Gwinnett Place Mall

Traffic Responsive System

Final Timing Report

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1. Introduction

This document describes and analyzes the effectiveness of the Traffic Responsive (TR) System implemented by Jacobs for the Gwinnett Place Mall system in Gwinnett County, Georgia. The system consists of 49 signalized intersections located around Gwinnett Place Mall. Primary corridors include Pleasant Hill Road, Satellite Boulevard, Steve Reynolds Boulevard, and Club Drive. The Locations of the 49 intersections are shown in Figure 1 and they are listed out in Table 1.

The Gwinnett Place Mall system includes two interchanges with I-85, a half diamond at Steve Reynolds Boulevard and a diverging diamond interchange (DDI) at Pleasant Hill Road. Pleasant Hill Road includes 23 of the study intersections and is bound by an interchange on either end of the corridor, SR 13/Buford Highway to the north and Ronald Reagan Parkway to the south. Pleasant Hill Road maintains heavy volumes throughout day with additional commuter travel during the peaks. Satellite Boulevard includes 14 of the study intersections and is parallel to I-85. It is a popular alternate route to I-85 with heavy peaks during the AM and PM. Steve Reynolds Boulevard, combined with Club Drive, are a popular alternative route to Pleasant Hill Road as it circumvents some of the congestion surrounding Gwinnett Place Mall. This route consists of 10 study intersections. The final 2 study intersections are located along Old Norcross Road and are within close proximity to Steve Reynolds Boulevard and Pleasant Hill Road.

Traffic Responsive Signal control systems (TR) are useful in areas with heavy traffic volumes and unpredictable traffic patterns. The system reacts to changes in traffic demand and calls up timing plans most suited for the traffic conditions. It works well along popular alternative or bypass routes that are impacted by weather, incidents, seasonal variations, or planned special events. The Gwinnett Place Mall system is an ideal location for a TR system because of the heavy and often variable volumes along Pleasant Hill Road, alternate route options for I-85 and Pleasant Hill Road, and volume variation on weekends due to traffic generated by Gwinnett Place Mall.

The goal for this project was to develop and implement a TR system designed to run the most suitable patterns based on traffic volumes. Developing a TR system involved a three-step process shown in Figure 2. Development of TR was then followed by implementation and fine-tuning.

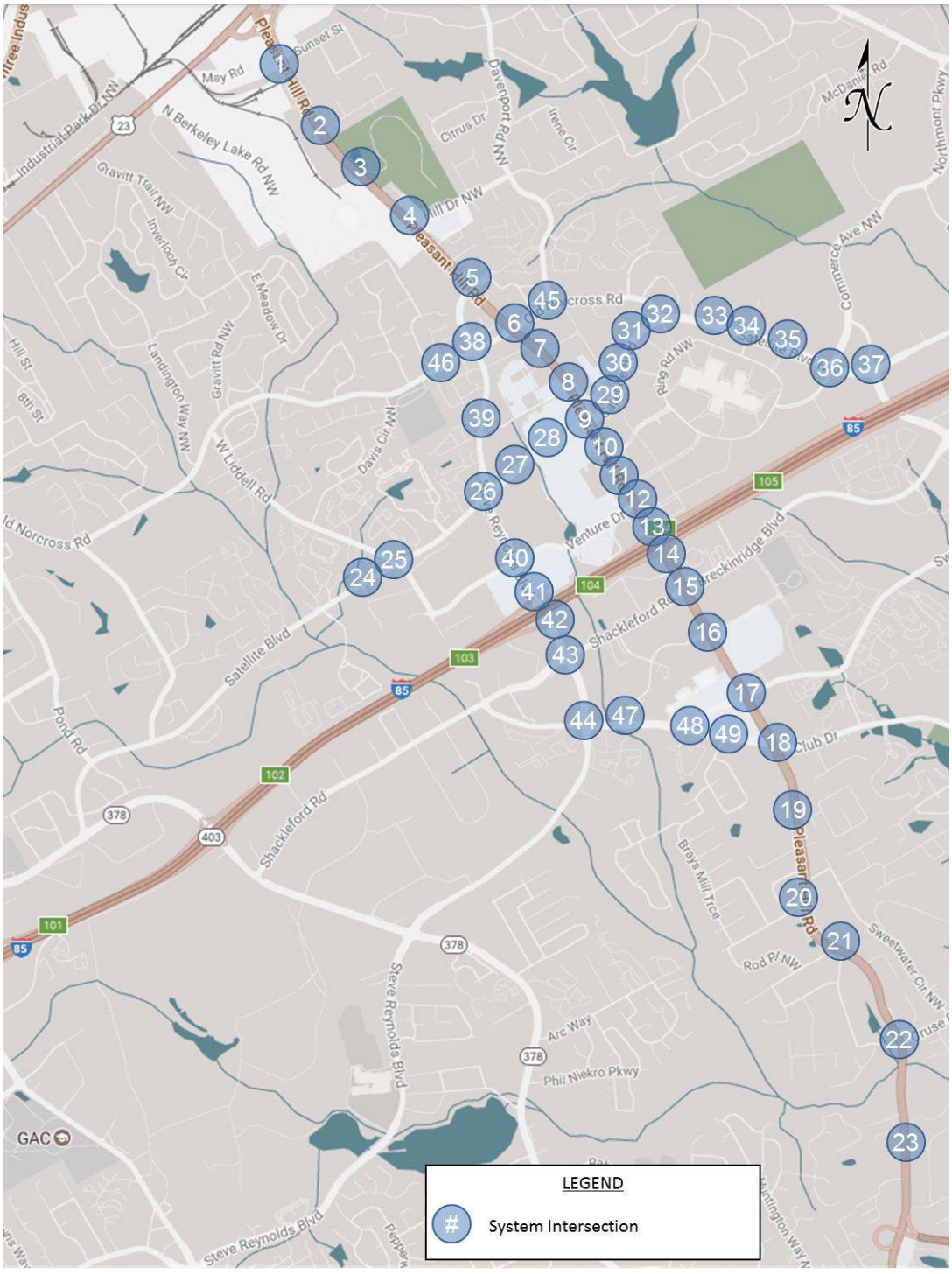

Figure 1: Gwinnett Place Mall System Project Limits and Intersection Locations

Table 1: System Signalized Intersections

Number	Intersection	Local Jurisdiction
1	Pleasant Hill Road at May Road/Sunset Street	Gwinnett County
2	Pleasant Hill Road at Woodberry Drive	Gwinnett County
3	Pleasant Hill Road at Shorty Howell Park	Gwinnett County
4	Pleasant Hill Road at Hill Drive/N Berkeley Lake Road	Gwinnett County
5	Pleasant Hill Road at Street Reynolds Boulevard	Gwinnett County
6	Pleasant Hill Road at Old Norcross Road	Gwinnett County
7	Pleasant Hill Road at Gwinnett Prado/Rooms to Go	Gwinnett County
8	Pleasant Hill Road at Gwinnett Street Station Shopping Center	Gwinnett County
9	Pleasant Hill Road at Satellite Boulevard	Gwinnett County
10	Pleasant Hill Road at Mall Boulevard	Gwinnett County
11	Pleasant Hill Road at Gwinnett Place Drive	Gwinnett County
12	Pleasant Hill Road at Venture Parkway	Gwinnett County
13	Pleasant Hill Road at I-85 SB Ramps	Gwinnett County
14	Pleasant Hill Road at I-85 NB Ramps	Gwinnett County
15	Pleasant Hill Road at Shackleford Road/Breckinridge Boulevard	Gwinnett County
16	Pleasant Hill Road at Crestwood Parkway/Koger Boulevard	Gwinnett County
17	Pleasant Hill Road at Sweetwater Road	Gwinnett County
18	Pleasant Hill Road at Club Drive	Gwinnett County
19	Pleasant Hill Road at Corley Place	Gwinnett County
20	Pleasant Hill Road at Arc Way	Gwinnett County
21	Pleasant Hill Road at Lakehill Drive/Bob Hannah Circle	Gwinnett County
22	Pleasant Hill Road at Cruse Road/Bob Hannah Circle	Gwinnett County
23	Pleasant Hill Road at Mary Street	Gwinnett County
24	Satellite Boulevard at Satellite Pointe	Gwinnett County
25	Satellite Boulevard at Liddell Road	Gwinnett County
26	Satellite Boulevard at Street Reynolds Boulevard	Gwinnett County
27	Satellite Boulevard at Satellite Square Driveway	Gwinnett County
28	Satellite Boulevard at Mall Corners Driveway	Gwinnett County
29	Satellite Boulevard at Market Street	Gwinnett County
30	Satellite Boulevard at Merchants Way	Gwinnett County
31	Satellite Boulevard at Gwinnett Plantation Way	Gwinnett County
32	Satellite Boulevard at Old Norcross Road (West)	Gwinnett County
33	Satellite Boulevard at Honda Dealership	Gwinnett County
34	Satellite Boulevard at Tandy Key Lane	Gwinnett County
35	Satellite Boulevard at Satellite Place Court	Gwinnett County
36	Satellite Boulevard at Commerce Avenue	Gwinnett County
37	Satellite Boulevard at Old Norcross Road (East)	Gwinnett County
38	Steve Reynolds Boulevard at Old Norcross Road	Gwinnett County
39	Steve Reynolds Boulevard at Chesden Drive	Gwinnett County
40	Steve Reynolds Boulevard at Venture Drive	Gwinnett County
41	Steve Reynolds Boulevard at I-85 SB On Ramp	Gwinnett County
42	Steve Reynolds Boulevard at I-85 NB Off Ramp	Gwinnett County
43	Steve Reynolds Boulevard at Shackleford Road	Gwinnett County
44	Steve Reynolds Boulevard at Club Drive	Gwinnett County
45	Old Norcross Road at Davenport Road	Gwinnett County
46	Old Norcross Road at Elkhorn Terrace	Gwinnett County
47	Club Drive at Crestwood Parkway	Gwinnett County
48	Club Drive at Sweetwater Road	Gwinnett County
49	Club Drive at Woodington Circle	Gwinnett County

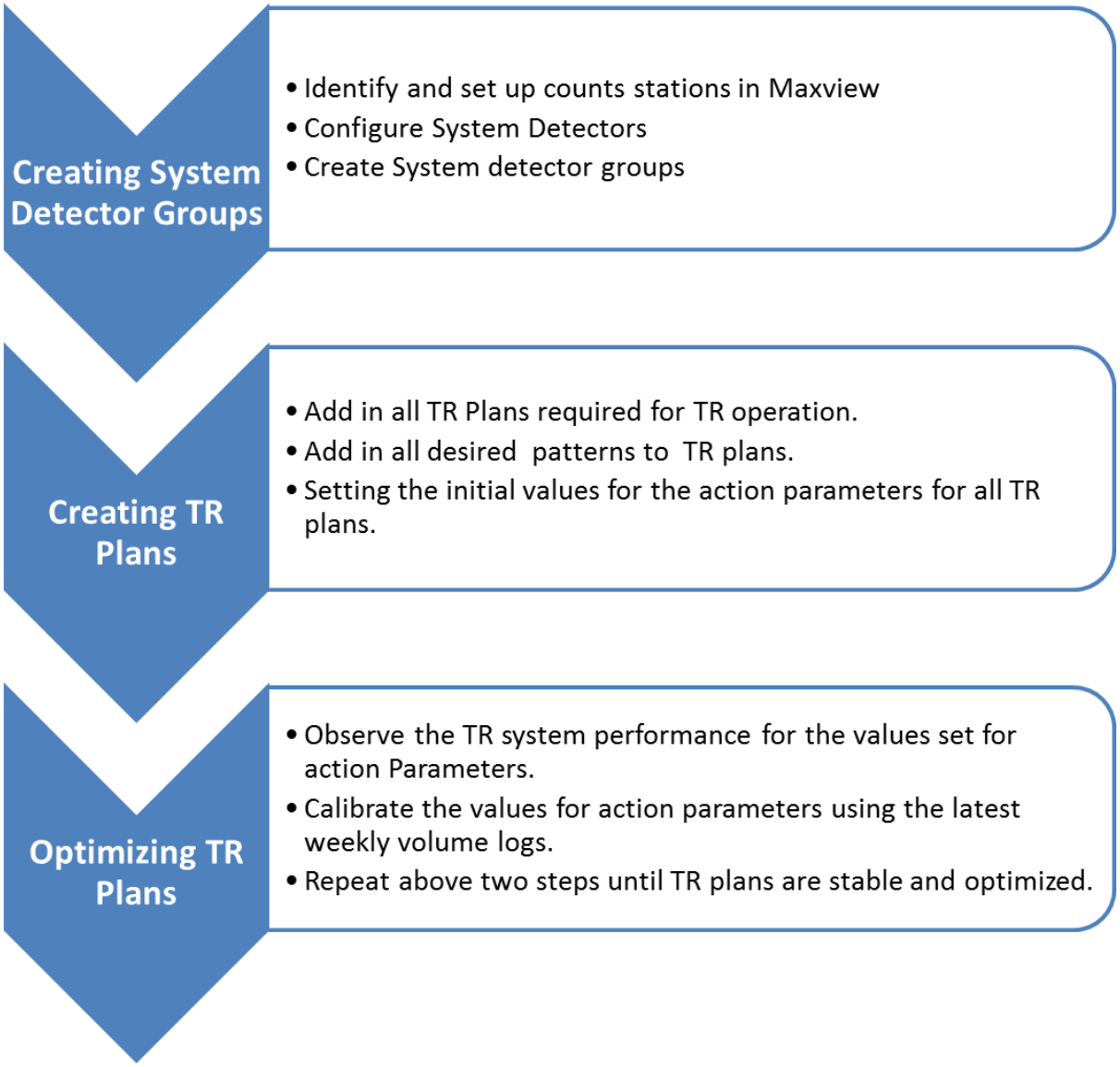

Figure 2: Three Step process for developing a TR system in MaxView

2. Creating System Detectors

Creating System Detector Groups involves three major steps:

1. Identifying and setting up count stations
2. Configuring system detectors
3. Creating system detector groups

2.1 Identifying Count Stations and System Detectors

Six intersections had pre-existing system detection for functioning TR operations under SEPAC operation. At these six intersections, a total of 21 system detectors were ideally situated to capture volume entering the network from either end of Pleasant Hill Road and exiting off of I-85. These intersections are listed in Table 2 and are shown in Figure 3. Detection zones for these system detectors were examined and reconfigured for use in MaxView.

To setup the system detectors in MaxView, each of the system detectors were first assigned IDs by using the MaxView ID of the intersection followed by the detector assignment number at the intersection. For example, the intersection of Pleasant Hill Road at I-85 SB Ramp has a MaxView ID of 64 and the system detector for the right turn lane coming off of I-85 has a detector assignment of 15; the resultant system detector ID will be 6415. The system detector IDs at each location are also provided in Table 2.

Table 2: Count Stations and System Detectors

Station ID	Intersection Name	System Detector Numbers
A	Pleasant Hill Road at Hill Drive/N Berkeley Lake Road	53005, 53006, 53007
B	Pleasant Hill Road at I-85 SB Ramps	6515, 6517, 6518
C	Pleasant Hill Road at I-85 NB Ramps	6415, 6417, 6418
D	Pleasant Hill Road at Club Drive	6904, 6905, 6906, 6923, 6924, 6925
E	Pleasant Hill Road at Cruse Road/Bob Hannah Circle	14205, 14207, 14223, 14225
F	Steve Reynolds Boulevard at I-85 NB Off Ramp	24733, 24735

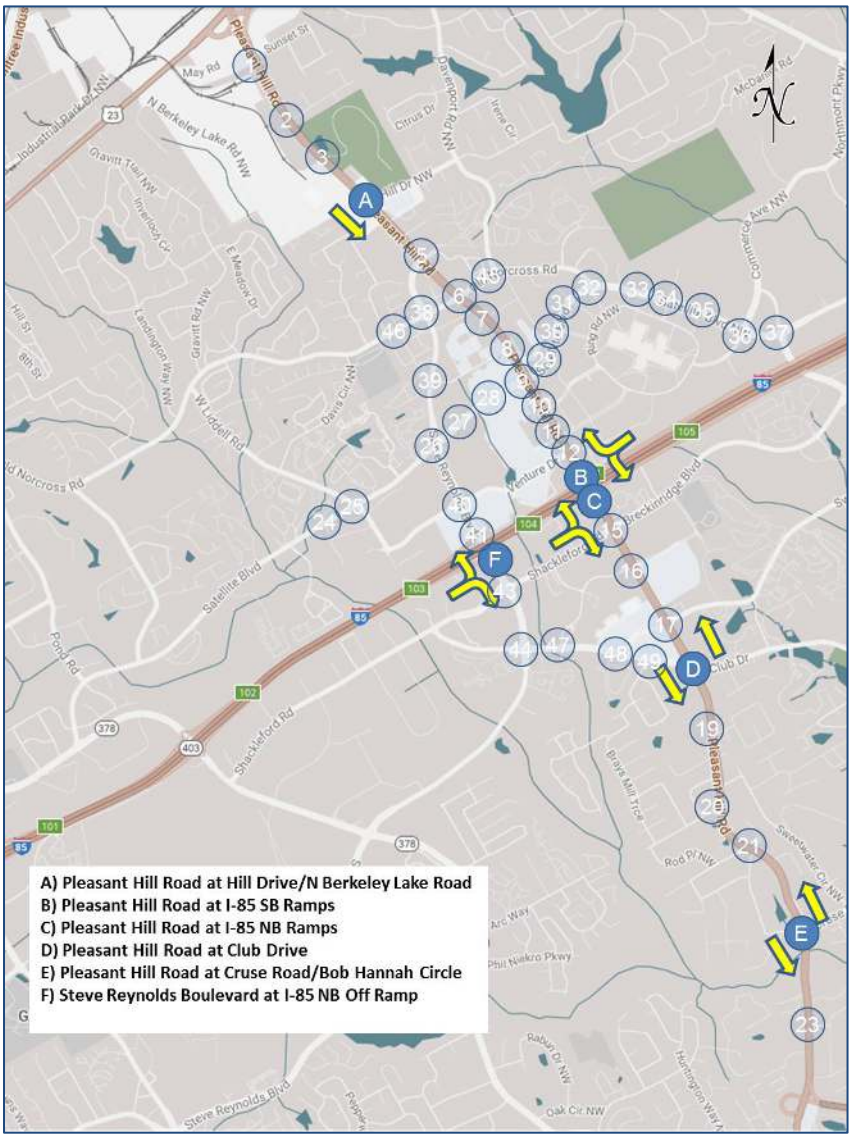

Figure 3 : Count Station Locations

2.2 System Detector Groups

The system detectors listed in Table 2 were consolidated into system detector groups. System detector groups are based on volume trends, such as directionality and peaks. Detector volume logs for the week of September 12, 2018 were analyzed. Based on the trends, it was determined that five detector groups were needed. The five groups and the assigned system detectors is provided in Table 3. Graphs depicting traffic volumes and existing cycle lengths for each of the five detector groups can be seen in Figure 4 through Figure 8. Note that the cycle lengths shown in the graphs are from the existing Time of Day system and the volumes are for a typical weekday (Tuesday through Thursday).

Table 3 : System Detector Groups

Group Number	Group Name	System Detectors Assigned
1	I-85 Northbound	415, 6417, 6418, 24733, 24735
2	I-85 Southbound	6515, 6517, 6518
3	Pleasant Hill Road Eastbound	6923, 6924, 6925, 14223, 14225
4	Pleasant Hill Road Westbound	6904, 6905, 6906, 14205, 14207
5	Hill Drive Eastbound	53005, 53006, 53007

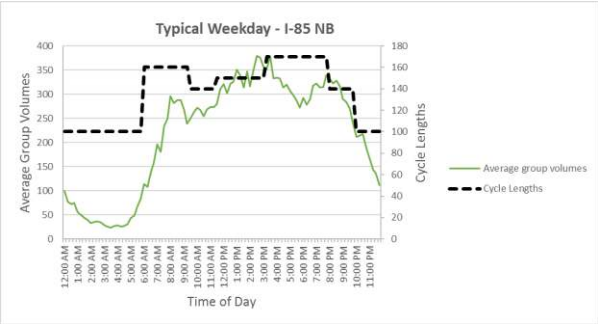

Figure 4 : System Detector Group 1

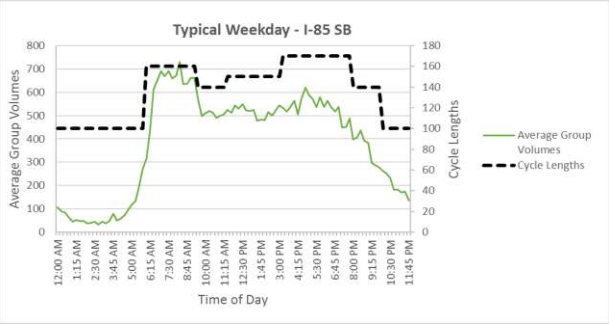

Figure 5 : System Detector Group 2

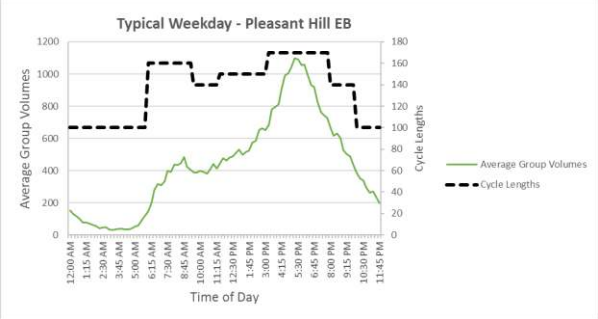

Figure 6: System Detector Group 3

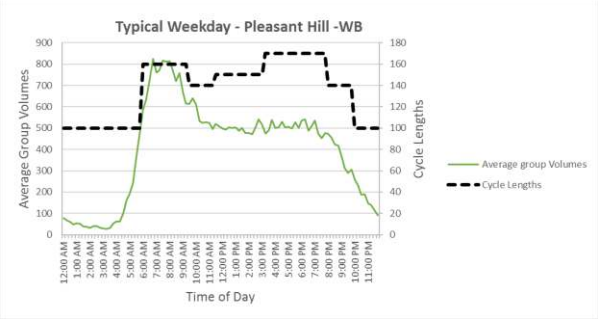

Figure 7 : System Detector Group 4

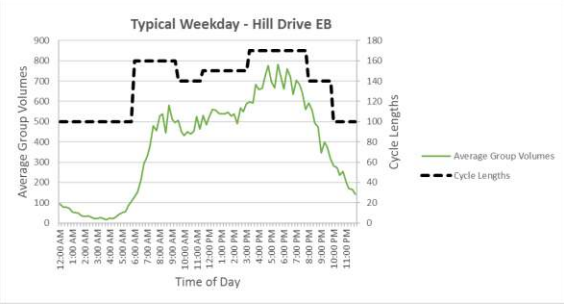

Figure 8 : System Detector Group 5

From the above figures it can be seen that each of the five groups have distinct volume trends. The five groups also represent different areas in the Gwinnett Place Mall System. Groups 1 and 2 represent the traffic demand along the interstate, which can reflect the impact on the system in the event of an incident on the interstate. Groups 3 and 4 capture traffic demand along Pleasant Hill Road. Group 5 represents traffic demand along Hill Drive. Similar trends within each of these groups were identified with weekend volumes too. The five groups together wholly represent traffic patterns for Gwinnett Place Mall system.

3. Creating TR Plans

Traffic Responsive (TR) plans are driven by a schedule where each plan includes different variables associated with them. For example, plans during the morning and evening hours of a weekday may have a different collection of patterns favoring different directions with different volume parameters to trigger each of those plans.

3.1 TR Plans and MaxView Schedule

For the Gwinnett Place Mall system, three TR Plans were created: Weekday AM plan, Weekday PM Plan, and Weekend Plan. The intent in using a Weekday AM and a Weekday PM plan is to differentiate directionality in the selection of patterns. The Weekday AM plan operates from 12 AM to 12 PM on weekdays. The Weekday PM plan operates from 12 PM to 12 AM on weekdays. The Weekend Plan runs throughout the entire weekend.

3.2 Patterns Associated with TR Plans

The existing Gwinnett Place Mall System operates with seven different patterns that are initiated using a fixed time-of-day schedule. For the TR System four additional patterns were created, totaling eleven patterns available for the TR plans to choose from. The three TR plans and the patterns assigned to each of them are listed in Table 4.

Table 4: TR Plans and Patterns

TR Plan Number	TR Plan Name	Patterns Included
1	Weekday AM	10,11,17,20,27,47
2	Weekday PM	20,27,30,31,37,47
3	Weekend	17,20,37,40,41,47

A brief description of each pattern is provided below:

AM Peak (Pattern 10)

The AM peak pattern is an existing 160-second cycle to meet traffic demands that exist during the morning rush hour. The 160-second cycle length handles the heavy commuter travel patterns. Additionally, the 160-second cycle length allows for coordination along Pleasant Hill Road with the adjacent systems on either end.

The AM traffic volumes are heavily directional northbound along Pleasant Hill Road towards Buford Highway, Peachtree Industrial Boulevard, and SR 141. Satellite Boulevard is heavily favored westbound towards Atlanta because it runs parallel to I-85. South of I-85, Club Drive and Steve Reynolds Boulevard are heavily favored northbound towards I-85. For this reason, the heavy left turn onto I-85 southbound was coordinated. North of I-85 Steve Reynolds Boulevard is fairly balanced. Peak directions were favored during the AM peak to help accommodate commuter traffic.

AM High (Pattern 11)

The AM high cycle length pattern is a newly developed 200-second cycle. It replicates the travel patterns of the existing AM peak (pattern 10) maintaining the same directionality and coordinated relationships between each intersection. The 200-second cycle length can meet higher than normal traffic demands during AM peak period.

AM Low (Pattern 17)

The AM low cycle length pattern is an existing 140-second cycle to accommodate the lower volumes during the morning hours yet still service directionality similar to the AM peak. The 140-second cycle length allows for coordination along Satellite Boulevard with the Sugarloaf Mills system as well as Pleasant Hill Road with the system to the north. Review of typical weekday daily counts revealed similar volume thresholds and directionality to the early Saturday and Sunday daily counts. For this reason, the AM low cycle length pattern is included with the weekend TR plans.

Midday Peak (Pattern 20)

The midday peak pattern is an existing 150-second cycle to meet traffic demands that exist throughout the day while maintaining access to all of the nearby retail and restaurants. It allows for two-way progression without adding unnecessary delay at minor intersections.

Traffic progression during the midday peak pattern is balanced in all directions to reflect that the traffic volumes are not heavily weighted in a particular direction during midday traffic operations.

Midday Low (Pattern 27)

The midday low cycle length pattern is a 120-second cycle. It replicates the travel patterns of the existing midday peak (Pattern 20) maintaining the same directionality and coordinated relationships between each intersection. The 120-second cycle length can will be used when traffic demands lower than that of the typical midday period.

PM Peak (Pattern 30)

The PM peak pattern is an existing 170-second cycle to meet traffic demands that exist during the afternoon rush hour. The 170-second cycle length was chosen to handle the heavy commuter travel

patterns. Additionally, the 170-second cycle length allows for coordination along Satellite Boulevard with the Sugarloaf Mills system.

The PM traffic volumes are directional southbound along Pleasant Hill Road towards Ronald Reagan Parkway. East of Old Norcross Road, Satellite Boulevard is heavily favored eastbound. West of Old Norcross Road it is fairly balanced. The Pleasant Hill Road, Steve Reynolds Boulevard, Club Drive alternate route is heavily favored southbound in the PM peak. Peak directions were favored during the PM peak to help accommodate commuter traffic.

PM High (Pattern 31)

The PM high cycle length pattern is a newly developed 200-second cycle. It replicates the travel patterns of the existing PM peak (Pattern 30) maintaining the same directionality and coordinated relationships between each intersection. The 200-second cycle length can meet higher than normal traffic demands during the PM Peak.

PM Low (Pattern 37)

The PM low cycle length pattern is a 140-second cycle. The 140-second cycle length was chosen to serve the lower traffic volumes following the PM peak and reduce side street delay. The 140-second cycle length allows for coordination along Pleasant Hill Road with the system to the north. This pattern is designed for lower volumes but similar traffic patterns following the PM Peak. A comparison of the weekday daily counts and weekend daily counts revealed similar volume thresholds and directionality. For this reason, the PM low cycle length pattern is used on Saturday and Sunday afternoon following to the peak period.

Weekend (Pattern 40)

The weekend pattern is an existing 180-second cycle length with multiple intersections that are half cycled and running a 90-second cycle length. The 180-second cycle length serves the heavy traffic volumes during the weekend midday peak. The multiple traffic signals operating a 90-second cycle length will help provide access to all of the nearby retail and restaurants. The weekend pattern provides two-way progression without adding unnecessary delay at the minor intersections.

Weekend High (Pattern 41)

The weekend high cycle length pattern is a new 210-second cycle. It replicates the travel patterns of the weekend (Pattern 40) maintaining the same directionality and coordinated relationships between each intersection. The 210-second cycle length can meet higher than normal traffic demands during the weekend.

Overnight/Free (Pattern 47)

Pleasant Hill Road operates 24-7 coordination while the rest of the system runs free operations overnight. Pattern 47 is the existing overnight pattern along Pleasant Hill Road. It is a 100-second cycle length and is

designed to provide balanced progression while minimizing side street delay. For the rest of the system, the existing Pattern 47 is set as a Free operation.

3.3 Setting the Variables/Action Parameters

The following parameters are able to be configured for the five detector groups for each TR Plan. They include the minimum improvement percentage, volume thresholds (V), occupancy thresholds (O), and K value (weightage factor for Occupancy) for every action in a TR Plan. Occupancy is not being considered for the Gwinnett Place Mall system because all system detection has been setup for counts and "pulse" and therefore cannot accurately determine occupancy the way "presence" detection would. Therefore, volume thresholds will be used by MaxView to calculate a Reference Value (RV) also called the "R score". The patterns are selected based on the lowest calculated R score for each pattern's algorithm. The calculation of R score is explained in detail in Section 3.4.1.

3.3.1 Volume Thresholds(V_{thresh})

MaxView calculates the weighted average volume for all the detectors in a detector group every 15 minutes. 'V_{thresh}', is a user defined threshold that MaxView compares to the weighted average volume for the detector group. An equal weight has been assigned for all 5 groups for the Gwinnett Place Mall System. The initial set of values for thresholds for a detector group determined by looking at the trends shown by average volumes for typical weekday (Tuesday through Thursday) and weekends. The thresholds for additional patterns (AM High, Midday Low, PM High and the Weekend High) were set at values higher or lower than typically observed volumes. The initial set of thresholds for weekdays were determined using volumes collected from days between 09/12/18 and 09/14/18 and the weekend thresholds were determined using volumes for 09/15/18 and 09/16/18.

The anticipated volume and cycle length graphs based on the proposed set of thresholds are shown in Figure 9 and Figure 10 for a typical weekday and Friday, respectively. These graphs show the cycle lengths increase and decrease with the peaks in volume as expected. The system will initiate the appropriate High or Low patterns based on volumes higher or lower than a typical period, illustrated in Figure 10 where the TR system calls the 200-second Pattern 31 when there is a higher than usual traffic volume between 5PM and 6PM.

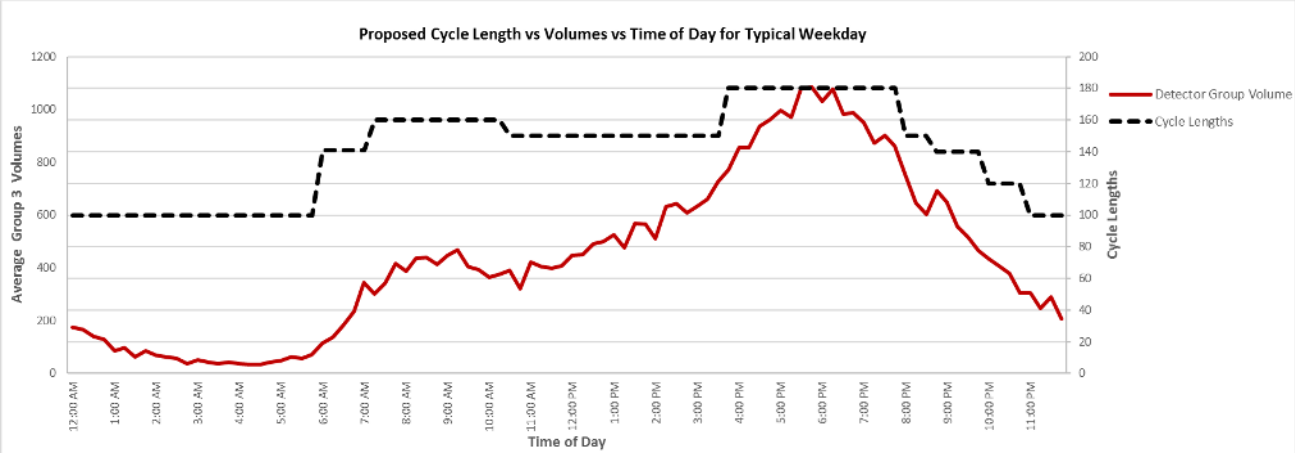

Figure 9: Existing Time of Day Schedule for Typical Weekday

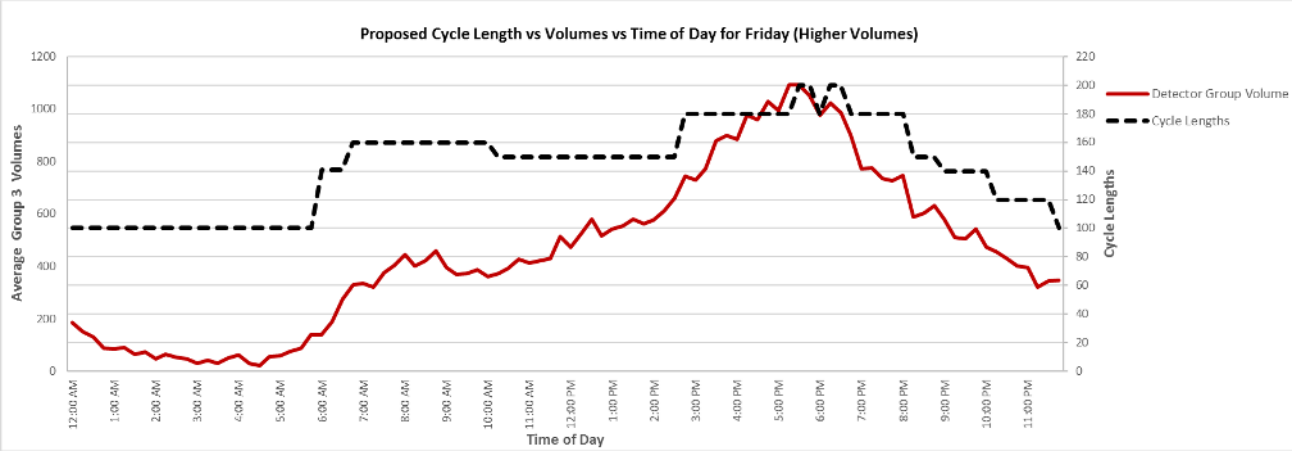

Figure 10: Proposed TR Schedule

3.3.2 Occupancy %

As mentioned earlier Occupancy is not taken into consideration for this system. So, this parameter is zeroed out for all detector groups.

3.3.3 K value

K value is the weightage factor for the Occupancy %. Since we are not using the Occupancy, K value is also zeroed out for all detector groups.

3.3.4 R Score

R score for an action is the difference between v+kO of the real time traffic volumes and the v+kO based on the values that are defined for v, k and O for each action. It is calculated every 15 minutes. TR system calls up the action with the lowest R score if the minimum improvement % criteria is met. Minimum Improvement % is defined below.

3.3.5 Minimum Improvement %

This is the parameter that controls how frequently the TR system changes from one action to another. It is the minimum ratio required between a current action's R score and a potential action's R score. For example, if the minimum improvement for Pattern 11 is 10% and at 8 AM, the existing Pattern 10 has an R score of 107 and Pattern 11 has an R score of 100, the ratio is 1.07; a 7% improvement. Although the R score is lower for Action 11, since the minimum improvement required is 10%, the TR system would not switch to Pattern 11. Minimum improvement % are generally set greater than 10% for the High and Low patterns so that these patterns only get used when volumes are significantly higher than normal. This setting assists to eliminate the action to jump to the higher cycle length for only 15 minutes when in fact the volume thresholds are close over that period.

3.4 MaxView Algorithm

MaxView uses a straightforward procedure to select the pattern to be called. First, R score is calculated, and then the pattern with minimum R score is identified. The R score is calculated every 15 minutes for every pattern in the TR plan. Next, the algorithm checks if the minimum improvement criteria are satisfied for selecting a new pattern.

3.4.1 Calculating R score

First, the weighted average volume (V_{avg}) for each detector group is calculated. This uses the 15-minute volume logs for each system detector. Then R score for Pattern 'a' in a TR Plan is calculated using the formula:

$$R_a = \sum_{i=1}^{5} |(V_{avg-i} - V_{thresh-i})|$$

Here V_{avg-i} is the weighted average volume for detector group 'i' and $V_{thresh-i}$ is the threshold volume for detector group 'i'. In this case the summation is done 5 times as there are 5 detector groups. R_a is the R score for the pattern whose threshold values (V_{thresh}) are being used in the equation. R_a is calculated for all the actions added to a TR plan. The TR system selects the action with the smallest R score (R_{min}) and checks for the minimum improvement factor before calling the action. This process is completed by the central software every 15 minutes.

4. Implemented TR System

The TR plans were optimized through an iterative process of setting the various pattern parameters, letting the algorithms run in the background for a week, and making notes on how the TR plans were performing compared to our desired results. Observations and adjustments were performed weekly from 09/12/17 till 10/06/17.

The TR system was turned live on Tuesday, November 13, 2018. Regular observations were made to ensure that the system was performing as desired. The volume thresholds and minimum improvement factors were further fine-tuned based on observations. The final set of values for the volume thresholds for all five detector groups and the percent improvement for every pattern added to the three TR plans are in Table 5.

Table 5: Pattern Parameter Values for Implemented TR Plans

Pattern Parameters - Weekday AM Plan						
Pattern #	**Min Improvement %**	**Group 1**	**Group 2**	**Group 3**	**Group 4**	**Group 5**
Pattern 10	10%	250	620	340	740	430
Pattern 11	10%	320	850	500	850	650
Pattern 17	10%	120	460	210	650	180
Pattern 20	10%	280	510	420	530	480
Pattern 27	10%	250	300	350	400	400
Pattern 47	10%	100	150	150	100	100
Pattern Parameters - Weekday PM Plan						
Pattern #	**Min Improvement %**	**Group 1**	**Group 2**	**Group 3**	**Group 4**	**Group 5**
Pattern 20	10%	340	515	550	500	545
Pattern 27	10%	250	300	300	200	300
Pattern 30	10%	325	550	800	500	700
Pattern 31	20%	400	625	1200	600	800
Pattern 37	12%	310	395	610	410	490
Pattern 47	10%	200	250	250	200	300
Pattern Parameters - Weekend Plan						
Pattern #	**Min Improvement %**	**Group 1**	**Group 2**	**Group 3**	**Group 4**	**Group 5**
Pattern 17	10%	205	405	325	460	328
Pattern 20	20%	300	450	450	500	450
Pattern 37	10%	275	315	430	350	350
Pattern 40	10%	380	580	630	580	625
Pattern 41	10%	450	635	700	700	700
Pattern 47	10%	150	200	200	150	175

5. Effectiveness/Responsiveness Analysis of the TR system

To analyze the effectiveness of the TR system observations were made to the TR system over the course of a typical week and a holiday week. The typical week chosen was from 01/06/2019 to 01/12/2019 and the holiday week chosen was from Wednesday of Thanksgiving (11/21/18) to the Sunday after Thanksgiving (11/25/18).

5.1 Typical Week

5.1.1 Monday through Thursday

Gwinnett Place Mall system currently has the same time of day schedule for Monday through Thursday. Table 6 shows the plans called up by the TR system on typical weekdays (Tuesday through Thursday) compared with the time of day schedule previously used.

Table 6 shows the times at which each plan is called up on different days varies. On Tuesday, 01/08/19, Pattern 10 (AM Peak) was called up once at 6:45 AM and again at 9:45 AM for half an hour to accommodate higher volumes at that time. Patterns 11 and 31, the AM high and PM high patterns respectively, are reserved for higher than normal demand. On Thursday (01/10/19), Pattern 11 (200 second cycle length) was activated at 8:45 AM for 15 minutes to accommodate higher than normal demand. The Gwinnett Place Mall area experiences higher volumes more frequently during the PM peak period. Pattern 31 is activated on all three days for approximately 30 minutes in the middle of the PM peak to service higher demand.

One benefit of the implemented TR plan is that there is now a gradual increase in cycle length into the peak periods and a gradual decrease in cycle length from the peak periods to the off-peak periods. Overall the system is being responsive to daily fluctuating demands.

Table 6: TR Operations Compared with Time-of-Day schedule (Tuesday - Thursday)

Traffic Responsive Operations - Tuesday			
Time	**Action**	**Action Description**	**Cycle Length**
0:15	Pattern 47	Overnight/Free	100/Free
5:45	Pattern 17	AM Off Peak	140
6:45	Pattern 10	AM Peak	160
9:30	Pattern 20	Midday	150
9:45	Pattern 10	AM Peak	160
10:15	Pattern 20	Midday	150
15:15	Pattern 30	PM Peak	170
17:30	Pattern 31	PM High	200
17:45	Pattern 30	PM Peak	170
19:45	Pattern 37	PM Off Peak	140
21:00	Pattern 27	Balanced Low	120
22:15	Pattern 47	Overnight/Free	100/Free

Traffic Responsive Operations - Wednesday			
Time	**Action**	**Action Description**	**Cycle Length**
0:15	Pattern 47	Overnight/Free	100/Free
6:00	Pattern 17	AM Off Peak	140
6:45	Pattern 10	AM Peak	160
10:15	Pattern 20	Midday	150
15:30	Pattern 30	PM Peak	170
18:15	Pattern 31	PM High	200
18:45	Pattern 30	PM Peak	170
19:30	Pattern 37	PM Off Peak	140
21:00	Pattern 27	Balanced Low	120
22:15	Pattern 47	Overnight/Free	100/Free
22:30	Pattern 27	Balanced Low	120
23:00	Pattern 47	Overnight/Free	100/Free

Traffic Responsive Operations - Thursday			
Time	**Action**	**Action Description**	**Cycle Length**
0:15	Pattern 47	Overnight/Free	100/Free
6:00	Pattern 17	AM Off Peak	140
6:45	Pattern 10	AM Peak	160
8:45	Pattern 11	AM High	200
9:00	Pattern 10	AM Peak	160
10:00	Pattern 20	Midday	150
15:15	Pattern 30	PM Peak	170
17:30	Pattern 31	PM High	200
18:15	Pattern 30	PM Peak	170
19:45	Pattern 37	PM Off Peak	140
21:00	Pattern 27	Balanced Low	120
22:00	Pattern 47	Overnight/Free	100/Free

Time-of-Day Schedule Monday-Thursday			
Time	**Action**	**Action Description**	**Cycle Length**
0:01	47 / 1	Overnight/Free	100/Free
6:00	10	AM Peak	160
9:30	17	AM Off Peak	140
11:30	20	Midday	150
15:15	30	PM Peak	170
20:00	37	PM Off Peak	140
22:00	47 / 1	Overnight/Free	100/Free

5.1.2 Friday

Gwinnett Place Mall system currently has a different time of day schedule for Friday. Table 7 shows the plans called up by the TR system on Friday compared with the previously used time of day schedule.

Table 7 displays the same benefits exist on Fridays that existed Monday through Thursday; the system experiences a gradual increase in cycle lengths moving into the peak periods and a gradual decrease in cycle lengths moving out of the peak periods.

Table 7: TR Operations Compared with Time-of-Day Schedule (Friday)

Traffic Responsive Operations - Friday			
Time	**Action**	**Action Description**	**Cycle Length**
0:15	Pattern 47	Overnight/Free	100/Free
6:00	Pattern 17	AM Off Peak	140
6:45	Pattern 10	AM Peak	160
9:15	Pattern 20	Midday	150
14:45	Pattern 30	PM Peak	170
17:30	Pattern 31	PM High	200
18:15	Pattern 30	PM Peak	170
19:45	Pattern 20	Midday	150
20:30	Pattern 37	PM Off Peak	140
22:00	Pattern 27	Balanced Low	120
23:00	Pattern 47	Overnight/Free	100/Free

Time-of-Day Schedule - Friday			
Time	**Action**	**Action Description**	**Cycle Length**
0:01	47 / 1	Overnight/Free	100/Free
6:00	10	AM Peak	160
9:30	17	PM Off Peak	140
11:30	20	Midday	150
14:00	30	PM Peak	170
20:00	37	PM Off Peak	140
22:00	47 / 1	Overnight/Free	100/Free

5.1.3 Saturday and Sunday

The Gwinnett Place Mall area has a different day plan for Saturday and Sunday as each day experiences slightly different volume trends. Table 8 and Table 9 below indicate both weekend days, the TR system activates Pattern 20 (the 150 second cycle length pattern) before and after Pattern 40 (the 180 second cycle length weekend pattern). The previously used weekend time of day schedule had pattern 40 run for almost 8 hours, whereas the TR system activated Pattern 40 for approximately 5 to 6 hours and utilizes Pattern 20 (a lower cycle length pattern) at other times when volume does not warrant the weekend peak pattern.

Table 8: TR Operations Compared with Time-of-Day Schedule (Saturday)

Traffic Responsive Operations - Saturday			
Time	**Action**	**Action Description**	**Cycle Length**
0:15	Pattern 47	Overnight/Free	100/Free
8:30	Pattern 17	AM Off Peak	140
9:45	Pattern 20	Weekend Low	160
11:30	Pattern 40	Weekend	180
18:30	Pattern 20	Weekend Low	150
20:30	Pattern 37	PM Off Peak	140
22:30	Pattern 47	Overnight/Free	100/Free

Time-of-Day Schedule - Saturday			
Time	**Action**	**Action Description**	**Cycle Length**
0:01	47 / 1	Overnight/Free	100/Free
7:00	17	AM Off Peak	140
10:30	40	Weekend	180
20:00	37	PM Off Peak	140
23:00	47 / 1	Overnight/Free	100/Free

Table 9: TR Operations Compared with Time-of-Day Schedule (Sunday)

Traffic Responsive Operations - Sunday			
Time	**Action**	**Action Description**	**Cycle Length**
0:15	Pattern 47	Overnight/Free	100/Free
10:00	Pattern 17	AM Off Peak	140
11:00	Pattern 20	Weekend Low	150
12:45	Pattern 40	Weekend	180
19:00	Pattern 20	Weekend Low	150
20:00	Pattern 37	PM Off Peak	140
22:00	Pattern 47	Overnight/Free	100/Free

Time-of-Day Schedule - Sunday			
Time	**Action**	**Action Description**	**Cycle Length**
0:01	47 / 1	Overnight/Free	100/Free
9:00	17	AM Off Peak	140
12:00	40	Weekend	180
19:00	37	PM Off Peak	140
22:00	47/1	Overnight/Free	100/Free

5.2 Holiday Weekend 2018

Thanksgiving 2018 was used to compare the effectiveness of the TR system, given the different travel patterns associated with this weekend from Wednesday prior to Thanksgiving through the Sunday following Thanksgiving. To quantify the benefits, travel time data provided by RITIS (Regional Integrated Transportation Information System) along two different routes for typical weekdays was analyzed for Thanksgiving 2018 and 2017. The two routes, primary routes in the area are Pleasant Hill Road and Pleasant Hill Road/Steve Reynolds Boulevard/Club Drive (Pleasant Hill-Steve Reynolds Bypass).

5.2.1 Wednesday prior to Thanksgiving

Wednesday prior to Thanksgiving experienced higher traffic demand during the PM peak period. Table 10 indicates the TR system responded well to the increase in demand. While the PM high pattern (pattern 31) was not activated, the duration of the normal PM peak was longer, coming on as early as 12:45PM (compared with 3:15 PM during typical time of day operations and compared with 3:30 PM during a typical Wednesday with TR operations). Adjustments to percent improvement were made to minimize a pattern change for a 15-minute period.

Table 11 compares the travel time data for Wednesday prior to thanksgiving of 2017 and 2018. The table validates the performance of the TR system as both Pleasant Hill Road and the Pleasant Hill Road – Steve Reynolds Bypass experienced significant travel time and average speed improvements throughout the day. The greatest improvement along Pleasant Hill road was experienced in the Southbound direction during the AM Peak and the greatest improvement along the Pleasant Hill – Steve Reynolds Bypass was experienced in the Northbound direction during AM peak.

Table 10: TR Operations Compared with Time-of-Day Operations (Wednesday prior to Thanksgiving)

Traffic Responsive Operations - Wednesday Prior to Thanksgiving			
Time	Action	Action Description	Cycle Length
0:15	Pattern 47	Overnight/Free	100/Free
6:15	Pattern 17	AM Off Peak	140
7:45	Pattern 10	AM Peak	160
8:30	Pattern 17	AM Off Peak	140
8:45	Pattern 10	AM Peak	160
9:15	Pattern 20	Midday	150
12:45	Pattern 30	PM Peak	170
13:30	Pattern 20	Midday	150
13:45	Pattern 30	PM Peak	170
19:15	Pattern 20	Midday	150
20:00	Pattern 37	PM Off Peak	140
21:15	Pattern 27	Balanced Low	120
23:00	Pattern 47	Overnight/Free	100/Free

Traffic Responsive Operations - Typical Wednesday			
Time	Action	Action Description	Cycle Length
0:15	Pattern 47	Overnight/Free	100/Free
6:00	Pattern 17	AM Off Peak	140
6:45	Pattern 10	AM Peak	160
10:15	Pattern 20	Midday	150
15:30	Pattern 30	PM Peak	170
18:15	Pattern 31	PM High	200
18:45	Pattern 30	PM Peak	170
19:30	Pattern 37	PM Off Peak	140
21:00	Pattern 27	Balanced Low	120
22:15	Pattern 47	Overnight/Free	100/Free
22:30	Pattern 27	Balanced Low	120
23:00	Pattern 47	Overnight/Free	100/Free

Time-of-Day Schedule - Typical Wednesday			
Time	Action	Action Description	Cycle Length
0:01	47 / 1	Overnight/Free	100/Free
6:00	10	AM Peak	160
9:30	17	AM Off Peak	140
11:30	20	Midday	150
15:15	30	PM Peak	170
20:00	37	PM Off Peak	140
22:00	47 / 1	Overnight/Free	100/Free

Table 11:Before and After Speed and Travel Time Comparisons for Wednesday prior to Thanksgiving

Pleasant Hill Road									
		24-Hour		AM Peak		MD Peak		PM Peak	
		NB	SB	NB	SB	NB	SB	NB	SB
Average Speed	Before Runs	29.29	27.67	33.72	29.65	27.94	26.15	23.38	21.67
(mph)	After Runs	29.81	29.72	31.21	33.38	27.47	28.34	25.35	21.19
	% Improved	1.80%	7.40%	-7.40%	12.60%	-1.70%	8.40%	8.50%	-2.20%
Travel Time	Before Runs	9.6	10.67	8.09	9.62	9.84	10.94	11.65	13.24
(mins)	After Runs	9.4	10.14	8.72	8.58	9.93	10.1	10.77	13.67
	% Improved	2.00%	4.90%	-7.80%	10.80%	-0.90%	7.60%	7.50%	-3.30%
Pleasant Hill Road - Steve Reynolds Bypass									
		24-Hour		AM Peak		MD Peak		PM Peak	
		NB	SB	NB	SB	NB	SB	NB	SB
Average Speed	Before Runs	26.82	26.77	25.95	29.83	25.22	23.26	23.56	20.02
(mph)	After Runs	28.65	28.15	30.55	31.53	27.16	26.89	26.07	21.38
	% Improved	6.80%	5.20%	17.70%	5.70%	7.70%	15.60%	10.60%	6.80%
Travel Time	Before Runs	6.62	7.32	6.77	6.28	6.95	8.05	7.48	9.45
(mins)	After Runs	6.17	6.91	5.72	5.98	6.41	7.02	6.72	8.82
	% Improved	6.70%	5.50%	15.50%	4.80%	7.70%	12.80%	10.20%	6.80%

5.2.2 Thanksgiving Thursday

Thanksgiving experienced lower traffic demand than a typical weekday. Table 12 indicates that neither the AM or PM peak patterns were called up on Thanksgiving Day as the travel demand was lower than usual. Also note that the Overnight/Free pattern was active until 10:00AM. These results show indicate the system was responsive to atypically low demand.

Table 13 compares the travel time data for Thanksgiving Day of 2017 and 2018. The table validates the performance of the TR system as both Pleasant Hill Road and the Pleasant Hill Road – Steve Reynolds Bypass experienced greater than 10% improvement in travel time and average speed during most times of the day. The greatest improvement along Pleasant Hill road was experienced in the Northbound direction during PM Peak (greater than 25%) and the greatest improvement along the Pleasant Hill – Steve Reynolds Bypass was experienced in the Southbound direction during AM peak (greater than 25%).

Table 12: TR Operations Compared with Time-of-Day Operations (Thanksgiving Thursday)

Traffic Responsive Operations - Thanksgiving			
Time	Action	Action Description	Cycle Length
0:15	Pattern 47	Overnight/Free	100/Free
10:00	Pattern 27	Balanced Low	120
12:00	Pattern 20	Midday	150
12:45	Pattern 37	PM Off Peak	140
15:00	Pattern 20	Midday	150
15:15	Pattern 37	PM Off Peak	140
19:15	Pattern 27	Balanced Low	120
19:30	Pattern 37	PM Off Peak	140
20:15	Pattern 27	Balanced Low	120
23:00	Pattern 47	Overnight/Free	100/Free

Time-of-Day Schedule - Thanksgiving			
Time	Action	Action Description	Cycle Length
0:01	47 / 1	Overnight/Free	100/Free
6:00	10	AM Peak	160
9:30	17	AM Off Peak	140
11:30	20	Midday	150
15:15	30	Pm Peak	170
20:00	37	PM Off Peak	140
22:00	47 / 1	Overnight/Free	100/Free

Table 13: Before and After Speed and Travel Time Comparisons for Thanksgiving

Pleasant Hill Road									
		24-Hour		AM Peak		MD Peak		PM Peak	
		NB	SB	NB	SB	NB	SB	NB	SB
Average Speed	Before Runs	29.1	28.81	26.75	25.78	29.15	26.61	24.23	25.05
(mph)	After Runs	32.98	32.61	33.61	32.79	30.23	31.29	32.39	30.36
	% Improved	13.30%	13.20%	25.60%	27.20%	3.70%	17.60%	33.70%	21.20%
Travel Time	Before Runs	9.61	10.16	10.45	11.18	9.37	10.85	11.29	11.51
(mins)	After Runs	8.31	8.81	8.19	8.73	9.06	9.12	8.43	9.4
	% Improved	13.50%	13.30%	21.60%	21.90%	3.30%	15.90%	25.40%	18.30%
Pleasant Hill Road - Steve Reynolds Bypass									
		24-Hour		AM Peak		MD Peak		PM Peak	
		NB	SB	NB	SB	NB	SB	NB	SB
Average Speed	Before Runs	26.74	28.13	26.43	24.49	22.64	26.2	22.96	25.59
(mph)	After Runs	29.76	31.05	29.98	32.84	28.45	27.8	28.11	30.2
	% Improved	11.30%	10.40%	13.40%	34.10%	25.70%	6.10%	22.40%	18.00%
Travel Time	Before Runs	6.64	6.8	6.67	7.74	7.68	7.22	7.58	7.35
(mins)	After Runs	5.89	6.08	5.83	5.72	6.13	6.71	6.25	6.23
	% Improved	11.20%	10.50%	12.60%	26.00%	20.20%	7.10%	17.50%	15.20%

5.2.3 Black Friday

Black Friday travel patterns are typically different than a normal Friday. There's a likelihood of increased bidirectional traffic during midday and PM periods. Midday patterns (20 and 27) are designed for bidirectional volumes. Table 14 indicates that the TR system responded by calling the Midday Pattern 20 earlier (10:00 AM compared with 11:30 AM during typical time of day operations) and stayed on until intermittently the end of the PM peak period (10:15 PM compared with 3:15 PM during typical time of day operations). Notice that the AM and PM peak patterns were not called due to a lack of directional commuter traffic on this day.

Table 15 compares the travel time data for Black Friday of 2017 and 2018. The table validates the performance of the TR system as both Pleasant Hill Road and Pleasant Hill Road – Steve Reynolds Bypass

experienced significant improvement in travel time and average speed improvements at almost all times of the day. The greatest improvement in travel time for Pleasant Hill road was experienced during the Midday and PM Peak periods and the greatest improvement in in travel time for the Pleasant Hill – Steve Reynolds Bypass was experienced in the Southbound direction during both the AM and PM peak periods.

Table 14: TR Operations Compared with Time-of-Day Operations (Black Friday)

Traffic Responsive Operations - Black Friday			
Time	Action	Action Description	Cycle Length
0:15	Pattern 47	Overnight/Free	100/Free
7:45	Pattern 17	AM Off Peak	140
8:45	Pattern 27	Balanced Low	120
10:00	Pattern 20	Midday	150
19:15	Pattern 37	PM Off Peak	140
20:30	Pattern 27	Balanced Low	120
21:45	Pattern 47	Overnight/Free	100/Free
22:15	Pattern 27	Balanced Low	120
22:45	Pattern 47	Overnight/Free	100/Free

Time-of-Day Schedule - Friday			
Time	Action	Action Description	Cycle Length
0:01	47 / 1	Overnight/Free	100/free
6:00	10	AM Peak	160
9:30	17	AM Off Peak	140
11:30	20	Midday	150
15:15	30	PM Peak	170
20:00	37	PM Off Peak	140
23:00	47 / 1	Overnight/Free	100/Free

Table 15: Before and After Speed and Travel Time Comparisons for Black Friday

Pleasant Hill Road									
		24-Hour		AM Peak		MD Peak		PM Peak	
		NB	SB	NB	SB	NB	SB	NB	SB
Average Speed	Before Runs	28.92	27.74	31.3	30.34	25.42	26.87	24.35	19.51
(mph)	After Runs	30.53	30.55	34.54	32.57	28.87	29.8	24.63	24.09
	% Improved	5.50%	10.10%	10.30%	7.40%	13.60%	10.90%	1.10%	23.50%
Travel Time	Before Runs	9.73	10.76	8.79	9.51	10.78	10.65	11.23	14.65
(mins)	After Runs	8.31	8.81	8.19	8.73	9.06	9.12	8.43	9.4
	% Improved	14.50%	18.10%	6.90%	8.20%	15.90%	14.40%	25.00%	35.80%
Pleasant Hill Road - Steve Reynolds Bypass									
		24-Hour		AM Peak		MD Peak		PM Peak	
		NB	SB	NB	SB	NB	SB	NB	SB
Average Speed	Before Runs	27.39	28.25	30.39	28.28	24.99	28.11	23.62	21.69
(mph)	After Runs	28.72	29.77	31.37	32.48	27.62	28.92	25.95	24.46
	% Improved	4.90%	5.40%	3.20%	14.80%	10.50%	2.90%	9.90%	12.80%
Travel Time	Before Runs	6.48	6.78	5.75	6.62	6.97	6.65	7.46	8.64
(mins)	After Runs	6.14	6.37	5.55	5.77	6.3	6.52	6.74	7.65
	% Improved	5.20%	6.00%	3.50%	12.90%	9.50%	2.00%	9.60%	11.40%

5.2.4 Saturday after Thanksgiving

Saturday after Thanksgiving experienced similar travel volumes than a typical Saturday, however during a later time period. Table 16 indicates that the weekend pattern was called up at 2 pm and was active intermittently until 6:00 PM; the system did not switch to free operations until 11:15 PM. Comparing the TR operations on the Saturday after Thanksgiving with a typical Saturday operating with TR, the weekend

pattern was activated later (11:30AM on a normal Saturday with TR compared with 2:00 PM on the Saturday after Thanksgiving) and maintained coordinated operations later (11:15 PM compared with 10:00 PM on a normal Saturday). However, under TR operations, both a normal Saturday and the Saturday after Thanksgiving, the weekend pattern transitioned into a lower cycle length pattern at 6:30PM. Adjustments to % improvement were made to minimize a pattern change for a 15-minute period.

Table 17 below compares the travel time data for Saturday after Thanksgiving of 2017 and 2018. The table validates the performance of the TR system as both Pleasant Hill Road and the Pleasant Hill Road – Steve Reynolds Bypass, which both experienced significant improvement in travel time and average speed improvements during most times of the day. The greatest improvement experienced was during PM peak period for both Pleasant Hill Road and the Pleasant Hill – Steve Reynolds Bypass (greater than 10% in both directions).

Table 16: TR Operations Compared with Time-of-Day Operations (Saturday after Thanksgiving)

Traffic Responsive Operations - Saturday after Thanksgiving			
Time	**Action**	**Action Description**	**Cycle Length**
0:15	Pattern 47	Overnight/Free	100/Free
9:00	Pattern 17	AM Off Peak	140
10:30	Pattern 20	Weekend Low	150
14:00	Pattern 40	Weekend	180
14:15	Pattern 20	Weekend Low	150
14:45	Pattern 40	Weekend	180
15:15	Pattern 20	Weekend Low	150
15:45	Pattern 40	Weekend	180
17:45	Pattern 20	Weekend Low	150
18:00	Pattern 40	Weekend	180
18:30	Pattern 20	Weekend Low	150
22:15	Pattern 17	PM Off Peak 2	140
22:30	Pattern 37	PM Off Peak	140
23:15	Pattern 47	Overnight/Free	100/Free

Traffic Responsive Operations - Saturday of Typical Week			
Time	**Action**	**Action Description**	**Cycle Length**
0:15	Pattern 47	Overnight/Free	100/Free
8:30	Pattern 17	AM Off Peak	140
9:45	Pattern 20	Weekend Low	160
11:30	Pattern 40	Weekend	180
18:30	Pattern 20	Weekend Low	150
20:30	Pattern 37	PM Off Peak	140
22:30	Pattern 47	Overnight/Free	100/Free

Time-of-Day Schedule - Saturday			
Time	**Action**	**Action Description**	**Cycle Length**
0:01	47 / 1	Overnight/Free	100/Free
7:00	17	AM Off Peak	140
10:30	40	Weekend	180
20:00	37	PM Off Peak	140
23:00	47 / 1	Overnight/Free	100/Free

Table 17:Before and After Speed and Travel Time Comparisons for Saturday after Thanksgiving

Pleasant Hill Road									
		24-Hour		AM Peak		MD Peak		PM Peak	
		NB	SB	NB	SB	NB	SB	NB	SB
Average Speed	Before Runs	29.12	29.02	33.38	30.93	25.69	28.67	23.5	23.19
(mph)	After Runs	32.18	31.18	34.02	32.66	31.8	31.32	27.33	27.46
	% Improved	10.50%	7.40%	1.90%	5.60%	23.80%	9.30%	16.30%	18.40%
Travel Time	Before Runs	9.66	10.07	8.17	9.23	10.62	9.97	11.59	12.35
(mins)	After Runs	8.56	9.23	8.01	8.75	8.59	9.18	9.96	10.37
	% Improved	11.40%	8.40%	2.00%	5.30%	19.10%	7.90%	14.10%	16.00%
Pleasant Hill Road - Steve Reynolds Bypass									
		24-Hour		AM Peak		MD Peak		PM Peak	
		NB	SB	NB	SB	NB	SB	NB	SB
Average Speed	Before Runs	27.72	28.61	29.35	32.23	26.63	25.52	24.51	23.43
(mph)	After Runs	29.71	30.31	30.08	31.09	29.71	27.93	28.26	26.23
	% Improved	7.20%	6.00%	2.50%	-3.50%	11.60%	9.50%	15.30%	12.00%
Travel Time	Before Runs	6.38	6.73	5.95	5.86	6.58	7.37	7.12	8.08
(mins)	After Runs	5.89	6.22	5.8	6	5.87	6.68	6.18	7.14
	% Improved	7.60%	7.50%	2.50%	-2.40%	10.70%	9.50%	13.10%	11.60%

5.2.5 Sunday after Thanksgiving

Traffic demand on the Sunday after Thanksgiving is somewhat higher than normal and the TR system responded accordingly. Table 18 indicates there was an earlier activation of, and the longer durations of, the weekend high pattern (Pattern 40). Table 19 compares the travel time data for Saturday after thanksgiving of 2017 and 2018. The table validates the performance of the TR system as both Pleasant Hill Road and the Pleasant Hill Road – Steve Reynolds Bypass experienced significant improvement in both travel time and average speed during most times of the day. The greatest improvements experienced was during both the midday and PM peak periods for both Pleasant Hill road and the Pleasant Hill – Steve Reynolds Bypass (less than 10% in both directions).

Table 18: TR Operations Compared with Time-of-Day Operations (Sunday after Thanksgiving)

Traffic Responsive Plan Operations - Sunday after Thanksgiving			
Time	**Action**	**Action Description**	**Cycle Length**
0:15	Pattern 47	Overnight/Free	100/Free
10:00	Pattern 17	AM Off Peak	140
11:00	Pattern 20	Weekend Low	150
11:15	Pattern 17	AM Off Peak	140
11:45	Pattern 20	Weekend Low	150
13:15	Pattern 40	Weekend	180
17:45	Pattern 20	Weekend Low	150
19:30	Pattern 37	PM Off Peak	140
21:30	Pattern 47	Overnight/Free	100/Free

Time-of-Day Schedule - Sunday			
Time	**Action**	**Action Description**	**Cycle Length**
0:01	47 / 1	Overnight/Free	100/Free
9:00	17	AM Off Peak	140
12:00	40	Weekend	180
19:00	37	PM Off Peak	140
22:00	47 / 1	Overnight/Free	100/Free

Table 19: Before and After Speed and Travel Time Comparisons for Sunday after Thanksgiving

Pleasant Hill Road									
		24-Hour		AM Peak		MD Peak		PM Peak	
		NB	SB	NB	SB	NB	SB	NB	SB
Average Speed	Before Runs	29.75	29.93	34.09	34.35	27.94	29.02	24.8	25.79
(mph)	After Runs	32.65	32.29	33.39	32.27	33.66	32.59	28.53	29.23
	% Improved	9.80%	7.90%	-2.10%	-6.10%	20.50%	12.30%	15.10%	13.30%
Travel Time	Before Runs	9.37	9.71	8.01	8.33	9.81	9.94	10.97	11.1
(mins)	After Runs	8.43	8.93	8.22	8.95	8.11	8.8	9.57	9.78
	% Improved	10.00%	8.10%	-2.60%	-7.50%	17.40%	11.40%	12.80%	11.80%
Pleasant Hill Road - Steve Reynolds Bypass									
		24-Hour		AM Peak		MD Peak		PM Peak	
		NB	SB	NB	SB	NB	SB	NB	SB
Average Speed	Before Runs	27.86	28.93	31.53	32.67	26.6	25.99	25.29	24.9
(mph)	After Runs	29.86	31.07	29.92	30.79	27.33	31.68	28.24	29.17
	% Improved	7.20%	7.40%	-5.10%	-5.80%	2.70%	21.90%	11.70%	17.10%
Travel Time	Before Runs	6.37	6.61	5.61	5.78	6.54	7.2	6.95	7.54
(mins)	After Runs	5.86	6.07	5.84	6.21	6.38	5.92	6.18	6.43
	% Improved	8.10%	8.10%	-4.00%	-7.50%	2.40%	17.70%	11.10%	14.70%

6. Effectiveness Study

The previous section discussed how the TR system responded to the fluctuations in travel demand. To quantify the benefits, travel time data provided by RITIS (Regional Integrated Transportation Information System) along two different routes for typical weekdays was analyzed. The two routes primary routes in the area are Pleasant Hill Road and Pleasant Hill Road/Steve Reynolds Boulevard/Club Drive (Pleasant Hill-Steve Reynolds Bypass). The time period chosen for analysis was November 14, 2017 to December 5, 2017 (before) and November 14, 2018 to December 5, 2018 (after). Note that November 13, 2018 was the day the TR system was turned live and that Thanksgiving weekend was analyzed separately in Section 5.2.

6.1 Typical Weekday

Travel time and speed were collected for Pleasant Hill Road from RITIS. Table 20 indicates Pleasant Hill Road experienced improved travel time and average speeds throughout the day with TR operations compared with time of day operations. Improvements to average speed range from 3.0% during the AM peak in the northbound direction to 22.7% during the midday peak in the northbound direction. The greatest improvements are experienced during the midday and PM peaks.

Table 20 also indicates that the Pleasant Hill Road – Steve Reynolds Boulevard Bypass experienced improved travel time and average speeds throughout the day with TR operations compared with time of day operations. Improvements to average speeds ranged from 4.6% during the AM peak in the northbound direction to 13.5% during the AM peak in the southbound direction with the greatest improvement experienced during Midday.

Table 20: Before and After Speed and Travel Time Comparisons for Typical Weekday

Pleasant Hill Road									
		24-Hour		AM Peak		MD Peak		PM Peak	
		NB	SB	NB	SB	NB	SB	NB	SB
Average Speed	Before	27.68	27.60	24.22	28.06	23.79	27.72	23.52	17.43
(mph)	After	29.43	28.96	24.94	29.87	29.18	29.40	25.63	19.33
	% Improved	6.3%	4.9%	3.0%	6.4%	22.7%	6.1%	9.0%	10.9%
Travel Time	Before	10.21	11.32	11.58	10.21	11.70	10.30	11.69	18.80
(mins)	After	9.50	10.39	11.53	9.58	9.34	9.69	10.63	15.40
	% Improved	6.9%	8.2%	0.5%	6.2%	20.2%	5.8%	9.1%	18.1%
Pleasant Hill Road – Steve Reynolds Boulevard Bypass									
		24-Hour		AM Peak		MD Peak		PM Peak	
		NB	SB	NB	SB	NB	SB	NB	SB
Average Speed	**Before**	**26.65**	**27.08**	**25.20**	**25.77**	**25.14**	**26.03**	**24.22**	**19.59**
(mph)	**After**	**28.30**	**28.59**	**26.36**	**29.25**	**27.38**	**28.68**	**26.01**	**21.29**
	% Improved	**6.2%**	**5.6%**	**4.6%**	**13.5%**	**8.9%**	**10.2%**	**7.4%**	**8.7%**
Travel Time	**Before**	**6.61**	**7.21**	**6.95**	**7.29**	**6.91**	**7.18**	**7.18**	**9.99**
(mins)	**After**	**6.19**	**6.73**	**6.68**	**6.42**	**6.34**	**6.51**	**6.69**	**8.92**
	% Improved	**6.4%**	**6.7%**	**3.9%**	**12.0%**	**8.3%**	**9.4%**	**6.9%**	**10.7%**

7. Conclusions

Jacobs completed a full system retiming for the Gwinnett Place Mall system in September of 2017. Therefore, the data comparisons from November 14 to December 5 of 2017 and 2018 are attributed to the efficiencies of the traffic responsive system. The Gwinnett Place Mall system experiences daily fluctuations in traffic volumes along Pleasant Hill Road, a popular alternate route option for I-85. It also experiences volume variation on weekends due to traffic generated by Gwinnett Place Mall and the surrounding retail establishments. Because of these dynamic traffic volumes, the system operates better with TR than with static time of day operations. The system was observed to react to these changes in traffic demand and called up patterns appropriate for the traffic conditions.

The data collected from RITIS also indicates that the reactions by the system on traffic volumes translated into improvements in travel times and average speeds in the area.