

2018

WOODRUFF ROAD CORRIDOR ORIGIN-DESTINATION ANALYSIS



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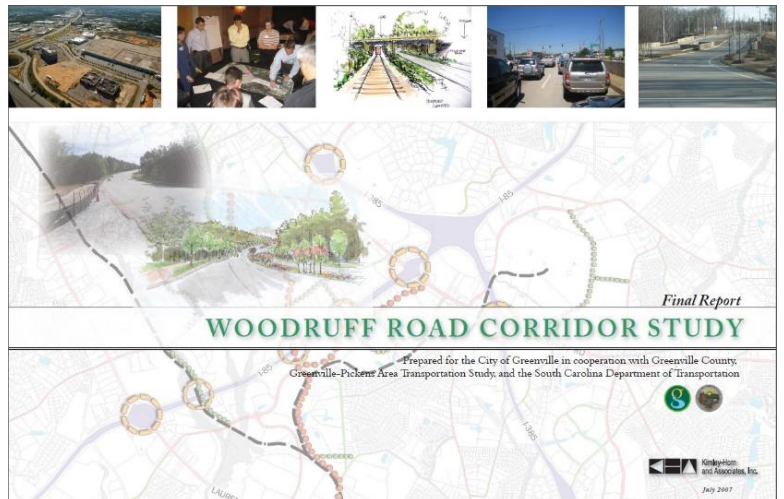
Introduction

Woodruff Road is the main road to and through the commercial area in Greenville, South Carolina. Businesses along the corridor have been increasing since the late 1970's with the development of the Greenville Mall. Improved access with the extension of I-385 south of I-85 further spurred development. Big box retail, restaurants, and stores catering to destination shopping have proliferated since the 1970's. However, accessibility to shopping along the corridor is limited to Woodruff Road, acting as the main arterial from which to access the commercial businesses. This report summarizes the origin-destination analysis completed for Woodruff Road. The results of the study are intended to better inform local decision-making groups regarding travel patterns, and the economic impacts while improving access along Woodruff Road.

BACKGROUND

In 2007, the City of Greenville and the South Carolina Department of Transportation conducted a corridor study on Woodruff Road. The study evaluated the corridor for improved access and intersection modifications. The study concluded with a process for implementation of the corridor study recommendations to address the challenges along the corridor and to provide guidance on the future planning of infrastructure.

Since 2007, several improvements have been made at the intersections, including signalization and driveway placement. Despite these improvements, the corridor continues to be heavily congested. For those familiar with the area it should come as no surprise that Woodruff Road is a point of congestion. The purpose of this study is to quantify the number of trips traveling along the corridor and to better understand their origins and destinations to aid in the development of solutions for addressing congestion on Woodruff Road and the surrounding area.



ORIGIN-DESTINATION STUDY

The intent of the Woodruff Road corridor origin-destination analysis is to understand the travel behavior of trips along the corridor, as well as the origin and destination of trips passing through certain locations along Woodruff Road, and in the zones bounded by Laurens Road, I-385, and SC Highway 14 (Figure 1). An origin-destination analysis can be a valuable tool in understanding the nature of trips generated in the area, travel patterns during selected time periods, and in identifying

future congestion issues. In developing this O-D study, information from the 2007 Woodruff Road Corridor Study, StreetLight data, and the GPATS travel demand model was utilized.

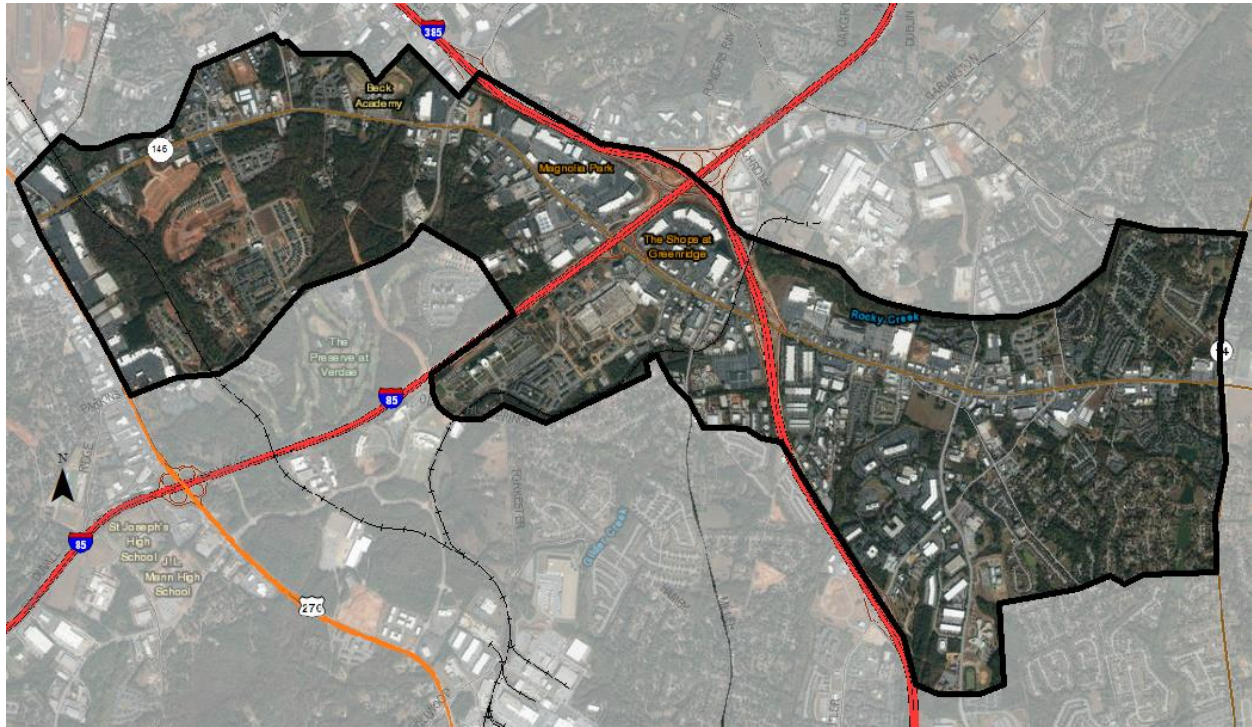


FIGURE 1 WOODRUFF ROAD STUDY AREA

DATA COLLECTION AND METHODOLOGY

StreetLight data was utilized to collect the origin and destination of trips within the study area. StreetLight is a data analytics company that collects location based information from mobile devices. The web based platform integrates millions of data points from mobile devices to show the movement of the device on the roadway network. To visualize the travel patterns of the mobile devices, the platform allows the user to create study area zones to match a specified geography. Gate filters can be created on roadways that serve as pass through zones to capture all trips that pass through the gate. This analysis provides information on the origin zone and destination zone of the specific trips passing through the gate filter. The information can be selected for any length of time, a month, six months, or a year. The data can be segmented by:

- Day Type – average day, average weekday (Monday to Thursday), average weekend day (Saturday to Sunday)
- Day Part - same as vehicle classification counts, including Early AM, AM Peak Period, Mid-Day, PM peak period, Late PM, and Daily

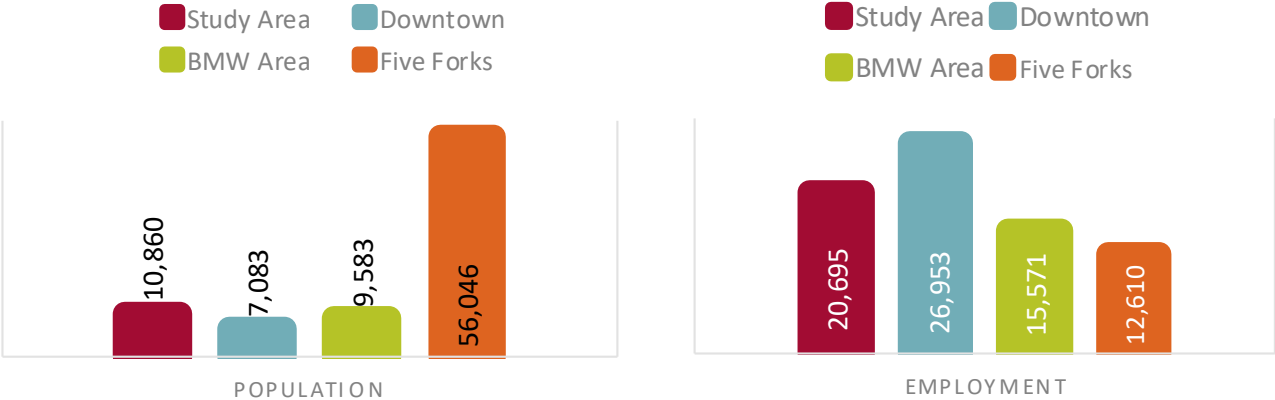
The final output is a trip frequency based on an index. According to StreetLight, “the trip index represents trip activity but does not indicate actual number of trips or vehicles. The values are

provided on an index. The value is normalized by adjusting the number of trips in the data sample to the actual number of trips on a region around Sacramento CA, as derived from the measurements published by the California Department of Transportation. This allows us to capture monthly and seasonal variation more accurately, even as our sample grows.” To get an estimate on the number of daily trips passing through the gate filter we utilized a traffic count at the same location to calculate absolute trips.

STUDY AREA DEMOGRAPHICS

The land uses along Woodruff Road are mainly commercial development. Restaurants, big box retail, and shopping are located along much of the corridor from Laurens Road to the south and South Carolina Highway 14 to the east. In addition to commercial development, there are several office parks and major employers all within the vicinity of the corridor, including the International Center for Automotive Research, Millennium Campus, Verdae Development, and GE. These land uses have a significant effect on travel patterns, including the numbers of trips, trip purpose, and length of the trip. According to the GPATS travel demand model, within the region, home-based work trips have a congested travel time between 16 - 17 minutes and a length of 8.9 miles. Home-based other trips, trips that include shopping, appointments, and activities have a travel time between 11-12 minutes and a trip length of 5.5 miles. The distance of these trip purposes from the Woodruff Road study area encompasses an area that extends to downtown Greenville, Mauldin, and Simpsonville.

The Woodruff Road study area has a population of 10,860 or 2.2% of the county total. Employment in the study area is 20,695 which is 7.4% of the county total. To compare, Downtown Greenville’s population is 1.4% and employment is 10% of the county total. The study also compared the travel patterns to the area around BMW, a major regional employer, and the communities southeast of Five Forks. The study area contains a significant amount of activity in terms of population and employment when compared to downtown and the regions highest single employer, BMW Manufacturing.



STUDY DESIGN

The traffic analysis zones (TAZ) from the GPATS travel demand model were aggregated to the district level in the area outside the study area. Within the study area TAZs were refined based on natural boundaries, roadways, and land use types (Figure 2).

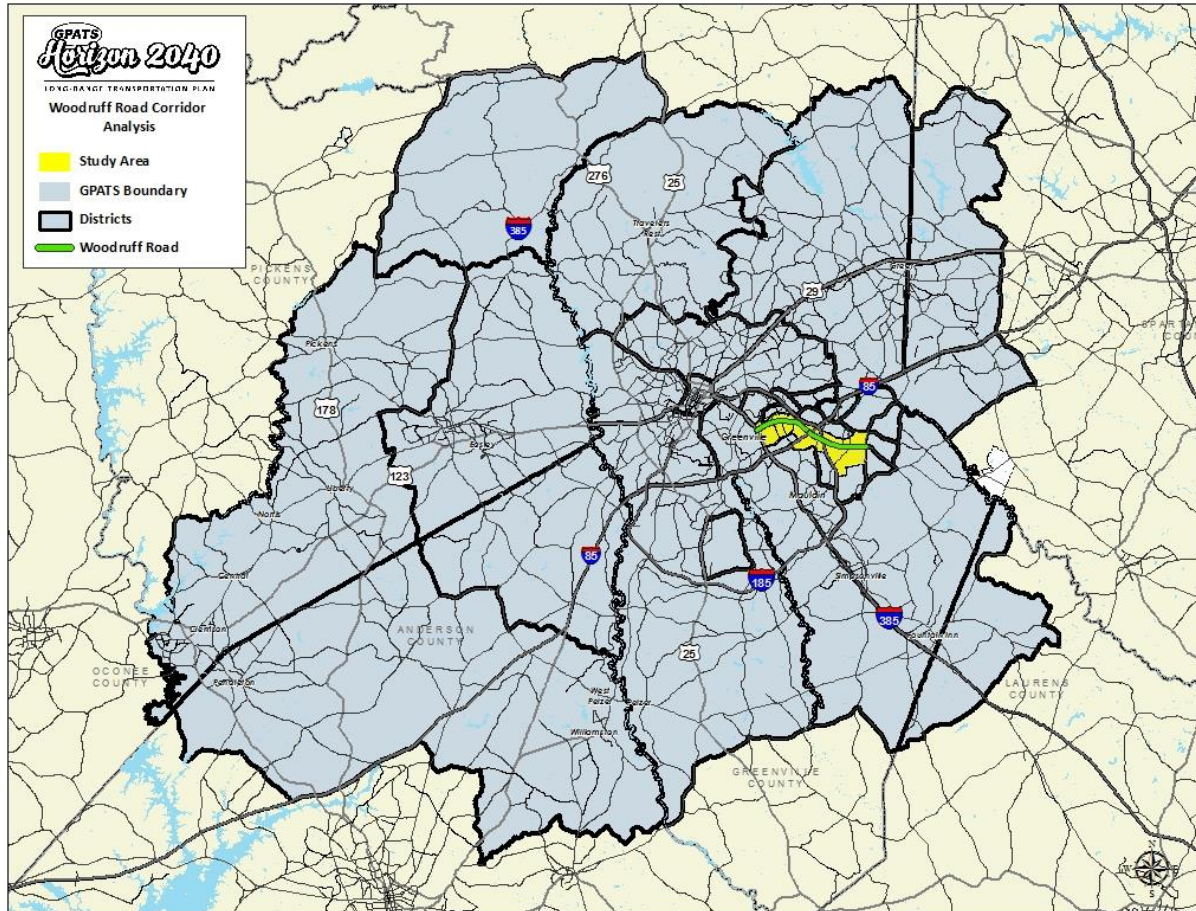


FIGURE 2 GPATS BOUNDARY

The corridor analysis along Woodruff Road attempts to understand three pattern types, trips going to and from the study area, trips utilizing Woodruff Road to reach destinations along the corridor, and trips using Woodruff Road as a pass-through route. The link level analysis provides the number of trips between each zone in the geographic layer that travels through the selected pass through location (Figure 3). The output of the link level analysis is a trip table that provides three points of travel, the origin zone, selected pass through location, and destination zone. Three gates were placed along Woodruff Road to analyze how the sections of Woodruff are utilized. Additional gates were included near Woodruff Road to analyze trips traveling to the study area zones. The gates for the analysis include:

WOODRUFF ROAD AT ROCKY SLOPE ROAD	WOODRUFF ROAD AT MARKET POINT DRIVE
WOODRUFF ROAD AT BUTLER ROAD	LAURENS ROAD AT PARKINS MILL ROAD
I-85 AT RIDGE ROAD	MAIN STREET
MILLER ROAD	GARLINGTON ROAD
I-85 AT ROPER MOUNTAIN ROAD	ROPER MOUNTAIN ROAD AT I-385

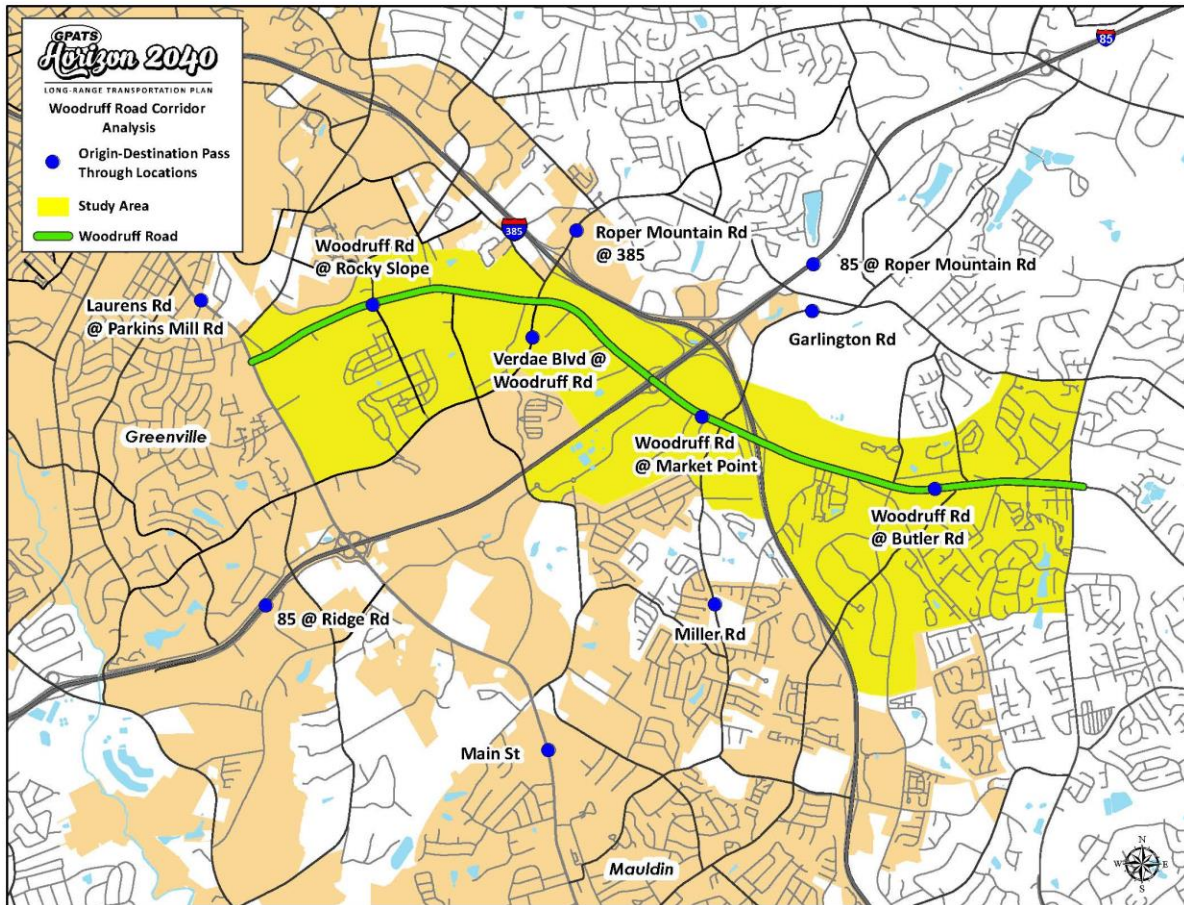


FIGURE 3 STUDY AREA GATE FILTERS

DATA ANALYSIS

Data output from Streetlight was reviewed to identify the origin-destination zones with the highest percentage of trips traveling from the Woodruff Road study area, as well as trips traveling to the study area. Information gathered from this analysis was used to develop origin-destination locations to apply the pass-through location filter.

ORIGIN-DESTINATION ANALYSIS

The internal to external map (Figure 4) provides information on trips traveling from the study area, the trip origin, to zones outside of the study area, the trip destination. The travel patterns from this analysis indicate trips from the Woodruff Road study area are primarily destined to:

- Southeast of Five Forks in the zone with Woodland Village and Simpsonville
- Zones south, including Mauldin
- Downtown Greenville, and zones to the east
- Zones north bounded by I-85 and Wade/Hampton Blvd, including Greer

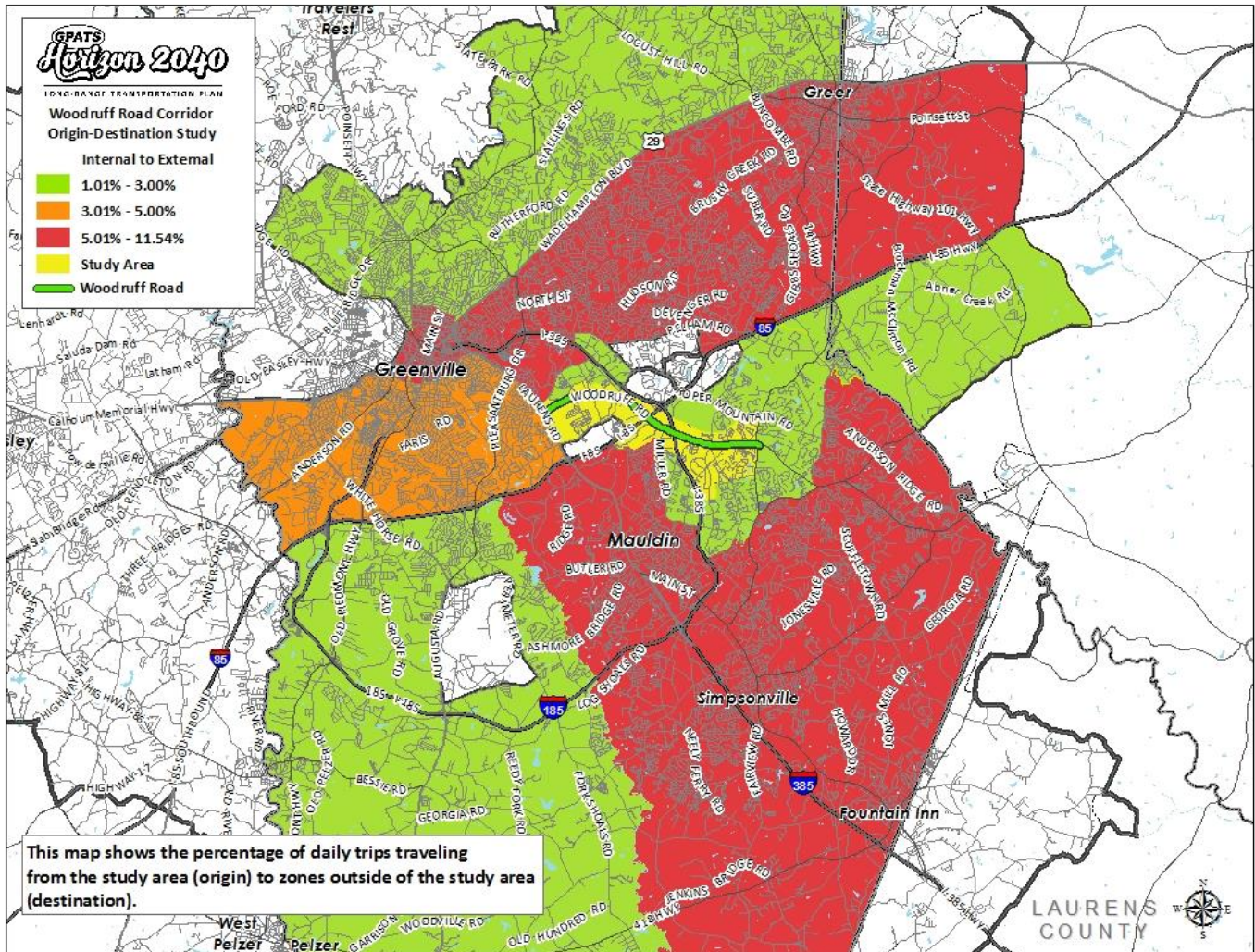


FIGURE 4 DISTRIBUTION OF INTERNAL TO EXTERNAL TRIPS

The external to internal map (Figure 5) provides information on trips traveling outside of the study area, the trip origin, to the study area, the trip destination. The travel patterns from this analysis indicate trips destined to the study area primarily originate from:

- Zones southeast of Five Forks, including Woodland Village and Simpsonville
- Zones south, including Mauldin
- Zones north bounded by I-85 and Wade/Hampton Blvd and west of Boiling Springs Road, including Greer

- The Zone northeast bounded by Pleasantburg Drive, I-385, Laurens Road, and Halton Road.

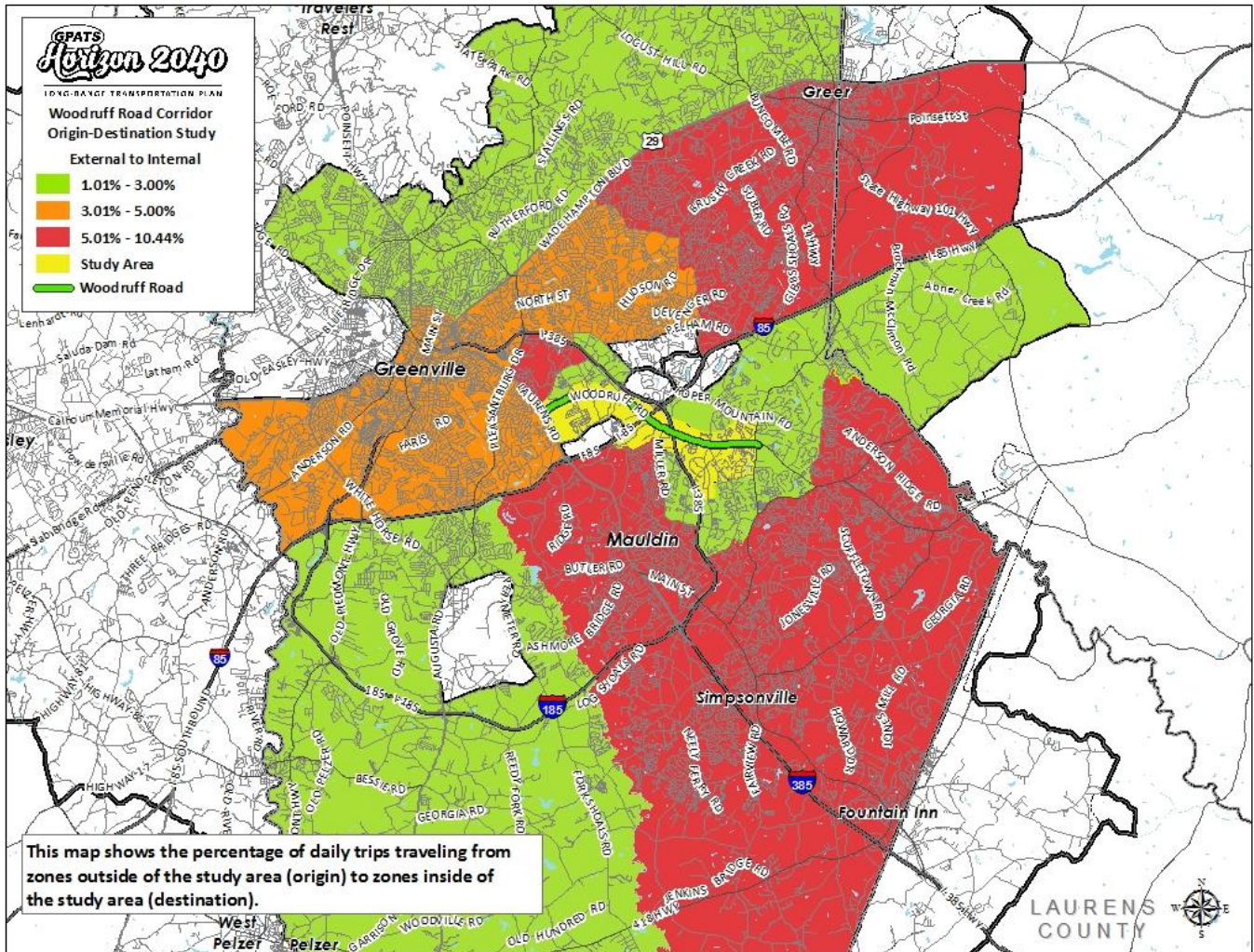


FIGURE 5 DISTRIBUTION OF EXTERNAL TO INTERNAL TRIPS

Pass-through Analysis

Information from the origin-destination analysis was used to identify destination zones to apply the pass-through location filter. This analysis identifies the origin zone and destination zone of trips passing through the gate filter. Data is summarized for the GPATS boundary area, as well as the Woodruff Road study area. The destination locations summarized include Downtown Greenville, BMW Manufacturing and Greenville International Airport, and the communities southeast of Woodruff Road including Five Forks, Simpsonville, and Woodland Village. The results are summarized by AM peak period (6 am – 10 am), PM peak period (3 pm – 7 pm), and daily percentages. The daily trip estimate is calculated using the GPATS geographic boundary and 2015 AADT traffic counts from the South Carolina Department of Transportation (Appendix A) at the pass-through gate locations, and represents an estimated number of daily trips.

DOWNTOWN GREENVILLE

Downtown Greenville is a popular destination for shopping, dining, and entertainment. The US Census Bureau has named it the fourth fastest growing large city in the nation between July 1, 2015 and July 1, 2016. The growth of downtown has spurred hotels and apartment developments to attract tourists and residents alike. Several major employers are located downtown including SunTrust, Wells Fargo, and Ernst & Young. The energy of downtown has made it an attractive place, and as such a major generator of trips.

Data from the origin-destination analysis indicates a high percentage of trips to downtown originate from the Woodruff Road study area. Trips traveling to downtown along Woodruff Road were analyzed to understand if the corridor is being utilized as a through route to downtown Greenville. Three pass-through gate filters were placed along Woodruff Road, a gate near Rocky Slope, Market Point, and Butler Road. The data was summarized for the AM, PM, and 24-Hours (Table 1). The pass-through location on Woodruff Road with the highest estimate of travel to downtown is the location at Butler Road, with 9.28% or an estimated 1,727 trips. The drop in the daily trip estimate indicates Woodruff Road is not being utilized as a major through route, but rather trips are utilizing it for some portion of their trip. According to Google maps, the shortest path to downtown Greenville from Woodruff Road near Butler Road routes the traveler to I-385.

DOWNTOWN DESTINATIONS FROM GPATS BOUNDARY ORIGIN	AM	PM	DAILY	DAILY TRIP ESTIMATE
WB WOODRUFF ROAD AT ROCKY SLOPE	23.31%	9.66%	12.90%	863
WB WOODRUFF ROAD AT MARKET POINT	2.18%	2.35%	1.80%	475
WB WOODRUFF ROAD AT BUTLER ROAD	17.86%	5.15%	9.28%	1,727

TABLE 1 TRIPS USING WOODRUFF ROAD TO ACCESS DOWNTOWN GREENVILLE WITHIN GPATS BOUNDARY

Table 1 is an estimate on the percentage of trips in the GPATS Boundary utilizing Woodruff Road to access downtown Greenville. To estimate the percentage of trips originating within the study area, a smaller subset of the data was used to calculate the percentage of trips originating within the study area, and utilizing Woodruff Road to access downtown Greenville (Table 2).

DOWNTOWN DESTINATIONS FROM STUDY AREA ORIGIN	AM	PM	DAILY
WB WOODRUFF ROAD AT ROCKY SLOPE	33.12%	13.96%	17.80%
WB WOODRUFF ROAD AT MARKET POINT	1.86%	1.84%	1.66%
WB WOODRUFF ROAD AT BUTLER ROAD	11.76%	3.17%	5.19%

TABLE 2 TRIPS USING WOODRUFF ROAD TO ACCESS DOWNTOWN GREENVILLE WITHIN STUDY AREA

BMW MANUFACTURING/AIRPORT

The BMW Manufacturing plant is the largest single employer in the Greenville-Pickens region. There are an estimated 10,000 employees that work on site. Located in Greer, the manufacturing plant is accessed from I-85 and SC 101. The manufacturing plant is near the Greenville-Spartanburg International Airport. The airport has 951 employees and 5,983 daily passengers. The analysis zone for this study includes the BMW plant, the Greenville-Spartanburg International Airport, and the southeastern portion of Greer. The origin-destination study provided information supporting the manufacturing plant as being a large destination of home-based work trips and the airport for home-based other trips.

All gate locations were analyzed to understand the travel patterns to the BMW Manufacturing/Airport zone. There are a small number of trips utilizing Woodruff Road that are destined to the zone (Table 3). The largest portion of daily trips destined to the zone are utilizing I-85, with 26,512 trips near Ridge Road and 44,621 trips near Roper Mountain Road. There is a small portion of trips on Miller Road, with 1,063 destined for the BMW Manufacturing/Airport zone. The shortest path traveling to this zone from Miller Road would indicate a small portion of the trip utilizes Woodruff Road to access I-385. In total, an estimated 5,616 trips are utilizing some portion of Woodruff Road and are destined for the BMW Manufacturing/Airport zone.

BMW MANUFACTURING/AIRPORT DESTINATION FROM GPATS BOUNDARY ORIGIN	AM	PM	DAILY	DAILY TRIP ESTIMATE
EB WOODRUFF ROAD AT ROCKY SLOPE	11.90%	.90%	2.70%	176
EB WOODRUFF ROAD AT MARKET POINT	15.70%	.52%	.72%	158
WOODRUFF ROAD AT BUTLER ROAD	4.82%	1.39%	2.22%	764
SB LAURENS ROAD AT PARKINS MILL ROAD	.91%	1.81%	1.54 %	171
NB I-85 AT RIDGE ROAD	59.72%	32.33%	47.09%	26,512
NB MAIN ST	21.92%	17.56%	19.57%	2,936
NB MILLER ROAD	48.19%	3.72%	29.52%	1,063
NB VERDAE BLVD AT WOODRUFF ROAD	10.51%	1.27%	4.22%	348
NB ROPER MOUNTAIN ROAD AT I-385	3.53%	.87%	1.00%	111
NB I-85 AT ROPER MOUNTAIN ROAD	87.93%	44.80%	68.49%	44,621
EB GARLINGTON ROAD	6.42%	1.66%	2.47%	184

TABLE 3 TRIPS USING WOODRUFF ROAD TO ACCESS THE BMW/AIRPORT AREA WITHIN GPATS BOUNDARY

FIVE FORKS AND EXTENDED COMMUNITIES

The Five Forks suburb is largely a residential area located southeast of downtown Greenville. Woodruff Road is the major roadway to access Five Forks. The town is largely an affluent community with a high median income and a population estimate of 15,000. Near Five Forks are the communities of Woodland Village and Simpsonville further south (Appendix B Map 3). For this study, these communities were combined into a single zone. The origin-destination analysis indicated zones east of the Woodruff Road study area have a significant number of trips where the study area serves as a destination. These communities are mainly residential with limited shopping and dining options. As such, the commercial development along Woodruff Road is a main destination for many of these communities.

Trips traveling eastbound along Woodruff Road were analyzed to understand if the corridor is being utilized as a through route to the Five Forks and extended communities zone. The three pass-through locations along Woodruff Road, Rocky Slope, Market Point, and Butler Road were used in the analysis. The pass-through location on Woodruff Road with the highest estimate of travel to the Five Forks Zone is the location at Butler Road, with 38.66% or an estimated 6,340 trips.

FIVE FORKS DESTINATIONS FROM GPATS BOUNDARY ORIGIN	AM	PM	DAILY	DAILY TRIP ESTIMATE
EB WOODRUFF ROAD AT ROCKY SLOPE	4.17%	3.39%	2.81%	218
EB WOODRUFF ROAD AT MARKET POINT	14.25%	19.54%	17.70%	3,674
EB WOODRUFF ROAD AT BUTLER ROAD	34.57%	39.68%	38.66%	6,340

TABLE 4 TRIPS USING WOODRUFF ROAD TO ACCESS THE FIVE FORKS/EXTENDED COMMUNITIES AREA WITHIN GPATS BOUNDARY

Table 4 is an estimate on the percentage of trips in the GPATS Boundary utilizing Woodruff Road to access Five Forks and the extended communities. To estimate the percentage of trips originating within the study area, a smaller subset of the data was used to calculate the percentage of trips originating within the study area, and utilizing Woodruff Road to access Five Forks (Table 5).

FIVE FORKS DESTINATIONS FROM STUDY AREA ORIGIN	AM	PM	DAILY
EB WOODRUFF ROAD AT ROCKY SLOPE	1.20%	4.14%	2.64%
EB WOODRUFF ROAD AT MARKET POINT	10.28%	16.51%	14.95%
EB WOODRUFF ROAD AT BUTLER ROAD	29.44%	39.85%	37.91%

TABLE 5 TRIPS USING WOODRUFF ROAD TO ACCESS THE FIVE FORKS/EXTENDED COMMUNITIES AREA WITHIN STUDY AREA

EXTERNAL TO INTERNAL

The gate filters located outside of the study area were used to provide an estimate on the percentage of trips destined to the study area. Each filter was used to determine the percentage of daily trips traveling through the select roadway and destined for the study area (Figure 6). The external-internal analysis indicates the highest percentage of trips destined for the Woodruff Road study area travel from the northeast and southeast. Garlington Road has the highest percentage, with 53% of southbound trips destined for the study area.

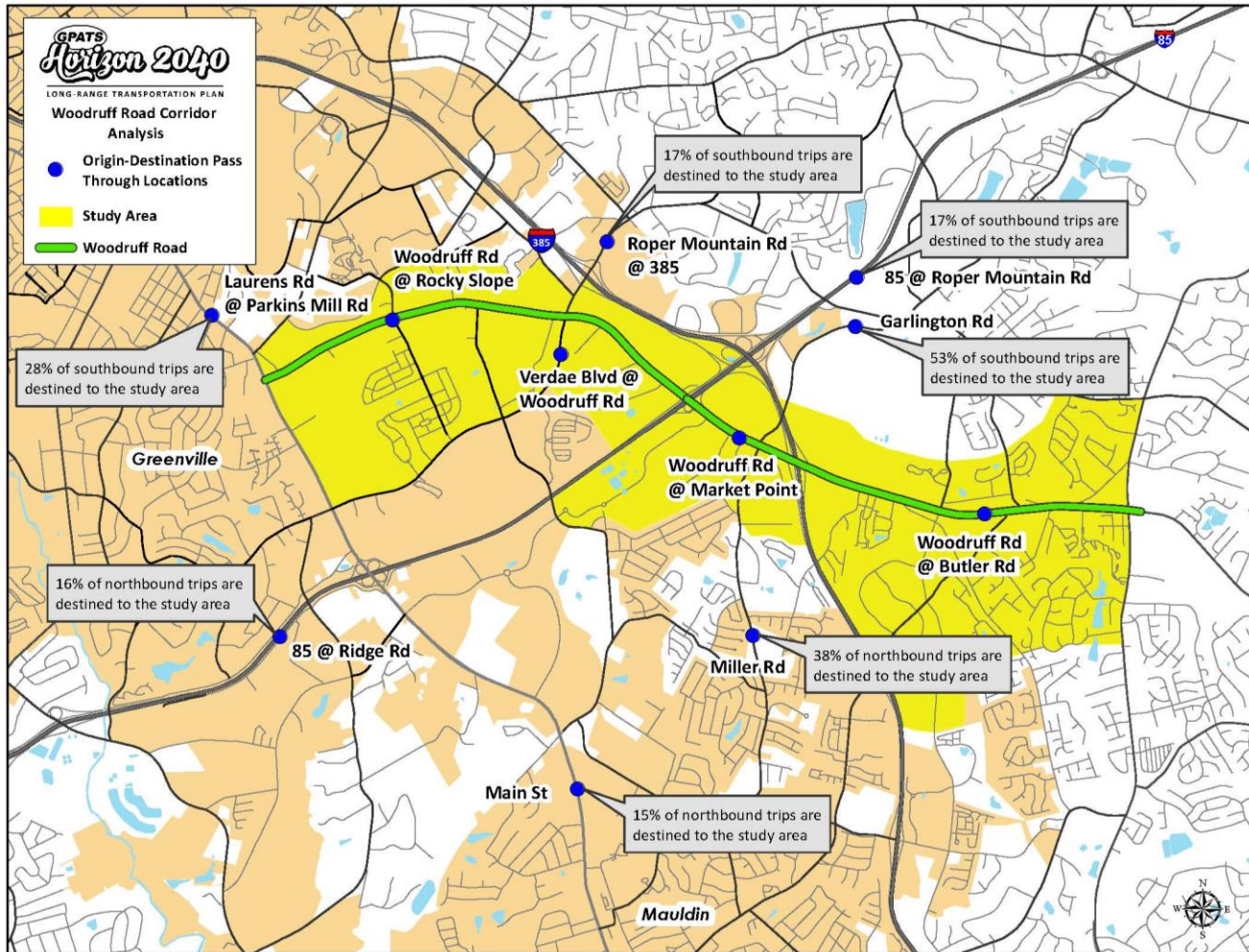


FIGURE 6 TRIPS DESTINED FOR STUDY AREA FROM SURROUNDING ROADWAYS

SOUTHBOUND ON ROPER MOUNTAIN ROAD AT 385 – 17%	SOUTHBOUND ON LAURENS ROAD AT PARKINS MILL ROAD – 28%
SOUTHBOUND ON I-85 AT RIDGE ROAD – 16%	NORTHBOUND ON MAIN STREET – 15%
NORTHBOUND MILLER ROAD – 38%	SOUTHBOUND ON GARLINGTON ROAD – 53%
SOUTHBOUND ON I-85 AT ROPER MOUNTAIN ROAD - 17%	

FINDINGS AND IMPLICATIONS

The results of the corridor analysis indicate the Woodruff Road study area contributes to a significant amount of activity in the region. Travel patterns show the corridor is primarily being used to access destinations along Woodruff Road, rather than being used as a through route. Three focus areas were selected as part of the origin-destination analysis: Downtown Greenville, BMW/Airport, and the area including Five Forks. These areas were selected after the origin-destination analysis indicated a high correlation of travel between the Woodruff Road study area and these areas. The zone containing Mauldin also showed a high percentage of trips to and from the study area but it was not selected as a focus area, primarily due to its proximity to the study area.

The first focus area, downtown Greenville, is a major destination of work and shopping trips. The origin-destination analysis indicated a high number of trips between the Woodruff Road study area and downtown Greenville. Three trip filters were located along Woodruff Road. These locations include Butler Road, Market Point, and Rocky Slope. The filters were analyzed to see if Woodruff Road is being used as a through route from SC 14 to downtown Greenville. While there are presumably some trips using Woodruff Road as a through route, the primary route from Butler Road to downtown Greenville is to access I-385. 9% of trips on Woodruff Road at Butler Road are traveling to downtown Greenville. This percentage drops to 2% at Market Point.

BMW manufacturing is the single largest employer in the region. The plant is located just off I-85 which makes it convenient to access from the surrounding communities. The plant is adjacent to the Greenville-Spartanburg International Airport which has 2 million passengers that travel through the airport a year. As part of the O-D analysis these two land uses were combined into a single zone. Each of the filters were analyzed to see the percentage that travel to the BMW/Airport zone in the AM, PM, and daily. While a parallel route might serve to access downtown, there is a significant portion of trips along Woodruff traveling north to BMW Manufacturing and the Greenville-Spartanburg International Airport.

The third focus area, Five Forks and surrounding communities, is primarily a residential zone. Woodruff Road continues west from SC-14 terminating at State Highway 101. Within this focus area, Woodruff Road connects to many residential communities. For many neighborhoods in this zone the commercial developments along Woodruff Road are the nearest shopping and dining options.

SCDOT is currently conducting the Woodruff Road Congestion Relief Project to evaluate solutions for improving operational efficiency and providing congestion relief along Woodruff Road.

According to SCDOT, "[t]he purpose of the project is to improve operational efficiency and alleviate traffic congestion on Woodruff Road in order to improve mobility in the busy commercial area between I-385 and Roper Mountain Road/Verdae Boulevard."

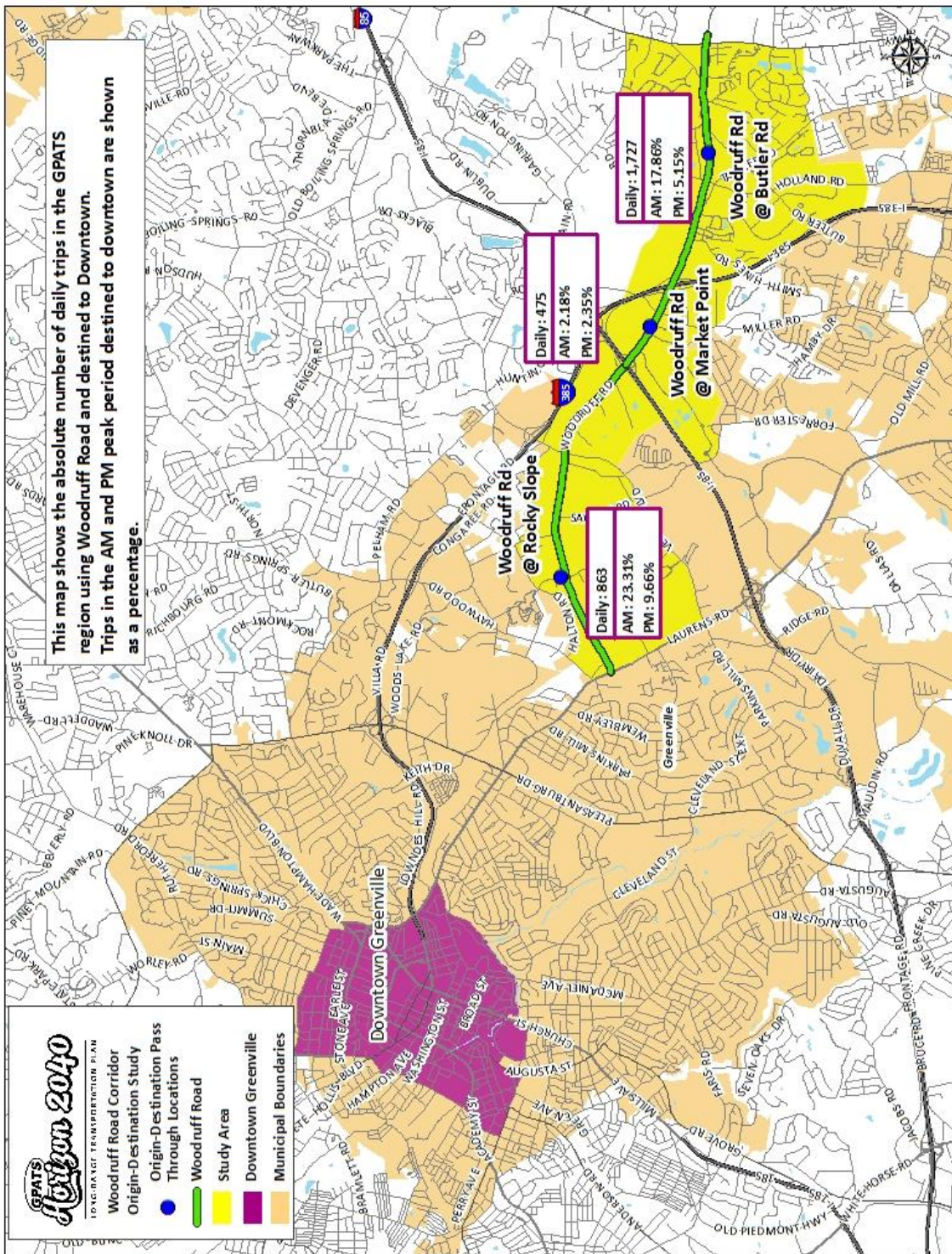
This study is anticipated to conclude in the Fall of 2018 with a federal decision on a preferred alternative. Previous studies evaluating traffic conditions along Woodruff Road note that the developments along this corridor account for a large portion of congestion, particularly between Roper Mountain Road and I-385. The data in this analysis confirms that the developments in the study area are a major destination of trips from communities within the study area, as well as downtown Greenville, BMW/Greenville-Spartanburg International Airport, and Five Forks.

The type of land uses located along this corridor such as Sam's Club, Walmart, The Shops at Greenridge, and many others are frequent destinations at all times of day. With the type of development present along Woodruff Road, operational efficiency and access management can provide good solutions for providing congestion relief. Implementing access management encourages smooth and safe traffic flow and helps communities mitigate some of the traffic problems caused by development. Access management can include signalization, controlled access, and limiting the amount of curb cuts on a roadway (driveway consolidation). Operational improvements can include parallel routes to Woodruff that serve the developments along the corridor. This type of improvement would allow trips destined to the area for shopping and dining alternative routes to Woodruff Road. The congestion relief efforts being explored in the Woodruff Road Congestion Relief Project include a focus on alternate entry and exit points from commercial areas as well as other solutions to help provide options to travelers. The findings of the analysis in the Woodruff Road Corridor Origin-Destination Analysis support the approach being taken in the Woodruff Road Congestion Relief Project.

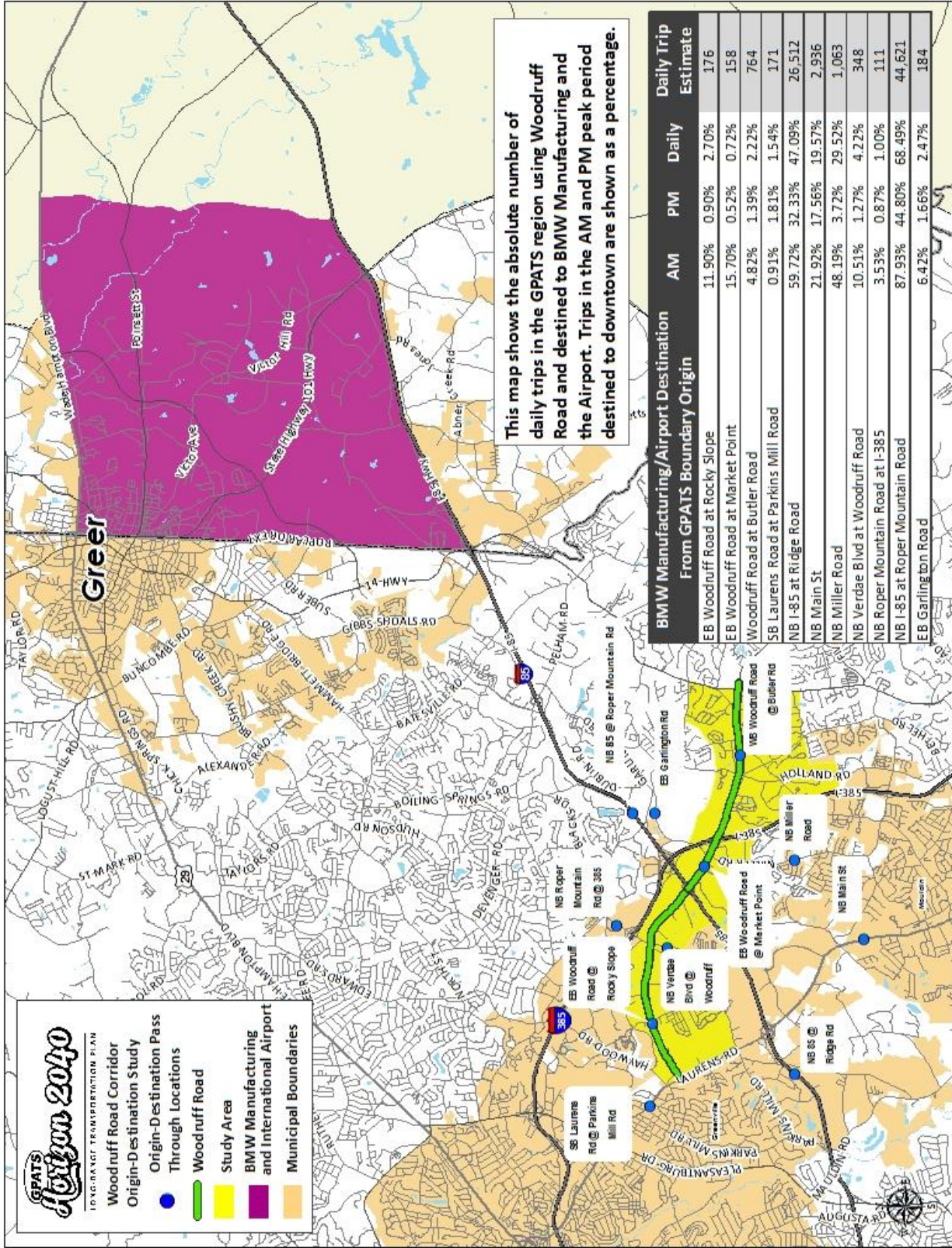
APPENDIX A

StreetLight Gate Locations		2015 AADT
1	Woodruff Road at Rocky Slope	13,000
2	Woodruff Road at Market Point*	44,000*
3	Woodruff Road at Butler Road	34,400
4	Laurens Road at Parkins Mill Road	22,200
5	I-85 at Ridge Road	112,600
6	Main St at Knollwood Drive	30,000
7	Miller Road at Pine Gate Drive	7,200
8	Verdae Boulevard at Woodruff Road	16,500
9	Roper Mountain Road at I-385	22,200
10	I-85 at Roper Mountain Road	130,300
11	Garlington Road	14,900
*2015 GPATS Travel Demand Model estimate		

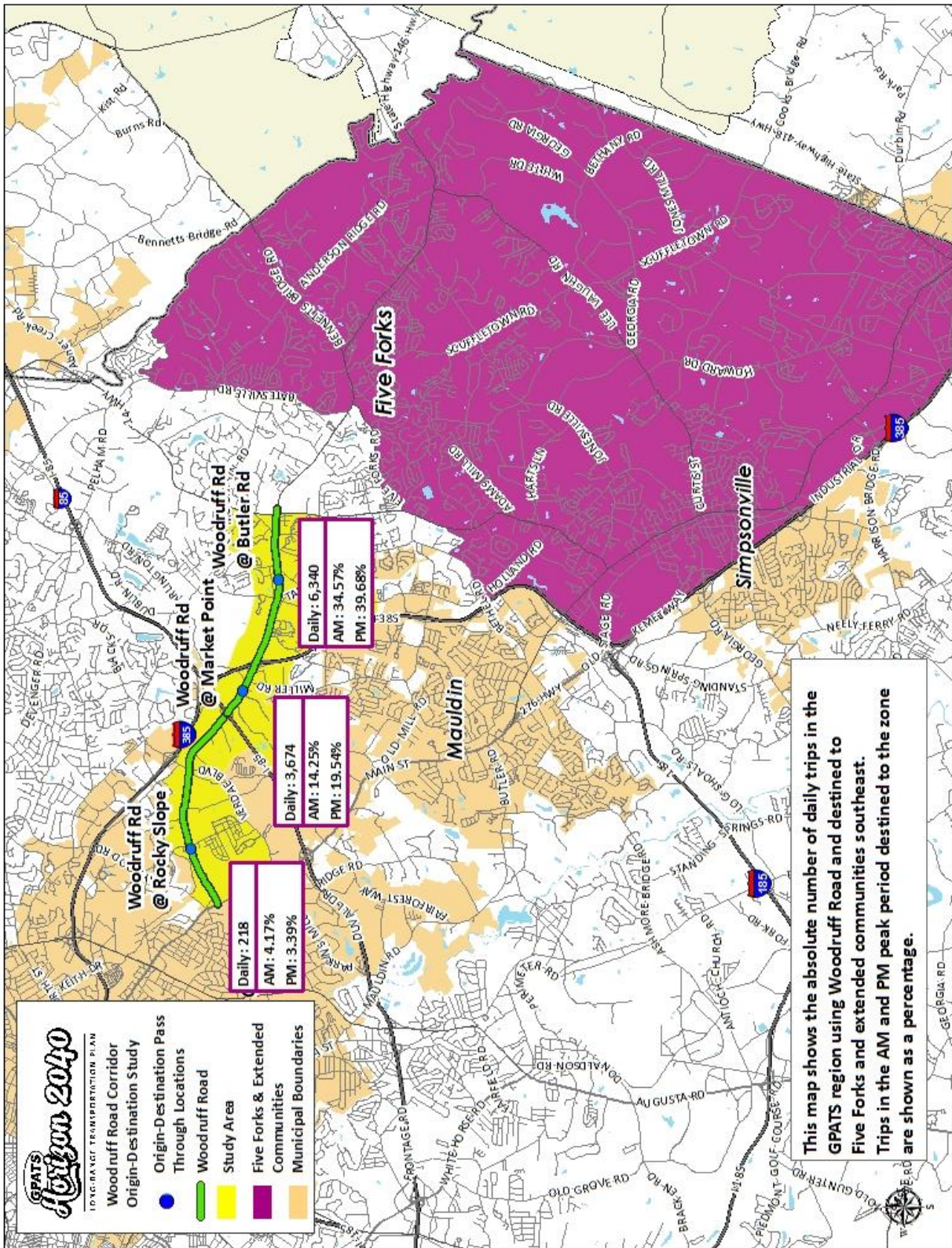
APPENDIX B



MAP 1



MAP 2



MAP 3