection to I-459/US-280 intersection
11	I-459	NB	0.86	70	1	-	I-459 & US-280 intersection
12	I-459	NB	8.56	70	5	19 to 29	From US-280 & I-459 intersection to I-459 & I-20 intersection
13	I-459	NB	0.99	70	1	-	I-459 & I-20 intersection
14	I-459	NB	3.68	65.44	6	29 to 33	from I-20&I-459 intersection merged towards I-59
15	I-65	NB	3.22	66.72	5	246 to 250	From 246 Exit of I-65, towards I-65 & I-459 intersection
16	I-65	NB	1.07	60	1	-	I-65 & I-459 intersection
17	I-65	NB	4.62	60	6	250 to 255	From I-65 & I-1459 intersection to I-65 & Lakeshore Pkwy road intersection
18	I-65	NB	5.06	57.19	15	255 to 261	From I-65 & Lakeshore Pkwy road intersection to I-65 & I-20/59 intersection
19	I-65	NB	0.48	50	1	-	I-65 & I-20/59 intersection
20	I-65	NB	4.75	58.75	10	261 to 265	From I-65 & I-20/59 intersection to Exit 265 of I-65 road
21	I-20	EB	2.97	54.14	8	130 to 132	From I-20/59 & I-20 intersection to Exit 132 near US-78 (Crestwood Blvd)

Seg No	Corridor Name	Direction	Length (mi)	FFS (mph)	Nos of TMC	Exit No	Description
22	I-20	EB	3.85	60.52	5	132 to 136	From Exit 132 of I-20 road near US-78 (Crestwood Blvd) to Exit 136 of I-20, I-20 & I-459 intersection
23	I-20	EB	0.94	70	1	-	I-20 & I-459 intersection
24	I-20	EB	2.85	70	2	136 to 140	From Exit 136 of I-20, I-20 & I-459 intersection to Exit 140 of I-20 near parkway drive of US-78
25	US-31	NB	3.85	53.67	5	-	Pelham Pkwy/US-31 near Cahaba valley road to I-459 & US-31 intersection
26	US-31	NB	1.93	55	4	-	From I-459 & US-31 intersection to I-65 & US-31 Intersection
27	US-31	NB	4.47	43.62	4	-	From I-65 & US-31 Intersection to near AL-149/ Shades Crest Pkwy/Lakeshore dr.
28	US-31	NB	1.51	42.49	2	-	From AL-149/ Shades Crest Pkwy/Lakeshore dr. to US-31 & US-280 merging section
29	US-31/ 280	NB	1.75	55	6	-	From US-31 & US-280 merging section to near University Blvd
30	US-31/ 280	NB	1.39	55	8	-	From US-31/280 near University Blvd to I-20/59 & US-31/280 intersection
31	US-280	EB	1.82	52.03	7	-	From near Shades Crest Pkwy of US-280 to US-31 & US-280 merging section
32	US-280	EB	2.94	55	11	-	From near Shades Crest Pkwy of US-280 to I-459 & US-280 Intersection
33	US-280	EB	0.35	55	1	-	I-459 & US-280 Intersection
34	US-280	EB	3.71	55	6	-	From I-459 & US-280 Intersection to near Cahaba valley road in US-280
35	1st Ave N	NB	7.14	40.37	11	-	1st Avenue north

Table 3: List of southbound and westbound road segments

Seg No	Corridor Name	Direction	Length (mi)	FFS (mph)	Nos of TMC	Exit No	Description
101	I-20/59	WB	5.44	70	4	100 to 106	From I-20/59 Exit 100 to I-20/59 & I-459 intersection
102	I-20/59	WB	18.48	66.55	22	106 to 124	I-20/59 & I-459 intersection to I-20/59 & I-65 Intersection
103	I-20/59	WB	0.62	50	1	-	I-20/59 & I-65 Intersection
104	I-20/59	WB	0.84	50	5	124 to 126	The work zone of the I-20/59 bridge replacement project
105	I-20/59	WB	3.95	54.74	8	126 to 130	I-20/59 & US-280/31 intersection to I-20 & I-59 intersection
106	I-59	SB	7.46	63.91	11	130 to 137	I-20 & I-59 intersection to I-59 & I-459 intersection
107	I-59	SB	10.48	70	7	137 to 148	I-59 & I-459 intersection towards Exit 148 on I-59 road
108	I-459	SB	13.47	69.15	8	106 to 13	From I-20/59 & I-459 intersection to I-459 & US-31 intersection
109	I-459	SB	2.57	70	3	13 to 15	I-459 & US-31 intersection to I-459/I-65 intersection
110	I-459	SB	3.65	70	3	15 to 19	I-65 &I-459 intersection to I-459/US-280 intersection
111	I-459	SB	0.87	70	1	-	I-459 & US-280 intersection
112	I-459	SB	8.28	70	5	19 to 29	From US-280 & I-459 intersection to I-459 & I-20 intersection
113	I-459	SB	0.90	70	1	-	I-459 & I-20 intersection
114	I-459	SB	3.79	70	6	29 to 33	from I-20&I-459 intersection merged towards I-59
115	I-65	SB	3.26	70	5	246 to 250	From 246 Exit of I-65, towards I-65 & I-459 intersection
116	I-65	SB	1.05	60	1	-	I-65 & I-459 intersection
117	I-65	SB	4.42	60	5	250 to 255	From I-65 & I-1459 intersection to I-65 & Lakeshore Pkwy road intersection
118	I-65	SB	5.22	58.93	16	255 to 261	From I-65 & Lakeshore Pkwy road intersection to I-65 & I-20/59 intersection
119	I-65	SB	0.59	50	1	-	I-65 & I-20/59 intersection
120	I-65	SB	4.62	63.38	10	261 to 265	From I-65 & I-20/59 intersection to Exit 265 of I-65 road

Seg No	Corridor Name	Direction	Length (mi)	FFS (mph)	Nos of TMC	Exit No	Description
121	I-20	WB	2.50	50.37	7	130 to 132	From I-20/59 & I-20 intersection to Exit 132 near US-78 (Crestwood Blvd)
122	I-20	WB	4.15	60	6	132 to 136	From Exit 132 of I-20 road near US-78 (Crestwood Blvd) to Exit 136 of I-20, I-20 & I-459 intersection
123	I-20	WB	1.17	70	1		I-20 & I-459 intersection
124	I-20	WB	2.78	70	2	136 to 140	From Exit 136 of I-20, I-20 & I-459 intersection to Exit 140 of I-20 near parkway drive of US-78
125	US-31	SB	3.60	53.66	5	-	Pelham Pkwy/US-31 near Cahaba valley road to I-459 & US-31 intersection
126	US-31	SB	1.98	55	4	-	From I-459 & US-31 intersection to I-65 & US-31 Intersection
127	US-31	SB	4.55	43.80	4	-	From I-65 & US-31 Intersection to near AL-149/ Shades Crest Pkwy/Lakeshore dr.
128	US-31	SB	1.76	42.46	3	-	From AL-149/ Shades Crest Pkwy/Lakeshore dr. to US-31 & US-280 merging section
129	US-31/ 280	SB	1.44	55	5	-	From US-31 & US-280 merging section to near University Blvd
130	US-31/ 280	SB	1.59	55	9	-	From US-31/280 near University Blvd to I-20/59 & US-31/280 intersection
131	US-280	WB	1.70	54.29	7	-	From near Shades Crest Pkwy of US-280 to US-31 & US-280 merging section
132	US-280	WB	2.92	55	11	-	From near Shades Crest Pkwy of US-280 to I-459 & US-280 Intersection
133	US-280	WB	0.36	55	1	-	I-459 & US-280 Intersection
134	US-280	WB	3.68	55	6	-	From I-459 & US-280 Intersection to near Cahaba valley road in US-280
135	1st Ave N	SB	7.72	40.94	12		1st Avenue north

The raw travel time data were processed to eliminate outlier values and missing data. TTI calculations for the network segments were adjusted to exclude TMC's with missing data. The TTI was calculated for each segment at 15-minute intervals for the months of February 2018, 2019, and 2020. Monthly 50th percentile TTI values were calculated for each segment for the AM and PM peak periods and were used for the maps and comparisons that follow. The peak period TTI values were used for comparison because on most routes the TTI values returned to the 1.0-1.2 range during off-peak periods even with additional detour traffic, thus the off-peak TTI values were not useful for drawing conclusions about detour patterns.

5.2.3 TTI Values Before, During, and After the Project

TTI maps of different road segments before the road closure (February 2018), during the road closure (February 2019), and after reopening the reconstructed segment (February 2020) were produced. Figures 29, 30, and 31 depict the traffic conditions during morning peak hours from 6:30 AM to 9:00 AM. In this analysis, traffic congestion was categorized into five levels depending on the computed TTI value. These levels were designated as Little to No Congestion (TTI<1.5), Mild Congestion (TTI: 1.5 to 2.0), Moderate Congestion (TTI: 2.0 to 2.5), Significant Congestion (TTI: 2.5 to 3.0) and Severe Congestion (TTI>3.0). For visualization purposes, the color code of TTI was used as dark green for "Little to None," Light Green for "Mild," orange for "Moderate," red for "Significant," and dark red for "Severe" congestion conditions.

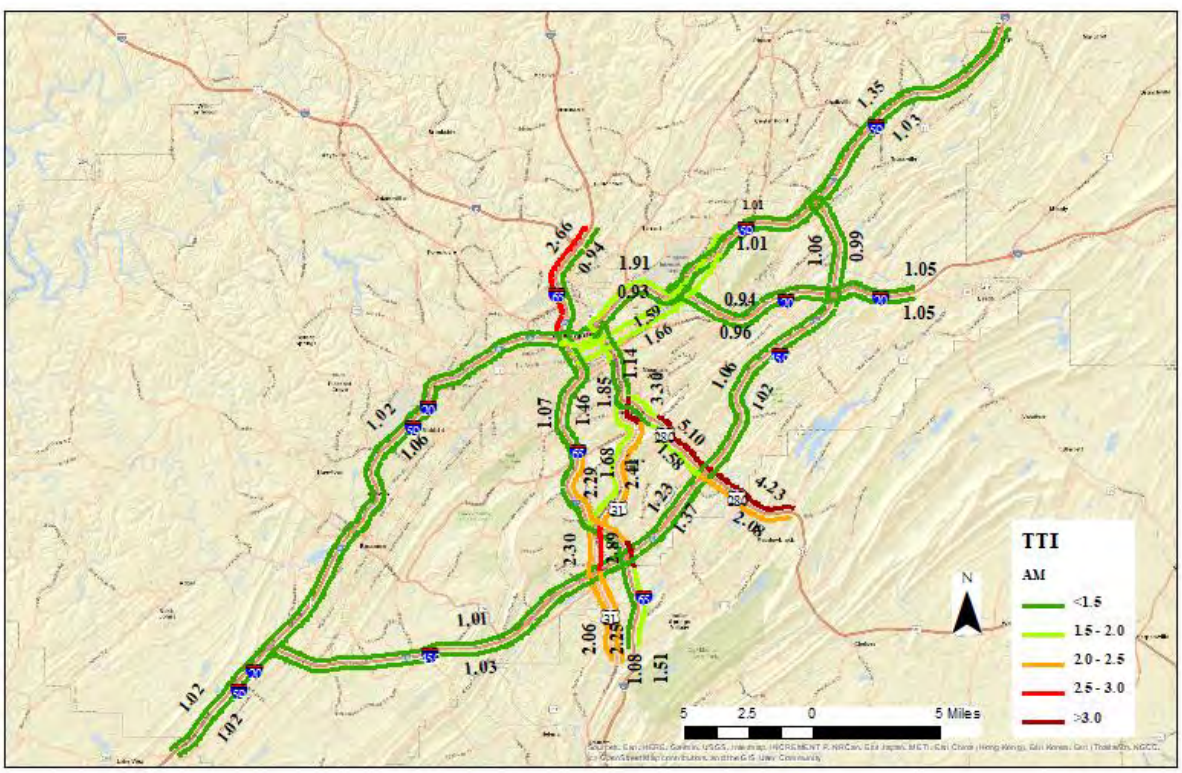


Figure 29. TTI for February 2018 - morning peak hours (before road closure)

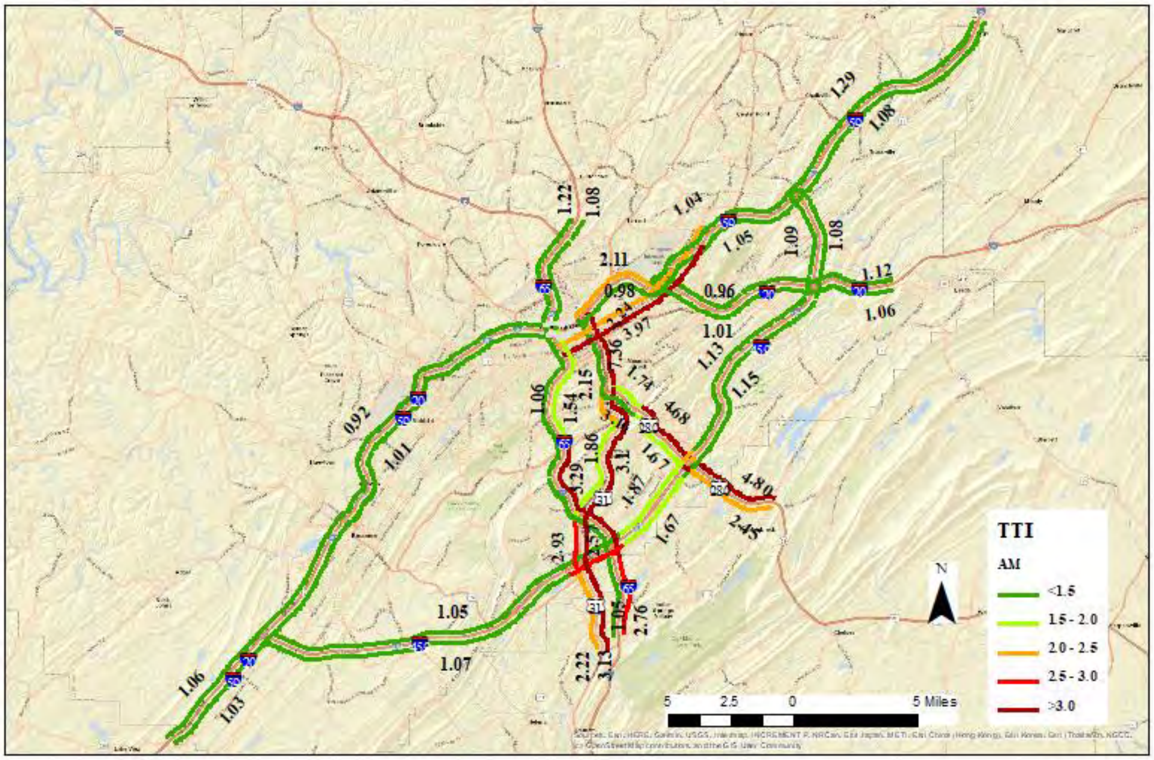


Figure 30. TTI for February 2019 - morning peak hours (during road closure)

Comparing the morning peak hours pre-construction and during construction, there were significant increases in TTI along some of the project detour routes. Three northbound segments of I-65 had TTI's near 3.00, which indicates severe congestions. Two segments of I-459 (from I-65 to US 280) had TTI values ranging from 1.50 to 2.00, indicating increased congestion. Increases in congestion were also observed along US 280 and US 31. When compared to pre-construction operations, the 1ST Ave North corridor also experienced significant increases in congestion during the AM peak.

Figure 31 shows that the extents of congestion in the first month after the completion of the reconstruction had already returned to levels similar to February 2018, although TTI values were still higher on some of the segments than they had been in 2018. Several segments of US-31 had TTI values near 2.50 and two segments of the westbound US-280 corridor had TTI values over 3.00, indicating severe congestion. Just one month after project completion, the 1st Avenue North segments had TTI values similar to those observed in 2018 prior to the project.

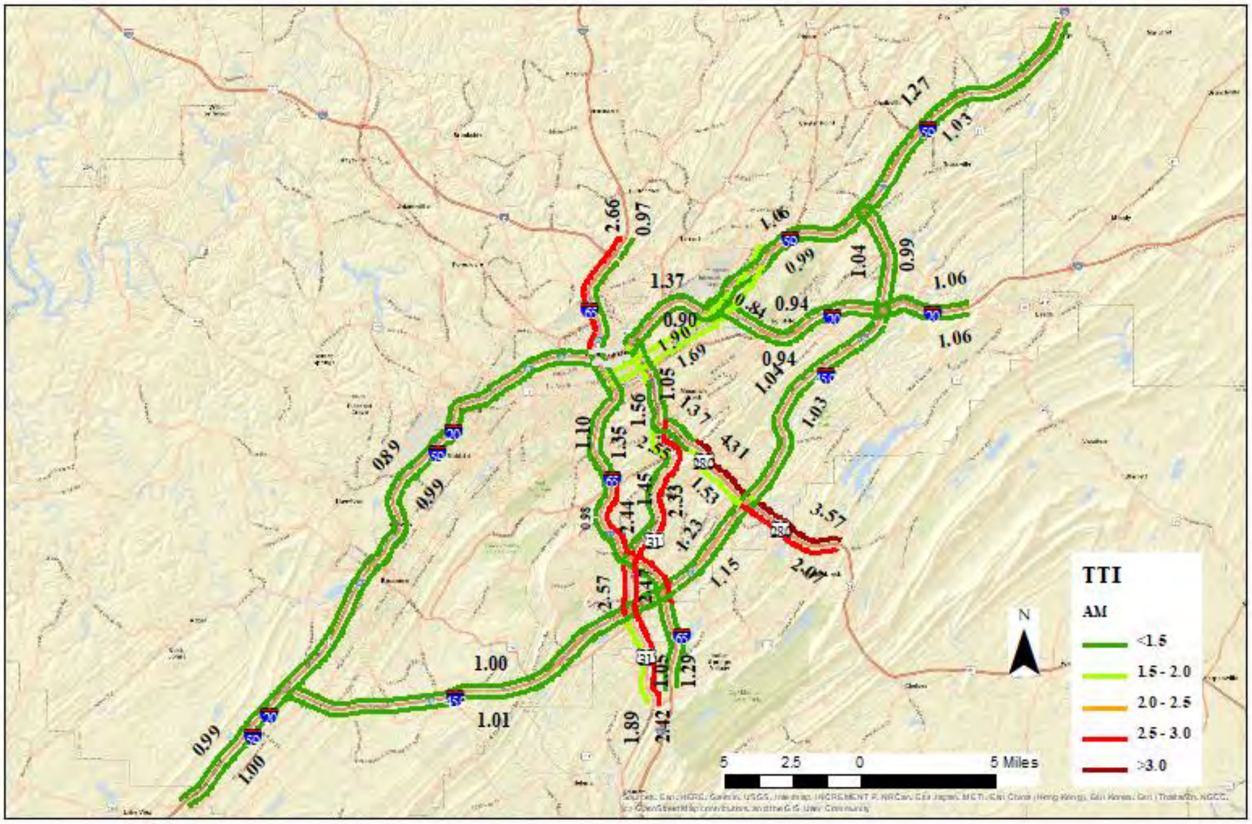


Figure 31. TTI for February 2020 - morning peak hours (after road closure)

Figures 32, 33, and 34 present monthly TTI values before, during, and after the reconstruction project for the PM peak hours. Figure 32 illustrates that prior to the project, the most congested network segments were on I-65 southbound near I-459, US 31 in Hoover, and US 280. The monthly TTI values for February 2020 (Figure 33) show that the interstate closure significantly increased TTI values on I-65, US 280, US 31, 1st Avenue North, and I-459. TTI on northbound I-459 between I-65 and I-20 increased from 1.12 and 1.09 to values of 1.98 and 1.98. Even though it is still considered only moderate congestion, it does represent a significant increase from pre-construction conditions. TTI also increased significantly along I-65 southbound (from 2.44 to 3.34) near downtown as traffic from I-59/20 and I-65 diverted down to I-459 to bypass the construction zone.

TTI values on US 280 westbound increased from 3.76 to 4.49 (19%) between downtown and I-459, indicating that US 280 was also being used as a detour route. TTI on US 280 beyond I-459 remained largely unchanged, as would be expected if most of the detour traffic was using US 280 to reach I-459. TTI on US 31 southbound increased from 2.31 to 3.26 (41%), indicating that US 31 was being used as a primary diversion route.

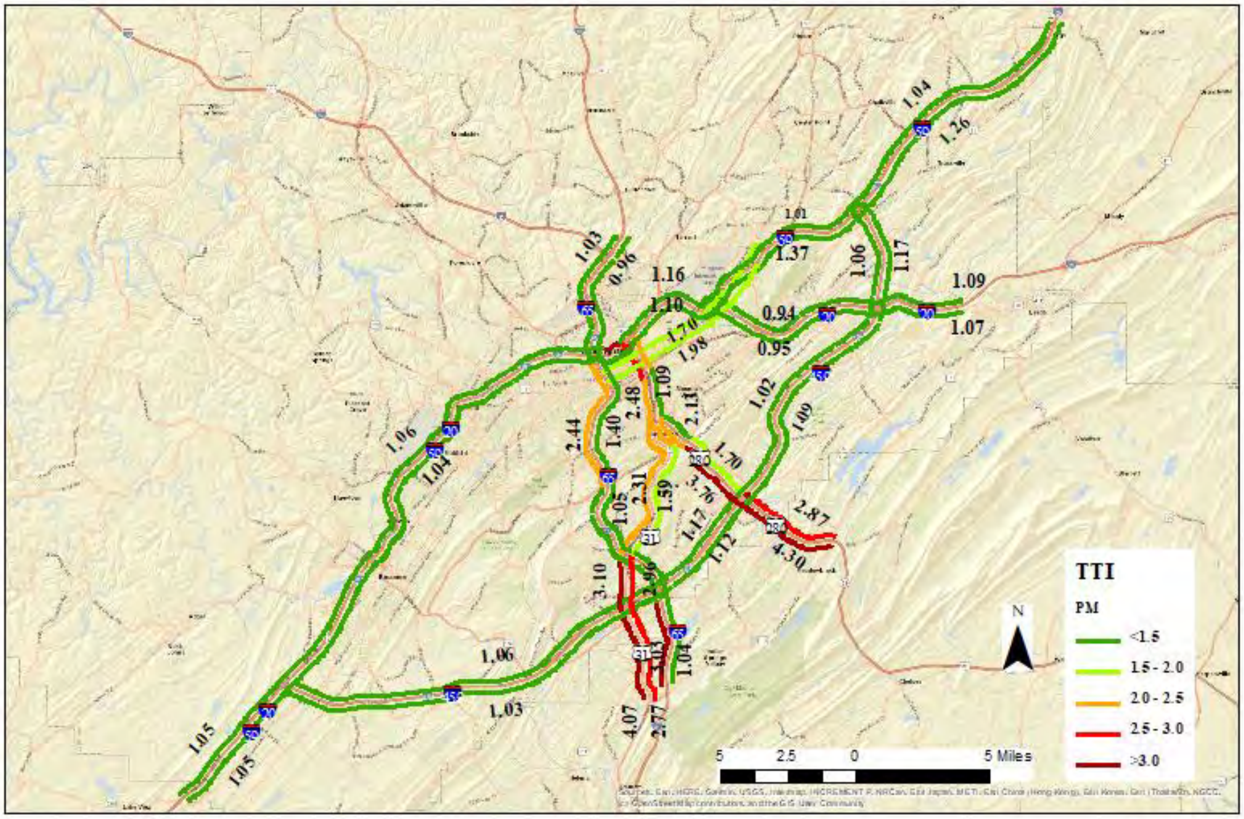


Figure 32. TTI for February 2018 - PM peak hours (before road closure)

One month after project completion, Figure 34 illustrates that the extents of congestion had largely returned to preconstruction conditions, although as was in the case during the AM peak hours, TTI values were significantly higher on some segments. Notably, TTI values on I-65 southbound near downtown had increased from 2.44 to 3.23 (32%) compared to pre-construction values. TTI values were also higher on the Red Mountain Expressway after project completion than they had been prior to construction. Within one month of project completion, TTI values on I-459 had returned to pre-construction levels, as did TTI values on US 31 and US 280.

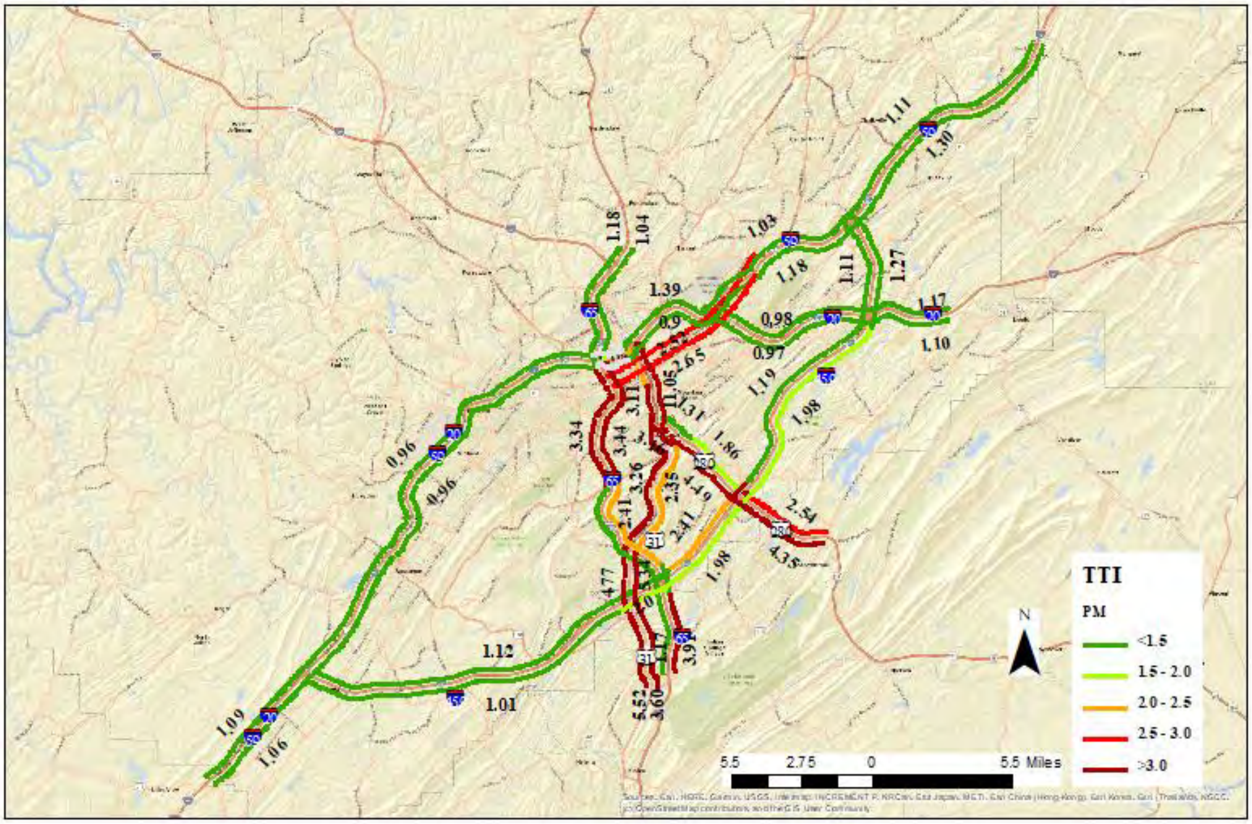


Figure 33. TTI for February 2019 - PM peak hours (during road closure)

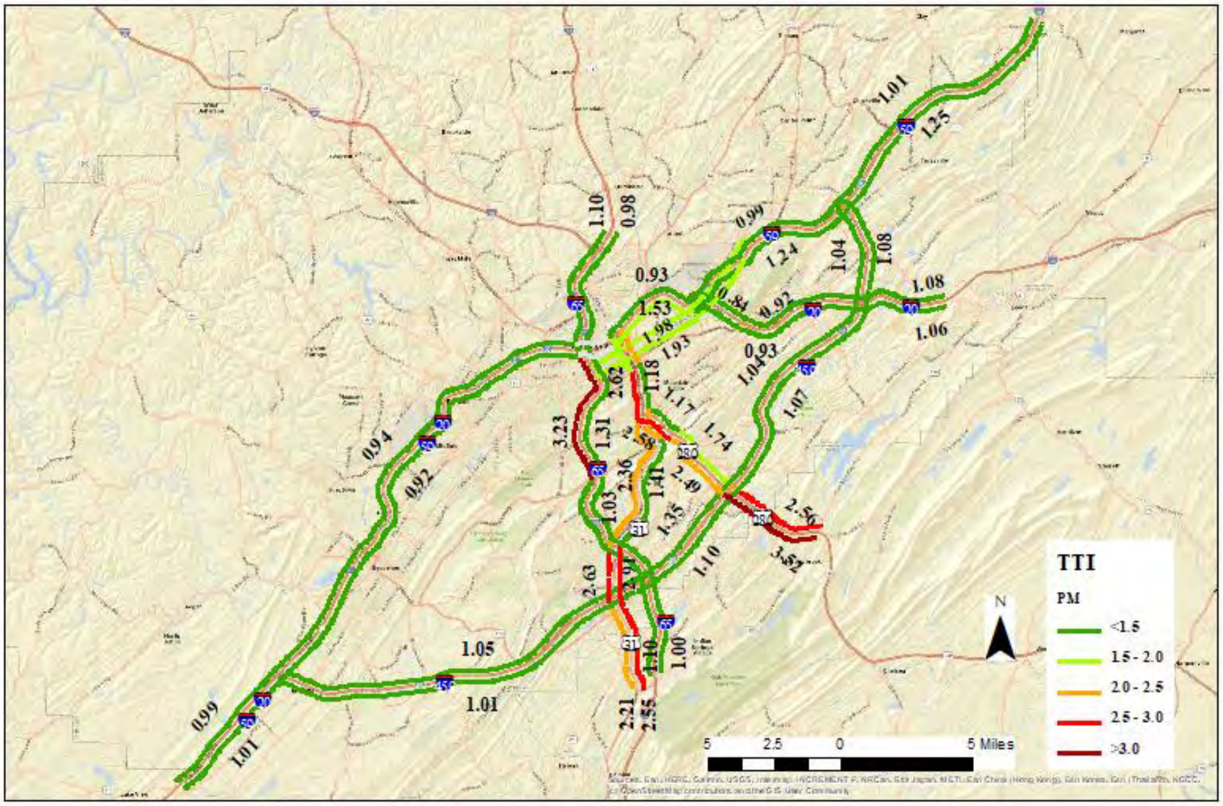


Figure 34. TTI for February 2020 - PM peak hours (after road closure)

5.2.4 Percent Changes in TTI Values During Construction Project

To better illustrate these changes, Figures 35 and 36 show the percent changes in TTI during construction relative to preconstruction conditions. Green shading indicates routes where TTI values decreased during the closure. Orange shading indicates routes where TTI increased between 0%–25%, red indicates TTI increases between 26%-50%, and dark red indicates routes that experienced the most significant increases in TTI (greater than 50%). The routes shaded with red and dark red can be assumed to have been those most heavily impacted by detouring vehicles.

During the AM peak hours, the most significant increases in TTI occurred on 1st Avenue North and the Red Mountain Expressway downtown, and on I-65 and US 31 south of town. Segments of I-459 between I-65 and I-20 east of town also showed TTI increases of up to 50%. TTI increases on I-459 west of I-65 were fairly small during the AM peak period, indicating that much of the detouring traffic on the eastern segments of I-459 were diverting to I-65 NB to approach destinations in Birmingham from that direction. As would be expected, TTI values decreased on the portion of I-59/20 between downtown and I-459 to the west. Curiously, TTI values actually decreased slightly on US 280 westbound during the AM peak, indicating this was not a major detour route for inbound traffic during the AM peak. This could have been due to the fact that US 280 already experienced significant congestion inbound in the morning and motorists may have selected I-65/US 31 as better detour routes. TTI values on both I-20 and I-59 west of I-459 experienced only small increases during the AM peak, likely due to the reductions in traffic volumes on those routes. TTI increases were less than 10% on those routes in most cases.

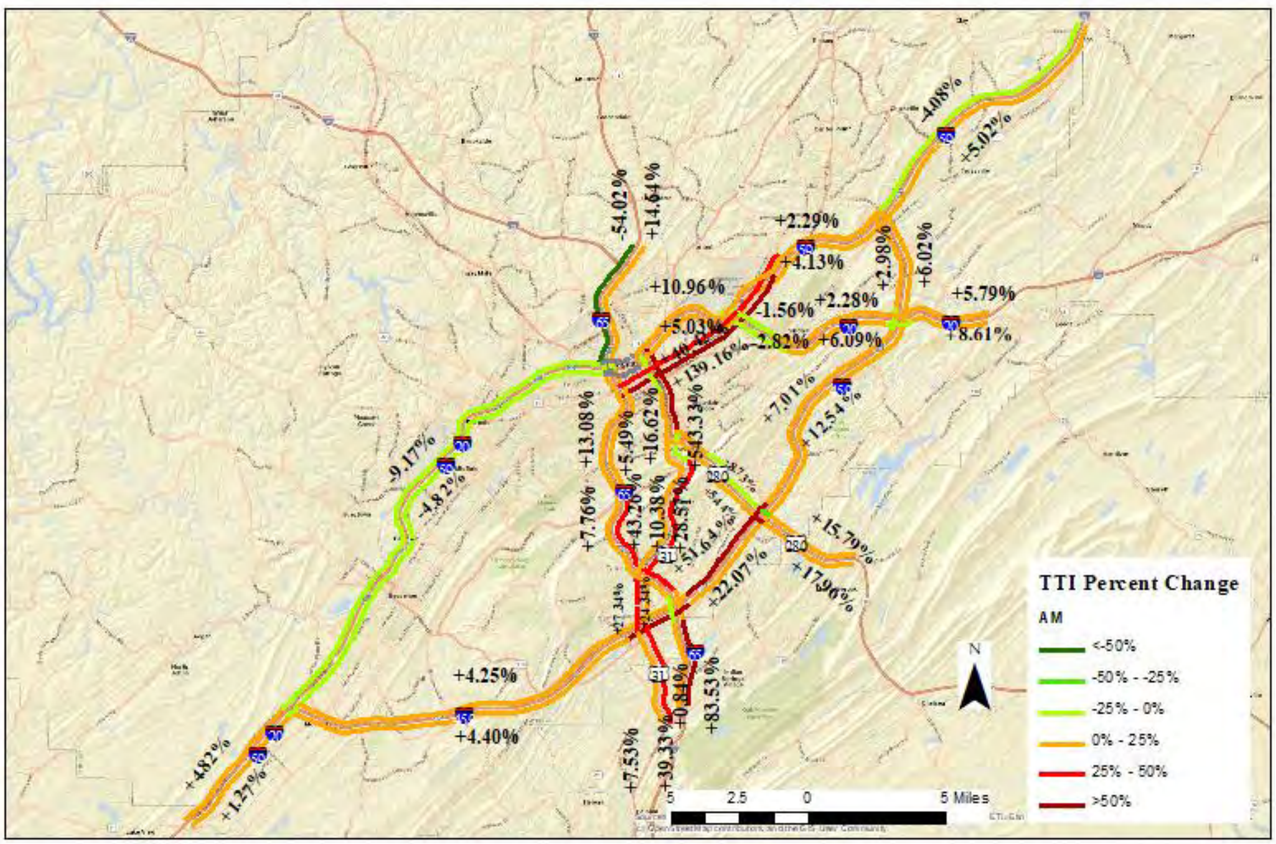


Figure 35. Percent change in TTI during construction - AM peak hours

Figure 36 shows that increases in TTI values were more significant during the PM peak period. Segments of US 31 and I-65 experienced 25%-50% increases in TTI while some segments of I-459 east of town experienced TTI increase greater than 50%. As with the AM peak, TTI values on I-459 west of I-65 remained essentially unchanged, indicating that the primary detour movement was from I-459 to I-65 and US 31. Also as with the AM peak period, increases in TTI values on I-20 and I-59 west of I-459 remained generally small and in most cases under 10%. As will be discussed in the following section, this may be due to the fact that there was a significant reduction in traffic volumes on these routes during the initial two months of the project that later adjusted upward as motorists re-evaluated detour routes.

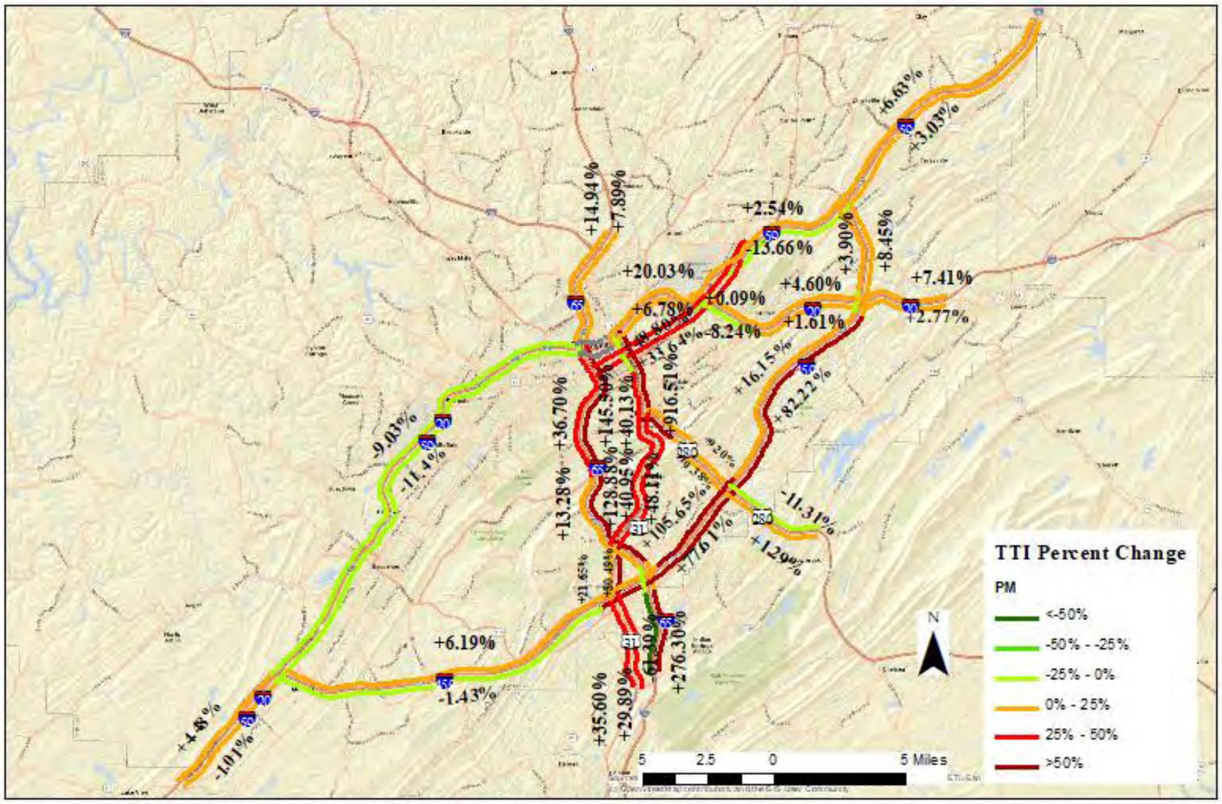


Figure 36. Percent change in TTI during construction - PM peak hours

The calculated TTI decreased on only 10 of the 70 study area road segments in the PM peak during the project construction. This was similar to what was observed for the morning peak. This indicates that the impacts of the project were truly regional and detour patterns were also regional. TTI increased significantly in most of the study road segments along I-65, I-459, I-59, US-31, US-280 & 1st Ave North corridors from February 2018 to February 2019. The data indicate that I-459, I-65, and US 31 were heavily used as detour routes. This is significant as US 31 south of downtown was not a detour route designated by ALDOT or necessarily modified to accept the additional traffic.

5.2.5 Changes in Local Detour Patterns during Construction

Detour volumes along I-459 remained fairly stable throughout the construction project (see Figures 25 and 26), however at other locations the volume patterns exhibited during the first two months of the project (February and March 2019) changed in subsequent months. This can be seen in Figure 27, for example, where traffic volumes on I-59/20 near the I-459 junction dropped significantly in the first two months of the project but then increased in April and May. A similar pattern can be seen in the downtown area as shown in Figure 37. Traffic volumes experienced sharp declines on I-65, I-59/20, and US 31/RME near downtown during the first two months of construction but rebounded in subsequent months. While the reasons cannot be known for certain, it appears that motorists adhered to detour recommendations during the first two months but then began to adapt their routes based on prevailing traffic conditions in subsequent months.

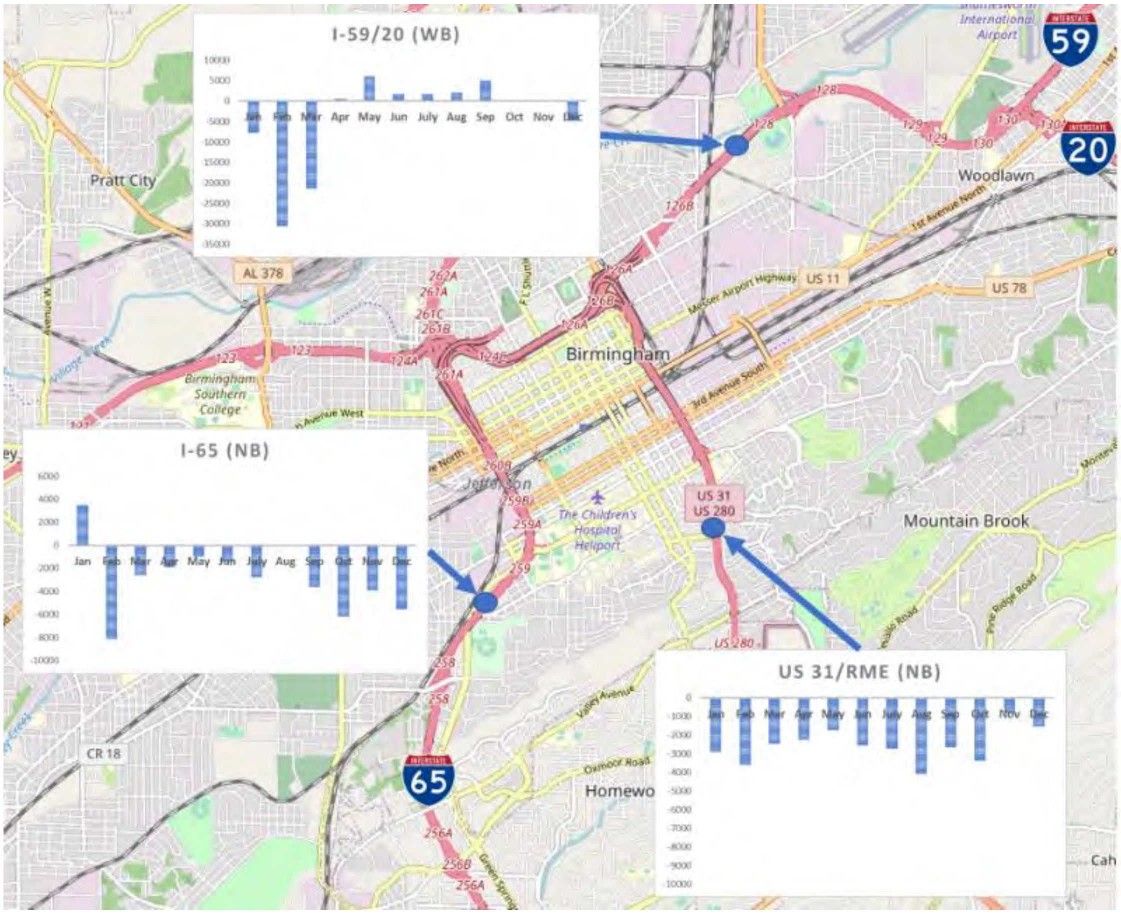


Figure 37. Changes in traffic volumes in downtown area during construction

The data suggest that the longer a detour condition is maintained the more likely it is that motorists will select unplanned detour routes for their daily trips, or at least alternate detours that minimize travel time.

5.2.6 Percent Changes in TTI Values Post-Construction

TTI values were also calculated for February 2020, the first complete month of data following the opening of the new interstate segment in January 2020. These TTI values were compared to TTI values from February 2018 to see the extent to which traffic patterns had returned to pre-construction conditions. A caveat with all data from this period is that it occurred during the earliest stages of the COVID-19 pandemic. Though significant shutdowns did not begin in Birmingham until March 2020, it is possible there were early impacts of the pandemic being felt in February as well.

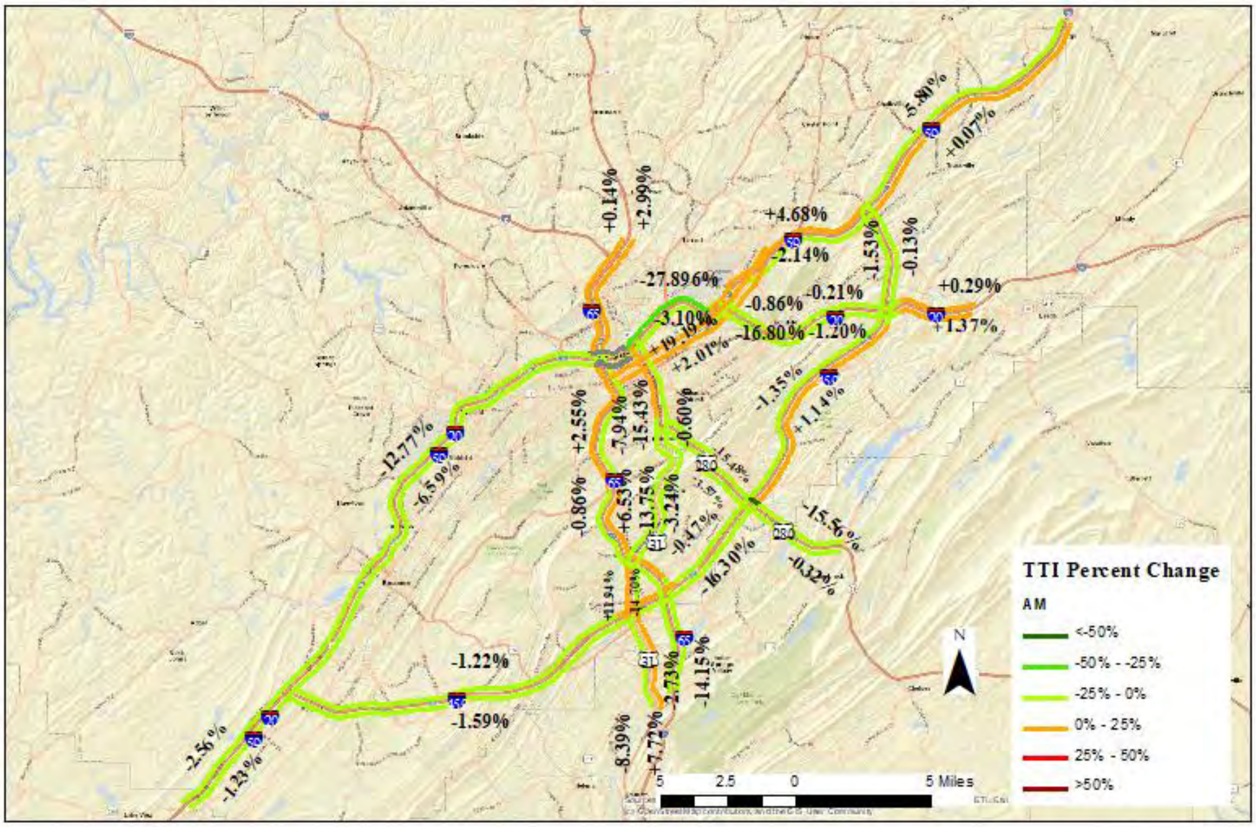


Figure 38. Percent change in TTI after construction - AM peak hours

From Figure 38, it can be observed that for most of the study road corridors, the AM TTI values had returned to values similar to pre-construction conditions within just one month of project completion. TTI values for I-20 and I-59/20 near downtown showed significant decreases compared to 2018, likely due to the new configuration of ramps and lanes in the downtown area. TTI values on I-59/20 west of downtown remained somewhat lower than in 2018, indicating that some residual traffic was likely still using detour routes.

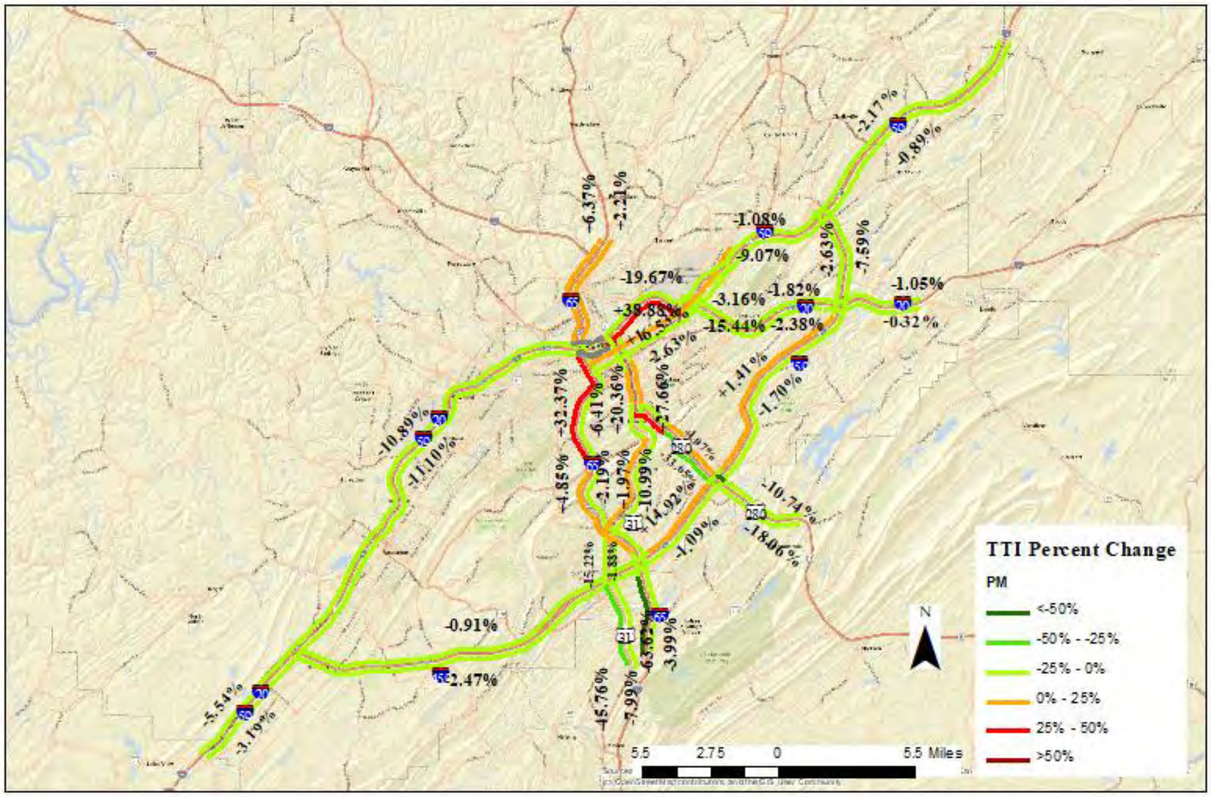


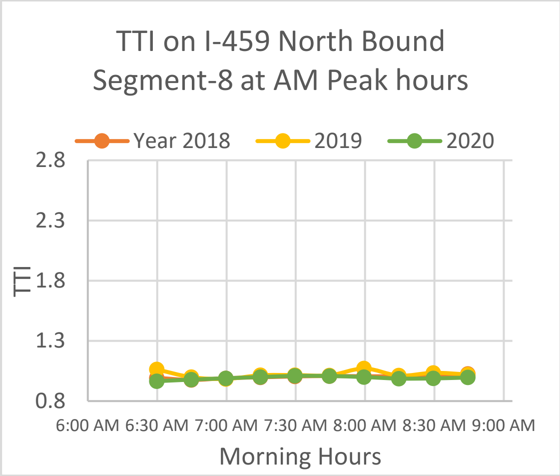
Figure 39. Percent change in TTI after construction - PM peak hours

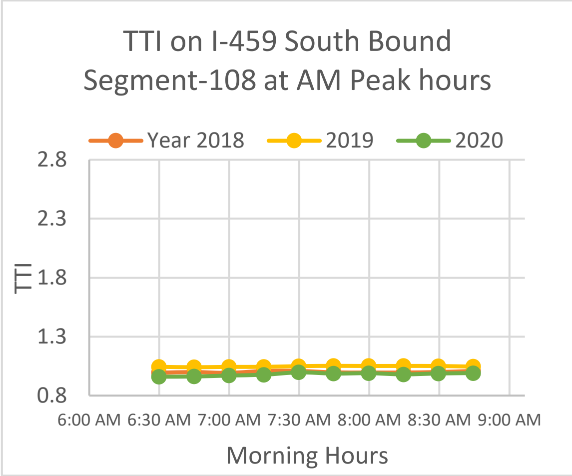
Similarly, most study corridors during the PM peak returned to pre-construction TTI levels within the first month after project completion. Notable exceptions were I-65 southbound near downtown and I-59/20 eastbound out of downtown. TTI on I-65 southbound was still approximately 32% higher than pre-construction levels while TTI values on I-59/20 were 38% higher than pre-construction levels. The reason for these changes are not clear, but it is possible that the new configuration of interstate lanes and ramps in the downtown increased throughput in this area and increased congestion on adjacent interstate segments. As in the AM peak, TTI levels on I-59/20 west of downtown remained about 10% below 2018 values, suggesting that some residual traffic may have still been using detour routes.

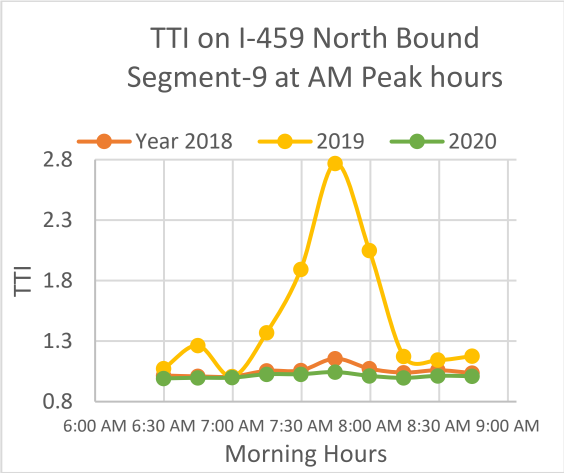
5.2.7 Detailed TTI Analysis

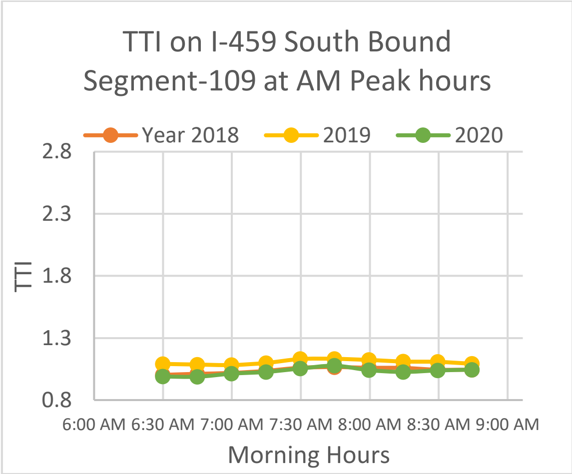
The previous TTI maps were prepared using the maximum values of TTI obtained during the morning and evening peak hours. Therefore, out of ten data points in the morning and ten data points in the evening peak time period , each representing a 15-min period, the highest TTI value was used to produce the maps. To better understand the changes in TTI values during the peak AM and PM periods, TTI graphs for each study corridor segment were plotted. The following figures display the 50th percentile monthly TTI fluctuations during the morning &

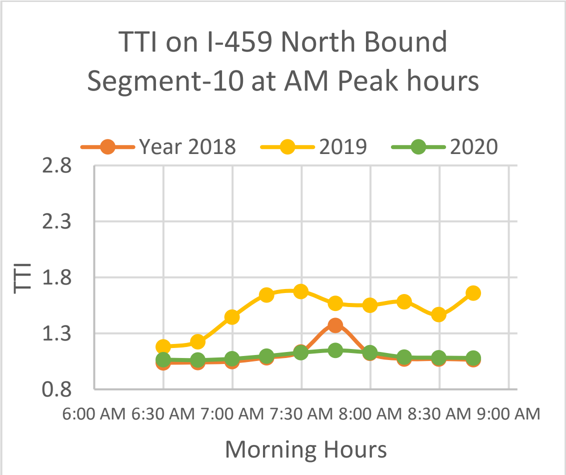
evening peak hours for each segment for the months of February 2018, 2019, and 2020. Each data point represents one 15-minute time increment.

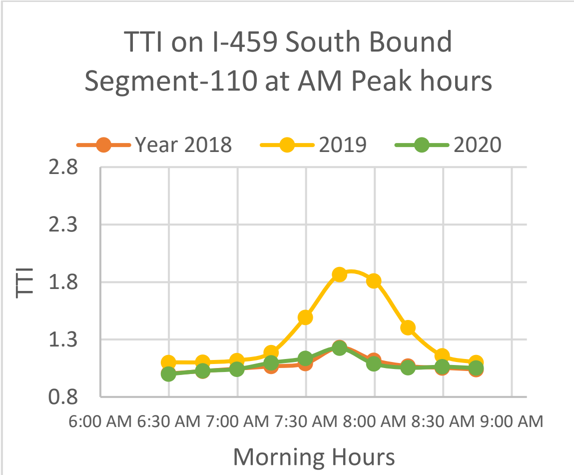












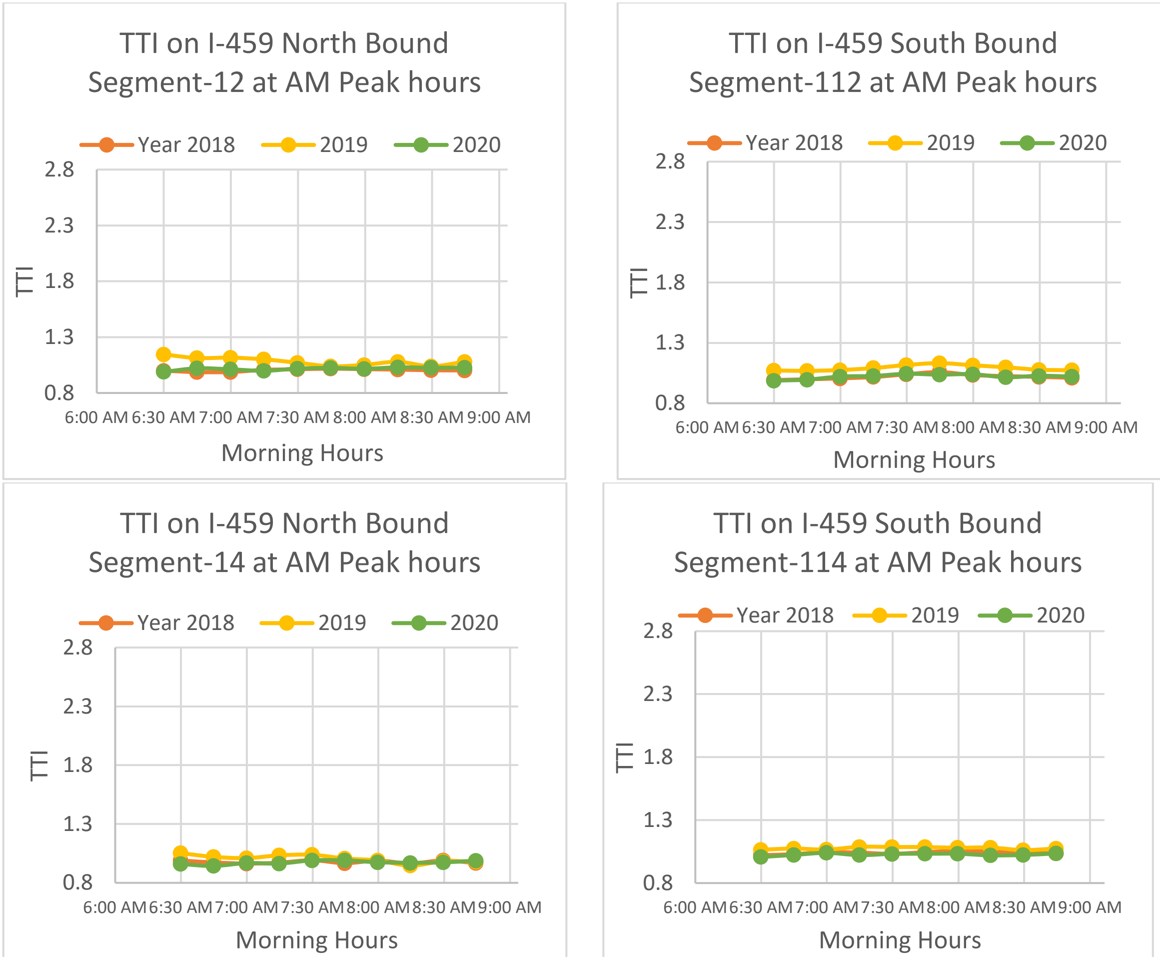
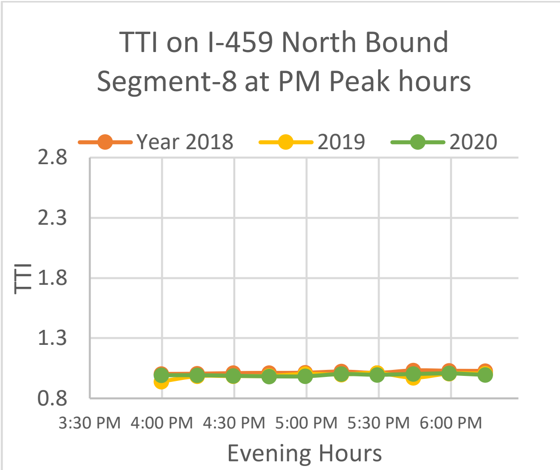
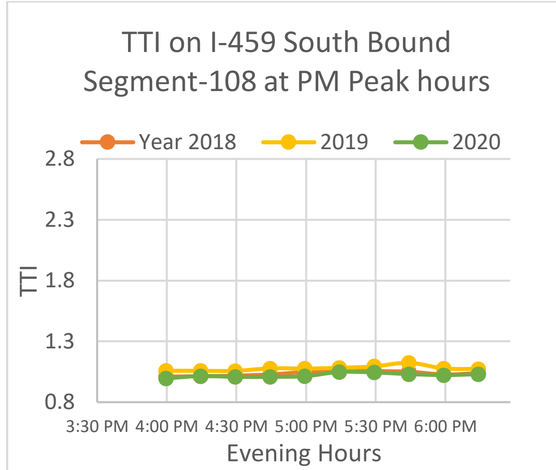
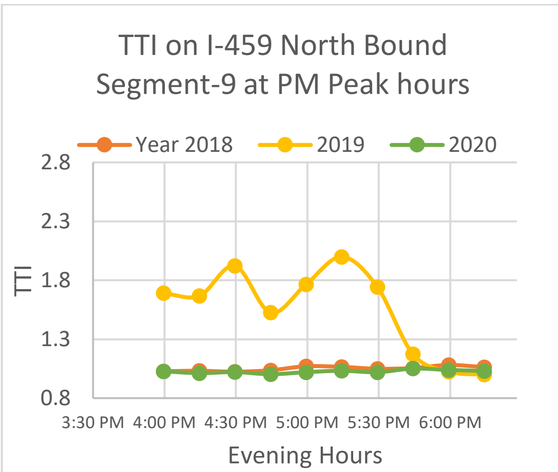


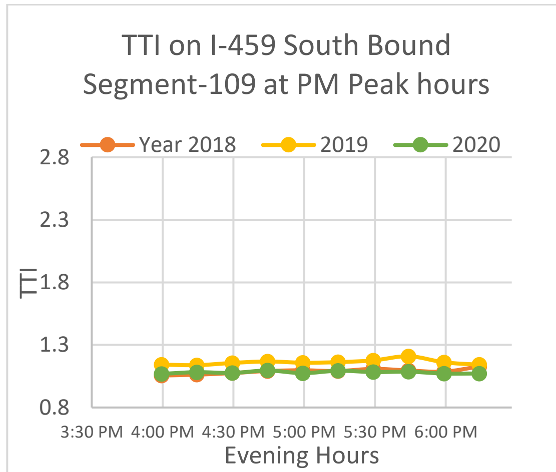
Figure 40. Detailed TTI Plots for I-459 Segments (AM peak)

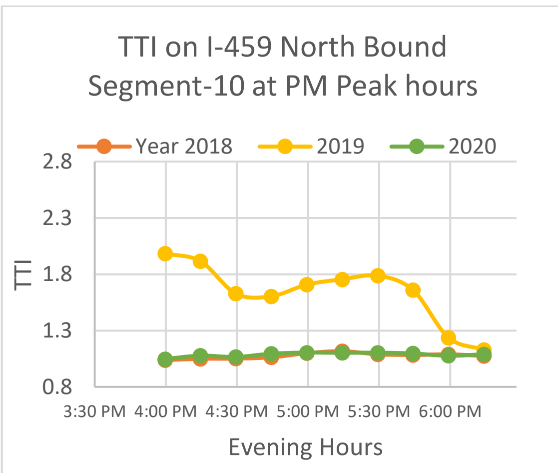
Figure 40 shows that prior to construction, most of the study road segments of the I-459 corridor on both directions had steady TTI values close to 1.0. except for the northbound road segments 9 & 10 and southbound road segment 110. Segments 9, 10, and 110 did experience significant increases in TTI in the AM peak period during construction but all other segments remained at low levels of TTI during and after construction.

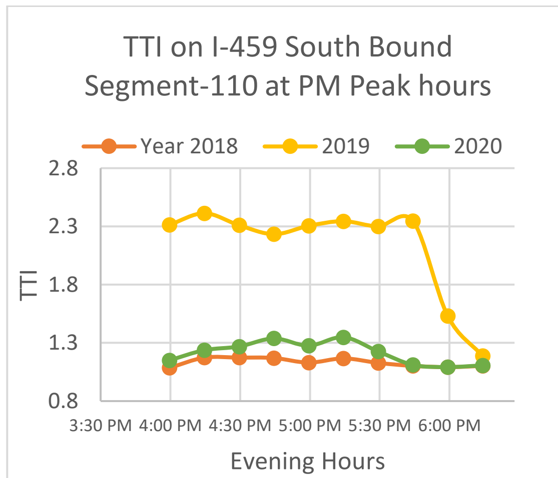

TTI on I-459 North Bound
Segment-8 at PM Peak hours
Year 2018
2019
2020
2.8
2.3
1.8
1.3
0.8
TTI
3:30 PM
4:00 PM
4:30 PM
5:00 PM
5:30 PM
6:00 PM
Evening Hours


TTI on I-459 South Bound
Segment-108 at PM Peak hours
Year 2018
2019
2020
2.8
2.3
1.8
1.3
0.8
TTI
3:30 PM
4:00 PM
4:30 PM
5:00 PM
5:30 PM
6:00 PM
Evening Hours


TTI on I-459 North Bound
Segment-9 at PM Peak hours
Year 2018
2019
2020
2.8
2.3
1.8
1.3
0.8
TTI
3:30 PM
4:00 PM
4:30 PM
5:00 PM
5:30 PM
6:00 PM
Evening Hours


TTI on I-459 South Bound
Segment-109 at PM Peak hours
Year 2018
2019
2020
2.8
2.3
1.8
1.3
0.8
TTI
3:30 PM
4:00 PM
4:30 PM
5:00 PM
5:30 PM
6:00 PM
Evening Hours


TTI on I-459 North Bound
Segment-10 at PM Peak hours
Year 2018
2019
2020
2.8
2.3
1.8
1.3
0.8
TTI
3:30 PM
4:00 PM
4:30 PM
5:00 PM
5:30 PM
6:00 PM
Evening Hours


TTI on I-459 South Bound
Segment-110 at PM Peak hours
Year 2018
2019
2020
2.8
2.3
1.8
1.3
0.8
TTI
3:30 PM
4:00 PM
4:30 PM
5:00 PM
5:30 PM
6:00 PM
Evening Hours

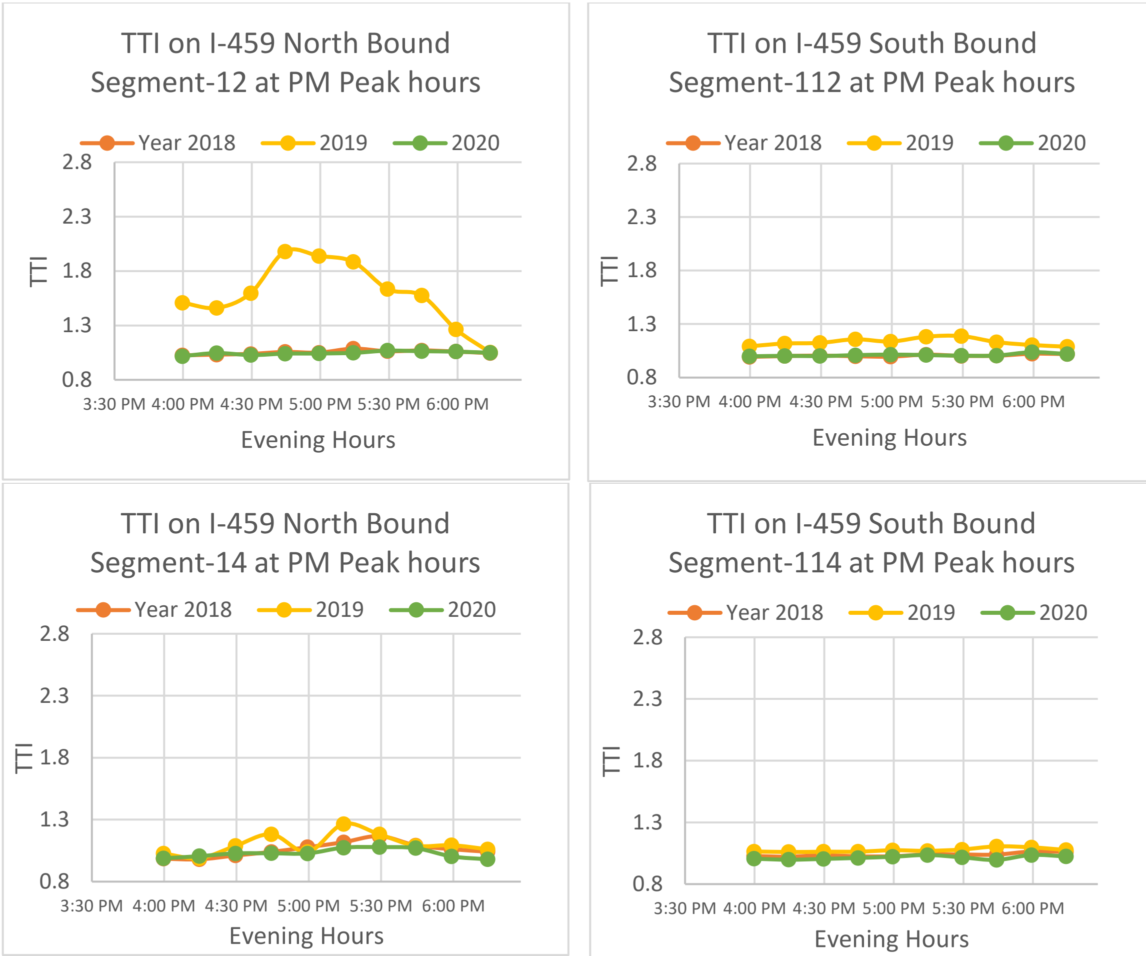
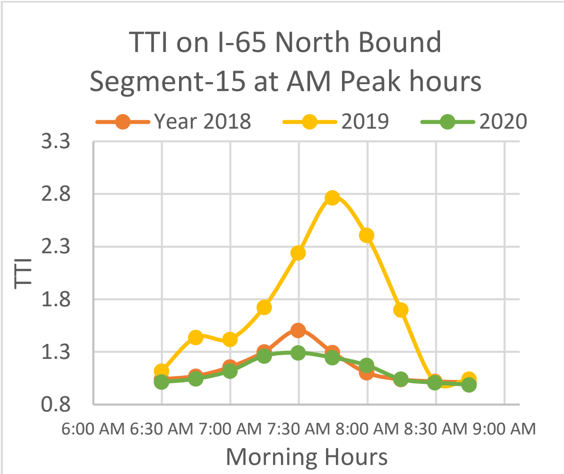
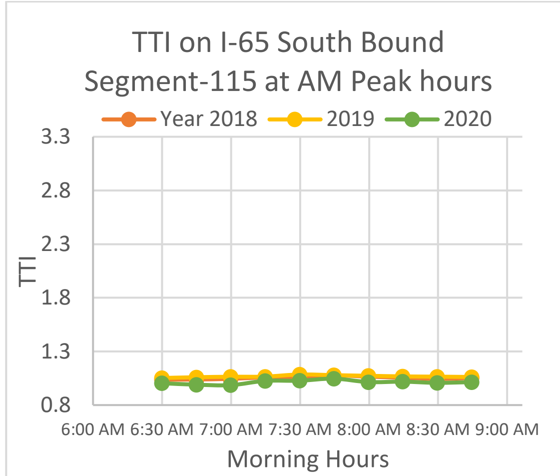
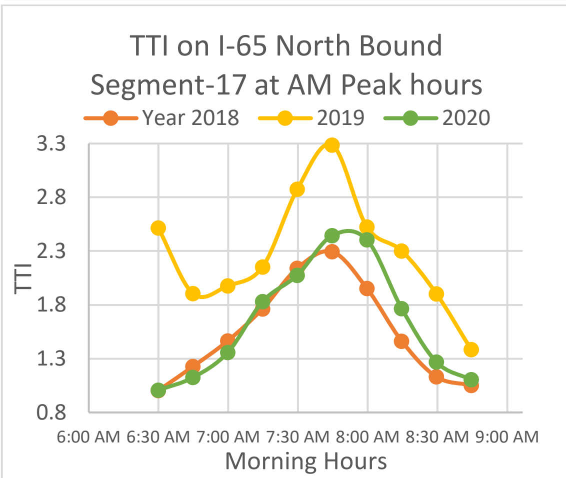


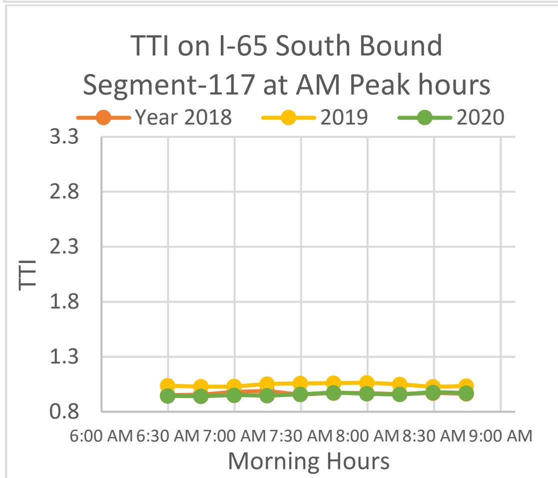
Figure 41. Detailed TTI Plots for I-459 Segments (PM peak)

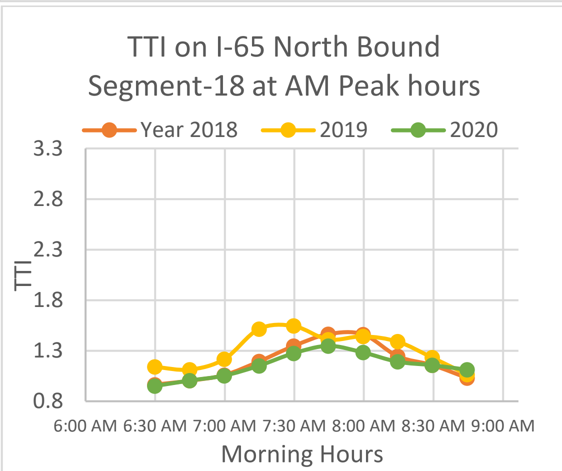
In Figure 41, the I-459 northbound segments 8 & 108 and parallel southbound segments 14 & 114 had almost similar TTI values of 1.0 for the evening peak period of the months of February 2018, 2019, and 2020. These indicate that there were no significant impacts on traffic performance along with these I-459 segments resulting from the I-59/20 road closure. It should be noted that in all cases, TTI values returned to values near 1.0 during off-peak periods.

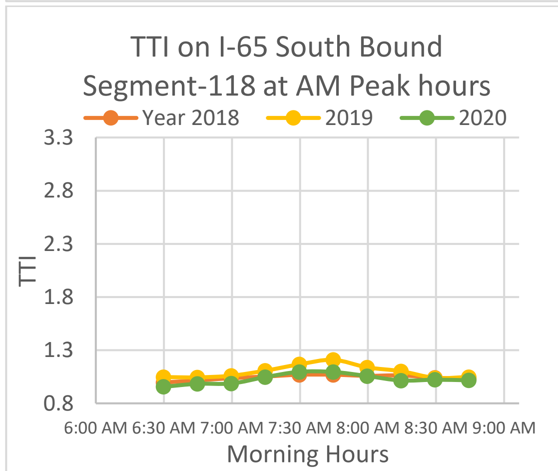

TTI on I-65 North Bound
Segment-15 at AM Peak hours
Year 2018
2019
2020
3.3
2.8
2.3
1.8
1.3
0.8
TTI
6:00 AM 6:30 AM 7:00 AM 7:30 AM 8:00 AM 8:30 AM 9:00 AM
Morning Hours


TTI on I-65 South Bound
Segment-115 at AM Peak hours
Year 2018
2019
2020
3.3
2.8
2.3
1.8
1.3
0.8
TTI
6:00 AM 6:30 AM 7:00 AM 7:30 AM 8:00 AM 8:30 AM 9:00 AM
Morning Hours


TTI on I-65 North Bound
Segment-17 at AM Peak hours
Year 2018
2019
2020
3.3
2.8
2.3
1.8
1.3
0.8
TTI
6:00 AM 6:30 AM 7:00 AM 7:30 AM 8:00 AM 8:30 AM 9:00 AM
Morning Hours


TTI on I-65 South Bound
Segment-117 at AM Peak hours
Year 2018
2019
2020
3.3
2.8
2.3
1.8
1.3
0.8
TTI
6:00 AM 6:30 AM 7:00 AM 7:30 AM 8:00 AM 8:30 AM 9:00 AM
Morning Hours


TTI on I-65 North Bound
Segment-18 at AM Peak hours
Year 2018
2019
2020
3.3
2.8
2.3
1.8
1.3
0.8
TTI
6:00 AM 6:30 AM 7:00 AM 7:30 AM 8:00 AM 8:30 AM 9:00 AM
Morning Hours


TTI on I-65 South Bound
Segment-118 at AM Peak hours
Year 2018
2019
2020
3.3
2.8
2.3
1.8
1.3
0.8
TTI
6:00 AM 6:30 AM 7:00 AM 7:30 AM 8:00 AM 8:30 AM 9:00 AM
Morning Hours

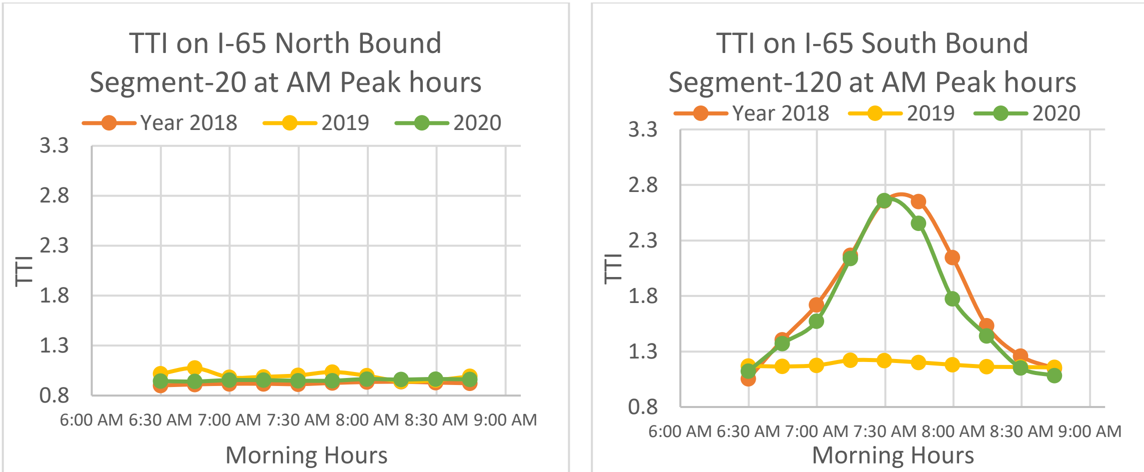
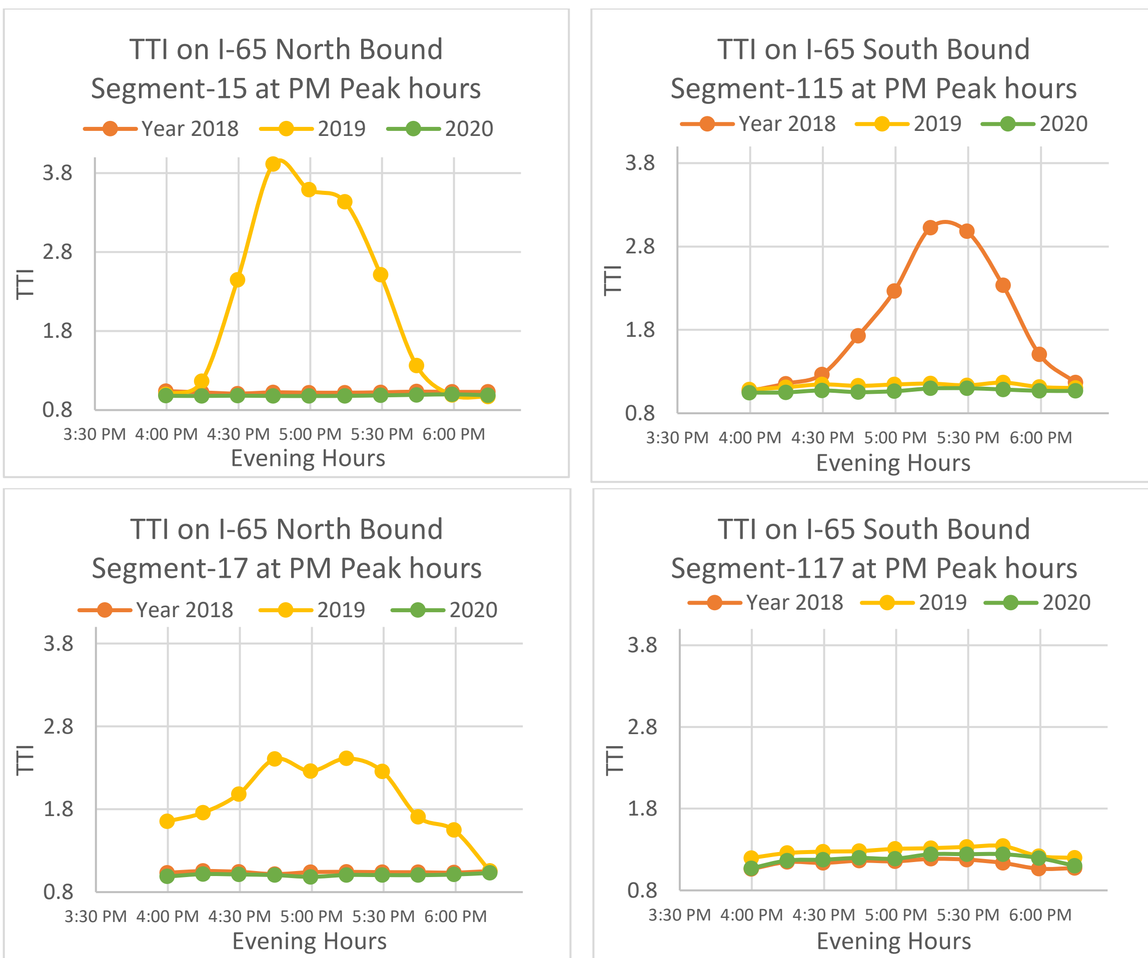


Figure 42. Detailed TTI Plots for I-65 Segments (AM peak)

Segments 15 and 17 on I-65 showed significant increases in TTI during the AM peak during construction. Segment 120, on the other hand, showed significant reductions in TTI during construction, likely from the elimination of delays previously caused by SB traffic exiting onto I-59/20.



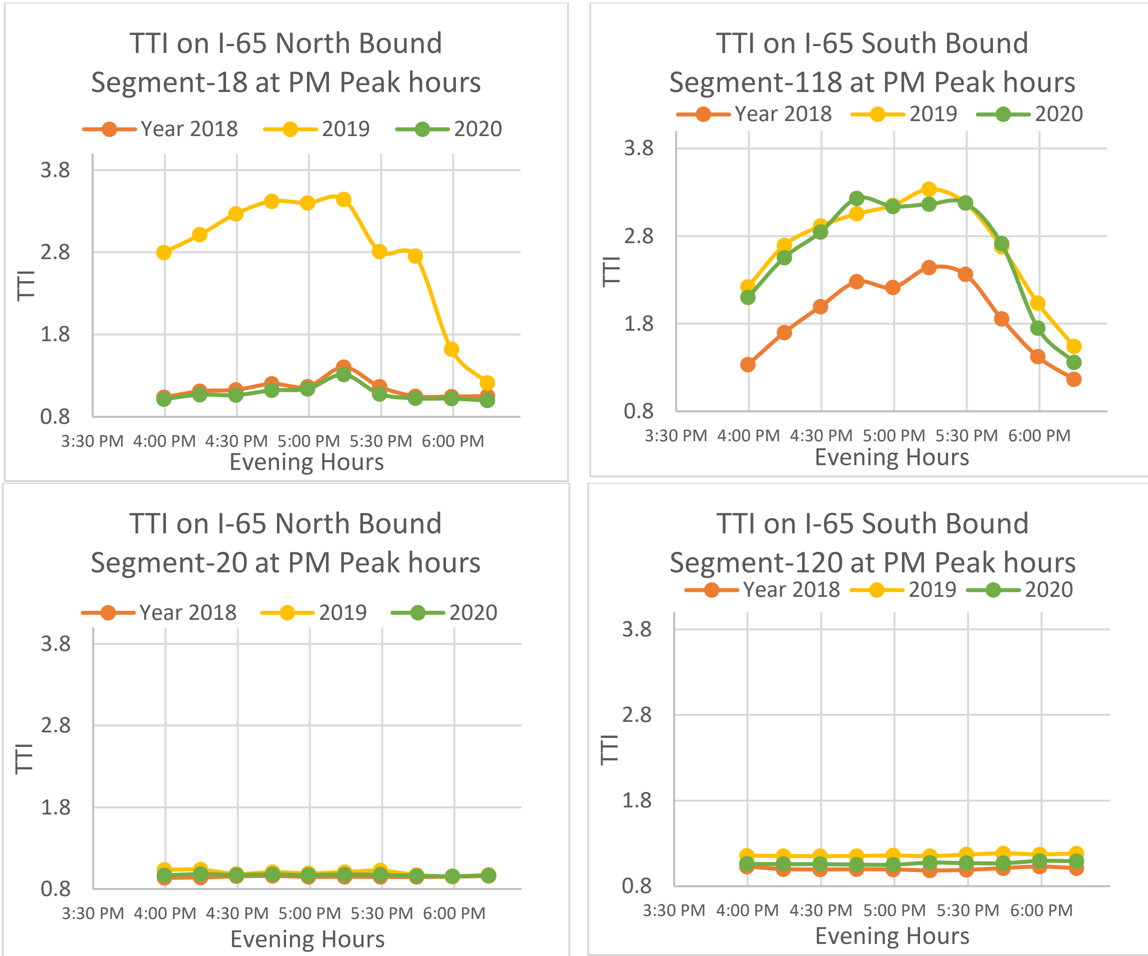
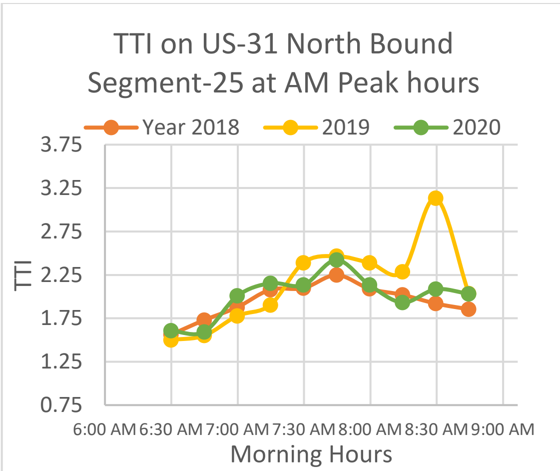
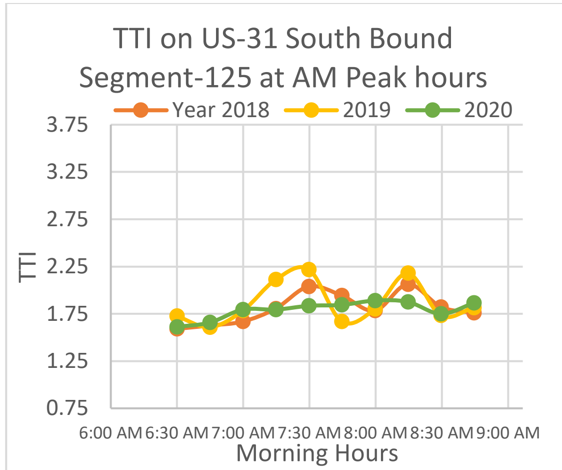
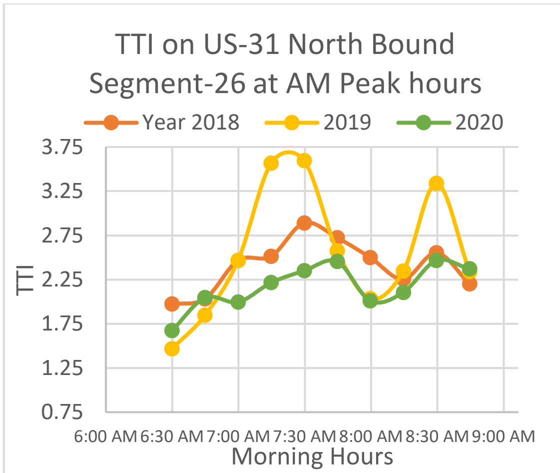
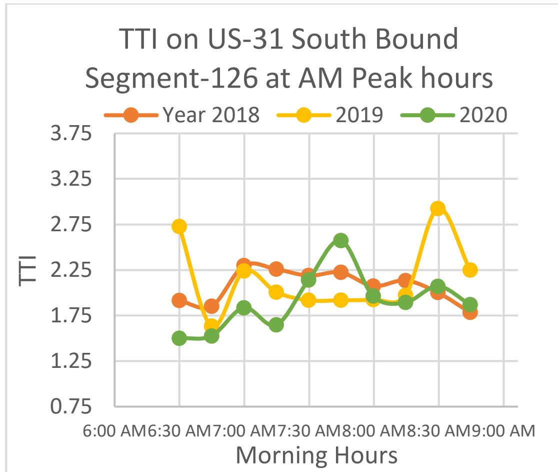


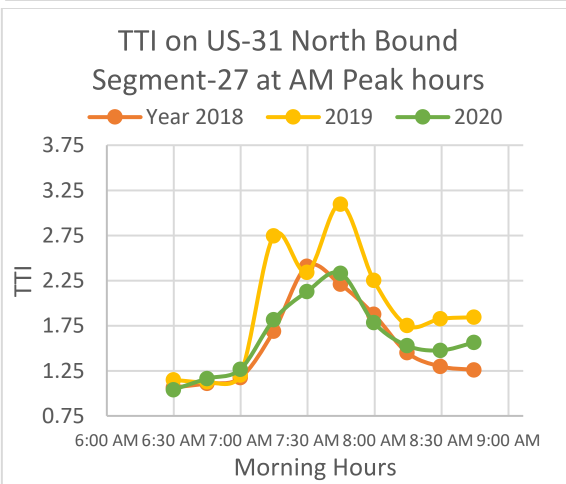
Figure 43. Detailed TTI Plots for I-65 Segments (PM peak)

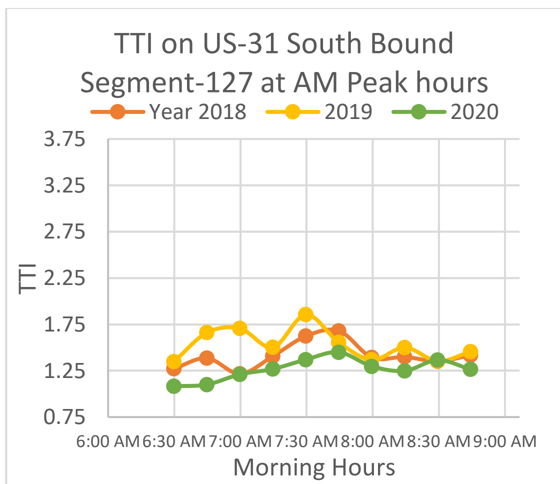

TTI on US-31 North Bound
Segment-25 at AM Peak hours
Year 2018
2019
2020
3.75
3.25
2.75
2.25
1.75
1.25
0.75
TTI
6:00 AM 6:30 AM 7:00 AM 7:30 AM 8:00 AM 8:30 AM 9:00 AM
Morning Hours


TTI on US-31 South Bound
Segment-125 at AM Peak hours
Year 2018
2019
2020
3.75
3.25
2.75
2.25
1.75
1.25
0.75
TTI
6:00 AM 6:30 AM 7:00 AM 7:30 AM 8:00 AM 8:30 AM 9:00 AM
Morning Hours


TTI on US-31 North Bound
Segment-26 at AM Peak hours
Year 2018
2019
2020
3.75
3.25
2.75
2.25
1.75
1.25
0.75
TTI
6:00 AM 6:30 AM 7:00 AM 7:30 AM 8:00 AM 8:30 AM 9:00 AM
Morning Hours


TTI on US-31 South Bound
Segment-126 at AM Peak hours
Year 2018
2019
2020
3.75
3.25
2.75
2.25
1.75
1.25
0.75
TTI
6:00 AM 6:30 AM 7:00 AM 7:30 AM 8:00 AM 8:30 AM 9:00 AM
Morning Hours


TTI on US-31 North Bound
Segment-27 at AM Peak hours
Year 2018
2019
2020
3.75
3.25
2.75
2.25
1.75
1.25
0.75
TTI
6:00 AM 6:30 AM 7:00 AM 7:30 AM 8:00 AM 8:30 AM 9:00 AM
Morning Hours


TTI on US-31 South Bound
Segment-127 at AM Peak hours
Year 2018
2019
2020
3.75
3.25
2.75
2.25
1.75
1.25
0.75
TTI
6:00 AM 6:30 AM 7:00 AM 7:30 AM 8:00 AM 8:30 AM 9:00 AM
Morning Hours

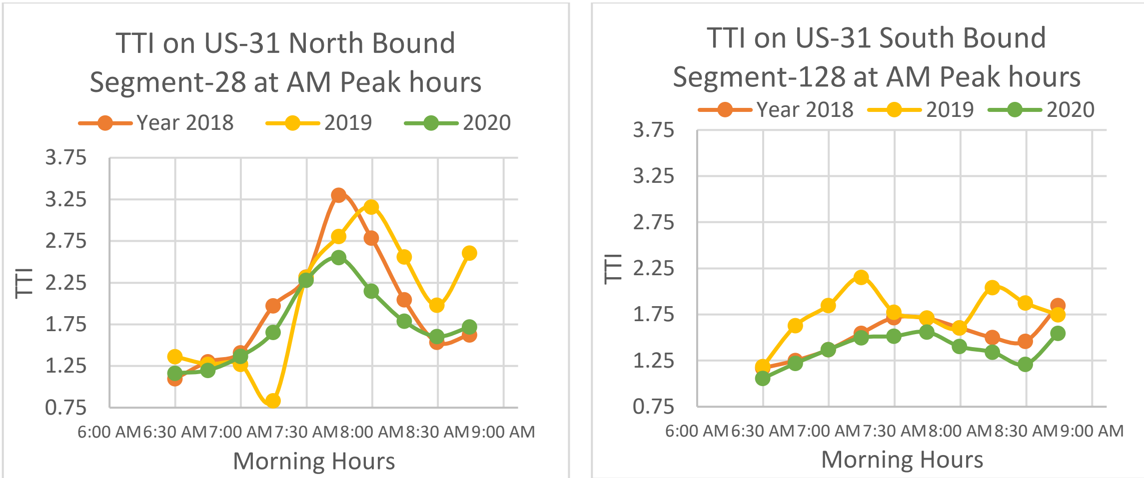
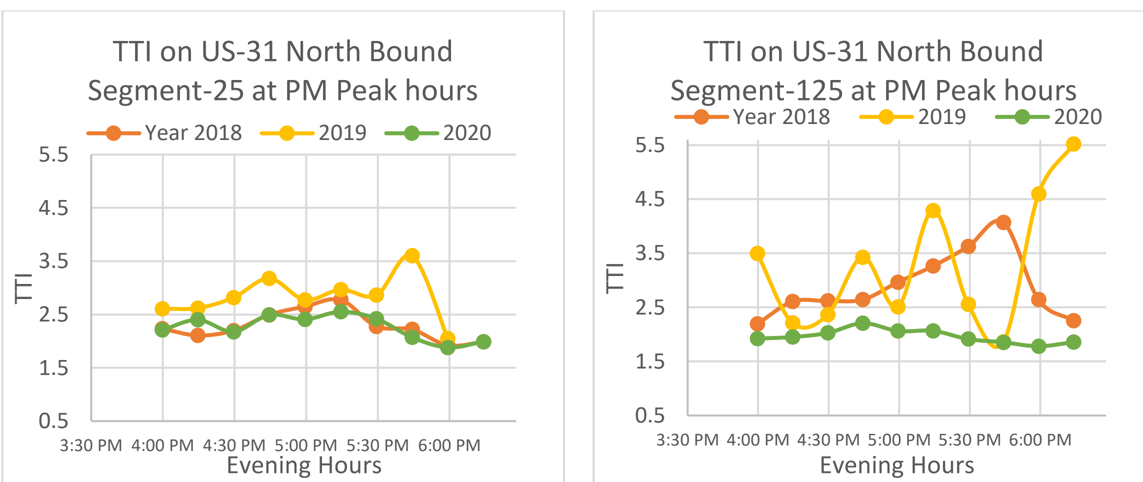


Figure 44. Detailed TTI Plots for US 31 Segments (AM peak)

Unlike the TTI variations observed along the interstate highway study segments, in Figure 44 almost all road segments in both directions of the US-31 corridor show variations of TTI values within the morning peak hours in February 2018, February 2019 and February 2020. The range of the TTI variations was from 0.75 to 3.75. TTI values were higher in 2019, whereas TTI values for most study segments along the US-31 corridor were found to be comparable when comparing the results for February 2018 and February 2020. This implies that US 31 was a major detour route during construction.



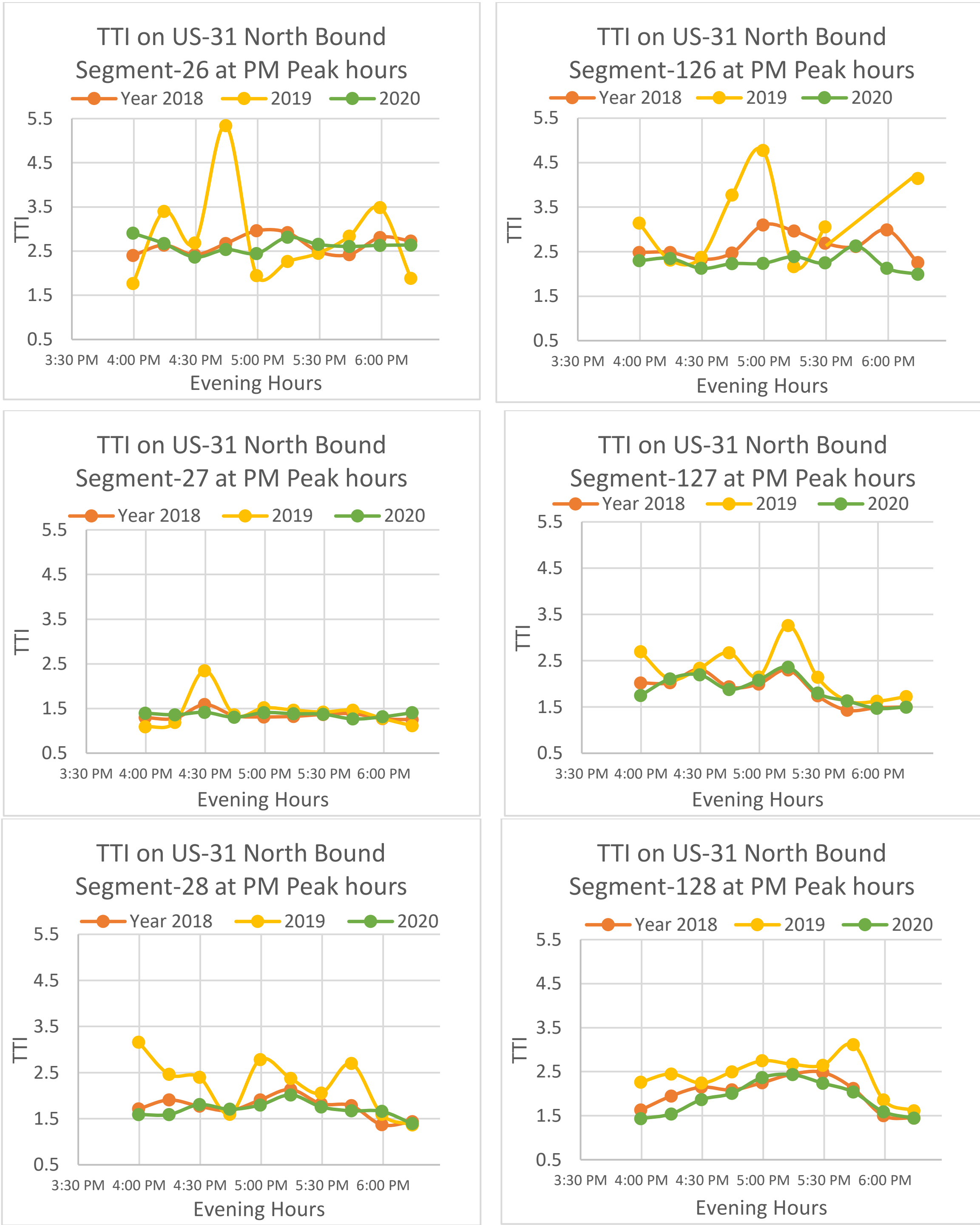


Figure 45. Detailed TTI Plots for US 31 Segments (PM peak)

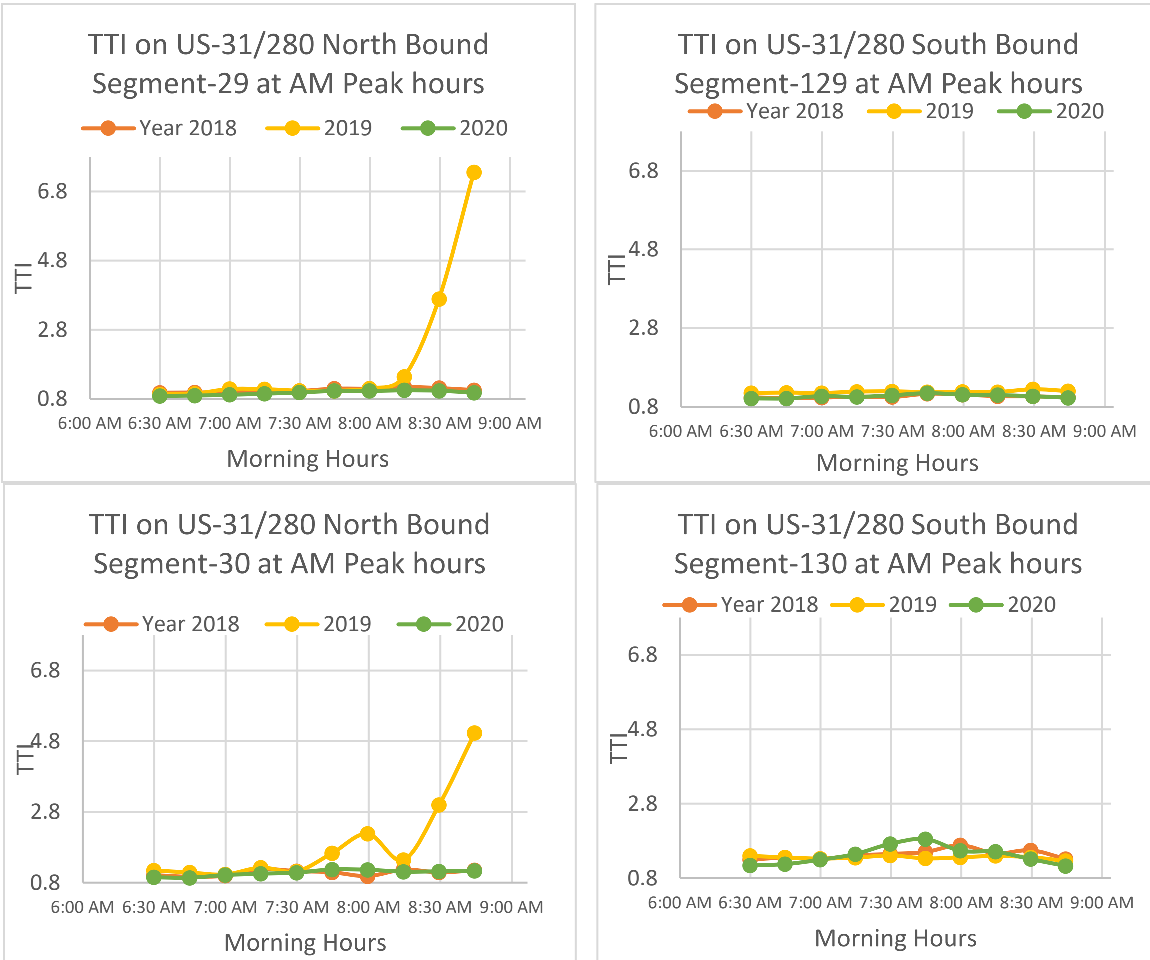
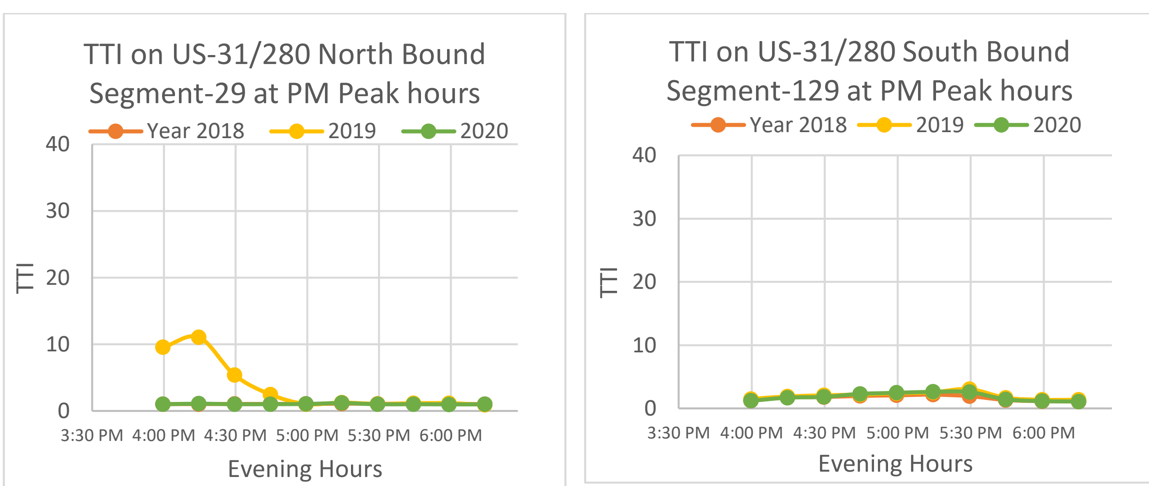


Figure 46. Detailed TTI Plots for US 31/US 280 RME Segments (AM peak)



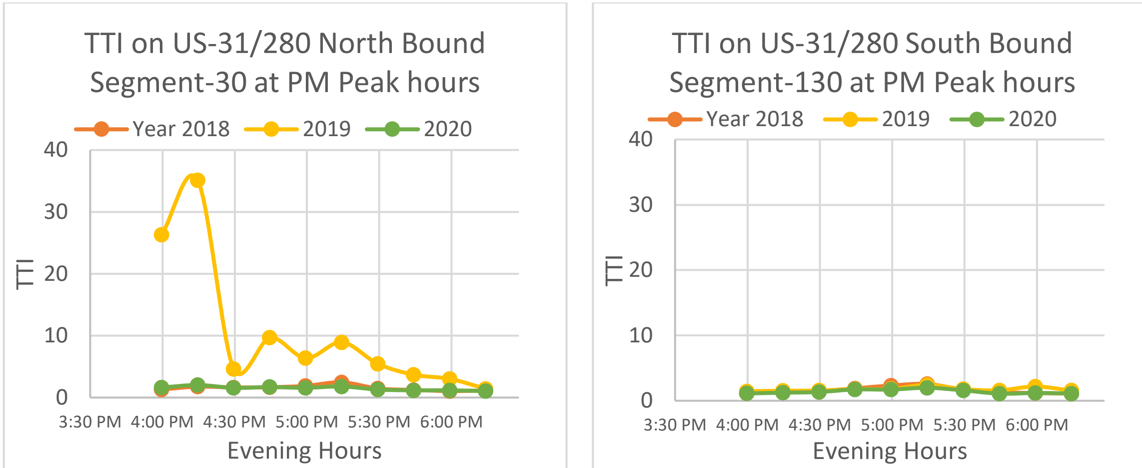
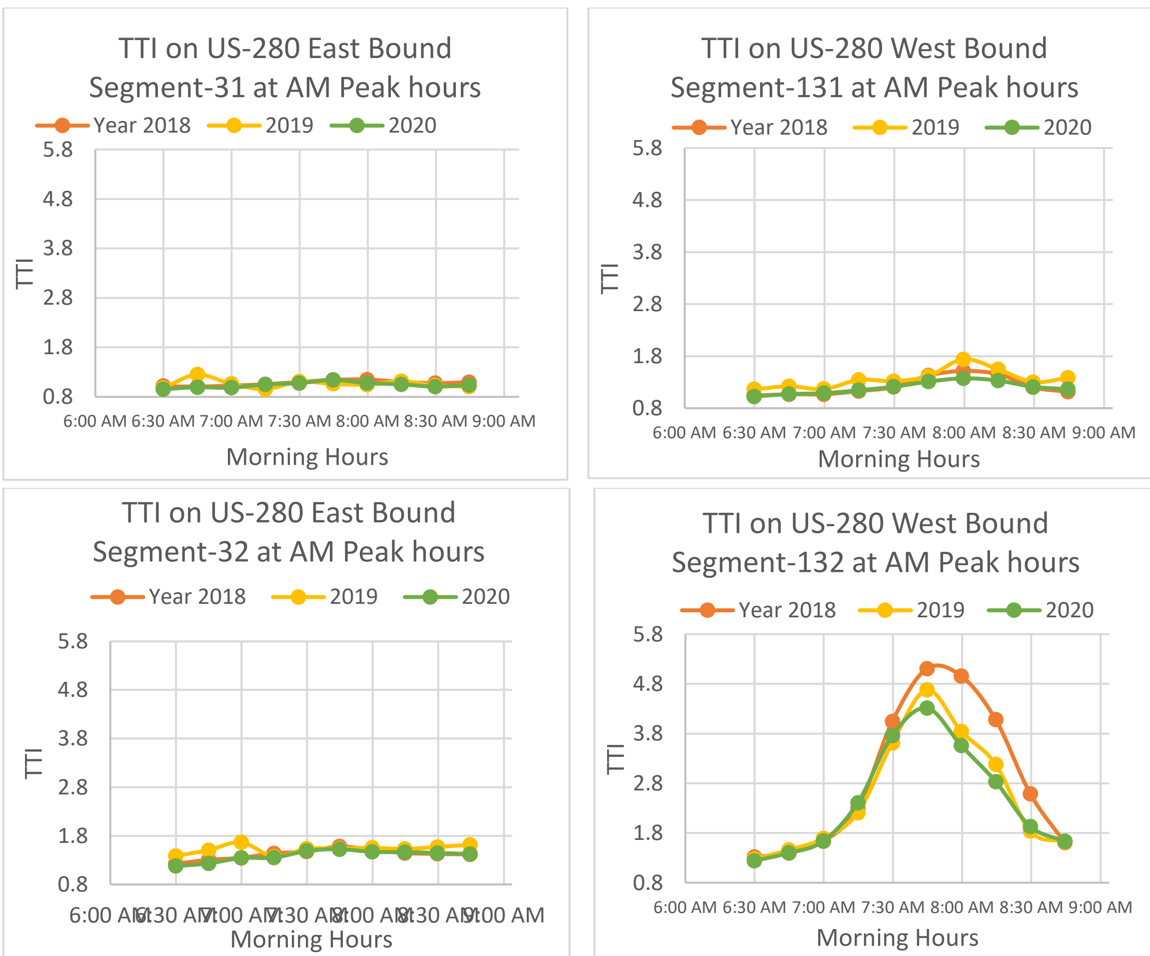


Figure 47. Detailed TTI Plots for US 31/US 280 RME Segments (PM peak)



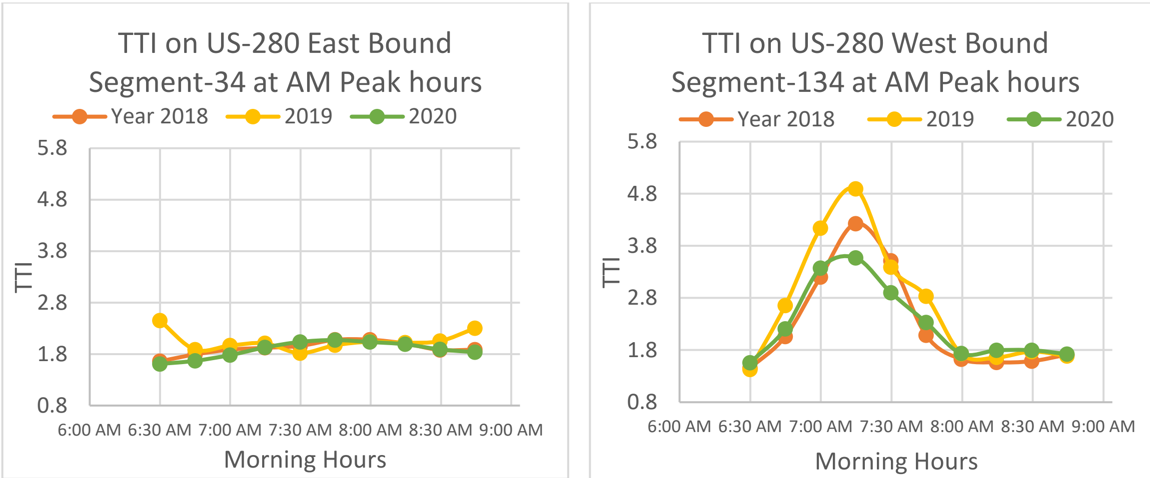
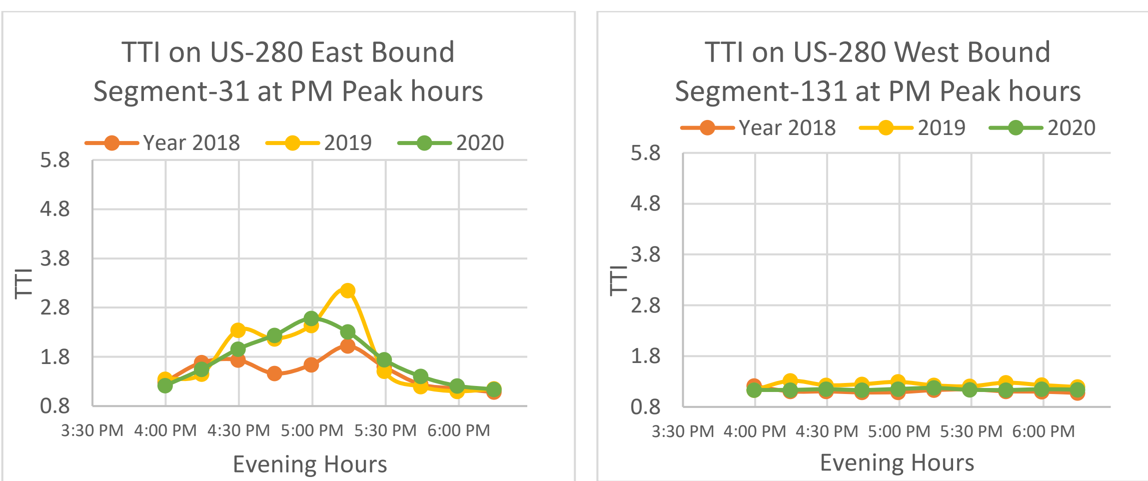


Figure 48. Detailed TTI Plots for US 280 Segments (AM peak)

AM TTI values along US 280 remained fairly consistent before, during, and after the construction project. This would indicate that US 280 was not a major detour route during the AM peak. It is likely due to the fact that the portion of US 280 inbound from I-459 to the Red Mountain Expressway already experiences significant congestion during the AM peak and was therefore not an attractive detour route. Similar patterns were seen in the PM peak as well (see Figure 49).



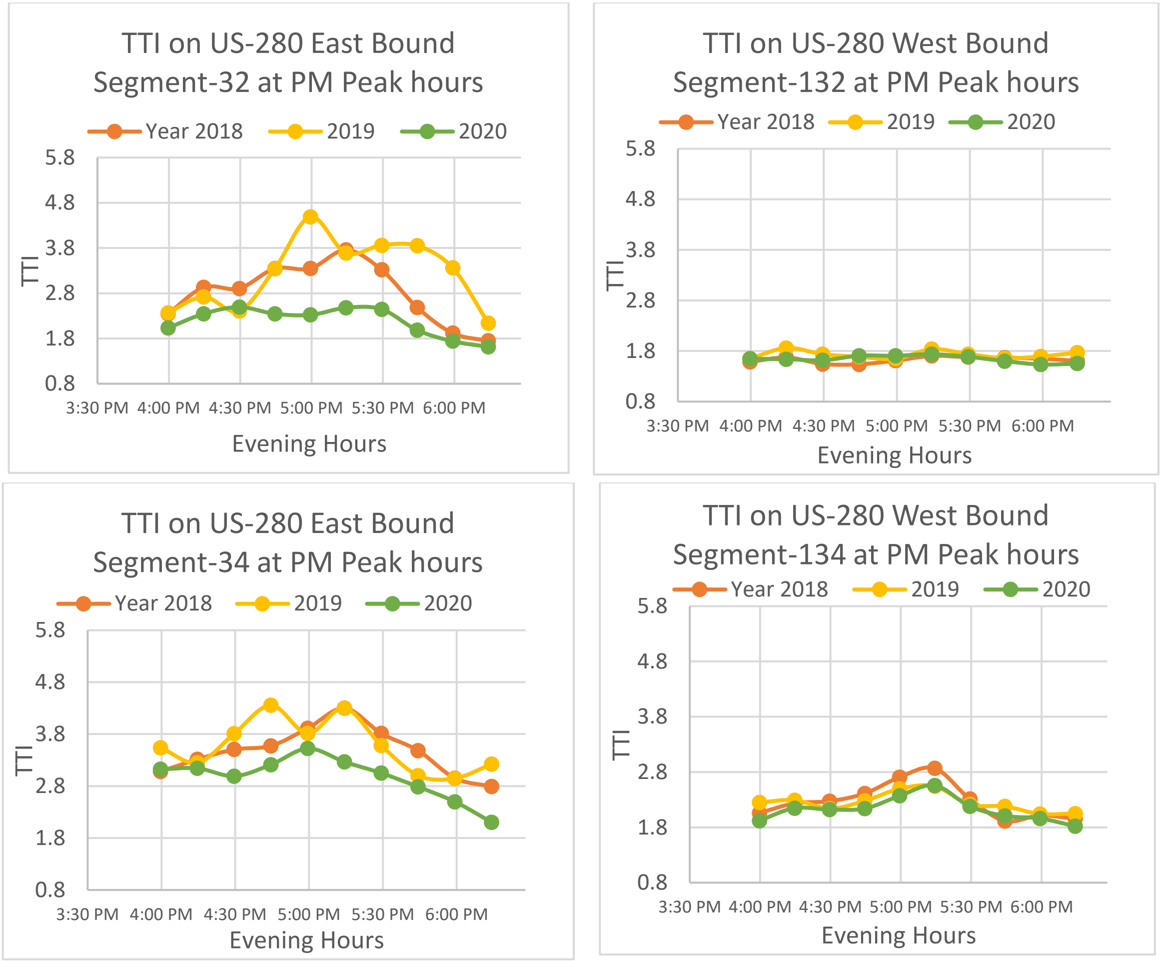


Figure 49. Detailed TTI Plots for US 280 Segments (AM peak)

5.2.8 Statistical Check of TTI Changes

The maps and graphs presented in this section provide an overview of the changes to travel times caused by the I-20/59 reconstruction project. In order to determine if the observed difference were statistically significant, t-tests were performed that compared TTI values between February 2018 & 2019 as well as between February 2018 & 2020 on a segment-by-segment basis. Tables 5, 6, 7, and 8 provide segment-wise t-test results and summary of significance by comparing the different data sets. Color-coded summary maps were also prepared to summarize the results of the t-tests. They are displayed in Figures 50, 51, 52, and 53.

Table 5: t-test summary for TTI comparison: 2108 vs 2019, AM peak

North-East Bound			South-West Bound		
Segment No	P-value	Significance	Segment No	P-value	Significance
1	0.2783	Insignificant	101	0.0000	Significant
2*	0.0001	Significant	102	0.0000	Significant
3	-	-	103	-	-
4	-	-	104	-	-
5	0.0605	Insignificant	105	0.3053	Insignificant
6	0.4123	Insignificant	106	0.0002	Significant
7	0.4691	Insignificant	107	0.1399	Insignificant
8	0.0158	Significant	108	0.0000	Significant
9	0.0136	Significant	109	0.0000	Significant
10	0.0000	Significant	110	0.0041	Significant
11	0.2818	Insignificant	111	0.0314	Significant
12	0.0001	Significant	112	0.0000	Significant
13	0.1309	Insignificant	113	0.0009	Significant
14	0.0062	Significant	114	0.0000	Significant
15	0.0048	Significant	115	0.0002	Significant
16	0.0045	Significant	116	0.0056	Significant
17	0.0000	Significant	117	0.0000	Significant
18	0.0049	Significant	118	0.0017	Significant
19	0.0182	Significant	119	0.0000	Significant
20	0.0002	Significant	120	0.0050	Significant
21	0.0001	Significant	121	0.0580	Insignificant
22	0.0114	Significant	122	0.0000	Significant
23	0.0063	Significant	123	0.0000	Significant
24	0.0118	Significant	124	0.0000	Significant
25	0.0815	Insignificant	125	0.1559	Insignificant
26	0.2039	Insignificant	126	0.3060	Insignificant
27	0.0061	Significant	127	0.0335	Significant
28	0.3429	Insignificant	128	0.0099	Significant
29	0.0952	Insignificant	129	0.0000	Significant
30	0.0345	Significant	130	0.0356	Significant
31	0.3204	Insignificant	131	0.0002	Significant
32	0.0085	Significant	132	0.0136	Significant
33	0.0461	Significant	133	0.0046	Significant
34	0.0767	Insignificant	134	0.0140	Significant
35	0.0429	Significant	135	0.0000	Significant

*Note: Underlined segments were part of diversion routes recommended by ALDOT as alternative routes during construction and included in the detour plans

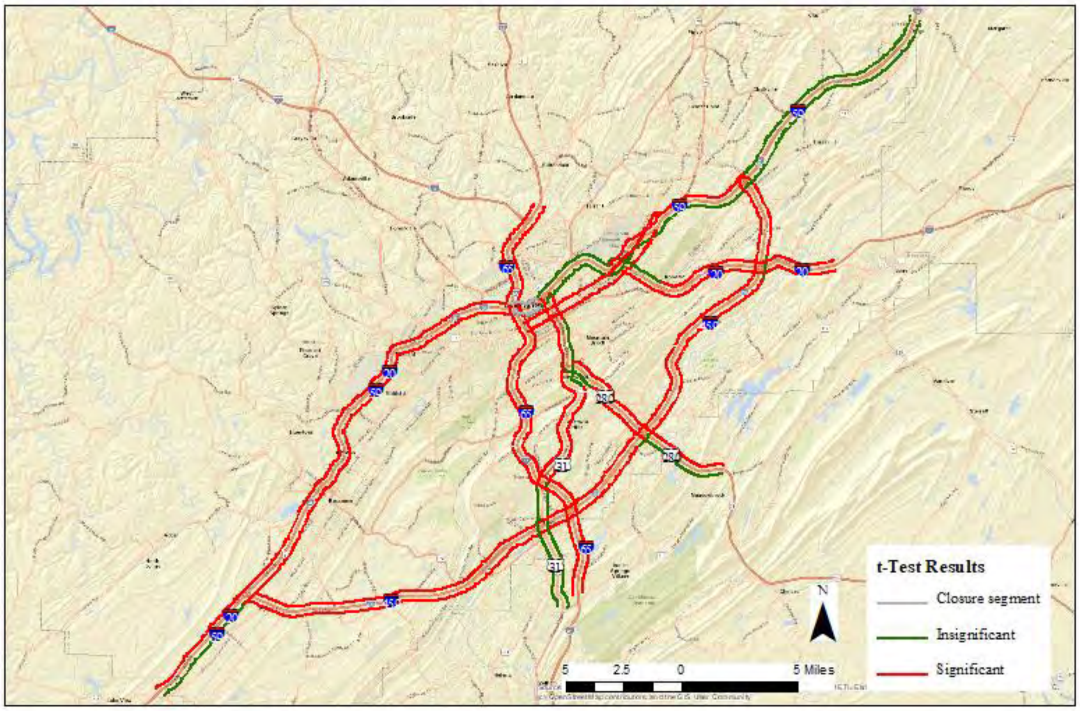


Figure 50. t-test summary for 2019 vs 2108 TTI, AM peak

As seen in Figure 50 and Table 5, 53 out of 70 roadway segments showed statistically significant changes in TTI during the AM peak as a result of the reconstruction project. Similar results were seen for the PM peak shown in Figure 51 and Table 6, where 59 out of 70 roadway segments showed statistically significant changes in TTI during construction.

Table 6: t-test summary for TTI comparison: 2108 vs 2019, PM peak

North-East Bound			South-West Bound		
Segment No	P-value	Significance	Segment No	P-value	Significance
1	0.0363	Significant	101	0.0000	Significant
<u>2*</u>	0.0000	Significant	<u>102</u>	0.0000	Significant
3			103		
4			104		
5	0.3829	Insignificant	105	0.0001	Significant
6	0.0011	Significant	106	0.0000	Significant
7	0.0088	Significant	107	0.0000	Significant
<u>8</u>	0.0009	Significant	<u>108</u>	0.0000	Significant
<u>9</u>	0.0011	Significant	<u>109</u>	0.0000	Significant
<u>10</u>	0.0001	Significant	<u>110</u>	0.0000	Significant
<u>11</u>	0.0451	Significant	<u>111</u>	0.0003	Significant
<u>12</u>	0.0001	Significant	<u>112</u>	0.0000	Significant
<u>13</u>	0.0278	Significant	<u>113</u>	0.0085	Significant
<u>14</u>	0.0236	Significant	<u>114</u>	0.0000	Significant
15	0.0081	Significant	115	0.0064	Significant
<u>16</u>	0.1672	Insignificant	<u>116</u>	0.0085	Significant
<u>17</u>	0.0001	Significant	<u>117</u>	0.0000	Significant
<u>18</u>	0.0000	Significant	<u>118</u>	0.0000	Significant
<u>19</u>	0.0016	Significant	<u>119</u>	0.0000	Significant
<u>20</u>	0.0005	Significant	<u>120</u>	0.0000	Significant
21	0.0000	Significant	121	0.0021	Significant
22	0.1438	Insignificant	122	0.0000	Significant
23	0.0256	Significant	123	0.0000	Significant
24	0.0072	Significant	124	0.0000	Significant
25	0.4105	Insignificant	125	0.2248	Insignificant
26	0.3260	Insignificant	126	0.0525	Insignificant
27	0.1770	Insignificant	127	0.0033	Significant
28	0.0050	Significant	128	0.0006	Significant
29	0.0374	Significant	129	0.0012	Significant
<u>30</u>	0.0158	Significant	<u>130</u>	0.1193	Insignificant
31	0.0396	Significant	131	0.0008	Significant
32	0.0457	Significant	132	0.0008	Significant
33	0.1122	Insignificant	133	0.0392	Significant
34	0.1906	Insignificant	134	0.3282	Insignificant
35	0.0015	Significant	135	0.0000	Significant

*Note: Underlined segments were part of diversion routes recommended by ALDOT as alternative routes during construction and included in the detour plans

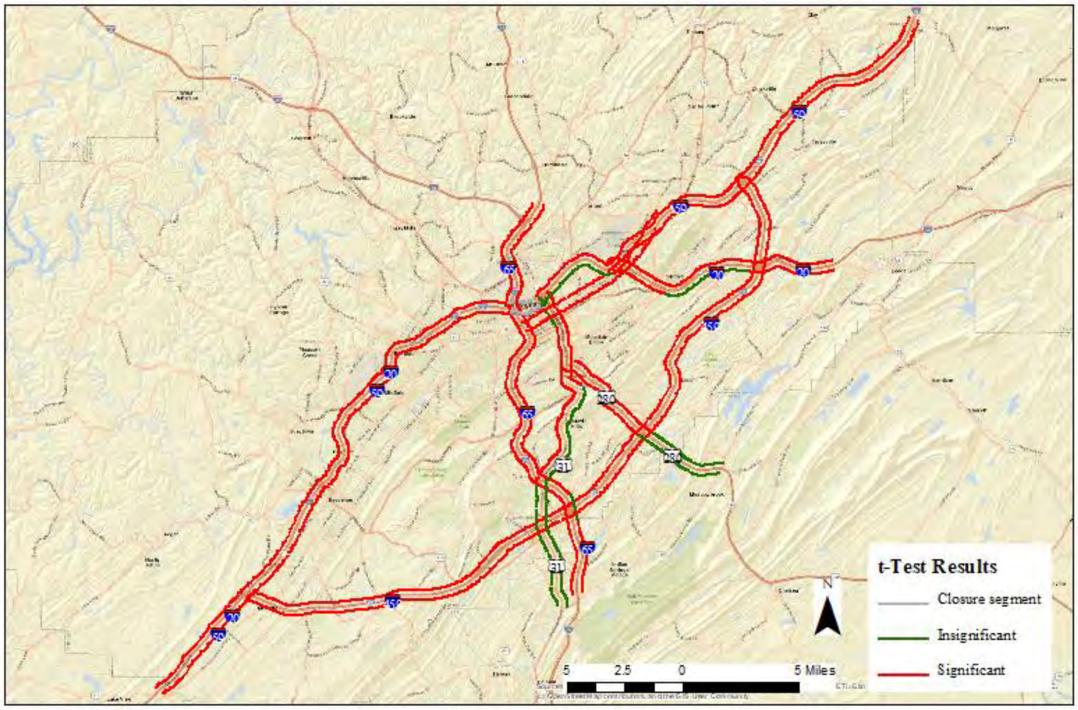


Figure 51. t-test summary for 2019 vs 2108 TTI, PM peak

Table 7: t-test summary for TTI comparison: 2108 vs 2020, AM peak

North-East Bound			South-West Bound		
Segment No	P-value	Significance	Segment No	P-value	Significance
1	0.0990	Insignificant	101	0.0000	Significant
2*	0.0000	Significant	**102**	0.0000	Significant
3			103		
4			104		
5	0.0014	Significant	105	0.0005	Significant
6	0.0013	Significant	106	0.1564	Insignificant
7	0.1504	Insignificant	107	0.0717	Insignificant
8	0.0267	Significant	**108**	0.0001	Significant
9	0.0012	Significant	**109**	0.0120	Significant
10	0.3533	Insignificant	**110**	0.2790	Insignificant
11	0.0000	Significant	**111**	0.0000	Significant
12	0.0149	Significant	**112**	0.3258	Insignificant
13	0.0007	Significant	**113**	0.0000	Significant
14	0.2354	Insignificant	**114**	0.0013	Significant
15	0.0767	Insignificant	115	0.0000	Significant
16	0.0426	Significant	**116**	0.0000	Significant
17	0.0766	Insignificant	**117**	0.0611	Insignificant
18	0.0554	Insignificant	**118**	0.0524	Insignificant
19	0.0000	Significant	**119**	0.0000	Significant
20	0.0000	Significant	**120**	0.0170	Significant
21	0.0000	Significant	121	0.1566	Insignificant
22	0.0307	Significant	122	0.1842	Insignificant
23	0.0000	Significant	123	0.0559	Insignificant
24	0.0327	Significant	124	0.0562	Insignificant
25	0.0510	Insignificant	125	0.3188	Insignificant
26	0.0044	Significant	126	0.0496	Significant
27	0.1484	Insignificant	127	0.0005	Significant
28	0.0365	Significant	128	0.0006	Significant
29	0.0000	Significant	129	0.1911	Insignificant
30	0.4743	Insignificant	**130**	0.3683	Insignificant
31	0.0009	Significant	131	0.1085	Insignificant
32	0.0384	Significant	132	0.0187	Significant
33	0.2824	Insignificant	133	0.0002	Significant
34	0.0710	Insignificant	134	0.4850	Insignificant
35	0.1035	Insignificant	135	0.0001	Significant

*Note: Underlined segments were part of diversion routes recommended by ALDOT as alternative routes during construction and included in the detour plans

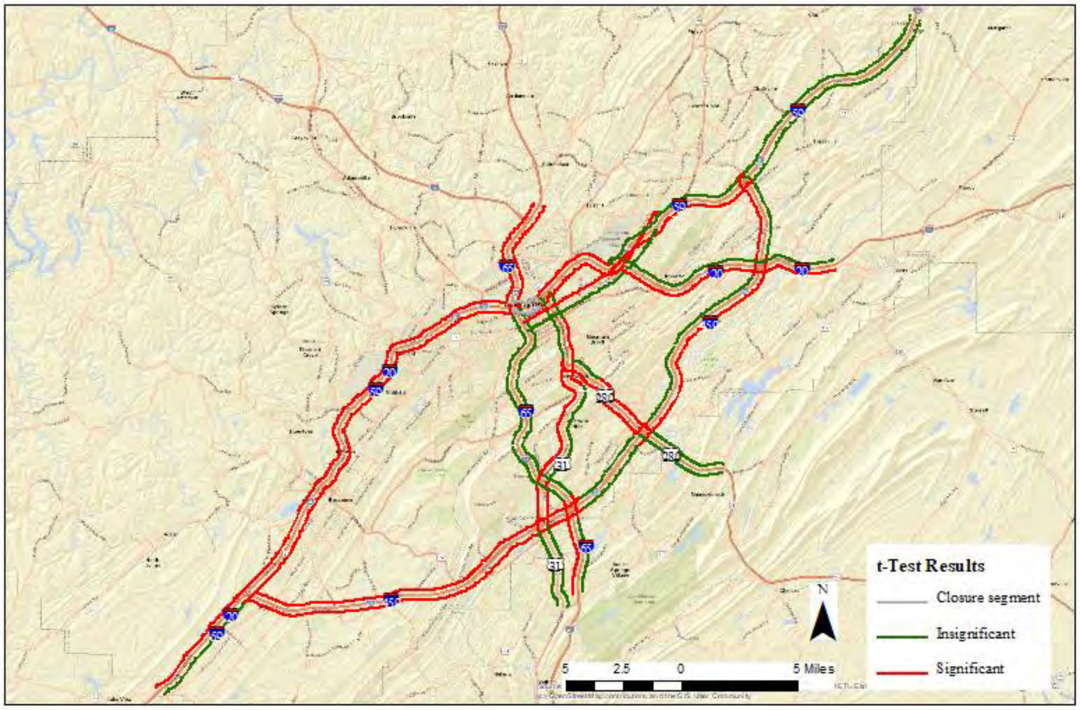


Figure 52. t-test summary for 2020 vs 2108 TTI, AM peak

Table 8: t-test summary for TTI comparison: 2108 vs 2020, PM peak

North-East Bound			South-West Bound		
Segment No	P-value	Significance	Segment No	P-value	Significance
1	0.0000	Significant	101	0.0000	Significant
2*	0.0000	Significant	102	0.0000	Significant
3			103		
4			104		
5	0.0142	Significant	105	0.0001	Significant
6	0.0217	Significant	106	0.0007	Significant
7	0.4805	Insignificant	107	0.0083	Significant
8	0.0000	Significant	108	0.0014	Significant
9	0.0007	Significant	109	0.1172	Insignificant
10	0.0263	Significant	110	0.0018	Significant
11	0.0000	Significant	111	0.0002	Significant
12	0.0908	Insignificant	112	0.0506	Insignificant
13	0.0000	Significant	113	0.0000	Significant
14	0.0184	Significant	114	0.0002	Significant
15	0.0000	Significant	115	0.0044	Significant
16	0.0000	Significant	116	0.0001	Significant
17	0.0000	Significant	117	0.0010	Significant
18	0.0001	Significant	118	0.0000	Significant
19	0.0000	Significant	119	0.0000	Significant
20	0.0001	Significant	120	0.0000	Significant
21	0.0000	Significant	121	0.0006	Significant
22	0.0561	Insignificant	122	0.0010	Significant
23	0.0000	Significant	123	0.0000	Significant
24	0.3653	Insignificant	124	0.4328	Insignificant
25	0.3108	Insignificant	125	0.0006	Significant
26	0.4086	Insignificant	126	0.0018	Significant
27	0.2703	Insignificant	127	0.4783	Insignificant
28	0.1537	Insignificant	128	0.0363	Significant
29	0.1808	Insignificant	129	0.0176	Significant
30	0.2439	Insignificant	130	0.0113	Significant
31	0.0279	Significant	131	0.0339	Significant
32	0.0003	Significant	132	0.2728	Insignificant
33	0.0017	Significant	133	0.0000	Significant
34	0.0003	Significant	134	0.0022	Significant
35	0.4540	Insignificant	135	0.0061	Significant

*Note: Underlined segments were part of diversion routes recommended by ALDOT as alternative routes during construction and included in the detour plans

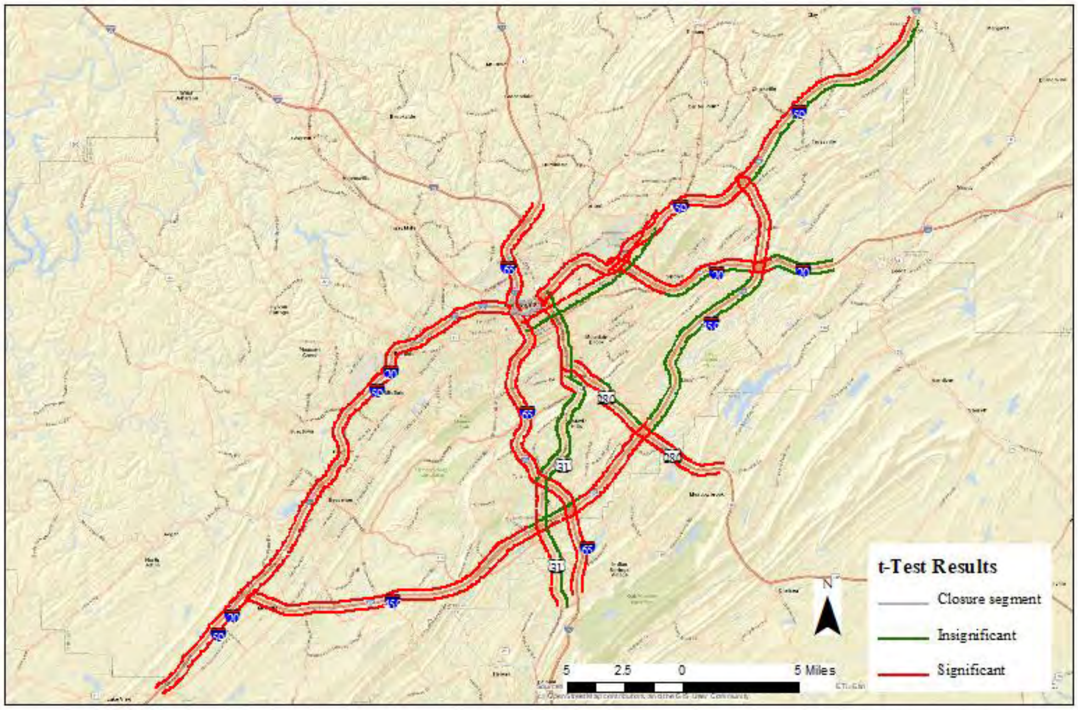


Figure 53. t-test summary for 2020 vs 2108 TTI, PM peak

5.3 Detour Patterns for Access to City Center

We examined TTI patterns for the primary detour routes designated for access to the city center. Figure 54 shows the primary detour routes to access the downtown area identified prior to the interstate reconstruction project. These routes included:

- 1st Avenue North
- Richard Arrington Boulevard
- Rev. Abraham Woods Boulevard
- Messer Airport Highway/5th Avenue North
- Carraway Boulevard
- Red Mountain Expressway

Travel time index data on these routes was obtained for the period October 1, 2018 through February 28, 2020 (just prior to the implementation of COVID protocols). Data were obtained using the Iteris ClearGuide software and TTI profiles were developed to assess the impacts of detour traffic during this period. TTI data were used as a surrogate for traffic count data, as detailed count data was simply not available for these routes before, during, and after the reconstruction project.

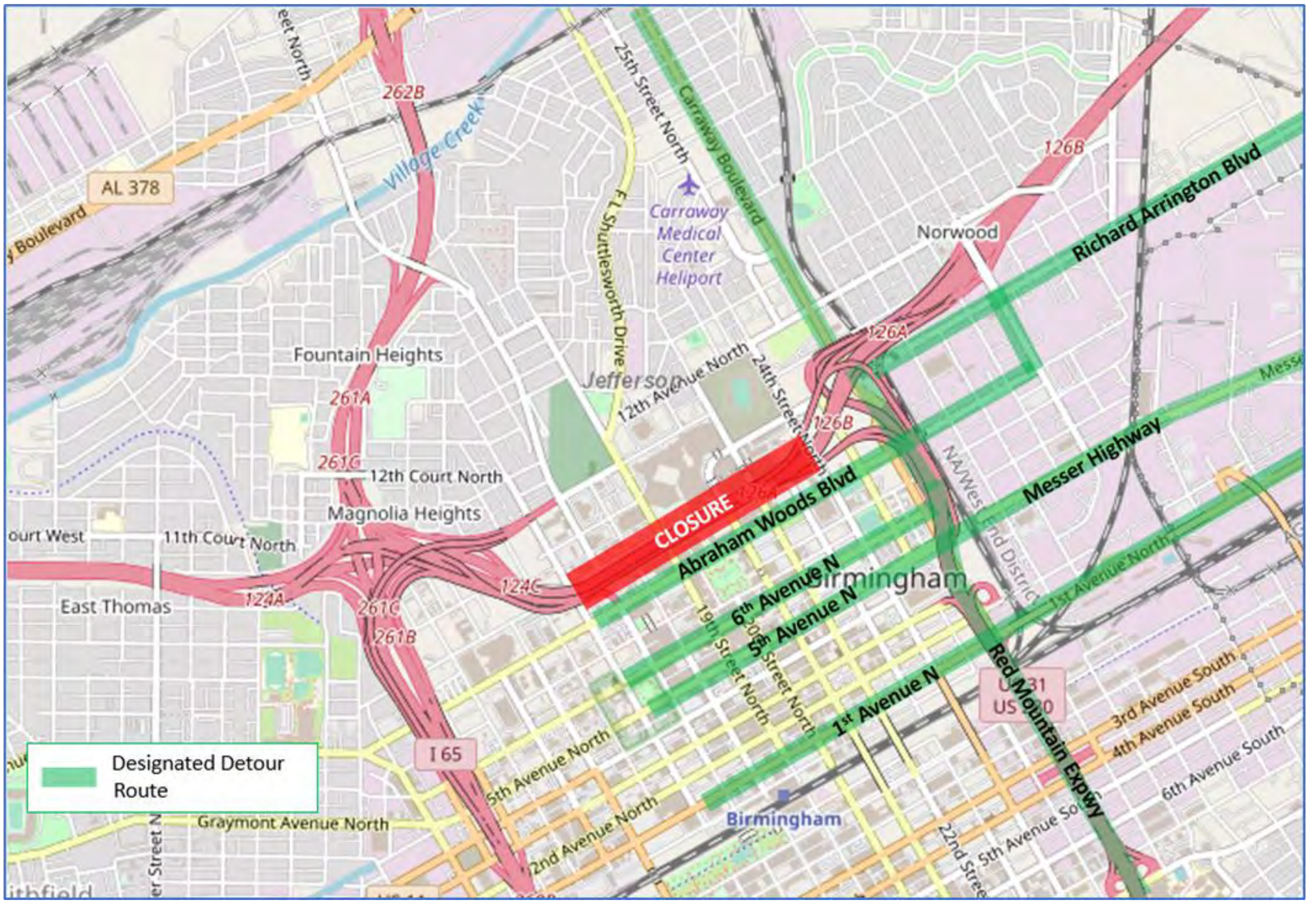


Figure 54. Designated detour routes for access to downtown Birmingham

Figures 55 and 56 present TTI profiles for inbound traffic on the major east-west designated detour routes during the AM peak (8:00 – 8:30 AM) and outbound traffic during the PM peak (5:00 – 5:30 PM). TTI data are for Monday-Thursday only during the period from October 1, 2018 to May 30, 2019, or 3.5 months prior to the reconstruction project and 4.5 months after the interstate closure. The purpose is to assess whether significant changes in TTI occurred in the months after construction began, and therefore significant changes in detour volumes. These routes include Richard Arrington Boulevard, 1st Avenue North, and Messer Airport Highway.

Figures 57 and 58 present TTI profiles for Carraway Boulevard and the Red Mountain Expressway during the same period from October 1, 2018 to May 30, 2019. They are for Monday-Thursday only and exclude weekends and holidays. In each graph, the red line denotes the beginning of the interstate closure and construction.

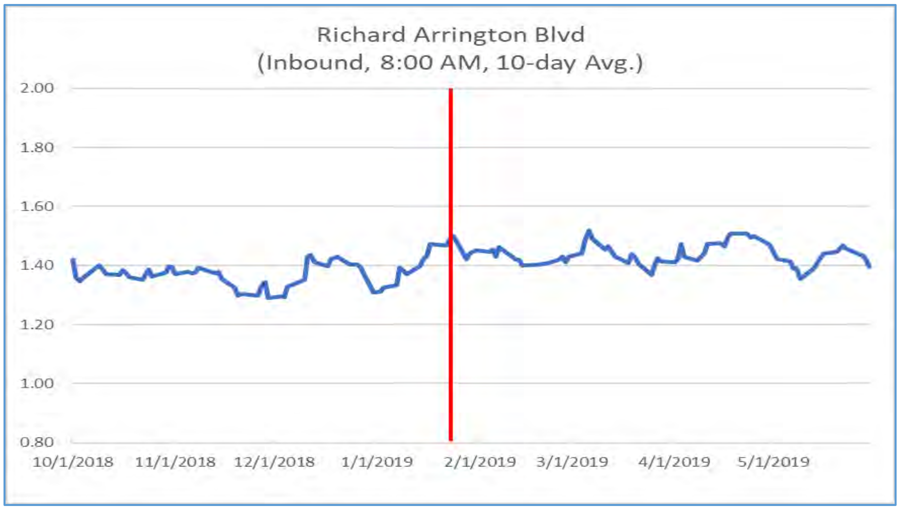


Figure 55. TTI for east-west designated detour routes (Inbound AM)

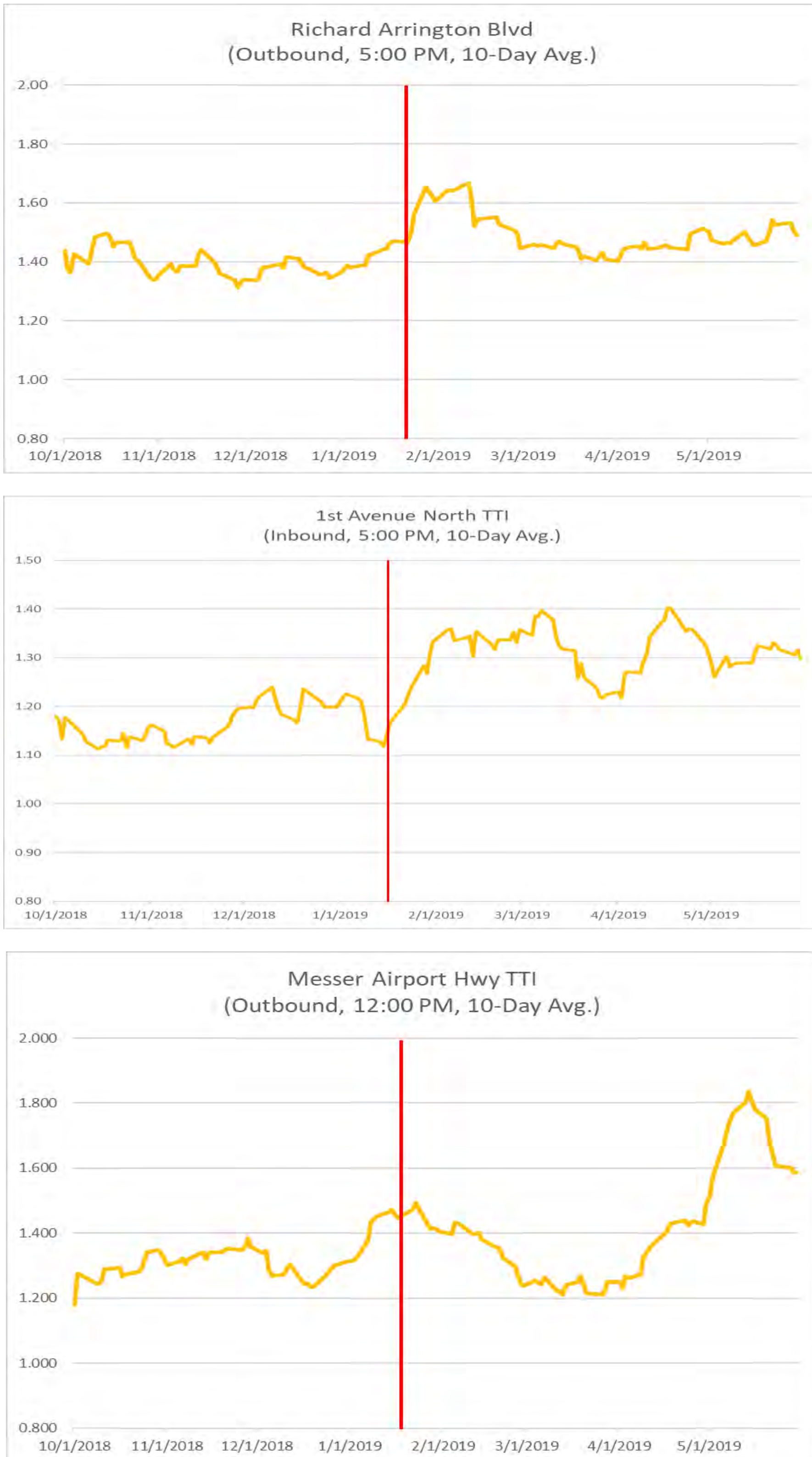
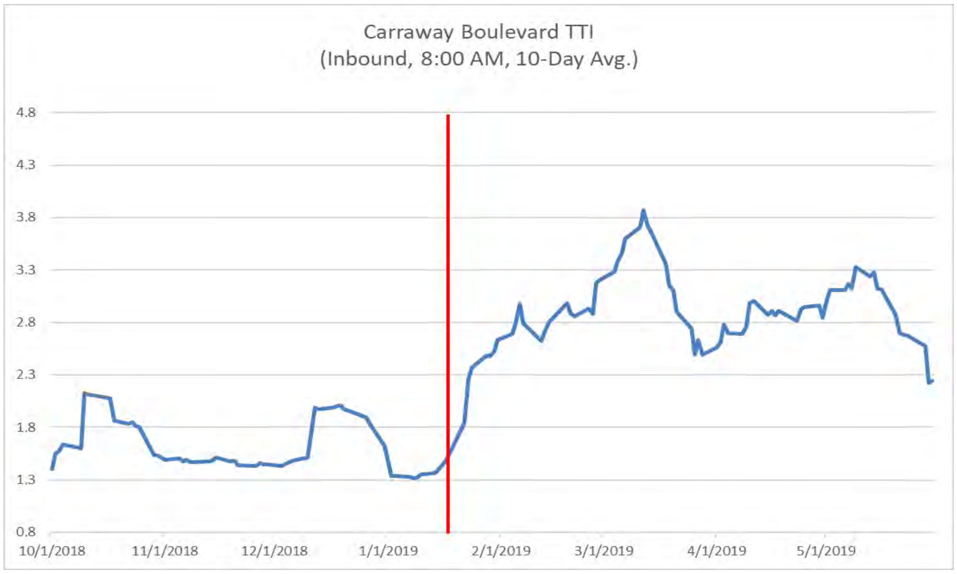


Figure 56. TTI for east-west designated detour routes (Outbound PM)



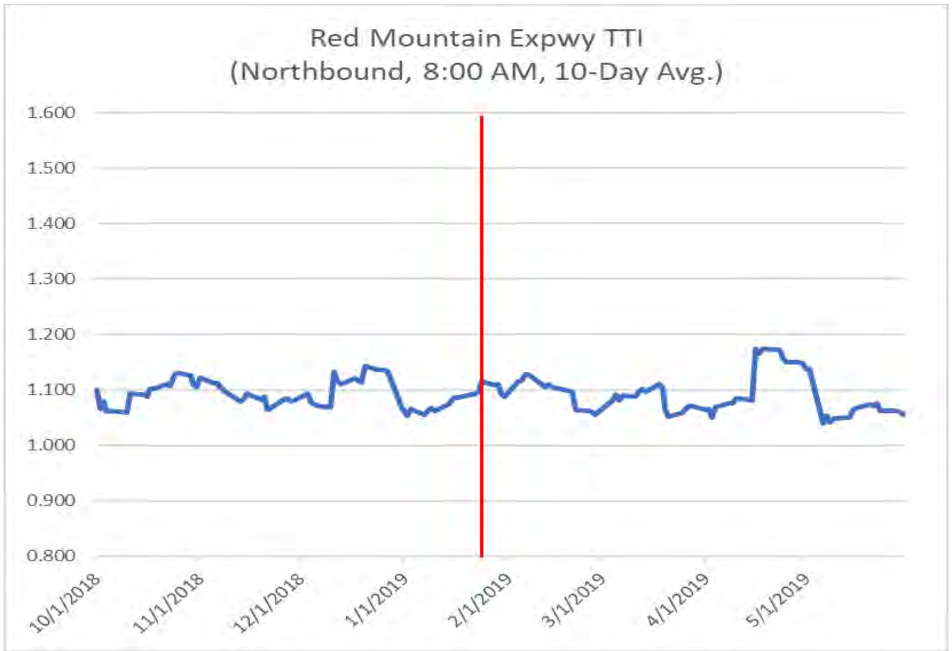


Figure 57. TTI for north-south designated detour routes (Inbound AM)

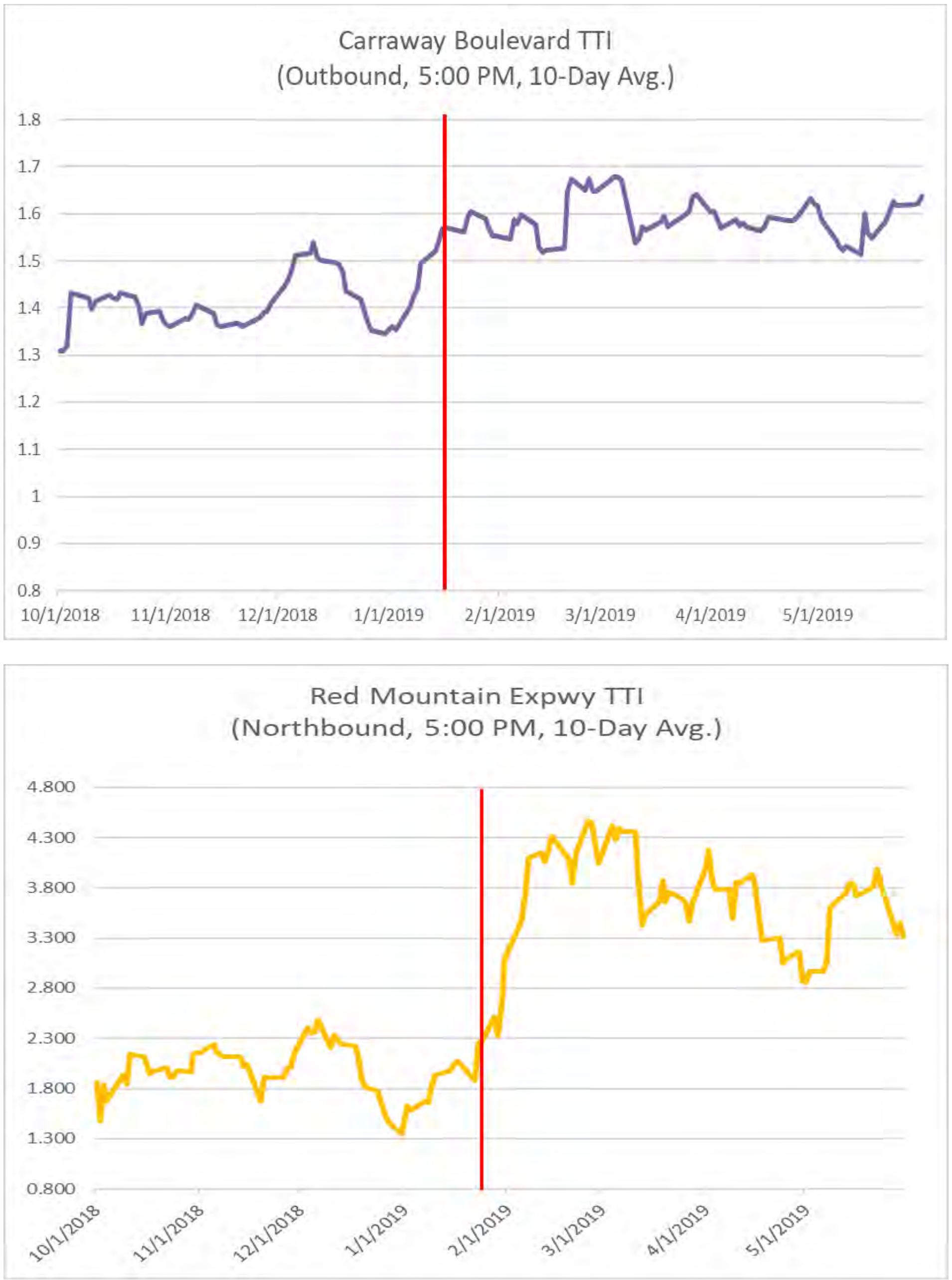


Figure 58. TTI for north-south designated detour routes (Outbound PM)

On the primary east-west designated detour routes, TTI values increased moderately during the AM peak period after the interstate closure and remained fairly constant on Richard Arrington Boulevard and Messer Airport Highway during the following months. Inbound TTI values on 1st Avenue North increased about 30% immediately after the closure, but began to decline about 6 weeks afterward, suggesting that motorists began to choose alternate routes during the AM.

This type of pattern was also found on all three east-west routes outbound during the PM peak. All three routes showed increases in TTI between 20-25% immediately after the interstate closure, but TTI values began to decline 4 to 6 weeks after that. On Richard Arrington Blvd. and Messer Airport Highway this decline began within 4 weeks of the initial closure. On 1st Avenue North, the decline in PM TTI values began about 6 weeks after the interstate closure, though there was a spike during the month of April.

One difficulty with using TTI values to evaluate detour traffic on these routes is that they operated significantly below capacity prior to the interstate closure, so travel time and travel time indices may not accurately reflect the true magnitude of traffic volume changes.

On the primary north-south detour routes, there was an immediate and consistent increase in TTI during the AM peak of nearly 100% on Carraway Boulevard. This increase remained significant throughout the 4.5 months following the interstate closure. TTI inbound on the Red Mountain Expressway remained largely unchanged on the segment from University Blvd. to US 31, but this is likely a reflection of the fact that this segment operated well below capacity during the AM peak period prior to the interstate closure.

During the PM peak, both Carraway Boulevard and the Red Mountain Expressway experienced significant increases in TTI in the outbound directions. This increase remained consistent on Carraway Boulevard but did show a decline on the Red Mountain Expressway about 6 weeks after the interstate closure.

Overall, several of the designated detour routes showed immediate and significant increases in TTI values immediately after the interstate closure but then showed significant declines in TTI beginning about 4 to 6 weeks after reconstruction began. This would seem to indicate that while motorists initially used the designated detour routes, there was migration to other routes beginning about a month into the project.

5.4 Summary and Conclusions

The following conclusions were drawn from the analysis of traffic volumes and travel time data before, during, and after the reconstruction project:

- There did not appear to be any significant diversion of external through traffic away from the Birmingham region as a result of the I-59/20 reconstruction. Traffic volume screen lines both east and west of the city showed little to no change in total traffic volumes from 2018 to 2019.
- Traffic volume data indicates that the diversion of external through traffic around the downtown area did show an initial adjustment period in February and March of 2019. This likely coincided with the adjustment of VMS locations east and west of the study area. After March 2019, the additional traffic volumes on I-459 west of I-65 appeared to stabilize and remained relatively consistent for the remainder of the project.
- Travel time data indicate that the most heavily used detour routes for local traffic included I-65, US 31, I-459, and 1st Avenue North.
- Travel time data indicated that US 280 was not a heavily used detour route, particularly during the AM peak period when congestion on that route is already high.
- From the TTI analysis, the US-31 and Red Mountain Expressway (US 31/US280) study corridors experienced the greatest increases in travel time. The northbound of the Red Mountain Expressway had the worst TTI value during the road closure.
- The traffic volume data suggest that local traffic initially followed the ALDOT recommended detour routes, but that motorists began to modify their detour choices as the project continued. Traffic volumes on both I-65 adjacent to downtown and I-59/20 east of downtown, for example, showed dramatic decreases in February and March 2019 but those decreases became far less pronounced after April 2019.

6.0 CONCLUSIONS

From the motorist survey on detour route choice, the following conclusions were drawn:

- The survey indicates that despite the prevalence of smartphones and navigation apps, motorists continue to use a wide variety of information sources to select detour routes. Navigation apps were reported to be the most popular source for traffic information and detour routing, but they were still only cited by about a quarter of respondents as the primary source of information used to select a detour route.
- All of the survey participants reported that the interstate reconstruction project directly impacted their travel. Even the small percentage who reported that they did not have to seek a detour route said that their everyday travel was impacted by other motorists detouring to their regular travel routes and impacting travel times.
- Overall, 96% of respondents reported that they used detour routes either designated by ALDOT (72%) or selected on their own (24%).
- When the users were asked about the information sources used for selecting a detour route, navigation apps were the most cited (24%), followed by radio and television newscasts (15%), and the ALDOT project website (14%). Other media cited as primary sources for detour route selection includes radio and television ads (10%), social media (12%), and roadside signs (11%). Only 2.5% of respondents reported using the ALDOT project website as a primary source for detour information.
- After the completion of the project, approximately 84% of detour users stated they returned to their pre-construction commuting routes.
- When asked what information sources they would prefer to use for future road construction projects, respondents cited navigation apps (22%), radio and television newscasts (22%), media ads (16%), social media (15%), and project websites (14%). Interestingly, road signage and VMS ranked lowest among the preferred information sources at (12%).
- It appears there are opportunities to expand the use of social media/ instant messaging to convey important traffic and detour information to the public, as a significant portion of respondents indicated this would be their preferred method of receiving information in the future.

From the evaluation of the planning model used to identify detour routes for the project, the following conclusions were drawn to improve the effectiveness of modeling efforts:

- Big Data should be considered to validate the model and identify if there are issues with the model trip generation, distribution, or a combination of both prior to analyzing outputs.

- The fundamental challenge with intersection forecasting for detour planning is the lack of integration between the regional travel demand model and the traffic analysis tools that the intersection forecasts are fed into. As regional travel demand models do not have traffic control, the impacts of signal timing and intersection geometries are not captured. As these items directly impact the traffic flow through the intersection, integrating traffic models into the regional travel model process is a key to improving the intersection forecasting process.

- The travel demand modeler should work with traffic engineers to manually constrain forecasts based on practical roadway capacity (accounting for bus stops, parking, pedestrians, and other urban activities not captured in the travel demand model that would impact capacity), intersection geometry, and traffic control.

- Currently, regional travel demand model daily forecasts are post processed using NCHRP 765 procedures to capture the difference between the base year model validation and traffic counts. These refined forecasts are then used to develop growth factors for existing peak hour link volumes. The peak hour link forecasts and the existing intersection counts are then used to develop the future year intersection forecasts. This process is conducted under the assumption that travelers would not change routes based on specific intersection delays, which is not the case in the field. To best address this behavior and fully integrate the traffic modeling and travel forecasting processes, a dynamic traffic simulation could be utilized in the intersection forecasting process. Regional model trip tables can be re-estimated to reflect peak hour conditions, and the re-estimated trip tables can be assigned dynamically in the simulation model. This process would capture the impacts of traffic control and intersection geometries on future travel demand by dynamically rerouting vehicles away from the most congested intersections to less congested intersection until overall system delay is minimized.

  While this process would improve the intersection forecasting process, it is currently labor intensive from the standpoint of network coding and the dual calibration of the travel demand model trip tables and the traffic simulation model. The effort for this process would be significantly more than the current processes using a regional travel demand model, NCHRP 765 procedures, and the highway capacity traffic analysis software.

- Employer policies that allow employees to work from home are now quite common. Models should attempt to account for the possibility that some employers will offer this option. An immediate adjustment that could be made to the current process would be to adjust the existing k-factors used to develop the peak hour link forecasts as a function of the estimated number of employees in the study area that are projected to work from home during construction. This approach could be used for future construction projects and to evaluate scenarios such as the impacts of a pandemic.

- It is also recommended that a detailed review of the functional class and area type be conducted for the roadway links in the vicinity of the construction zone and along all major detour routes. In the case of this study, it appears the capacities for some of the major detour routes, such as Carraway Boulevard, were set too high in the travel demand model. Adjustments to the capacity lookup tables could be made to account for unique urban forms in the vicinity of major projects, including increased transit, pedestrian, and parking activity.

- Finally, it is important to collect transit ridership data in the construction area and compare it to the ridership in the travel demand model as mode choice directly impacts the trip tables used in highway assignment.

From the evaluation of traffic volume and travel time data, the following conclusions were drawn:

- There did not appear to be any significant diversion of external through traffic away from the Birmingham region as a result of the I-59/20 reconstruction. Traffic volume screen lines both east and west of the city showed little to no change in total traffic volumes from 2018 to 2019.

- External through traffic is likely to rely on VMS and navigation apps to select detour routes around a construction zone. Consistent with the findings of other studies, the placement of VMS in the vicinity of decision can influence their effectiveness.

- Traffic volume data indicates that the diversion of external through traffic around the downtown area did show an initial adjustment period in February and March of 2019. This likely coincided with the adjustment of VMS locations east and west of the study area. After March 2019, the additional traffic volumes on I-459 west of I-65 appeared to stabilize and remained relatively consistent for the remainder of the project.

- The traffic volume data suggest that local traffic initially followed the ALDOT recommended detour routes, but that motorists began to modify their detour choices as the project continued. Traffic volumes on both I-65 adjacent to downtown and I-59/20 east of downtown, for example, showed dramatic decreases in February and March 2019 but those decreases became far less pronounced after April 2019.

7.0 RECOMMENDATIONS

There are opportunities to expand and/or improve on the findings of this study:

- The motorist survey was distributed to local commuters. It could not be sent to motorists who traveled through the region and therefore the detour practices of these external trips were not captured. Future studies could use in-person surveys at rest stops to query motorists about their detour choices and information sources used. Unfortunately, this study was not initiated until the reconstruction project was complete, so this type of survey was not possible.

- Similarly, future surveys could attempt to target commercial vehicle operators to determine whether their detour choices are based on similar or different information sources than those used by commuters.

- The travel time data used in this study was gathered from the NPMRDS website. At the time the travel data analysis was performed for this study, data was not available for several of the downtown detour routes. Some of these routes have since been added to the database.

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9.0 APPENDICES

9.1 Appendix A – Acronyms, abbreviations, etc.

AADT	Average Annual Daily Traffic
ADT	Average Daily Traffic
ALDOT	Alabama Department of Transportation
RPCGB	Regional Planning Commission of Greater Birmingham
TTI	Travel Time Index
VMS	Variable Message Sign
VPD	Vehicles Per Day

9.2 Appendix B – Associated websites, data, etc., produced

No websites developed for this project. All data will be stored per STRIDE requirements.

9.3 Appendix C – Summary of Accomplishments

Date	Type of Accomplishment *(select from drop down list)*	Detailed Description *Provide name of person, name of event, name of award, title of presentation, location and any links to announcements if available*
	Student Accomplishment or Award	Md. Saiful Khan successfully defended his master's thesis related to this project.

9.4 Appendix D – Survey Instrument

2021 Survey of Birmingham Motorists Regarding Detour Selection

Start of Block: Welcome

Q1 **Welcome to the Survey of Detour Planning for the I-20/59 Bridge Project. Your opinion matters!**

Dr. Virginia Sisiopiku (UAB) invites you to be part of a research project that studies detour plans for long-term roadway construction projects. Your feedback is very important, as it will help the UAB researchers to understand motorist preferences and decision criteria for selecting detours in the presence of work zones.

The survey relates to the road closure in downtown Birmingham where a 1.5-mile segment of the interstate has been completely closed for over one year for the I-20/59 Bridge Project. If you are an adult driver who lived in the Birmingham region from 2019 until present you are eligible to participate. The survey should take approximately 5 minutes to complete, and your participation is voluntary. Please be assured that your responses will be kept entirely confidential and exempt from public disclosure by law. Please note that this survey will be best displayed on a laptop or desktop computer. While you can complete the survey on a mobile device, some features may be less compatible for use on a mobile device.

Your kind assistance in providing input through the completion of this survey is greatly appreciated. If you have questions about the survey or research study, you can contact Dr. Sisiopiku, UAB, Civil, Construction, and Environmental Engineering, Birmingham, AL 35294, or via email at vsisiopi@uab.edu.

If you have questions about your rights as a research participant, or concerns or complaints about the research, you may contact the UAB Office of the IRB (OIRB) at 205-934-3789 or toll-free at 1-855-860-3789. Regular hours for the OIRB are 8:00 a.m. to 5:00 p.m. CT, Monday through Friday. By clicking the consent button below, you acknowledge that your participation in the study is voluntary, you are 18 years of age, and that you are aware that you may choose to terminate your participation in the study at any time and for any reason.

- O I agree, begin the study
- O I do not agree, terminate the study

Q2 **Did you live or work in Birmingham Metropolitan over the past 2 years (2019 to present)?**

O Yes

O No

Q3 **Do you recall the I-20/59 Bridge Reconstruction Project that took place in downtown Birmingham in 2019?**

O Yes

O No

Q4 **Was your travel directly affected by this project?**

O Yes, my commute to/from my workplace was affected

O Yes, my travel to other places (e.g., shopping, entertainment, school) was affected

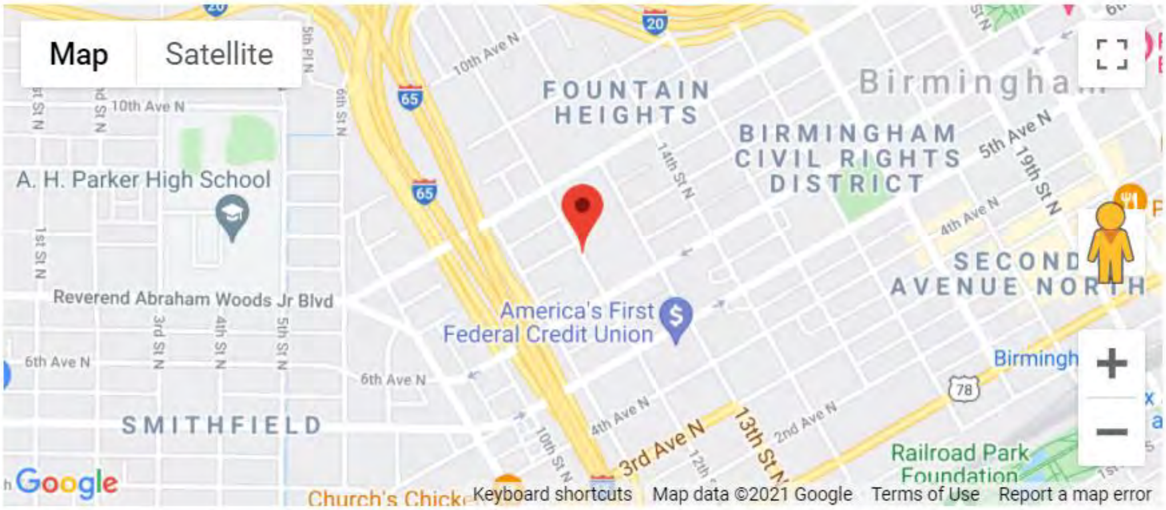
O No, it was not directly affected

End of Block: Welcome

Start of Block: Project Query

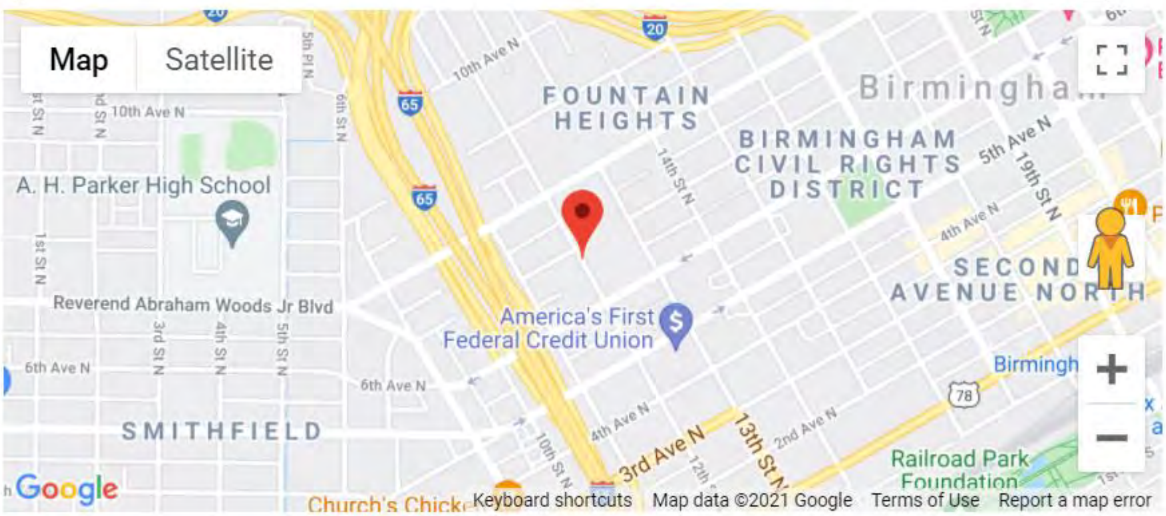
Q5 **Where did you live in 2019-2020? (Closest intersection from your home)**

Enter a location



Q6 **Where do you work in 2019-2020? (Closest intersection to your work)**

Enter a location



Q7 **Were you anxious about the potential impact of the I-20/59 bridge reconstruction project on your travel when you first learned about it?**

- O Yes
- O Somewhat
- O No

Q8 **During road closure for** the I-20/59 Bridge Project **did you typically choose the designated ALDOT detour routes?**

- O Yes, I did
- O No, I had to use a detour but chose the alternate route by own
- O No, as I did not have to alter my route

Q9 **Did you consider any of the following information for selecting your detour? (Select the top two)**

- ☐ None, as I did not have to use a detour
- ☐ ALDOT Project Website
- ☐ Media Ads and Announcements (TV, Radio)
- ☐ Newscasts (Morning news, evening news)
- ☐ Social Media (Facebook, Twitter)
- ☐ Google maps/Waze or other GPS Navigation Mobile Apps
- ☐ Roadside Electronic Message Signs
- ☐ ALDOT Call Center
- ☐ ALDOT text alerts
- ☐ Other

Q10 **How many times a day did you travel using the detour?**

- O None, I didn't have to use a detour
- O Once
- O Twice
- O Three times
- O More than three times per day

Q11
From your recollection, did the detour affect the length of your daily commute?

O No - not much

O Yes - added up to 15 minutes each way

O Yes - added up to 30 minutes each way

O Yes - added more than 30 minutes each way

Q12
Did you choose to vary your route frequently based on the progress of the I-20/59 Bridge Project**?**

O No - I used the same detour/alternative route during the road closure

O Yes - I always checked the information and acted accordingly

O Yes - I always use my GPS navigation or other mobile apps to select my route

O I typically did not change my route due to the I20/59 closure

Q13 **Overall, were you able to manage the discomfort associated with the road closures during** the I-20/59 Bridge Project**?**

O Yes, without any problem

O Yes, I was able to manage reasonably well

O No, the road closure had a negative impact on my everyday life

O No, I was constantly inconvenienced by the road closure and unhappy about having to take detours

Q14 **After completion of the project in 2020 did you return to your original route (i.e., the one you used prior to 2019)?**

- O Yes, I did
- O No - I am still using the alternative route
- O I did not alter my route due to the I-20/59 closure

Q15 **What are your top 2 preferred methods for being informed about local roadway construction projects in the future?**

- ☐ ALDOT Project Websites
- ☐ Media Ads and Announcements (TV, Radio)
- ☐ Newscasts (Morning news, evening news)
- ☐ Social Media (Facebook, Twitter)
- ☐ Google Maps/Waze or other GPS Navigation Mobile Apps
- ☐ Roadside Electronic Message Signs

Q16 **Was your commuting affected due to the pandemic situation (from March 2020 to now)?**

- O Yes, i work mostly remotely as a result
- O Yes, somewhat
- O No, it was not affected
- O I no longer commute to work

End of Block: Project Query

Start of Block: Demographic

Q17 **What is your age?**

- O Under 18
- O 18 - 24
- O 25 - 34
- O 35 - 44
- O 45 - 54
- O 55 - 64
- O 65 - 74
- O 75 - 84
- O 85 or older

Q18 **What is your race(s)?**

- ☐ White
- ☐ Black or African American
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Native Hawaiian or Pacific Islander
- ☐ Other ____

Q19 **What is your gender at birth?**

- O Male
- O Female
- O Other

Q20 **What type of vehicle do you use regularly?**

- ☐ Sedan/SUV
- ☐ Coupe
- ☐ Pickup/Truck
- ☐ Motorcycle
- ☐ Taxi/Uber/Lyft or other similar service
- ☐ Commercial vehicle
- ☐ Public transit

Q21 **What is the highest level of education that you have completed?**

- O Less than high school degree
- O High school graduate (high school diploma or equivalent including GED)
- O Some college but no degree
- O Associate degree in college (2-year)
- O Bachelor's degree in college (4-year)
- O Master's degree
- O Doctoral degree
- O Professional degree (JD, MD)

Q22 Please provide your comments/suggestions regarding best ways to receive information related to future detours.

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End of Block: Demographic

We thank you for your time spent taking this survey.

Your response has been recorded.