I-77 Interchange Improvements at Gilead Road

Mecklenburg County

STIP Project No. I-5714

WBS No. 50127.1.FS1

Traffic Operations Analysis Technical Memorandum

Prepared For:
North Carolina Department of Transportation

Prepared By:
Patriot Transportation Engineering, PLLC

June 2016

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Transportation Mobility and Safety Unit

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The North Carolina Department of Transportation (NCDOT) proposes to construct State Transportation Improvement Program (STIP) Project Number I-5714 (I-77 at Gilead Road interchange) The proposed improvements include converting the existing diamond interchange to a diverging diamond interchange (DDI).

The Purpose Statement for the project is to reduce delay and congestion at the interchange by reconfiguring the interchange. One of the primary goals of the analysis was to improve the interchanges such that, in the 2040 design year, traffic did not back up onto I-77 and cause delays to the freeway traffic. The objective of this technical memorandum is to analyze the traffic operations for the proposed conversion of the existing diamond interchange to a DDI. The study includes the analysis of the 2015 existing scenario and 2040 scenarios for both the No-Build and Build conditions. The analysis utilizes microscopic simulation of each of the scenarios in TransModeler, including the development of a visually validated base year model that was developed from a larger calibrated model of the I-77 Corridor.

Currently, I-77 carries between 94,600 vehicles per day (vpd) and 99,700 vpd with the volumes along Gilead Road ranging from 33,100 to 38,600 vpd and the volumes along US 21 parallel to I-77 ranging from 17,900 to 21,400. By 2040, the volume on I-77 (including the Express Lanes) is anticipated to carry between 124,500 and 134,700 vpd, while Gilead Road is anticipated to increase to between 45,900 and 52,300 vpd and US 21 is anticipated to increase to between 50,000 and 61,800 vpd.

2015 Base Year No-Build Scenario

The analysis of the existing conditions within the study area shows that the traffic is generally operating at an unsatisfactory level, with 9 of 10 freeway segments operating at LOS_S[1] E or F during either the AM or PM peak period. At the overall intersection level both of the signalized intersections associated with the I-77 interchange are operating at LOS_S D or better; however, at the lane group[2] level six individual lane groups have movements that operate at LOS_S E or F during one or both the peak periods. The adjacent intersection of Gilead Road and US 21 is currently operating at an overall intersection LOS_S F during the AM peak and LOS_S E during the PM Peak. Additionally, an evaluation of the queue lengths[3] along the ramps showed that during the AM peak period the I-77 Southbound ramp is backing up onto I-77 and affecting through traffic along I-77.

2040 Future Year No-Build Scenario

The 2040 No-Build analysis shows what the traffic operations in the study area are anticipated to be if all of the planned projects within the study area, with the exception of the proposed project, are constructed. Without the proposed project, it is anticipated that I-77 will operate at LOS_S E or F at 9 of 10 segments during at least one of the peak periods. The analysis of the signalized intersections shows that it is anticipated that one of the two signals associated with the Gilead Road interchange will operate at an overall LOS_S E during one of the peak periods. The analysis of the signalized intersections at the lane group level shows that seven lane groups are anticipated to operate at LOS_S E or F in 2040 under the no-build scenario. Additionally, an analysis of the queue lengths found that the I-77 Northbound ramp is anticipated to have queue lengths that exceed its length during the both the AM and PM peak periods and will result in queuing on I-77.

2040 Future Year Build Scenario – Alternative 1

The proposed improvements included in Build Alternative 1 are described as follows:

- Convert existing interchange to DDI with 3 lanes in each direction along Gilead Road through the interchange
- Add 240-foot northbound turn lane on Reese Boulevard and changed the lane markings to include an exclusive left lane, through lane, and dual right turn lanes

[1] LOS_S denotes simulation based Level of Service that is consistent with the methodologies included in the Highway Capacity Manual, 2010 Edition

[2] A lane group is generally defined as a set of lanes that operate at the same time during the signal phase and may be either exclusive movements (such as a left or right turn) or shared movements from a single lane (shared through and right turn lane).

[3] Queue lengths are the distance traffic backs up along a roadway at an intersection or bottleneck.

The 2040 Build analysis for Alternative 1 shows what the traffic operations in the study area are anticipated to be if Alternative 1 is constructed. With Alternative 1 constructed, it is anticipated that I-77 will operate at LOS_S E or F at 8 of 10 segments during at least one of the peak periods. The analysis of the signalized intersections shows that all of the intersection movements associated with the DDI ramp terminals, at a lane group level, will operate at an overall LOS_S C or better. Additionally, an analysis of the queue lengths found that none of the ramps are anticipated to have queue lengths that exceed their length; therefore, no traffic is anticipated to back up onto I-77.

2040 Future Year Build Scenario – Alternative 2

The proposed improvements included in Build Alternative are described as follows:

- Convert existing interchange to DDI with 3 lanes in the westbound direction and 2 lanes in the eastbound direction along Gilead Road through the interchange
- Add 240-foot northbound turn lane on Reese Boulevard and changed the lane markings to include an exclusive left lane, through lane, and dual right turn lanes

The 2040 Build analysis for Alternative 2 shows what the traffic operations in the study area are anticipated to be if Alternative 2 is constructed. With Alternative 2 constructed, it is anticipated that I-77 will operate at LOS_S E or F at 8 of 10 segments during at least one of the peak periods. The analysis of the signalized intersections shows that all of the intersection movements associated with the DDI ramp terminals, at a lane group level, will operate at an overall LOS_S C or better. Additionally, an analysis of the queue lengths found that none of the ramps are anticipated to have queue lengths that exceed their length; therefore, no traffic is anticipated to back up onto I-77.

Conclusions and Recommendation

Based on the results of the analysis it is recommended that Build Alternative 1 be constructed for STIP Project Number I-5714 as it provides the best operations within the study area. Overall, both of the Build Alternatives operate about the same for the I-77 Corridor with LOS_S F in the southbound direction during the AM peak and LOS_S F in the northbound direction during the PM peak. The I-77/Gilead Road interchange operates slightly better for Alternative 1 with the additional eastbound lane allowing for improved operations for eastbound traffic along Gilead Road and to I-77 Northbound. The primary benefit of Alternative 1 is that it allows for substantially lower queue lengths to the west of the I-77 ramp terminal, allowing for substantially improved operations for Reese Boulevard. For Alternative 2, the eastbound queues at the I-77 Southbound ramp terminal extend all the way back to Reese Boulevard and do not allow all of the traffic turning from Reese Boulevard to access Gilead Road due to the queuing. The overall delay at the Gilead Road/Reese Boulevard intersection is decreased by over 20 seconds for Alternative 1 with several individual lane groups having over a 100-second improvement in delay.

The traffic operations analysis showed that the DDI would work well for the 2040 traffic; however, the operations are closely tied to the operations of the US 21/Gilead Road intersection. In order for the 2040 analysis to operate acceptably the median u-turn configuration along US 21 was used to meter traffic into the interchange area. The segment of Gilead Road westbound between US 21 and I-77 was found to be the critical link in the operations of the interchange and the operations were optimized when the signal was coordinated such that the US 21 Southbound movement to Gilead Road was coordinated with the westbound movement along Gilead Road through the DDI. For the interchange to operate efficiently, the coordination should advance from US 21 SB to Gilead Road Westbound and the US 21 u-turn signals should be timed such that they do not allow the US 21/Gilead Road intersection to be overloaded.

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1. PROJECT BACKGROUND

Patriot Transportation Engineering, PLLC (Patriot), has been contracted by the North Carolina Department of Transportation (NCDOT) to develop the traffic operations for NCDOT State Transportation Improvement Program (STIP) Project Number I-5714; I-77 at Gilead Road Interchange Improvements in Mecklenburg County.

1.1 PURPOSE OF TECHNICAL MEMORANDUM

The purpose of this technical memorandum is to analyze the traffic operations for the proposed conversion of the existing diamond interchange to a diverging diamond interchange. The study includes the analysis of the 2015 and 2040 Scenarios for the No-Build and two 2040 Build scenarios. The analysis utilizes microscopic simulation of each of the scenarios in TransModeler (Version 4, Build 6070), including the development of a visually validated base year model that is based on a larger calibrated model of the I-77 corridor.

1.2 PROJECT DESCRIPTION

Interstate 77 is a four-lane divided facility with a 160-foot grass median within the project study area. The Project Study Area, shown in Figure 1-1, includes Exit 23, a diamond interchange at Gilead Road with ramps in all four quadrants. Along Gilead Road the analysis also includes the following intersections: Reese Boulevard (signalized), I-77 SB ramp terminal (signalized), I-77 NB ramp terminal (signalized) and US 21 (Statesville Road) (signalized).

The analysis of the proposed project includes the evaluation of two design alternatives for converting the diamond interchange into a diverging diamond interchange in an effort to improve traffic operations.

STIP Project No. I-5714 **I-77 Interchange Improvements** **Mecklenburg County**	**Figure 1-1**	**Project Study Area**	PATRIOT TRANSPORTATION ENGINEERING, PLLC Prepared By: **Patriot Transportation Engineering, PLLC** 3008 Anderson Drive, Suite 120 Raleigh, North Carolina 27609 (919)977-9125

2. DESCRIPTION OF SCENARIOS ANALYZED

The scenarios that require analysis as a part of this study include analysis of both existing and future conditions, both with and without the project. The following scenarios were evaluated in the microscopic simulation of the traffic operations.

2.1 2015 BASE YEAR NO-BUILD CONDITIONS

The Base Year No-Build analysis is based on the current traffic volumes and existing configuration of the transportation network within the project study area. This analysis provides a baseline for comparison against future scenarios. The 2015 Base Year No-Build Model includes visual validation, which is the process of comparing the overall model-predicted traffic performance against field observations of traffic performance, and modifying parameters to better emulate the observed conditions. The objective of visual validation is to obtain a reasonable match between model performance estimates and the field observations during the base year period and then utilize the parameters developed in the validated model to evaluate alternative scenarios including future years and/or design variations.

2.2 2040 FUTURE YEAR NO-BUILD AND BUILD SCENARIOS

These scenarios evaluated what the traffic operations will be in the vicinity of the proposed project in the design year 2040 if the proposed project is or is not constructed. The 2040 scenarios assume that all improvements included in the Charlotte Regional Transportation Planning Organizations (CRTPO) *Metropolitan Transportation Plan* (2040 MTP), adopted April 16, 2014, are completed. There are four projects from the 2040 MTP located within the study area:

- US 21 (Statesville Road) Widening from Gilead Road to Holly Point Drive
- US 21 (Statesville Road) Widening from WT Harris Boulevard to Gilead Road
- I-77 Managed Lanes from I-277 to West Catawba Avenue (STIP I-5405)
- US 21/Gilead Road Intersection Improvements (STIP U-5114)

3. METHODOLOGY

The use of microscopic simulation was completed using TransModeler software (version 4.0 Build 6070), due to the complexity of the project and the integration of freeway and arterial networks. TransModeler is a microscopic, behavior-based multi-purpose traffic simulation program that has emerged as one of the leading simulation software programs. For many engineering disciplines, simulation has become an indispensable instrument for the optimization of complex technical systems. This is also true for transportation planning and traffic engineering, where simulation is an invaluable and cost-reducing tool. The microscopic simulation model was developed for the build and no-build alternatives for the project and was based on a validated base model for the area.

The methodology for microscopic simulation begins with a base model developed from data collected for the transportation network. The base model is then validated against the observations made in the field to arrive at a validated base model. Once the base model is validated, the future year build alternatives can be developed and their results compared. For this study, a larger model of the I-77 Corridor from south of I-485 to north of Catawba Avenue was developed and is documented in the *Traffic Operations Analysis Technical Memorandum for STIP Project I-5715* (Patriot Transportation Engineering and Kimley-Horn and Associates, 2016). The larger model was calibrated based on actual traffic and speed data collected in November 2014. The analysis for the subject project included clipping the portion of the model for the project study area out of the corridor model and utilizing all of the parameters from the calibrated model.

4. MEASURES OF EFFECTIVENESS

Measures of Effectiveness (MOE) are system performance statistics that best characterize the degree to which a particular alternative meets the project objectives. The MOEs for microscopic simulation can be abundant due to the nature of the type of analysis. On an overall network level, MOEs such as vehicle hours traveled (VHT), vehicle miles traveled (VMT), average system speed, average system delay, and number of stops can provide overall indications of the operations of a network. The primary MOEs for freeway facilities are typically average speed, density and Level of Service for individual segments within the network. For arterial corridors, the primary MOEs are control delay, Level of Service and queue lengths.

The selection of MOEs for the evaluation is critical, especially as the *FHWA Traffic Analysis Toolbox* cautions against the use of LOS in comparing simulation results to the HCM derived results. It notes that the analyst needs to review the software documentation to understand the differences and to be sure that the microsimulation software is calculating LOS properly. Based on a review of the TransModeler documentation and discussions with Caliper, the software developer, the project team feels comfortable that the software appropriately presents the LOS results in a manner that is consistent with the HCM 2010 methodologies. However, to be clear that there is a difference between the empirically derived HCM methodologies and those derived through simulation, the use of the "LOS_S" is being utilized to denote that the LOS is a simulation based LOS result.

Several additional considerations must be evaluated when determining how to interpret simulation based MOEs. According to the *FHWA Traffic Analysis Toolbox*, the analyst needs to determine if the alternatives should be evaluated based on their average predicted performance or their worst case predicted performance. Typically, the worst case predicted performance is determined based on a calculation of the 95th percentile result. Additionally, the HCM 2010 methodologies are based on an analysis of the peak hour of the day, with a further adjustment to the peak 15-minute period within the peak hour for the analysis. Following discussions with the project team it was determined that the most appropriate application for LOS_S would include extracting the data in one-hour increments and applying the following formula (taken from Section 6.3.3 of the *FHWA Traffic Analysis Toolbox, Volume III*) to determine the 95th percentile worst result:

$$95\%\text{Worst Result} = m + 1.64 \bullet s$$

where:

m = mean observed result in the model runs

s = standard deviation of the result in the model runs

Additionally, the microscopic simulation models were developed to account for both the horizontal and vertical geometry of the design. TransModeler accounts for the vertical geometry through the use of a grade on each roadway; therefore, it was necessary to break the links into segments where there is a change in grade. Due to the breaks in a link, it is possible that a series of segments will make up the limits of a link that will be analyzed as a single analysis point in HCM. For example, a basic freeway segment that is three-miles long and has a two-mile downgrade at 5 percent followed by a one-mile upgrade of 3 percent, will actually be broken into two segment in the simulation but would be analyzed as a single segment in the deterministic HCM approach. Therefore, the LOS calculations for freeway segments (basic freeway segments and freeway weaving) will be based on the aggregation of the individual segments, utilizing a weighted average of the results based on length.

Additionally, the Highway Capacity Manual 2010 does not include a definitive density threshold for LOS F along isolated freeway merge/diverge segments and weaving segments, and simply includes the conclusion that LOS F occurs when demand exceeds capacity. Because simulation models do not include capacity as an input, the determination of LOS is very difficult. TransModeler does include a complex calculation that will determine the LOS for each individual simulation run. However, because part of the methodology is to use the 95th percentile worst case

result, the ability to determine this for aggregated data for multiple simulation runs is not possible. Therefore, it was decided that the LOS F threshold would be set at 45 pc/mi/ln, which corresponds to the LOS threshold for Freeway Facilities as described on Page 10-9 of the HCM 2010.

The default parameters in TransModeler do have one condition that is not fully compatible with the HCM 2010 methodology. TransModeler defines the Vehicle Fleet Attributes for Passenger Car Equivalents (PCE) in a different manner than the HCM 2010. Therefore, prior to running any output the >Parameters>Vehicle Fleet>Attributes were changed to 1.0 for the PU class and 2.5 for the TT and ST classes, consistent with the HCM methodology for rolling terrain.

For this analysis it was determined that the use of segment level MOEs for the freeway elements, such as density and level of service, would be used as the primary method of comparison for alternatives. For the arterial portions of the study area, the control delay and level of service at each intersection is the primary MOE. The queue lengths also played a substantial role in the evaluation as the goal was to improve the operations such that traffic will not queue onto the mainline portions of I-77.

In TransModeler there are two types of queue MOEs: 95th percentile queue lengths for each lane group and spillback queue lengths for each intersection approach. The lane group level queue lengths are limited to the length of the link in TransModeler and any exceedance of the link length is noted by what percentage of the simulation period includes the queue exceeding the link length. Due to this limitation, the second queue length measure is the spillback queue length that reports the maximum queue length along each approach to the intersection and follows the queue back as far as it reaches. Therefore, the queue length MOE includes both the link level 95th percentile queue for each lane group and the maximum spillback queue length for each approach to the intersection.

The following MOEs were developed for each scenario being analyzed:

- Freeway MOEs
    - Freeway LOS by Analysis Segment
- Intersection MOEs
    - Delay and LOS by Intersection for signalized intersections
    - Delay and LOS by Lane Group for signalized and stop-controlled intersections
    - 95th percentile Queue Length by Lane Group for all intersections
    - Maximum Spillback Queue by Approach for all intersections

5. TRAFFIC VOLUME DEVELOPMENT

Traffic demand is one of the most important elements of a simulation project. Defining traffic demand in TransModeler includes not only the volumes of vehicle trips to be simulated, but also the paths vehicles choose to travel to reach their assigned destination. Traffic demand can be specified through a variety of methods, such as defining link volumes and turning movements, origin-destination trip tables, or a specific set of vehicle paths.

The primary source of volume data for this study was the *Traffic Forecast for I-5714/I-5715* (NCDOT, April 2015). A copy of the traffic forecast diagrams are included in Appendix A.

5.1 ORIGIN-DESTINATION MATRIX DEVELOPMENT

For a network of this size and the level of detail for the design options, it was determined that utilizing an Origin-Destination (O-D) matrix would be the best method to define how the actual volumes are loaded onto the network. Trip matrices have two components. The first component is an O-D matrix that lists the number of trips between each O-D pair. The second component is a set of Trip Matrix Settings which govern the specifics of how each of the trips between each O-D pair should be simulated. The trip matrix settings are saved as part of the standard matrix file. Both components are necessary in order to use a Trip Matrix as a simulation input.

The TransModeler model is capable of using unbalanced input volumes and using its own algorithms to balance the network; however, using this method of traffic volume input can produce inaccuracies in actual processed volumes at particular locations. To accurately model the network in TransModeler, the input volumes were developed into a balanced network. The traffic forecast for the proposed project is based on Average Annual Daily Traffic (AADT) with Directional Split (D) and Design Hourly Volume factor (K). The forecast volumes are balanced with regard to AADT; however, the K factor varied throughout the analysis. The traffic forecast was first converted to peak hour volumes for each of the intersections/interchanges included in the analysis. A spreadsheet based Origin-Destination Matrix Estimation (ODME) process was utilized to initially balance the network and develop a balanced O-D matrix. The O-D matrix was then reviewed based on the trip patterns from the calibrated 2014 network and modified manually to better represent the calibrated travel patterns. Vehicle fleet data was defined at the entry node level for the model as there was not a substantial variation in the truck percentages for the modeled roadways.

At the completion of the O-D matrix development process, the demand volumes for the AM and PM peaks were established. However, the matrices only included the total number of trips occurring between each O-D pair and were not broken down by vehicle type. TransModeler defines the percentage of vehicle types as each trip is generated at an origin based on a distribution provided in the model. Vehicle fleet data was defined at the entry node level for the model as there was not a substantial variation in the truck percentages for the modeled roadways. The initial IAU output and each of the matrices, by vehicle class, are included in Appendix B.

5.2 ORIGIN-DESTINATION MATRIX SETTINGS

A variety of other parameters describe how trips are to be generated from the matrix. These settings are defined in the trip matrix settings. The trip matrix settings include four groups of information: setup, contents, paths and curves. The setup defines all parameters that apply to the entire matrix. The contents determine the parameters for all cores in a matrix file. Additionally, the analyst can constrain the paths available to trips generated from the matrix and the rules drivers follow to choose between alternative paths. Lastly, the curves settings tab defines the loading distribution over time for traffic entering the model network.

The Trip Matrix Setup includes the basic parameters describing the O-D matrix, including the time period of the day to which the O-D matrix applies and the temporal spacing of vehicles. The model was set to have time intervals that run from 7:45 AM to 9:00 AM for the AM peak and 4:45 PM to 6:00 PM for the PM peak. The matrices were also set

up to generate departure headways by O-D and to have a random (uniform) departure headway distribution. The matrices included the matrix unit being set to an hourly rate and the time distribution being curve based.

The matrix curves used to feed traffic onto the model are based on the NCDOT defaults that create a peak hour demand with a Peak Hour Factor of 0.90. The matrix loading curves are included in Table 5-1.

Table 5-1: Curve Based Time Distribution

AM Peak Period	PM Peak Period	Percentage
8:00-8:15	**17:00-17:15**	22.2%
8:15-8:30	**17:15-17:30**	25.0%
8:30-8:45	**17:30:17-45**	27.8%
8:45-9:00	**17:45-18:00**	25.0%

5.3 VEHICLE ROUTING

One of the more important tasks of a traffic simulation model is to ensure that the paths that vehicles follow through the network reflect those that drivers actually choose and that the distribution of vehicles, both in spacing throughout the network and over time throughout the simulation period, result in realistic congestion patterns. The Routing settings are project settings that are used as inputs to the route choice model. In TransModeler, a path is selected for each individual vehicle. Because of varying perceptions and behaviors, drivers traveling between the same origin-destination pair likely may not always follow the same path. Furthermore, drivers do not necessarily choose the minimum cost path. Route choice is one of the most complex of driver behaviors and one of the most critical in traffic modeling.

The route choice setting for this model was set to stochastic shortest path and included the use of turning delays. The stochastic shortest path method is similar to the deterministic shortest path in that all vehicles choose a shortest path. Path costs are randomized, however, for each individual vehicle to account for variations in perception and behavior. Thus, if multiple physical paths exist, there is not one, but multiple potential shortest paths between a given origin-destination pair.

The shortest path can be determined in one of two ways: (1) based on the free flow speed of the facilities between the origin-destination points or (2) through the use of historical travel times. The historical travel time table is a table of segment travel times by time period representing historical, or expected, average travel conditions. TransModeler employs a route choice model to determine, prior to departure, the path each vehicle will follow from its origin to its destination. That choice is primarily a function of each path's total generalized cost, which, in turn, is primarily based on historical travel time information. If no historical travel time table is given, path costs will be based on calculated free-flow travel times, which are derived from free flow speeds associated with each link's road class. The models for this study did not include the use of the TransModeler features for both historic travel times along each link and the turning delay at each node that is generated through the dynamic traffic assignment process as there were very limited alternative routes available within the simulation network.

6. 2015 BASE YEAR NO-BUILD ANALYSIS

6.1 MODEL GEOMETRY

The basis for developing the geometric data was aerial photography and contour data. Aerial photography from NCOneMap (Mecklenburg County, 2015 imagery; http://nconemap.org/) was used as a background to digitize the network into the simulation model. The three-dimensional attributes and grades were determined based on contour data from the NCDOT GIS Unit (Elevation Data at 20-foot Grid, Mecklenburg County; https://connect.ncdot.gov/resources/gis/pages/cont-elev_v2.aspx).

The limits of the model network, shown in Figure 1-1, include I-77 from south of the Gilead Road interchange (Exit 23) to north of the interchange. The model limits were selected such that they would allow for the full effects of the freeway operations to be captured and to better evaluate the project study area as part of the overall transportation system.

The geometry of the Build network is based on the build design included in the SPOT 3.0 analysis and preliminary concepts discussed with NCDOT and the design team during scoping. It is assumed that the gore locations along I-77 will not be modified under the proposed project; thus, an Interchange Access Report will not be required.

6.2 MODEL PARAMETERS

Every microscopic simulation package has its own unique methodology for coding the model. Most models include a default set of parameters that define how the model operates and is based on data taken from locations outside of North Carolina. The initial model development included the use of the NCDOT default parameters file for TransModeler (dated August 2015). The process of visual validation reviews and refines these model parameters to better replicate the conditions observed in the field; however, the base model must be developed first. The following sections discuss the model development process in TransModeler prior to the visual validation step.

6.3 INTERSECTIONS

Traffic control devices of varying designs and purposes are used in transportation systems to manage rights of way, guide traffic, and mitigate congestion. These devices vary widely from the common stop sign to changeable message signs conveying dynamic traveler information. TransModeler simulates a broad range of devices as well as the behavioral responses of drivers to those devices. Some of the more common types of traffic control devices are those used for intersection control, where conflicting traffic streams must share the same rights of way. The intersection control editing tools in TransModeler are used to create stop signs, yield signs, and traffic signals.

The geometric layouts for the signalized intersections were coded in the network according to the signal design plans collected for this study and included in Appendix C. For each signal, the signal detectors were coded based on the signal plans. The signal phases and attributes (including minimum/maximum green times, yellow and red clearance times, recall mode, and actuated signal parameters) were then coded based on the respective signal plan's Timing Chart. Next, the Ring and Barrier Table was coded in TransModeler based on the Phasing Diagram shown on the signal control plan.

6.3.1 SIGNAL OPTIMIZATION

The signals along the Gilead Road corridor were optimized utilizing the simulation based signal optimization feature in TransModeler. The signals were optimized for the final 50 minutes of the peak hour with a five-minute warmup period. Each corridor was optimized in 10 second increments with a minimum cycle length of 90 seconds and a maximum cycle length of 180 seconds. The default Performance Index MOE Weights were maintained as were the settings for Offset optimization. Once the optimized signal timings were developed the simulation was run and the timings were fine-tuned by the analyst on an as-needed basis.

6.4 VOLUME DATA AND VEHICLE ROUTING

Traffic demand and vehicle routing inputs were defined in the model as described in Section 5. The O-D matrices for the 2015 Base Year analysis are included in Appendix B.

6.5 OUTPUTS AND MEASURES OF EFFECTIVENESS

After running a simulation, the next step is to use the output statistics in order to analyze traffic conditions in the network. A variety of measures of effectiveness can be derived from these raw outputs in order to characterize the traffic operations in a network or in particular parts of a network. Such measures of performance may also be used to judge the performance of a particular traffic control scenario or geometric design. The development of selection sets in TransModeler was completed, including defining the nodes for delay and queue output and links for the spillback queue analysis. For the purposes of the 2015 Base Year Model, the MOEs detailed in Section 4 were extracted from the model and summarized in Section 6.8.

6.6 SIMULATION AND RUN CONTROLS

All simulation software contains run control parameters to enable the modeler to customize the software operation for their specific modeling needs. Multiple repetitions of the same model are required because microscopic simulation results will vary depending on the random number seed used in each run. The random number seed is an input that TransModeler uses to select a sequence of random numbers, which are utilized in the model to make numerous decisions throughout the simulation run. The outcomes of all of these decisions will affect the simulation results. The results of each run are usually close to the average of all of the runs; however, each run will be different from the other.

The number of repetitions required for the base model is typically based on a statistical evaluation of the results based on a desired range and confidence interval. However, experience on simulation projects in North Carolina has found that ten repetitions tends to be adequate for project level analysis. Therefore, a total of ten runs was completed initially and then reviewed to determine if the standard deviation for the output data is large enough that detailed statistical analysis is required. Based on a review of the output data it was determined that ten simulation runs would be adequate for this project. Therefore, each model was assigned a random seed between 5 and 50 in increments of 5.

When a simulation model is run, it begins with an empty network and begins loading the traffic onto the network. Due to this, the model requires a certain amount of time to reach a steady state of traffic such that the output generated is meaningful. For the base year model a 15-minute warm-up period (with the peak hour volume reduced by 25 percent) was included to allow the model to load traffic onto the network prior to any outputs being generated.

6.7 BASE YEAR MODEL VISUAL VALIDATION

The study area for this project is included in the study area for the I-77/NC 73 (Sam Fur Rd) Interchange (STIP Project I-5715). The I-5715 project team is currently working on a simulation study that included developing a calibrated base year model in TransModeler. The I-5714 model was created from the I-77 corridor model, which was calibrated based on collected field data. (For details on the calibration process, refer to the *Traffic Operations Analysis Technical Memorandum for STIP Project I-5715* (Patriot Transportation Engineering and Kimley-Horn and Associates, 2016.) As stated, the calibrated model was developed based on field collected data; however, the base year analysis for this study was developed based on the 2015 existing volumes from the traffic forecast. Once the 2015 forecast volumes were added to the model the simulation was reviewed and it was determined that the base year model was still visually valid.

6.8 2015 BASE YEAR NO-BUILD MODEL RESULTS

The output data was extracted from the TransModeler model via the Output Manager using the Delay, Queue and Queue Spillback reports. The outputs were collected in accordance with the MOEs defined in Section 4 and are summarized in the following sections.

6.8.1 FREEWAY RESULTS

The results of the freeway analysis are included in Table 6-1 and Figure 6-1. During the AM peak period 4 of the 10 analysis segment on I-77 are operating at LOS_S D, 2 of 10 analysis segments are operating at LOS_S E and 4 of 10 analysis segments is operating at LOS_S F. During the PM peak period 6 of the 10 analysis segment is operating at LOS_S D, 2 of the 10 analysis segment are operating at LOS_S E, and 2 of 10 analysis segments are operating at LOS_S F. Based on the results the following freeway segments are currently operating at LOS_S E or F under the 2015 No-Build Scenario:

- I-77 Northbound, south of Gilead Road is operating at LOS_S E during the PM Peak
- I-77 Northbound, diverge to Gilead Road is operating at LOS_S F during the PM Peak
- I-77 Northbound, between the Gilead Road ramps is operating at LOS_S E during the AM Peak and LOS_S F during the PM Peak
- I-77 Northbound, merge from Gilead Road is operating at LOS_S E during the PM Peak
- I-77 Southbound, north of Gilead Road is operating at LOS_S F during the AM Peak
- I-77 Southbound, diverge to Gilead Road is operating at LOS_S F during the AM Peak
- I-77 Southbound, between the Gilead Road ramps is operating at LOS_S F during the AM Peak
- I-77 Southbound, merge from Gilead Road is operating at LOS_S F during the AM Peak
- I-77 Southbound, south of Gilead Road is operating at LOS_S E during the AM Peak

Table 6-1: 2015 Base Year No-Build Freeway Measures of Effectiveness

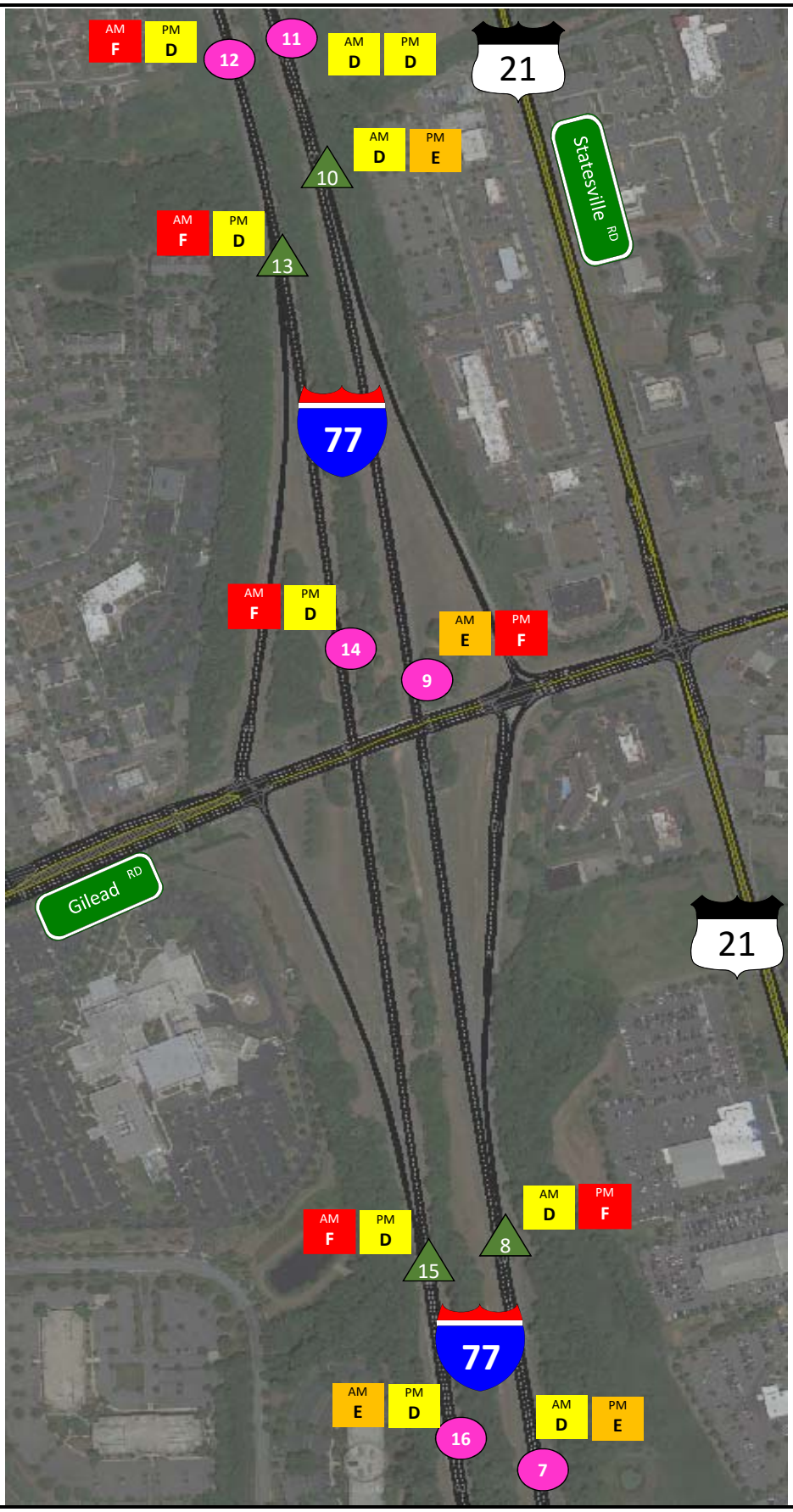
Segment No.	Type	Description	Density		Level of Service[1]	
			AM	PM	AM	PM
7	BFS	I-77 Northbound, south of Gilead Road	28.9	42.5	D	E
8	Diverge	I-77 Northbound to Gilead Road	30.6	46.1	D	F
9	BFS	I-77 Northbound, between Gilead Road Ramps	35.4	51.5	E	F
10	Merge	I-77 Northbound from Gilead Road	31.5	36.4	D	E
11	BFS	I-77 Northbound, north of Gilead Road	29.6	32.8	D	D
12	BFS	I-77 Southbound, north of Gilead Road	58.3	28.0	F	D
13	Diverge	I-77 Southbound to Gilead Road	65.7	34.6	F	D
14	BFS	I-77 Southbound, between Gilead Road Ramps	75.5	27.6	F	D
15	Merge	I-77 Southbound, from Gilead Rd	56.9	29.2	F	D
16	BFS	I-77 Southbound, south of Gilead Road	38.4	32.3	E	D

Notes:

1 Level of Service shown is Simulation based and calculated in a manner that is consistent with the HCM 2010 Methodologies

6.8.2 ARTERIAL/INTERSECTION RESULTS

The results of the intersection analysis along the arterial portions of the study area are included in Table 6-2 and Figure 6-2. The overall intersection LOS_S for all signalized intersections in the 2015 Base Year No-Build scenario shows that 2 of the 4 signals are operating at LOS_S D or better. During the AM peak period 3 of 4 intersections are operating at LOS_S C and 1 of 4 intersections is operating at LOS_S F. During the PM peak period 1 of 4 intersections is operating at LOS_S C, 1 of 4 intersections is operating at LOS_S D and 2 of 4 intersections are operating at LOS_S E.



N

Basic Freeway Segments

Freeway Merge and Diverge

Level of Service	
	LOS_S A/LOS B
	LOS_S C
	LOS_S D
	LOS_S E
	LOS_S F

STIP Project No. I-5714
I-77 Interchange Improvements
Mecklenburg County

Figure 6-1

2015 Base Year No-Build Freeway Measures of Effectivenes

PATRIOT TRANSPORTATION ENGINEERING, PLLC

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Based on a review of the intersection operations at the lane group level, the following movements operate at LOS_S E or F in the 2015 Base Year No-Build scenario:

- Gilead Road at Reese Boulevard, southbound left operates at LOS_S E during the AM Peak and LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, southbound through/right operates at LOS_S E during the AM Peak and LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, westbound left operates at LOS_S E during the AM and PM Peaks
- Gilead Road at Reese Boulevard, northbound left operates at LOS_S E during the AM Peak
- Gilead Road at Reese Boulevard, northbound through/right operates at LOS_S E during the PM Peak
- Gilead Road at Reese Boulevard, eastbound left operates at LOS_S E during the AM Peak and LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, eastbound through operates at LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, eastbound through/right operates at LOS_S F during the PM Peak
- Gilead Road at I-77 southbound ramps, southbound left/through operates at LOS_S F during the AM and PM Peaks
- Gilead Road at I-77 southbound ramps, westbound left operates at LOS_S F during the AM and PM Peaks
- Gilead Road at I-77 southbound ramps, eastbound through operates at LOS_S F during the PM Peak
- Gilead Road at I-77 northbound ramps, northbound left operates at LOS_S E during the AM Peak
- Gilead Road at I-77 northbound ramps, northbound right operates at LOS_S E during the AM Peak
- Gilead Road at I-77 northbound ramps, eastbound left operates at LOS_S F during the AM and PM Peaks
- Gilead Road at US 21, southbound left operates at LOS_S F during the AM Peak and LOS_S E during the PM Peak
- Gilead Road at US 21, southbound through operates at LOS_S F during the AM Peak
- Gilead Road at US 21, southbound right operates at LOS_S F during the AM Peak
- Gilead Road at US 21, westbound left operates at LOS_S F during the AM and PM Peaks
- Gilead Road at US 21, westbound through operates at LOS_S F during the AM Peak and LOS_S E during the PM Peak
- Gilead Road at US 21, westbound through/right operates at LOS_S F during the AM and PM Peaks
- Gilead Road at US 21, northbound left operates at LOS_S F during the AM and PM Peaks
- Gilead Road at US 21, northbound through operates at LOS_S F during the AM Peak and PM Peaks
- Gilead Road at US 21, northbound right operates at LOS_S F during the AM and PM Peaks
- Gilead Road at US 21, eastbound left operates at LOS_S E during the AM and PM Peaks

A review of the queue data showed that the system is currently operating such that queued traffic is affecting the operations of adjacent locations. One of the primary goals for projects located in the vicinity of freeways is to not allow traffic to queue back onto the freeway such that it affects freeway operations. The maximum queue lengths for traffic on the two exit ramps included in the study is shown as follows:

- I-77 Southbound off ramp to Gilead Road has a maximum queue length of 6,485 feet (AM) and 610 feet (PM) with the AM queue length exceeding the available storage on the ramp by 5,000 feet
- I-77 Northbound off ramp to Gilead Road has a maximum queue length of 631 feet (AM) and 514 feet (PM)

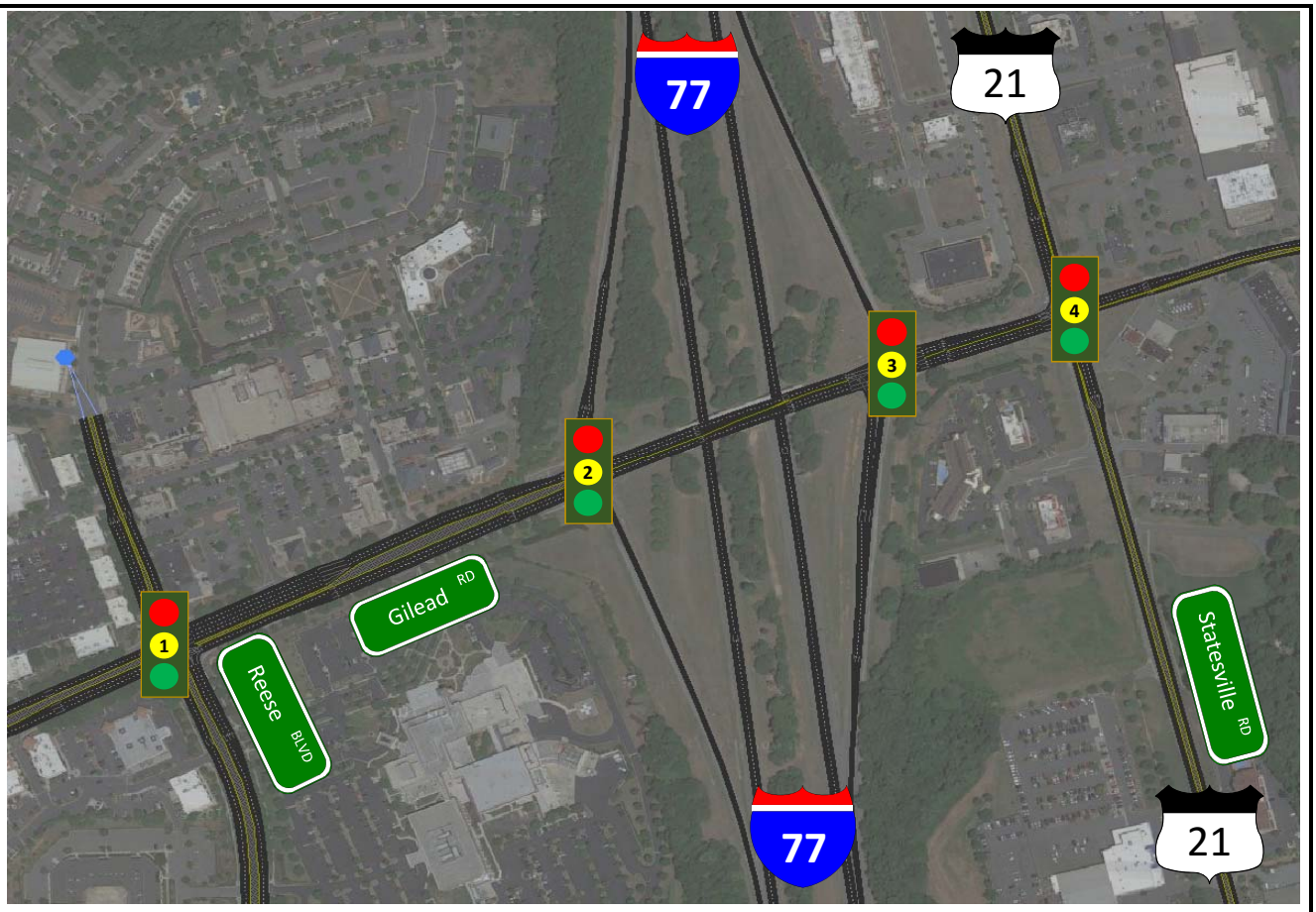
Table 6-2: 2015 Base Year No-Build Intersection Measures of Effectiveness

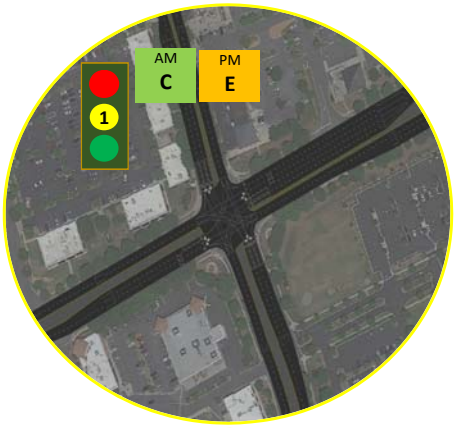
Intersection No.	Intersection	Approach	Lane Group	Delay[1] (s)		Level of Service[2]		95th % Queue (ft)/Spillback Rate		Maximum Queue Length (ft)	
				AM	PM	AM	PM	AM	PM	AM	PM
1	Gilead Rd at Reese Blvd	**Overall**		**33.8**	**70.5**	**C**	**E**				
		Reese Rd Southbound	L	61.1	174.2	E	F	136 (0%)	661 (13%)	244	653
			T/R	60.8	83.6	E	F	187 (0%)	262 (0%)		
		Gilead Rd Westbound	L	57.4	58.8	E	E	205 (0%)	98 (0%)	292	382
			T	14.5	27.9	B	C	113 (0%)	269 (0%)		
			R	3.7	6.0	A	A	67 (0%)	91 (0%)		
		Reese Rd Northbound	L	79.1	42.9	E	D	54 (0%)	106 (0%)	127	991
			T/R	52.1	61.5	D	E	84 (0%)	461 (0%)		
			R	7.4	27.4	A	C	70 (0%)	232 (0%)		
		Gilead Rd Eastbound	L	73.3	171.5	E	F	95 (0%)	86 (0%)	505	2358
			T	29.4	127.3	C	F	337 (0%)	2032 (1%)		
			T/R	29.7	166.7	C	F	352 (0%)	1820 (0%)		
2	Gilead Rd at I-77 Southbound Ramps	**Overall**		**29.9**	**51.5**	**C**	**D**				
		I-77 Southbound Off Ramp	L/T	84.8	104.5	F	F	204 (0%)	460 (0%)	6485	610
			R	17.2	15.9	B	B	98 (0%)	85 (0%)		
		Gilead Rd Westbound	L	109.4	106.7	F	F	682 (11%)	690 (3%)	682	785
			T	11.8	15.8	B	B	183 (0%)	257 (0%)		
		Gilead Rd Eastbound	T	27.6	99.4	C	F	422 (0%)	1091 (15%)	506	1100
			R	7.7	17.9	A	B	90 (0%)	93 (0%)		
3	Gilead Rd at I-77 Northbound Ramps	**Overall**		**28.1**	**34.6**	**C**	**C**				
		Gilead Rd Westbound	T	5.4	5.6	A	A	36 (95%)	36 (99%)	377	406
		I-77 Northbound Off Ramp	L	58.3	46.7	E	D	178 (0%)	167 (0%)	631	514
			R	58.3	54.1	E	D	422 (6%)	391 (5%)		
		Gilead Rd Eastbound	L	98.9	90.8	F	F	665 (5%)	636 (1%)	679	683
			T	19.8	42.4	B	D	187 (0%)	717 (9%)		
4	Gilead Rd at US 21 (Statesville Rd)	**Overall**		**121.7**	**63.1**	**F**	**E**				
		US 21 Southbound	L	254.5	58.4	F	E	74 (0%)	106 (0%)	8882	373
			T	260.3	54.7	F	D	440 (0%)	277 (0%)		
			R	269.7	16.5	F	B	2625 (0%)	176 (0%)		
		Gilead Rd Westbound	L	133.4	109.7	F	F	140 (0%)	74 (0%)	2329	783
			T	103.2	75.5	F	E	881 (1%)	556 (0%)		
			T/R	98.7	82.7	F	F	820 (0%)	588 (0%)		
		US 21 Northbound	L	233.1	179.1	F	F	1966 (0%)	1517 (0%)	3195	2772
			T	171.8	156.7	F	F	199 (0%)	1002 (0%)		
			R	135.7	113.9	F	F	18 (0%)	34 (0%)		
		Gilead Rd Eastbound	L	62.2	59.0	E	E	335 (9%)	334 (17%)	382	380
			T	38.1	33.5	D	C	337 (18%)	335 (26%)		
			R	9.7	10.9	A	B	137 (0%)	134 (0%)		

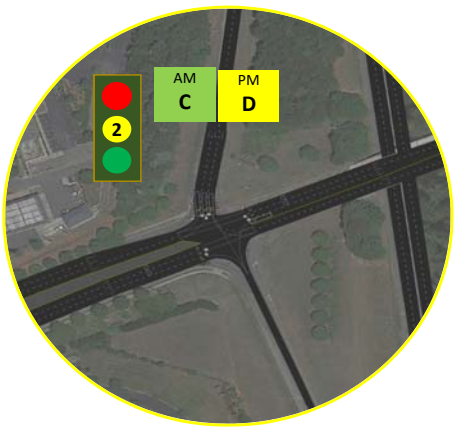
Notes:

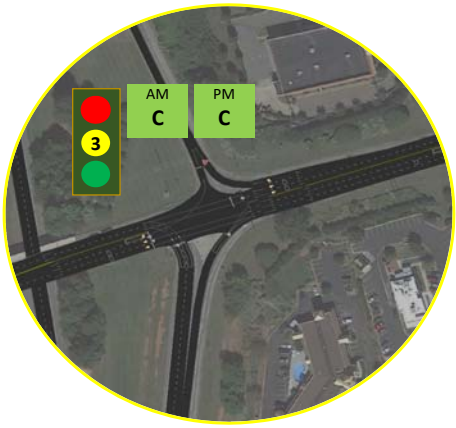
1 Delay shown is the 95th percentile worst case control delay for the full 60-minute simulation period as derived from the 10 random seed simulations

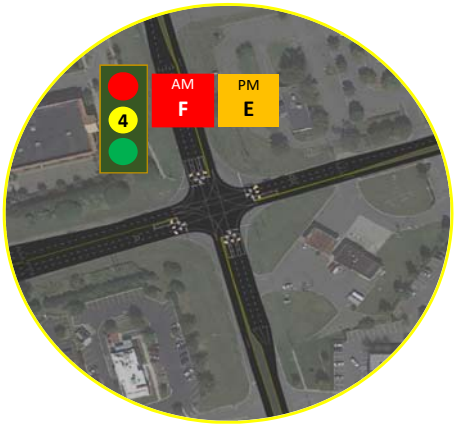
2 Level of Service shown is Simulation based and calculated in a manner that is consistent with the HCM 2010 Methodologies











STIP Project No. I-5714 **I-77 Interchange Improvements** **Mecklenburg County**	**Figure 6-2**	**2015 Base Year No-Build Intersection Measures of Effectivenes**	PATRIOT TRANSPORTATION ENGINEERING, PLLC Prepared By: **Patriot Transportation Engineering, PLLC** 3008 Anderson Drive, Suite 120 Raleigh, North Carolina 27609 (919)977-9125

7. 2040 FUTURE YEAR NO-BUILD ANALYSIS

Based on the requirements of the National Environmental Policy Act (NEPA), the Future Year No-Build alternative must be given full consideration and is often used as a means of comparison for the build alternatives. Therefore, the next step was to utilize the validated base model to determine how the transportation network within the study area will operate in the future.

7.1 MODEL PARAMETERS

All of the driver behaviors and parameters established while validating the base year model were reviewed and it was determined that they would be carried forward to the future year network.

7.2 DESIGN ASSUMPTIONS/MODEL NETWORK

The 2040 scenarios assume that all improvements included in the Charlotte Regional Transportation Planning Organizations (CRTPO) *Metropolitan Transportation Plan* (2040 MTP), adopted April 16, 2014, are completed. There are four projects from the 2040 MTP located within the study area:

- US 21 (Statesville Road) Widening from Gilead Road to Holly Point Drive
- US 21 (Statesville Road) Widening from WT Harris Boulevard to Gilead Road
- I-77 Managed Lanes from I-277 to West Catawba Avenue (STIP I-5405)
- US 21/Gilead Road Intersection Improvements (STIP U-5114)

The 2040 future year model is based on the Preliminary Design Plans for STIP No. U-5114 that were provided to NCDOT in December 2015

7.3 VOLUME DATA

The development of the volume data for the 2040 No-Build model was described in Section 5. The O-D matrices for the 2040 Future Year No-Build analysis are included in Appendix B. The vehicle loading and matrix setting were identical to those used in the 2015 Base Year No-Build model with the vehicles being loaded onto the network based on the curve data included in Table 5-1.

7.4 SIGNAL TIMINGS AND OPERATIONS

The next step in developing the 2040 No-Build model was to re-optimize the signals for the new traffic volumes. The signal optimization was done in the same manner as for the 2015 Base Year No-Build model described in Section 6.3.1. The *NCDOT Congestion Management Capacity Analysis Guidelines* (Effective July 1, 2015) prohibit the use of protected/permitted phasing for future year operations for signals included in the Build design.

7.5 VISUAL VALIDATION OF MODEL

Quality control was performed for the 2040 No-Build model to ensure it was developed in a manner consistent with the current guidelines and best practices being utilized for TransModeler. The model was then visually validated by observing the model animations in the same manner that was described in Section 6.7. Following the conclusion of the model review process it was determined that 2040 No-Build model was visually valid and ready for developing detailed MOEs.

7.6 MEASURES OF EFFECTIVENESS

The MOEs extracted for the 2040 No-Build scenario are identical to those utilized for the 2015 Base Year No-Build model and are discussed in detail in Section 4.

7.7 SIMULATION RUN CONTROL

The simulation model run controls for the future year no-build model were identical to those included in Section 6.6 for the 2015 Base Year No-Build model.

7.8 2040 FUTURE YEAR NO-BUILD MODEL RESULTS

The output data was extracted from the TransModeler model via the Output Manager using the Delay, Queue and Queue Spillback reports. The outputs were collected in accordance with the MOEs defined in Section 4 and are summarized in the following sections.

7.8.1 FREEWAY RESULTS

The results of the freeway analysis are included in Table 7-1 and Figure 7-1. During the AM peak period for the 2040 No-Build scenario, 2 of the 10 analysis segment on I-77 are anticipated to operate at LOS_S C, 3 of the 10 analysis segment on I-77 are anticipated to operate at LOS_S D, 1 of 10 analysis segments is anticipated to operate at LOS_S E, and 4 of 10 analysis segments are anticipated to operate at LOS_S F. During the PM peak period 6 of the 10 analysis segment are anticipated to operate at LOS_S D, 2 of the 10 analysis segment are anticipated to operate at LOS_S E, and 2 of 10 analysis segments are anticipated to operate at LOS_S F. Based on the results the following freeway segments are anticipated to operate at LOS_S E or F under the 2040 No-Build Scenario:

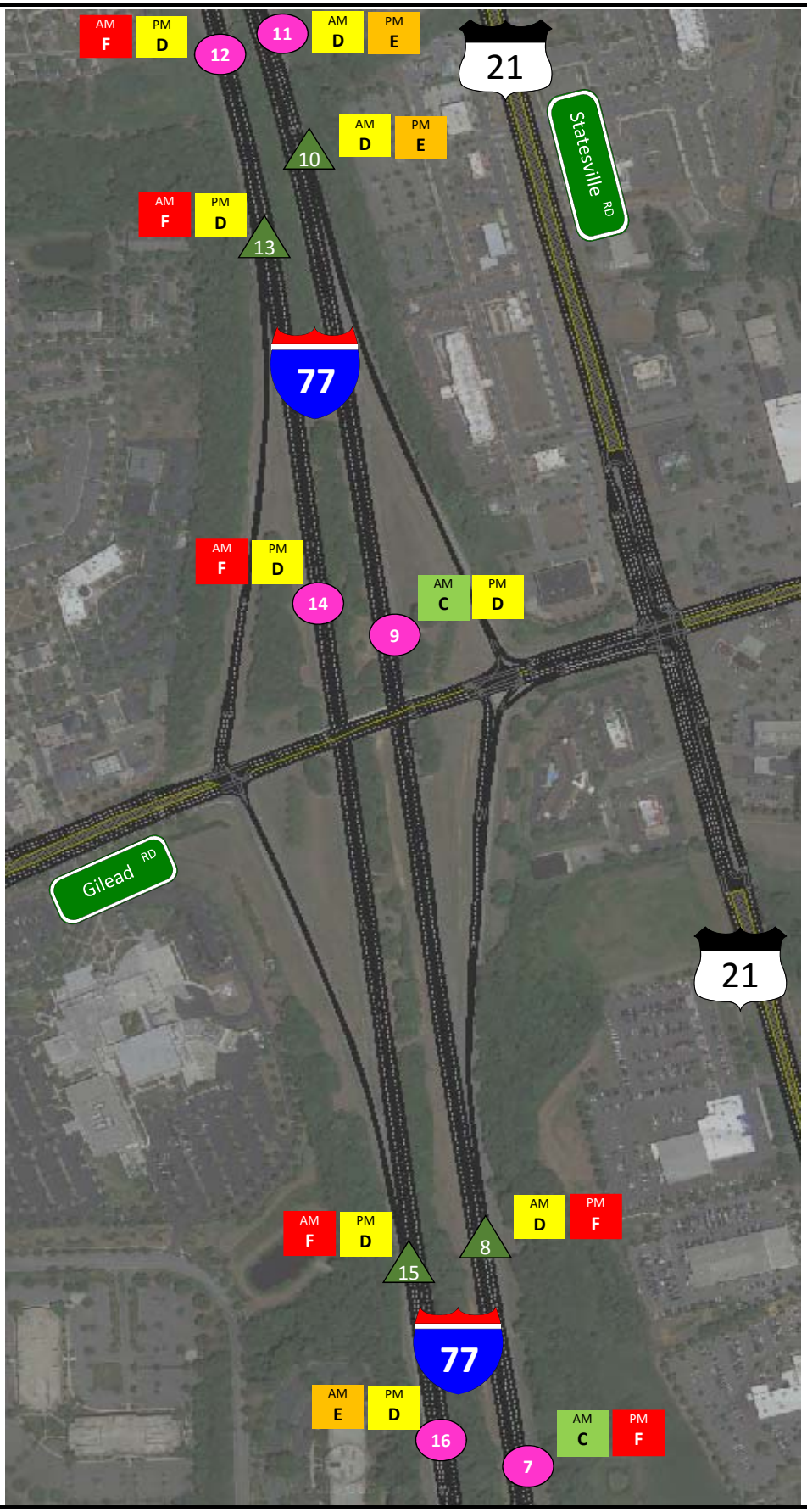
- I-77 Northbound, south of Gilead Road is operating at LOS_S F the PM Peak
- I-77 Northbound, diverge to Gilead Road is operating at LOS_S F the PM Peak
- I-77 Northbound, merge from Gilead Road is operating at LOS_S E during the PM Peak
- I-77 Northbound, north of Gilead Road is operating at LOS_S E during the PM Peak
- I-77 Southbound, north of Gilead Road is operating at LOS_S F during the AM Peak
- I-77 Southbound, diverge to Gilead Road is operating at LOS_S F during the AM Peak
- I-77 Southbound, between the Gilead Road ramps is operating at LOS_S F during the AM Peak
- I-77 Southbound, merge from Gilead Road is operating at LOS_S F during the AM Peak
- I-77 Southbound, south of Gilead Road is operating at LOS_S E during the AM Peak

Table 7-1: 2040 Future Year No-Build Freeway Measures of Effectiveness

Segment No.	Type	Description	Density		Level of Service[1]	
			AM	PM	AM	PM
7	BFS	I-77 Northbound, south of Gilead Road	19.7	67.1	C	F
8	Diverge	I-77 Northbound to Gilead Road	28.6	80.7	D	F
9	BFS	I-77 Northbound, between Gilead Road Ramps	23.4	32.4	C	D
10	Merge	I-77 Northbound from Gilead Road	28.8	40.9	D	E
11	BFS	I-77 Northbound, north of Gilead Road	28.1	35.2	D	E
12	BFS	I-77 Southbound, north of Gilead Road	53.7	28.0	F	D
13	Diverge	I-77 Southbound to Gilead Road	57.3	29.8	F	D
14	BFS	I-77 Southbound, between Gilead Road Ramps	66.2	27.2	F	D
15	Merge	I-77 Southbound, from Gilead Rd	57.3	30.2	F	D
16	BFS	I-77 Southbound, south of Gilead Road	37.6	33.2	E	D

Notes:

1 Level of Service shown is Simulation based and calculated in a manner that is consistent with the HCM 2010 Methodologies



STIP Project No. I-5714
I-77 Interchange Improvements
Mecklenburg County

Figure 7-1

2040 Future Year No-Build Freeway Measures of Effectivenes

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7.8.2 ARTERIAL/INTERSECTION RESULTS

The results of the intersection analysis along the arterial portions of the study area are included in Table 7-2 and Figure 7-2. The overall intersection LOS_S for the signalized intersections in the 2040 Future Year No-Build scenario shows that 4 of the 6 signals are anticipated to operate at LOS_S E or F. During the AM peak period 4 of 6 intersections are anticipated to operate at LOS_S C, 1 of 6 intersections is anticipated to operate at LOS_S D, and 1 of 6 intersections is anticipated to operate at LOS_S F. During the PM peak period 2 of 6 intersections are anticipated to operate at LOS_S D, 1 of 6 intersections are anticipated to operate at LOS_S E, and 3 of 6 intersections are anticipated to operate at LOS_S F.

Based on a review of the intersection operations at the lane group level, the following movements are anticipated to operate at LOS_S E or F in the 2040 Future Year No-Build scenario:

- Gilead Road at Reese Boulevard, southbound left operates at LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, southbound through/right operates at LOS_S E during the PM Peak
- Gilead Road at Reese Boulevard, westbound left operates at LOS_S E during the PM Peak
- Gilead Road at Reese Boulevard, northbound through/right operates at LOS_S E during the PM Peak
- Gilead Road at Reese Boulevard, eastbound left operates at LOS_S E during the AM Peak and LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, eastbound through operates at LOS_S E during the AM Peak and LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, eastbound through/right operates at LOS_S E during the AM Peak and LOS_S F during the PM Peak
- Gilead Road at I-77 southbound ramps, southbound through/left operates at LOS_S E during the PM Peak
- Gilead Road at I-77 southbound ramps, westbound left operates at LOS_S F during the PM Peak
- Gilead Road at I-77 southbound ramps, eastbound through operates at LOS_S E during the AM Peak and LOS_S F during the PM Peak
- Gilead Road at I-77 northbound ramps, northbound left operates at LOS_S E during the PM Peak
- Gilead Road at I-77 northbound ramps, northbound right operates at LOS_S F during the AM and PM Peaks
- Gilead Road at I-77 northbound ramps, eastbound left operates at LOS_S E during the AM Peak and LOS_S F during the PM Peak
- Gilead Road at I-77 northbound ramps, eastbound through operates at LOS_S E during the PM Peak
- Gilead Road at US 21, westbound through operates at LOS_S F during the AM and PM Peaks
- Gilead Road at US 21, westbound right operates at LOS_S E during the AM Peak
- Gilead Road at US 21, eastbound right operates at LOS_S E during the PM Peak
- US 21 Southbound U-turn, southbound U-turn operates at a LOS_S E during the AM Peak
- US 21 Southbound U-turn, northbound through operates at a LOS_S F during the PM Peak
- US 21 Northbound U-turn, southbound through operates at a LOS_S F during the AM and PM Peaks
- US 21 Northbound U-turn, northbound U-turn operates at a LOS_S E during the PM Peak

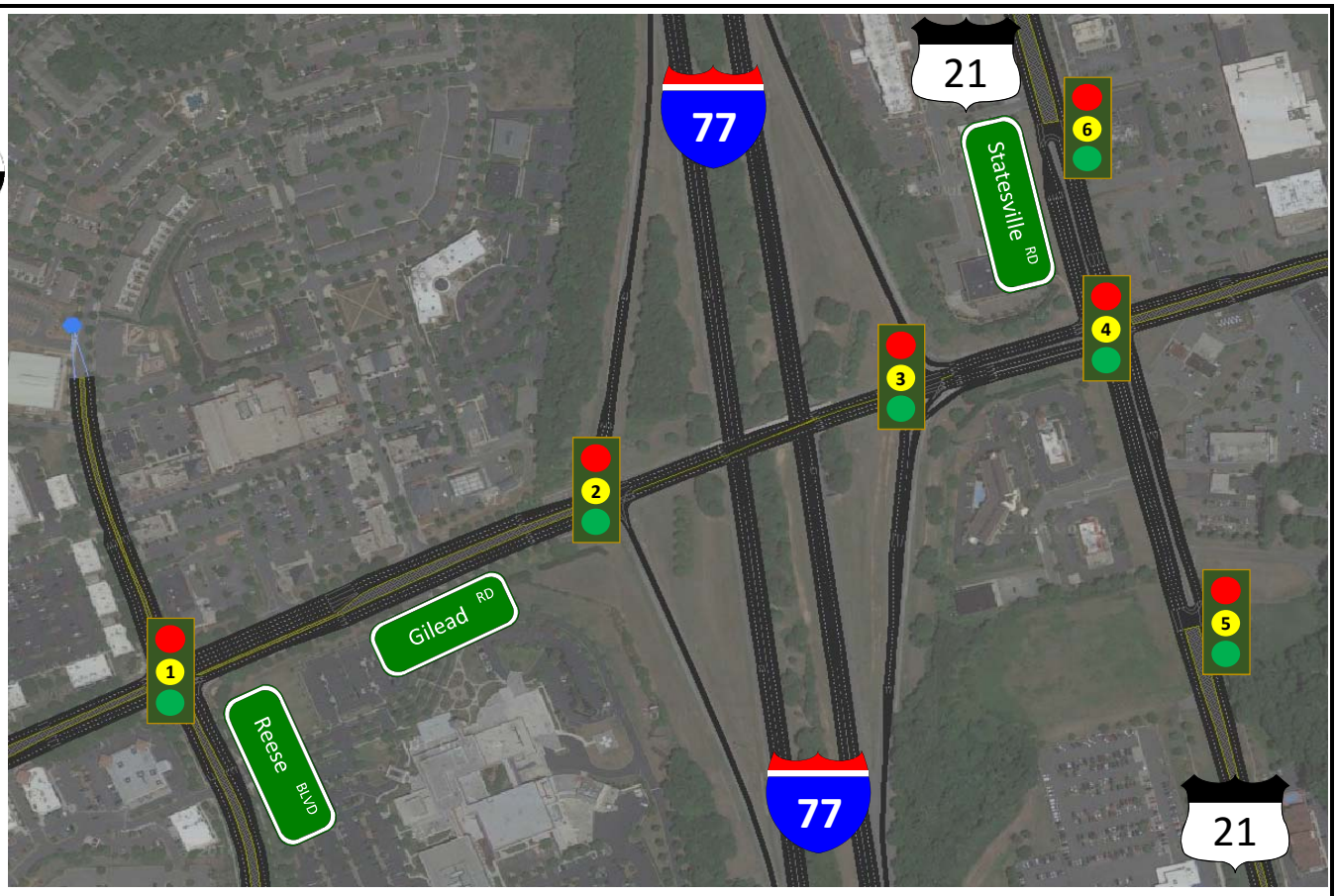
Table 7-2: 2040 Future Year No-Build Intersection Measures of Effectiveness

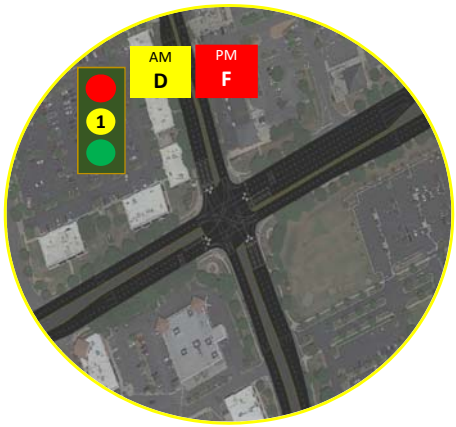
Intersection No.	Intersection	Approach	Lane Group	Delay[1] (s)		Level of Service[2]		95th % Queue (ft)/Spillback Rate		Maximum Queue Length (ft)	
				AM	PM	AM	PM	AM	PM	AM	PM
1	Gilead Rd at Reese Blvd	**Overall**		**36.6**	**112.1**	**D**	**F**				
		Reese Rd Southbound	L	46.6	189.7	D	F	126 (0%)	636 (0%)	176	739
			T/R	33.6	74.2	C	E	126 (0%)	171 (0%)		
		Gilead Rd Westbound	L	43.3	55.9	D	E	146 (0%)	182 (0%)	357	364
			T	24.3	25.7	C	C	224 (0%)	224 (0%)		
			R	6.5	5.9	A	A	73 (0%)	90 (0%)		
		Reese Rd Northbound	L	42.4	48.5	D	D	51 (0%)	68 (0%)	215	800
			T/R	30.8	61.5	C	E	122 (0%)	359 (0%)		
			R	18.2	44.9	B	D	140 (0%)	430 (0%)		
		Gilead Rd Eastbound	L	68.0	387.1	E	F	53 (0%)	136 (0%)	1283	2137
			T	62.7	317.0	E	F	962 (0%)	2109 (15%)		
			T/R	61.8	332.8	E	F	894 (0%)	2107 (13%)		
2	Gilead Rd at I-77 Southbound Ramps	**Overall**		**31.0**	**58.7**	**C**	**E**				
		I-77 Southbound Off Ramp	L/T	47.1	72.8	D	E	109 (0%)	203 (0%)	170	282
			R	21.0	28.4	C	C	81 (0%)	116 (0%)		
		Gilead Rd Westbound	L	33.6	87.3	C	F	286 (0%)	710 (5%)	560	707
			T	8.0	12.0	A	B	210 (0%)	183 (0%)		
		Gilead Rd Eastbound	T	64.0	115.8	E	F	941 (0%)	1086 (9%)	1131	1100
			R	23.8	36.2	C	D	184 (0%)	183 (0%)		
3	Gilead Rd at I-77 Northbound Ramps	**Overall**		**28.0**	**48.3**	**C**	**D**				
		Gilead Rd Westbound	T	4.1	5.1	A	A	50 (98%)	49 (98%)	353	365
		I-77 Northbound Off Ramp	L	41.7	65.6	D	E	190 (0%)	330 (2%)	2627	7527
			R	104.0	117.7	F	F	435 (25%)	405 (47%)		
		Gilead Rd Eastbound	L	56.9	101.2	E	F	327 (0%)	685 (6%)	683	685
			T	41.7	77.1	D	E	294 (0%)	344 (0%)		
4	Gilead Rd at US 21 (Statesville Rd)	**Overall**		**34.5**	**37.3**	**C**	**D**				
		US 21 Southbound	T	4.7	19.6	A	B	78 (0%)	481 (12%)	299	520
			R	13.1	28.9	B	C	243 (0%)	474 (3%)		
		Gilead Rd Westbound	T	155.5	96.2	F	F	922 (31%)	903 (3%)	4156	1079
			R	68.8	46.6	E	D	315 (0%)	308 (0%)		
		US 21 Northbound	T	18.6	26.4	B	C	275 (0%)	543 (0%)	2515	6935
			R	21.3	28.6	C	C	171 (0%)	236 (0%)		
		Gilead Rd Eastbound	T	25.3	35.1	C	D	223 (3%)	258 (15%)	478	689
			R	48.8	60.0	D	E	259 (72%)	263 (84%)		
5	US 21 (Statesville Rd) at Southbound U-turn	**Overall**		**29.5**	**198.8**	**C**	**F**				
		US 21 Southbound	U	66.0	39.9	E	D	241 (0%)	199 (0%)	422	417
		US 21 Northbound	T	47.1	474.5	D	F	847 (0%)	1366 (0%)	1273	12012
6	US 21 (Statesville Rd) at Northbound U-turn	**Overall**		**103.4**	**83.5**	**F**	**F**				
		US 21 Southbound	T	207.9	178.6	F	F	786 (0%)	920 (0%)	7892	6503
		US 21 Northbound	U	39.9	59.1	D	E	64 (0%)	90 (0%)	291	366

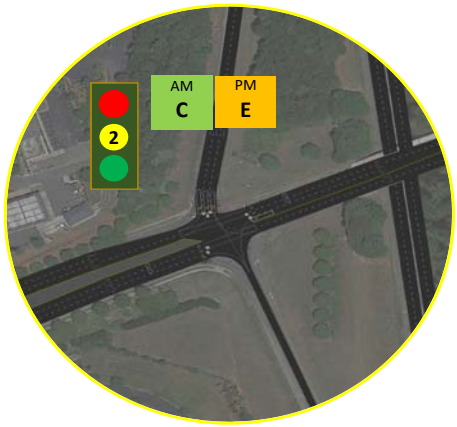
Notes:

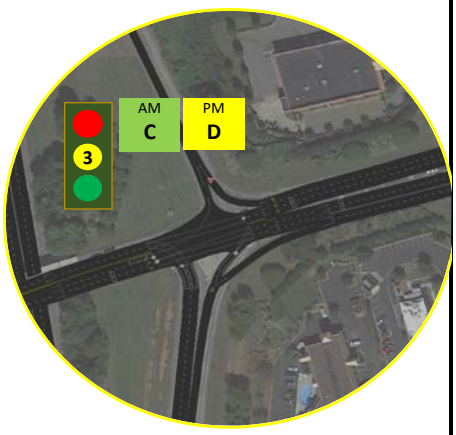
1 Delay shown is the 95th percentile worst case control delay for the full 60-minute simulation period as derived from the 10 random seed simulations

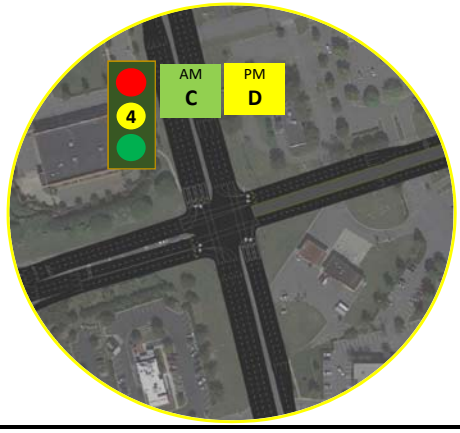
2 Level of Service shown is Simulation based and calculated in a manner that is consistent with the HCM 2010 Methodologies

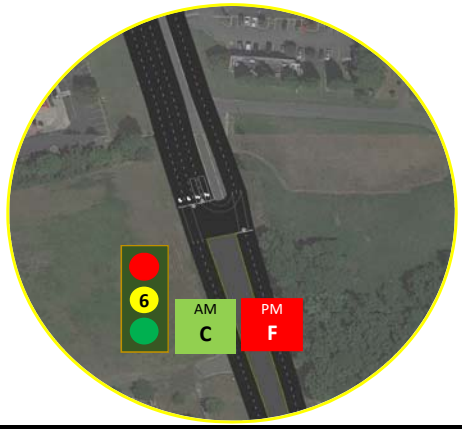


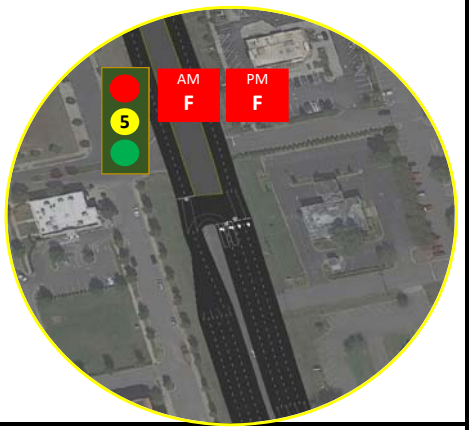












STIP Project No. I-5714 **I-77 Interchange Improvements** **Mecklenburg County**	**Figure 7-2**	**2040 Future Year No-Build Intersection Measures of Effectivenes**	PATRIOT TRANSPORTATION ENGINEERING, PLLC Prepared By: **Patriot Transportation Engineering, PLLC** 3008 Anderson Drive, Suite 120 Raleigh, North Carolina 27609 (919)977-9125

A review of the queue data showed that by 2040 the operations under the No-Build scenario are anticipated to deteriorate to a level where some queues are affecting the operations of adjacent intersections or freeway segments. As stated previously, one of the primary goals for projects located in the vicinity of freeways is to not allow traffic to queue back onto the freeway such that it affects freeway operations. The maximum queue lengths for traffic on the five exit ramps/loops included in the study is shown as follows:

- I-77 Southbound off ramp to Gilead Road has a maximum queue length of 170 feet (AM) and 282 feet (PM)
- I-77 Northbound off ramp to Gilead Road has a maximum queue length of 2,627 feet (AM) and 7,527 feet (PM) with the queue length exceeding the available storage on the ramp by 1,100 feet in the AM and by 6,000 feet in the PM

8. 2040 FUTURE YEAR BUILD ANALYSIS

This section presents a summary of the model development and results for the 2040 Build scenario and includes two alternatives. The following two alternatives were evaluated for the subject project:

- Alternative 1 (Figure 8-1): 3x3 Diverging Diamond with three lanes in each direction on Gilead Road through the interchange
- Alternative 2 (Figure 8-2): 3x2 Diverging Diamond on Gilead Road with two lanes on eastbound Gilead Road and three lanes on westbound Gilead Road through the interchange

The following sections describe the development of the build models for both alternatives.

8.1 MODEL PARAMETERS

All of the driver behaviors and parameters established while validating the base year model were reviewed and it was determined that they would be carried forward to the future year network.

8.2 DESIGN ASSUMPTIONS/MODEL NETWORK

The 2040 scenarios assume that all improvements included in the Charlotte Regional Transportation Planning Organizations (CRTPO) *Metropolitan Transportation Plan* (2040 MTP), adopted April 16, 2014, are completed. There are four projects from the 2040 MTP located within the study area:

- US 21 (Statesville Road) Widening from Gilead Road to Holly Point Drive
- US 21 (Statesville Road) Widening from WT Harris Boulevard to Gilead Road
- I-77 Managed Lanes from I-277 to West Catawba Avenue (STIP I-5405)
- US 21/Gilead Road Intersection Improvements (STIP U-5114)

The Build model for **Alternative 1** was developed and optimized, with the final models including the following improvements:

- Converted the diamond interchange into a diverging diamond interchange with 3 lanes in both directions on Gilead Road
- Added additional right lane on the I-77 northbound exit ramp with 450 feet of storage and maintained dual lane storage of approximately 800 feet
- Added 700-foot dual receiving lane on the I-77 northbound on ramp

- Added 600-foot dual lane ramp on the I-77 southbound exit ramp with 250 feet of dual right lane storage and 250 feet of single left turn lane storage
- Added 700-foot dual receiving lane on the I-77 southbound on ramp
- Added 240-foot additional right turn lane on northbound Reese Boulevard and changed the approach laneage to include an exclusive left lane, through lane, and dual right turn lanes.

The Build model for **Alternative 2** was developed and optimized, with the final models including the following improvements:

- Converted the diamond interchange into a diverging diamond interchange with 3 lanes in the westbound direction and 2 lanes in the eastbound on Gilead Road
- Added additional right lane on the I-77 northbound exit ramp with 450 feet of storage and maintained dual lane storage of approximately 800 feet
- Added 700-foot dual receiving lane on the I-77 northbound on ramp
- Added 600-foot dual lane ramp on the I-77 southbound exit ramp with 250 feet of dual right lane storage and 250 feet of single left turn lane storage
- Added 700-foot dual receiving lane on the I-77 southbound on ramp
- Added 240-foot additional right turn lane on northbound Reese Boulevard and changed the approach laneage to include an exclusive left lane, through lane, and dual right turn lanes.

8.3 VOLUME DATA

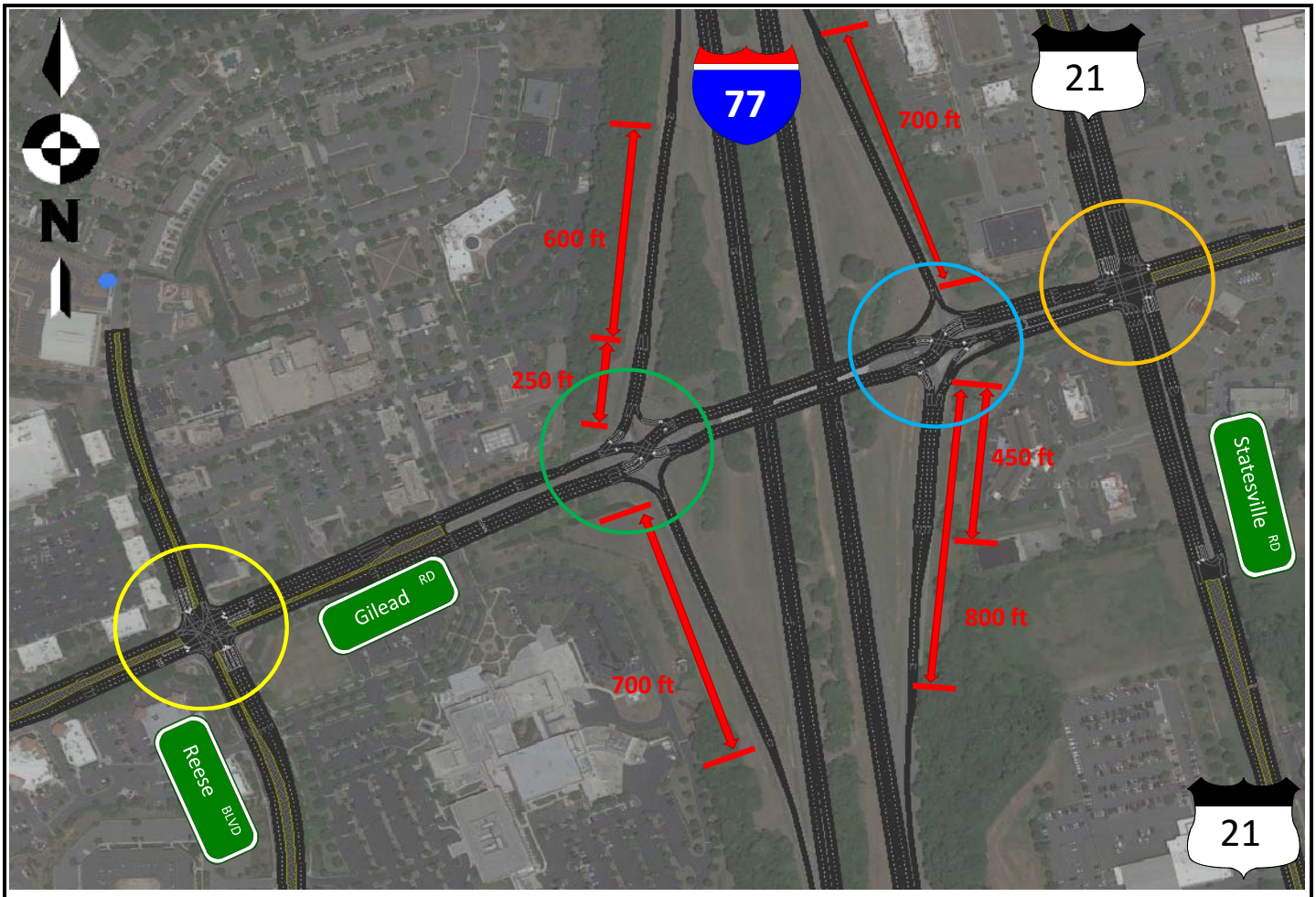
The development of the volume data for the 2040 build model was described in Section 5 and is the same for both alternatives. The 2040 Build volumes are the same as those used for the 2040 No-Build scenario as the regional magnitude of the improvements is minimal and should not affect the overall traffic demand within the study area. The O-D matrices for the 2040 Future Year Build analysis are included in Appendix B. The vehicle loading and matrix settings were identical to those used in the 2015 Base Year No-Build and 2040 Future Year No-Build models with the vehicles being loaded onto the network based on the curve data included in Table 5-1.

8.4 SIGNAL TIMINGS AND OPERATIONS

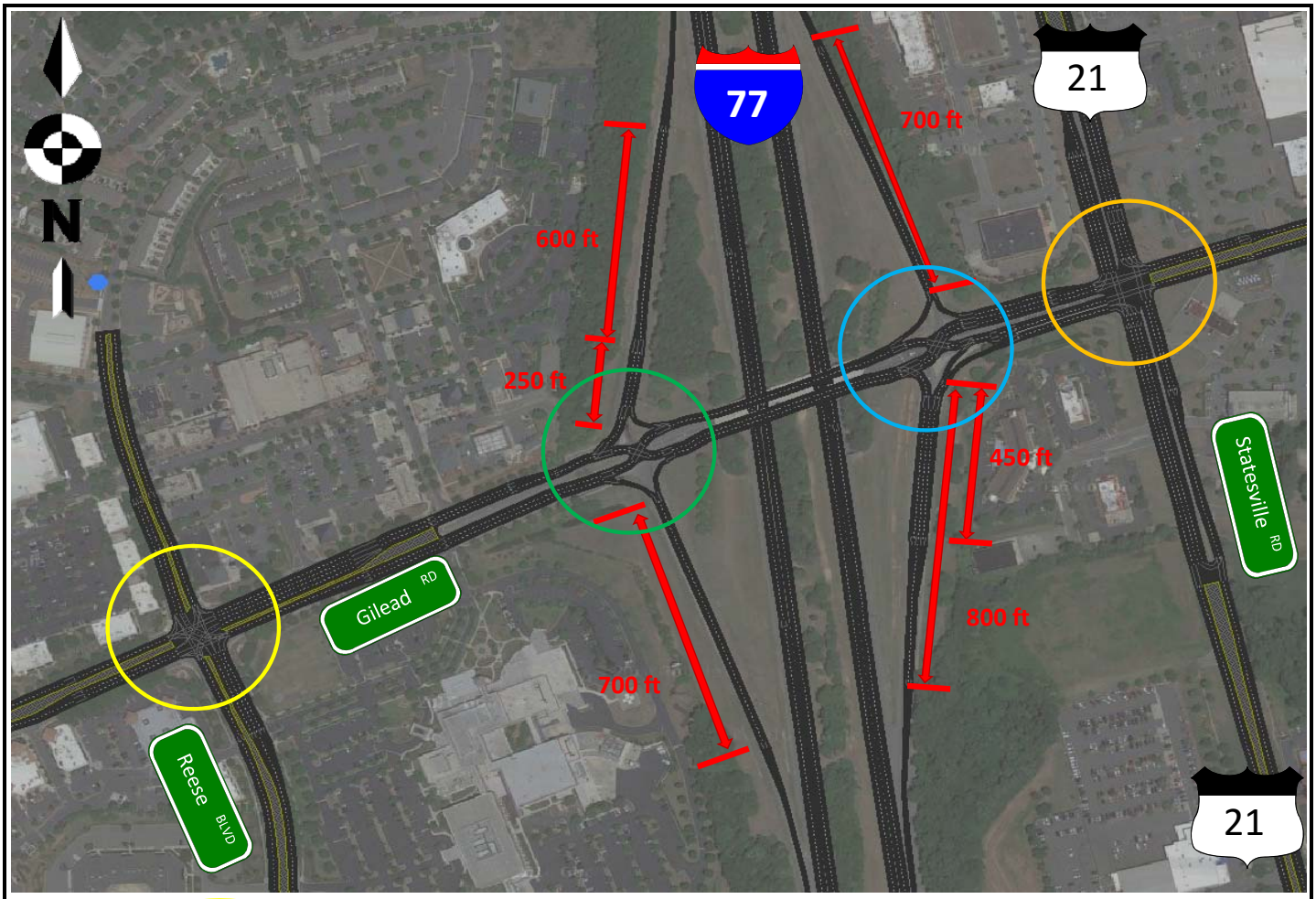
The signal timings and operations for the 2040 Build models were re-optimized for the signals based on the new traffic volumes and design configurations. The signal optimization was done in the same manner as for the 2015 Base Year No-Build model and 2040 No-Build model, as described in Section 6.3.1 and then reviewed and fine-tuned manually by the analyst. The signal timing was developed to coordinate the US 21 southbound right turn movement to Gilead Road and continue westbound along Gilead Road. As stated in Section 7.4, protected/permitted phasing was not included for either signal at the interchange or at the intersection at US 21. Protected/permitted phasing, as well as right turn on red, was kept in place at the intersection at Reese Blvd given that no improvements were originally planned at this location. However, during the analysis process and discussions with Congestion Management and Division 10, it was decided to evaluate minor improvements on Reese Blvd in the Build Alternatives.

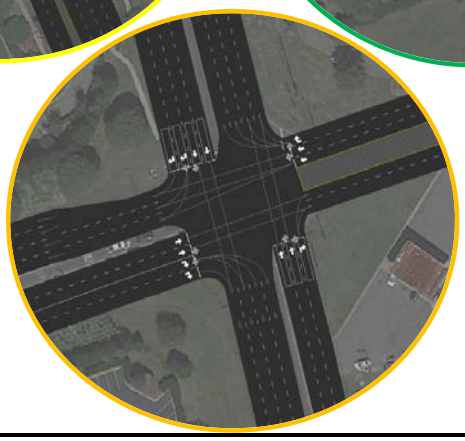
8.5 VISUAL VALIDATION OF MODEL

Quality control was performed for the 2040 Build models to ensure it was developed in a manner consistent with the current guidelines and best practices being utilized for TransModeler. The model was then visually validated by observing the model animations in the same manner that was described in Section 6.7. Following the conclusion of the model review process it was determined that 2040 Builds models were visually valid and ready for developing detailed MOEs.



STIP Project No. I-5714 **I-77 Interchange Improvements** **Mecklenburg County**	**Figure 8-1**	**2040 Future Year Build Alternative 1**	PATRIOT TRANSPORTATION ENGINEERING, PLLC	Prepared By: **Patriot Transportation Engineering, PLLC** 3008 Anderson Drive, Suite 120 Raleigh, North Carolina 27609 (919)977-9125





STIP Project No. I-5714 **I-77 Interchange Improvements** **Mecklenburg County**	**Figure 8-2**	**2040 Future Year Build Alternative 2**	PATRIOT TRANSPORTATION ENGINEERING, PLLC	Prepared By: **Patriot Transportation Engineering, PLLC** 3008 Anderson Drive, Suite 120 Raleigh, North Carolina 27609 (919)977-9125

8.6 MEASURES OF EFFECTIVENESS

The MOEs extracted for the 2040 Build scenario are identical to those utilized for the 2015 Base Year No-Build and 2040 Future Year No-Build models and are discussed in detail in Section 4.

8.7 SIMULATION RUN CONTROL

The simulation model run controls for the future year build models were identical to those included in Section 6.6 for the 2015 Base Year No-Build model.

8.8 2040 FUTURE YEAR ALTERNATIVE 1 BUILD MODEL RESULTS

The output data was extracted from the TransModeler model via the Output Manager using the Delay, Queue and Queue Spillback reports. The outputs were collected in accordance with the MOEs defined in Section 4 and are summarized in the following sections.

8.8.1 FREEWAY RESULTS – ALTERNATIVE 1

The results of the freeway analysis for Alternative 1 are included in Table 8-1 and Figure 8-3. During the AM peak period for the 2040 Build Alternative 1 scenario, 3 of 10 analysis segments are anticipated to operate at LOS_S C, 2 of 10 analysis segments are anticipated to operate at LOS_S D, 1 of 10 analysis segments is anticipated to operate at LOS_S E, and 4 of 10 analysis segments are anticipated to operate at LOS_S F. During the PM peak period for the 2040 Build Alternative 1 scenario, 7 of 10 analysis segments are anticipated to operate at LOS_S D, 1 of 10 analysis segments is anticipated to operate at LOS_S E, and 2 of 10 analysis segments are anticipated to operate at LOS_S F. Based on the results the following freeway segments are anticipated to operate at LOS_S E or F under the 2040 Build Alternative 1 Scenario:

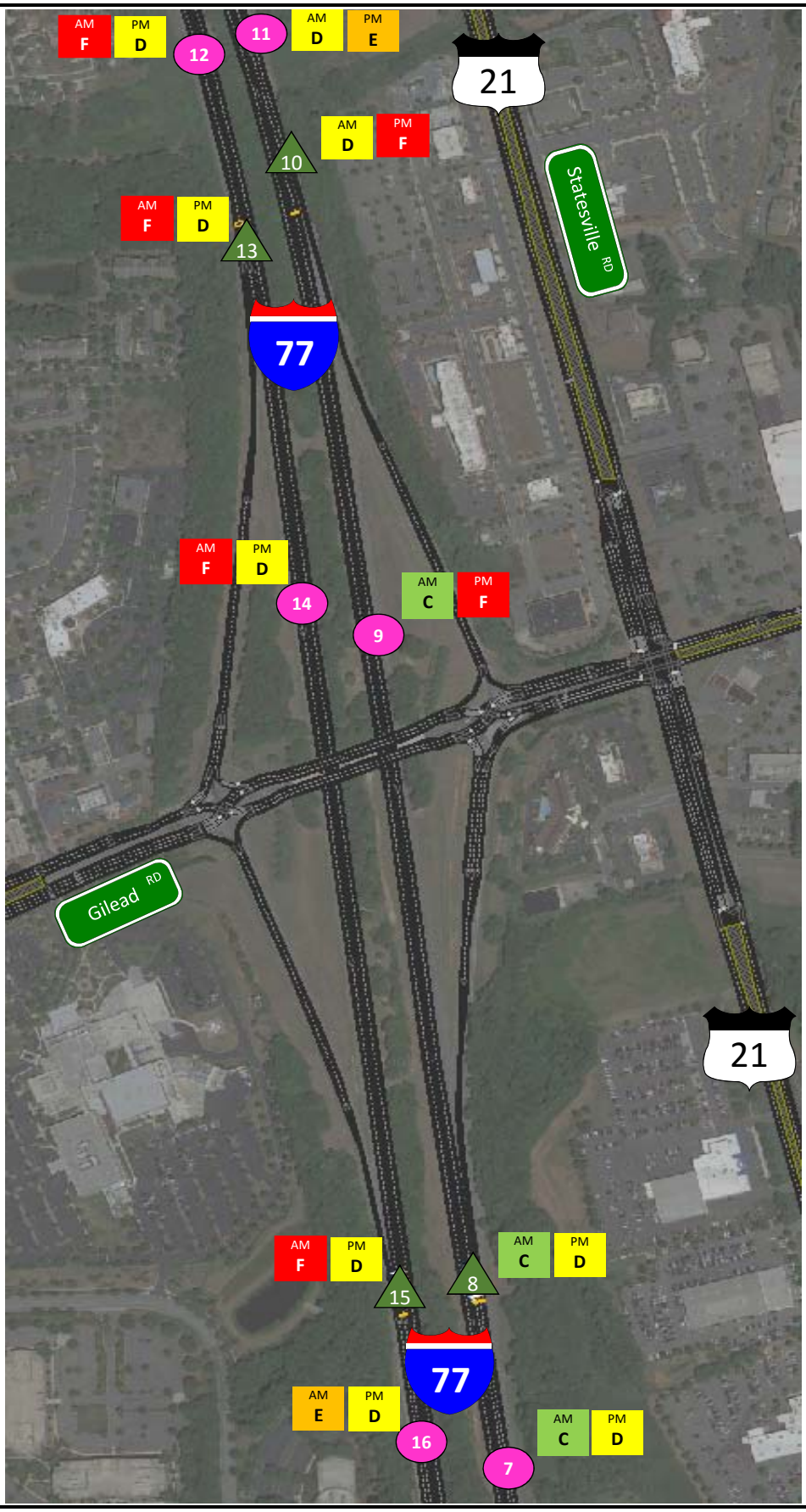
- I-77 Northbound, between the Gilead Road ramps is operating at LOS_S F during the PM Peak
- I-77 Northbound, merge from Gilead Road is operating at LOS_S F during the PM Peak
- I-77 Northbound, north of Gilead Road is operating at LOS_S E during the PM Peak
- I-77 Southbound, north of Gilead Road is operating at LOS_S F during the AM Peak
- I-77 Southbound, diverge to Gilead Road is operating at LOS_S F during the AM Peak
- I-77 Southbound, between the Gilead Road ramps is operating at LOS_S F during the AM Peak
- I-77 Southbound, merge from Gilead Road is operating at LOS_S F during the AM Peak
- I-77 Southbound, south of Gilead Road is operating at LOS_S E during the AM Peak

Table 8-1: 2040 Future Year Build Alternative 1 Freeway Measures of Effectiveness

Segment No.	Type	Description	Density		Level of Service[1]	
			AM	PM	AM	PM
7	BFS	I-77 Northbound, south of Gilead Road	20.9	29.2	C	D
8	Diverge	I-77 Northbound to Gilead Road	20.6	32.8	C	D
9	BFS	I-77 Northbound, between Gilead Road Ramps	24.5	54.0	C	F
10	Merge	I-77 Northbound from Gilead Road	30.0	52.1	D	F
11	BFS	I-77 Northbound, north of Gilead Road	29.9	36.2	D	E
12	BFS	I-77 Southbound, north of Gilead Road	56.4	28.0	F	D
13	Diverge	I-77 Southbound to Gilead Road	59.9	30.1	F	D
14	BFS	I-77 Southbound, between Gilead Road Ramps	69.0	27.1	F	D
15	Merge	I-77 Southbound, from Gilead Rd	60.2	30.0	F	D
16	BFS	I-77 Southbound, south of Gilead Road	39.5	33.3	E	D

Notes:

1 Level of Service shown is Simulation based and calculated in a manner that is consistent with the HCM 2010 Methodologies



STIP Project No. I-5714
I-77 Interchange Improvements
Mecklenburg County

Figure 8-3

2040 Future Year Build Alternative 1 Freeway Measures of Effectivenes

PATRIOT TRANSPORTATION ENGINEERING, PLLC

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Raleigh, North Carolina 27609
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8.8.2 ARTERIAL/INTERSECTION RESULTS – ALTERNATIVE 1

The results of the intersection analysis along the arterial portions of the study area are included in Table 8-2 and Figure 8-4. The overall intersection LOS_S for the signalized intersections in the 2040 Future Year Build Alternative 1 scenario shows that 3 of the 4 signals are anticipated to operate at LOS_S D or better. Given the design of a DDI, the ramp terminals include multiple intersections, which make determining an overall LOS not practical. During the AM peak period 1 of 4 intersections is anticipated to operate at LOS_S C, 1 of 4 intersections are anticipated to operate at LOS_S D, and 2 of 6 intersections are anticipated to operate at LOS_S F. During the PM peak period 1 of 4 intersections are anticipated to operate at LOS_S C, 1 of 4 intersections is anticipated to operate at LOS_S D, and 2 of 4 intersections are anticipated to operate at LOS_S F.

Based on a review of the intersection operations at the lane group level, the following movements are anticipated to operate at LOS_S E or F in the 2040 Future Year Build Alternative 1 scenario:

- Gilead Road at Reese Boulevard, southbound left operates at LOS_S E during the AM Peak and LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, southbound through/right operates at LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, westbound left operates at LOS_S E during the PM Peak
- Gilead Road at Reese Boulevard, northbound left operates at LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, northbound through operates at LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, northbound right operates at LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, eastbound left operates at LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, eastbound through operates at LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, eastbound through/right operates at LOS_S F during the PM Peak
- Gilead Road at US 21, southbound right operates at LOS_S E during the AM Peak
- Gilead Road at US 21, westbound through operates at LOS_S F during the AM Peak and LOS_S E during the PM Peak
- Gilead Road at US 21, westbound right operates at LOS_S E during the AM Peak
- US 21 Southbound U-turn, southbound U-turn operates at a LOS_S F during the AM Peak and LOS_S E during the PM Peak
- US 21 Southbound U-turn, northbound through operates at a LOS_S F during the AM and PM Peaks
- US 21 Northbound U-turn, southbound through operates at a LOS_S F during the AM and PM Peaks

A review of the queue data showed that by 2040 the operations under the Alternative 1 Build scenario are anticipated to deteriorate to a level where some queues are affecting the operations of adjacent intersections or freeway segments at only a few locations. As stated previously, one of the primary goals for projects located in the vicinity of freeways is to not allow traffic to queue back onto the freeway such that it affects freeway operations. The maximum queue lengths for traffic on the five exit ramps/loops included in the study is shown as follows:

- I-77 Southbound off ramp to Gilead Road has a maximum queue length of 887 feet (AM) and 256 feet (PM)
- I-77 Northbound off ramp to Gilead Road has a maximum queue length of 142 feet (AM) and 369 feet (PM)

Table 8-2: 2040 Future Year Build Alternative 1 Intersection Measures of Effectiveness

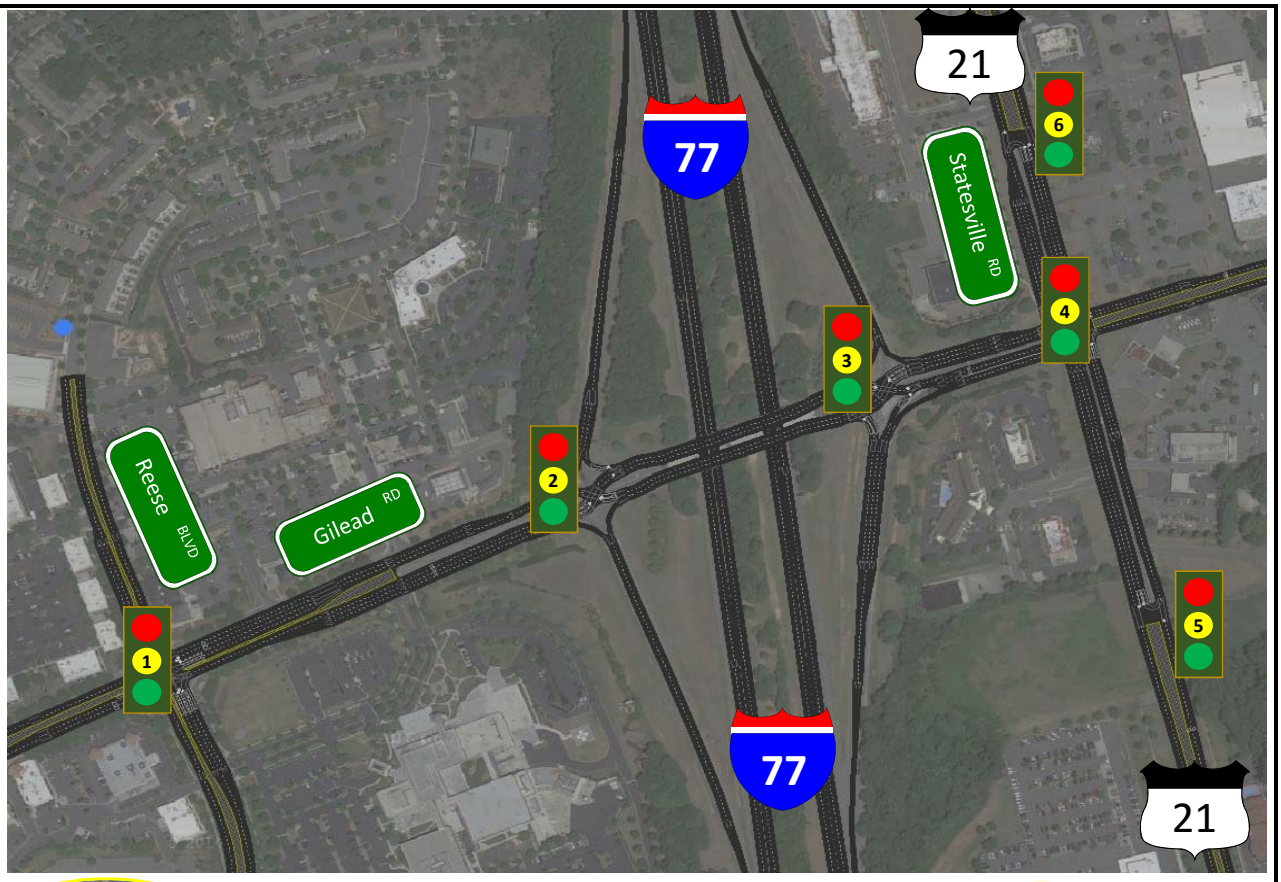
Intersection No.	Intersection	Approach	Lane Group	Delay[1] (s)		Level of Service[2]		95th % Queue (ft)/Spillback Rate		Maximum Queue Length (ft)	
				AM	PM	AM	PM	AM	PM	AM	PM
1	Gilead Rd at Reese Blvd	**Overall**		**27.0**	**122.4**	**C**	**F**				
		Reese Rd Southbound	L	57.5	201.5	E	F	145 (0%)	727 (1%)	231	852
			T/R	45.4	173.6	D	F	157 (0%)	331 (0%)		
		Gilead Rd Westbound	L	49.5	73.0	D	E	182 (0%)	233 (0%)	253	439
			T	13.2	23.3	B	C	145 (0%)	285 (0%)		
			R	2.9	7.4	A	A	64 (0%)	138 (0%)		
		Reese Rd Northbound	L	43.1	125.2	D	F	54 (0%)	113 (0%)	198	1788
			T	39.8	146.1	D	F	67 (0%)	1277 (0%)		
			R	18.0	184.8	B	F	80 (0%)	1341 (0%)		
		Gilead Rd Eastbound	L	48.0	229.3	D	F	53 (0%)	111 (0%)	347	2118
			T	26.3	211.9	C	F	193 (0%)	2267 (8%)		
			T/R	26.6	226.3	C	F	241 (0%)	2108 (19%)		
2	Gilead Rd at I-77 Southbound Ramps	**Overall[3]**		**N/A**	**N/A**	**N/A**	**N/A**				
		I-77 Southbound Off Ramp	L	28.0	41.9	C	D	81 (55%)	86 (71%)	887	256
			R	18.8	18.2	B	B	102 (23%)	91 (17%)		
		Gilead Rd Westbound	L	0.0	0.0	A	A	0 (0%)	0 (0%)	655	689
			T	5.3	5.9	A	A	59 (100%)	57 (100%)		
		Gilead Rd Eastbound	T	12.5	14.3	B	B	75 (86%)	75 (86%)	661	1135
			R	0.0	0.0	A	A	0 (0%)	0 (0%)		
3	Gilead Rd at I-77 Northbound Ramps	**Overall[3]**		**N/A**	**N/A**	**N/A**	**N/A**				
		Gilead Rd Westbound	T	11.2	11.2	B	B	69 (98%)	69 (96%)	440	414
		I-77 Northbound Off Ramp	L	17.6	17.2	B	B	72 (78%)	79 (83%)	142	369
			R	16.4	26.6	B	C	89 (13%)	130 (40%)		
		Gilead Rd Eastbound	L	0.0	0.0	A	A	0 (0%)	0 (0%)	717	743
			T	10.0	10.9	A	B	81 (91%)	81 (94%)		
4	Gilead Rd at US 21 (Statesville Rd)	**Overall**		**47.4**	**34.6**	**D**	**C**				
		US 21 Southbound	T	22.0	15.7	C	B	284 (0%)	293 (0%)	493	503
			R	78.6	42.2	E	D	307 (0%)	278 (0%)		
		Gilead Rd Westbound	T	105.3	62.4	F	E	903 (8%)	564 (0%)	3328	937
			R	75.7	47.3	E	D	340 (0%)	299 (0%)		
		US 21 Northbound	T	40.2	34.9	D	C	565 (0%)	453 (0%)	711	589
			R	30.9	28.0	C	C	176 (0%)	213 (0%)		
		Gilead Rd Eastbound	T	38.6	44.0	D	D	259 (64%)	261 (79%)	377	390
			R	25.6	31.7	C	C	252 (13%)	256 (33%)		
5	US 21 (Statesville Rd) at Southbound U-turn	**Overall**		**114.3**	**223.7**	**F**	**F**				
		US 21 Southbound	U	97.0	67.2	F	E	311 (0%)	267 (0%)	560	539
		US 21 Northbound	T	244.2	569.8	F	F	1198 (0%)	1565 (0%)	6480	11806
6	US 21 (Statesville Rd) at Northbound U-turn	**Overall**		**170.5**	**46.9**	**F**	**D**				
		US 21 Southbound	T	387.1	98.2	F	F	1034 (0%)	1048 (0%)	7864	6489
		US 21 Northbound	U	36.3	39.5	D	D	53 (0%)	56 (0%)	301	341

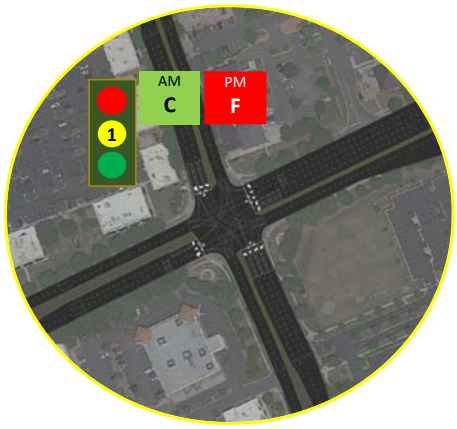
Notes:

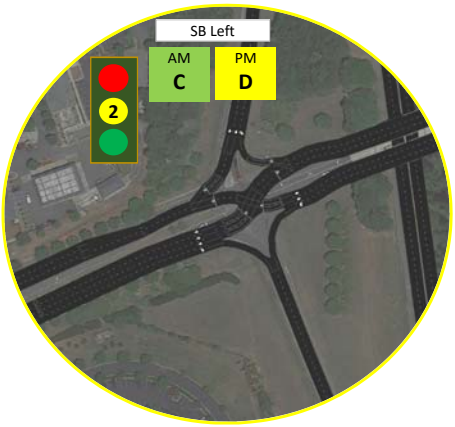
1 Delay shown is the 95th percentile worst case control delay for the full 60-minute simulation period as derived from the 10 random seed simulations

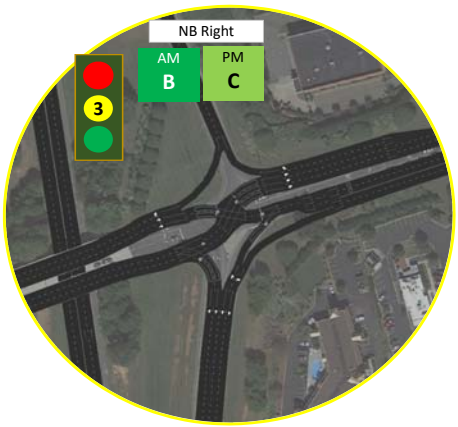
2 Level of Service shown is Simulation based and calculated in a manner that is consistent with the HCM 2010 Methodologies

3 Diverging Diamond Interchange ramp terminals include three nodes that operate with a single signal controller, therefore overall intersection LOS is not applicable

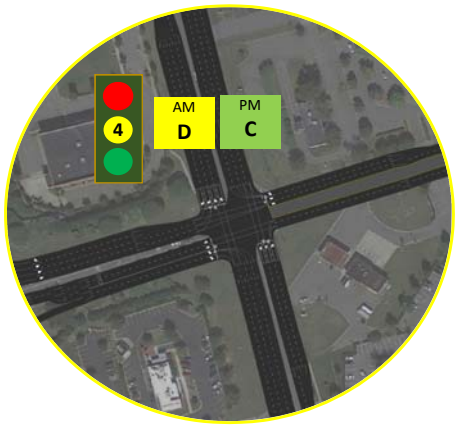


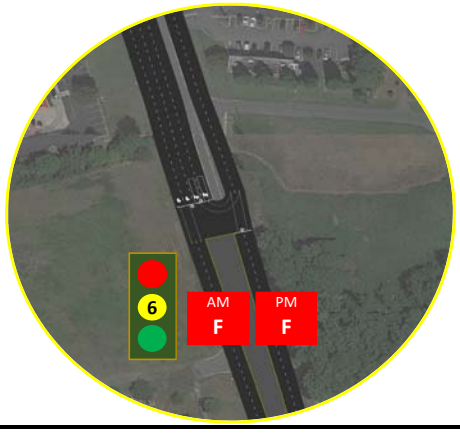


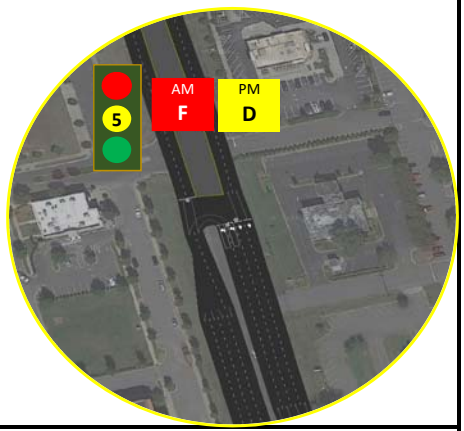




Given that overall LOS is not applicable for DDI ramp terminals, the LOS for the worst lane group for each peak hour are shown above







STIP Project No. I-5714 **I-77 Interchange Improvements** **Mecklenburg County**	**Figure 8-4**	**2040 Future Year Build Alternative 1 Intersection Measures of Effectivenes**	Prepared By: **Patriot Transportation Engineering, PLLC** 3008 Anderson Drive, Suite 120 Raleigh, North Carolina 27609 (919)977-9125

8.9 2040 FUTURE YEAR ALTERNATIVE 2 BUILD MODEL RESULTS

The output data was extracted from the TransModeler model via the Output Manager using the Delay, Queue and Queue Spillback reports. The outputs were collected in accordance with the MOEs defined in Section 4 and are summarized in the following sections.

8.9.1 FREEWAY RESULTS – ALTERNATIVE 2

The results of the freeway analysis for Alternative 2 are included in Table 8-3 and Figure 8-5. During the AM peak period for the 2040 Build Alternative 2 scenario, 3 of 10 analysis segments are anticipated to operate at LOS_S C, 2 of 10 analysis segments are anticipated to operate at LOS_S D, 1 of 10 analysis segments is anticipated to operate at LOS_S E, and 4 of 10 analysis segments are anticipated to operate at LOS_S F. During the PM peak period for the 2040 Build Alternative 2 scenario, 7 of 10 analysis segments are anticipated to operate at LOS_S D, 1 of 10 analysis segments is anticipated to operate at LOS_S E, and 2 of 10 analysis segments are anticipated to operate at LOS_S F. Based on the results the following freeway segments are anticipated to operate at LOS_S E or F under the 2040 Build Alternative 2 Scenario:

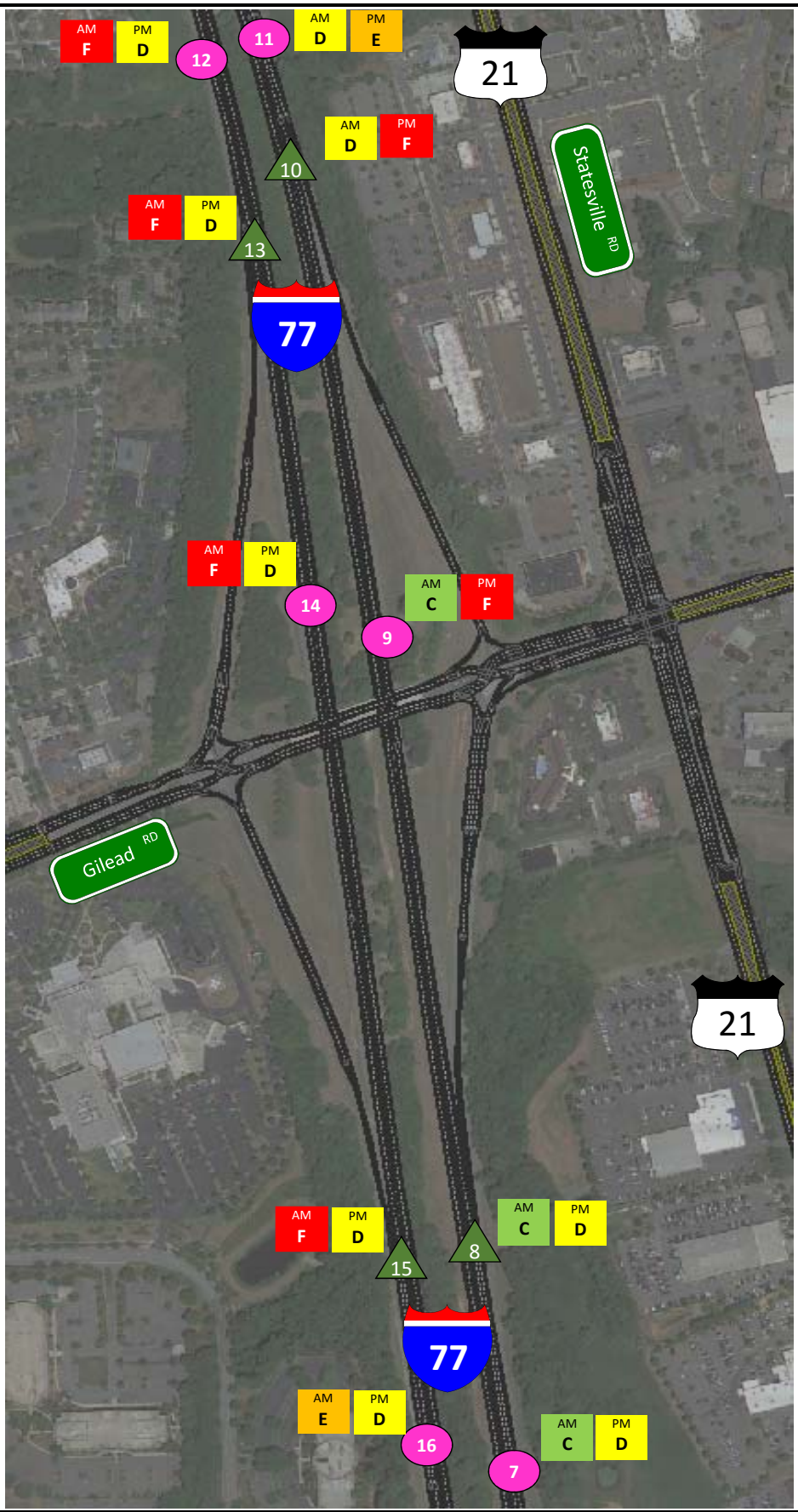
- I-77 Northbound, between the Gilead Road ramps is operating at LOS_S F during the PM Peak
- I-77 Northbound, merge from Gilead Road is operating at LOS_S F during the PM Peak
- I-77 Northbound, north of Gilead Road is operating at LOS_S E during the PM Peak
- I-77 Southbound, north of Gilead Road is operating at LOS_S F during the AM Peak
- I-77 Southbound, diverge to Gilead Road is operating at LOS_S F during the AM Peak
- I-77 Southbound, between the Gilead Road ramps is operating at LOS_S F during the AM Peak
- I-77 Southbound, merge from Gilead Road is operating at LOS_S F during the AM Peak
- I-77 Southbound, south of Gilead Road is operating at LOS_S E during the AM Peak

Table 8-3: 2040 Future Year Build Alternative 2 Freeway Measures of Effectiveness

Segment No.	Type	Description	Density		Level of Service[1]	
			AM	PM	AM	PM
7	BFS	I-77 Northbound, south of Gilead Road	20.9	27.0	C	D
8	Diverge	I-77 Northbound to Gilead Road	20.4	30.0	C	D
9	BFS	I-77 Northbound, between Gilead Road Ramps	24.5	52.7	C	F
10	Merge	I-77 Northbound from Gilead Road	30.7	47.6	D	F
11	BFS	I-77 Northbound, north of Gilead Road	29.7	36.3	D	E
12	BFS	I-77 Southbound, north of Gilead Road	55.1	28.0	F	D
13	Diverge	I-77 Southbound to Gilead Road	59.1	30.6	F	D
14	BFS	I-77 Southbound, between Gilead Road Ramps	67.9	27.3	F	D
15	Merge	I-77 Southbound, from Gilead Rd	58.6	30.1	F	D
16	BFS	I-77 Southbound, south of Gilead Road	39.5	33.1	E	D

Notes:

1 Level of Service shown is Simulation based and calculated in a manner that is consistent with the HCM 2010 Methodologies



STIP Project No. I-5714
I-77 Interchange Improvements
Mecklenburg County

Figure 8-5

2040 Future Year Build Alternative 2 Freeway Measures of Effectivenes

PATRIOT TRANSPORTATION ENGINEERING, PLLC

Prepared By:
Patriot Transportation Engineering, PLLC
3008 Anderson Drive, Suite 120
Raleigh, North Carolina 27609
(919)977-9125

8.9.2 ARTERIAL/INTERSECTION RESULTS – ALTERNATIVE 2

The results of the intersection analysis along the arterial portions of the study area are included in Table 8-4 and Figure 8-6. Given the design of a DDI, the ramp terminals include multiple intersections, which make determining an overall LOS not practical. The overall intersection LOS_S for the signalized intersections in the 2040 Future Year Build Alternative 2 scenario shows that 3 of the 4 signals are anticipated to operate at LOS_S D or better. During the AM peak period and 2 of 4 intersections are anticipated to operate at LOS_S D, and 2 of 4 intersections are anticipated to operate at LOS_S F. During the PM peak period 2 of 4 intersections are anticipated to operate at LOS_S D, and 2 of 4 intersections are anticipated to operate at LOS_S F.

Based on a review of the intersection operations at the lane group level, the following movements are anticipated to operate at LOS_S E or F in the 2040 Future Year No-Build scenario:

- Gilead Road at Reese Boulevard, southbound left operates at LOS_S F during the AM and PM Peaks
- Gilead Road at Reese Boulevard, southbound through/right operates at LOS_S F during the AM Peak and LOS_S E during the PM Peak
- Gilead Road at Reese Boulevard, westbound left operates at LOS_S E during the PM Peak
- Gilead Road at Reese Boulevard, northbound left operates at LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, northbound through operates at LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, northbound right operates at LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, eastbound left operates at LOS_S E during the AM Peak and LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, eastbound through operates at LOS_S E during the AM Peak and LOS_S F during the PM Peak
- Gilead Road at Reese Boulevard, eastbound through/right operates at LOS_S E during the AM Peak and LOS_S F during the PM Peak
- Gilead Road at US 21, southbound right operates at LOS_S E during the AM Peak
- Gilead Road at US 21, westbound through operates at LOS_S F during the AM Peak and LOS_S E during the PM Peak
- Gilead Road at US 21, westbound right operates at LOS_S E during the AM Peak
- US 21 Southbound U-turn, southbound U-turn operates at a LOS_S F during the AM Peak and LOS_S E during the PM Peak
- US 21 Southbound U-turn, northbound through operates at a LOS_S F during the AM and PM Peaks
- US 21 Northbound U-turn, southbound through operates at a LOS_S F during the AM and PM Peaks

A review of the queue data showed that by 2040 the operations under the Alternative 2 Build scenario are anticipated to deteriorate to a level where some queues are affecting the operations of adjacent intersections or freeway segments at only a few isolated locations. As stated previously, one of the primary goals for projects located in the vicinity of freeways is to not allow traffic to queue back onto the freeway such that it affects freeway operations. The maximum queue lengths for traffic on the five exit ramps/loops included in the study is shown as follows:

- I-77 Southbound off ramp to Gilead Road has a maximum queue length of 923 feet (AM) and 117 feet (PM)
- I-77 Northbound off ramp to Gilead Road has a maximum queue length of 186 feet (AM) and 192 feet (PM)

Table 8-4: 2040 Future Year Build Alternative 2 Intersection Measures of Effectiveness

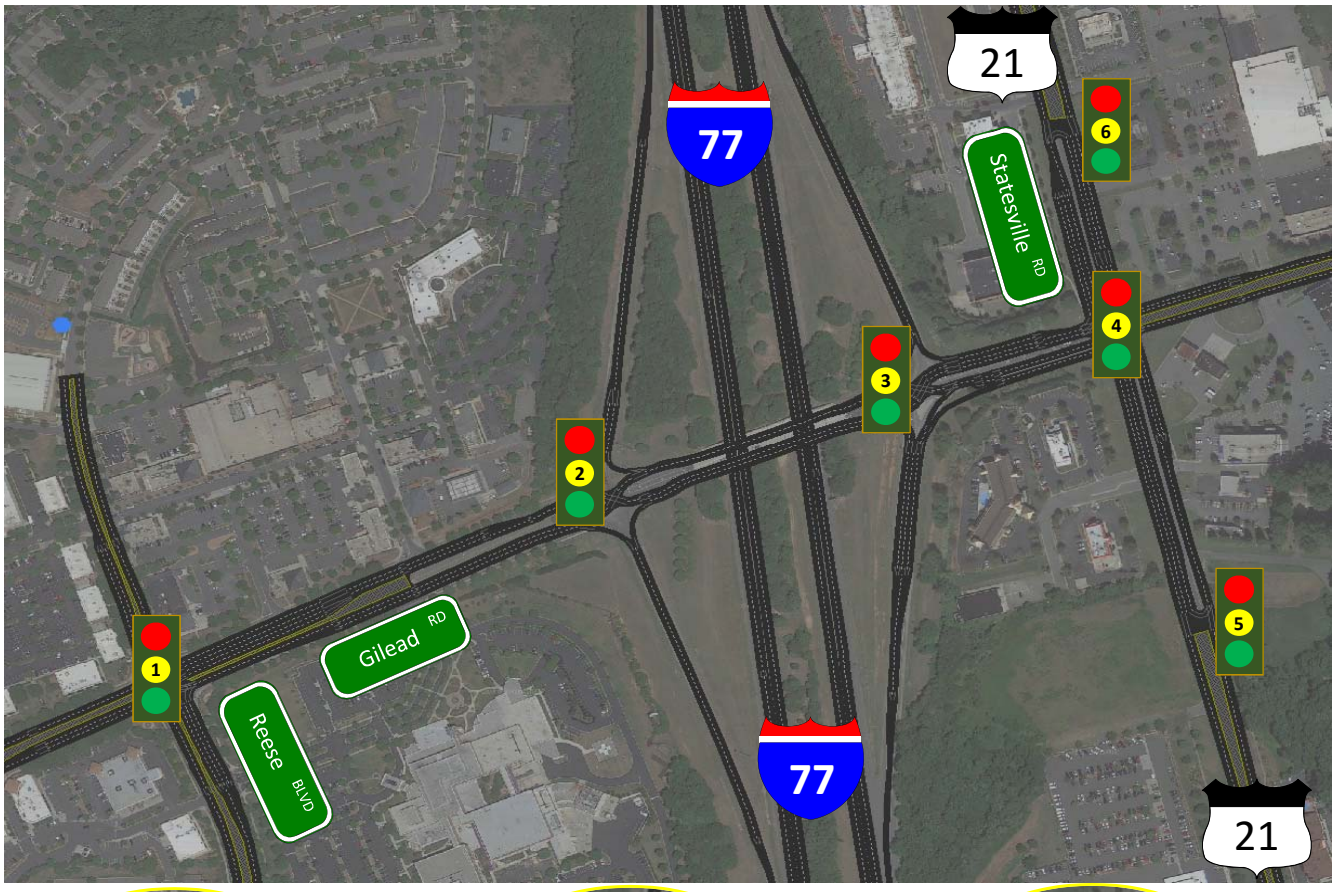
Intersection No.	Intersection	Approach	Lane Group	Delay[1] (s)		Level of Service[2]		95th % Queue (ft)/Spillback Rate		Maximum Queue Length (ft)	
				AM	PM	AM	PM	AM	PM	AM	PM
1	Gilead Rd at Reese Blvd	**Overall**		**46.8**	**146.6**	**D**	**F**				
		Reese Rd Southbound	L	188.0	87.7	F	F	802 (31%)	221 (0%)	812	288
			T/R	121.5	78.7	F	E	171 (0%)	193 (0%)		
		Gilead Rd Westbound	L	49.5	70.0	D	E	168 (0%)	225 (0%)	293	410
			T	13.8	22.4	B	C	154 (0%)	276 (0%)		
			R	2.6	7.1	A	A	62 (0%)	154 (0%)		
		Reese Rd Northbound	L	38.6	144.2	D	F	57 (0%)	104 (0%)	212	1765
			T	42.4	161.5	D	F	64 (0%)	1206 (0%)		
			R	23.6	222.7	C	F	131 (0%)	1588 (0%)		
		Gilead Rd Eastbound	L	69.1	378.8	E	F	63 (0%)	163 (0%)	1064	2120
			T	70.1	358.3	E	F	718 (0%)	2109 (21%)		
			T/R	67.6	352.4	E	F	784 (0%)	2108 (19%)		
2	Gilead Rd at I-77 Southbound Ramps	**Overall[3]**		**N/A**	**N/A**	**N/A**	**N/A**				
		I-77 Southbound Off Ramp	L	18.1	20.8	B	C	76 (45%)	74 (57%)	923	117
			R	19.0	18.1	B	B	100 (21%)	97 (17%)		
		Gilead Rd Westbound	L	0.0	0.0	A	A	0 (0%)	0 (0%)	687	693
			T	5.3	5.8	A	A	60 (100%)	57 (100%)		
		Gilead Rd Eastbound	T	10.4	10.6	B	B	86 (96%)	76 (96%)	1160	1165
			R	0.0	0.0	A	A	0 (0%)	0 (0%)		
3	Gilead Rd at I-77 Northbound Ramps	**Overall[3]**		**N/A**	**N/A**	**N/A**	**N/A**				
		Gilead Rd Westbound	T	10.9	11.2	B	B	68 (97%)	67 (98%)	433	437
		I-77 Northbound Off Ramp	L	18.0	17.3	B	B	74 (77%)	76 (79%)	186	192
			R	14.6	17.1	B	B	96 (8%)	116 (26%)		
		Gilead Rd Eastbound	L	0.0	0.0	A	A	0 (0%)	0 (0%)	741	714
			T	10.6	11.0	B	B	83 (90%)	86 (93%)		
4	Gilead Rd at US 21 (Statesville Rd)	**Overall**		**47.1**	**36.0**	**D**	**D**				
		US 21 Southbound	T	24.2	15.3	C	B	297 (0%)	257 (0%)	491	514
			R	75.6	38.7	E	D	294 (0%)	284 (1%)		
		Gilead Rd Westbound	T	109.1	55.0	F	E	904 (8%)	481 (0%)	3607	725
			R	77.3	44.2	E	D	290 (0%)	315 (0%)		
		US 21 Northbound	T	44.0	34.2	D	C	560 (0%)	421 (0%)	729	681
			R	33.8	27.9	C	C	138 (0%)	191 (0%)		
		Gilead Rd Eastbound	T	35.7	41.2	D	D	256 (50%)	260 (65%)	314	362
			R	23.8	30.9	C	C	198 (2%)	252 (17%)		
5	US 21 (Statesville Rd) at Southbound U-turn	**Overall**		**128.1**	**231.1**	**F**	**F**				
		US 21 Southbound	U	99.2	61.4	F	E	305 (0%)	244 (0%)	537	504
		US 21 Northbound	T	292.6	551.9	F	F	1206 (0%)	1449 (0%)	7535	11805
6	US 21 (Statesville Rd) at Northbound U-turn	**Overall**		**173.1**	**44.9**	**F**	**D**				
		US 21 Southbound	T	381.1	91.5	F	F	1082 (0%)	918 (0%)	7863	5320
		US 21 Northbound	U	36.9	35.7	D	D	58 (0%)	51 (0%)	295	231

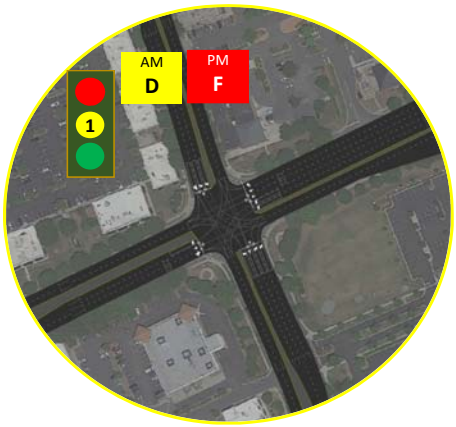
Notes:

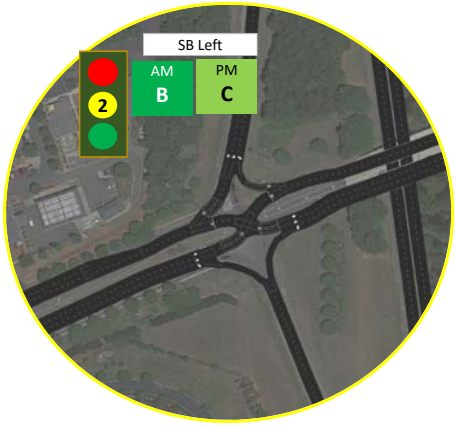
1 Delay shown is the 95th percentile worst case control delay for the full 60-minute simulation period as derived from the 10 random seed simulations

2 Level of Service shown is Simulation based and calculated in a manner that is consistent with the HCM 2010 Methodologies

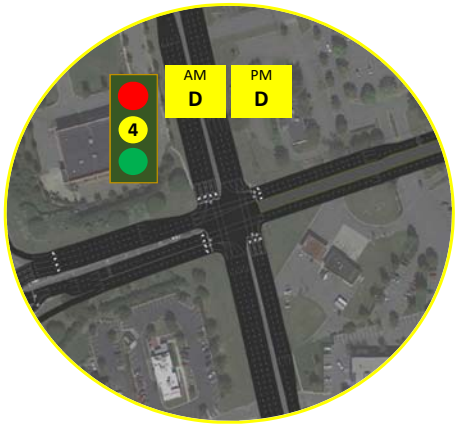
3 Diverging Diamond Interchange ramp terminals include three nodes that operate with a single signal controller, therefore overall intersection LOS is not applicable

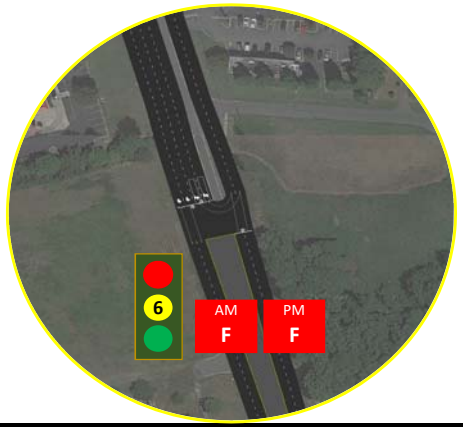


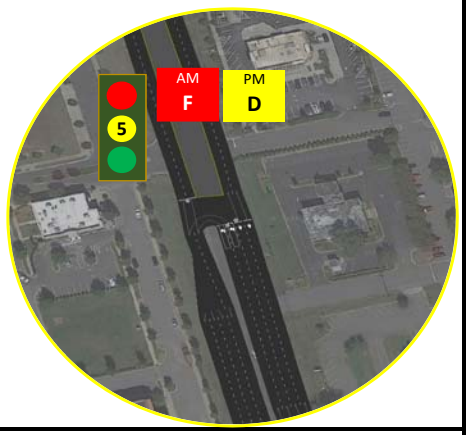




Given that overall LOS is not applicable for DDI ramp terminals, the LOS for the worst lane group for each peak hour are shown above







STIP Project No. I-5714 **I-77 Interchange Improvements** **Mecklenburg County**	**Figure 8-6**	**2040 Future Year Build Alternative 2 Intersection Measures of Effectivenes**	Prepared By: **Patriot Transportation Engineering, PLLC** 3008 Anderson Drive, Suite 120 Raleigh, North Carolina 27609 (919)977-9125

9. CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the analysis it is recommended that Build Alternative 1 be constructed for STIP Project Number I-5714 as it provides the best operations within the study area. Overall, both of the Build Alternatives operate about the same for the I-77 Corridor with LOS_S F in the southbound direction during the AM peak and LOS_S F in the northbound direction during the PM peak. The I-77/Gilead Road interchange operates slightly better for Alternative 1 with the additional eastbound lane allowing for improved operations for eastbound traffic along Gilead Road and to I-77 Northbound. The primary benefit of Alternative 1 is that it allows for substantially lower queue lengths to the west of the I-77 ramp terminal, allowing for substantially improved operations for Reese Boulevard. For Alternative 2, the eastbound queues at the I-77 Southbound ramp terminal extend all the way back to Reese Boulevard and do not allow all of the traffic turning from Reese Boulevard to access Gilead Road due to the queuing. The overall delay at the Gilead Road/Reese Boulevard intersection is decreased by over 20 seconds for Alternative 1 with several individual lane groups having over a 100-second improvement in delay.

The traffic operations analysis showed that the DDI would work well for the 2040 traffic; however, the operations are closely tied to the operations of the US 21/Gilead Road intersection. In order for the 2040 analysis to operate acceptably the median u-turn configuration along US 21 was used to meter traffic into the interchange area. The segment of Gilead Road westbound between US 21 and I-77 was found to be the critical link in the operations of the interchange and the operations were optimized when the signal was coordinated such that the US 21 Southbound movement to Gilead Road was coordinated with the westbound movement along Gilead Road through the DDI. For the interchange to operate efficiently, the coordination should advance from US 21 SB to Gilead Road Westbound and the US 21 u-turn signals should be timed such that they do not allow the US 21/Gilead Road intersection to be overloaded.

APPENDIX A:

TRAFFIC FORECAST

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

PAT MCCRORY
GOVERNOR

ANTHONY J. TATA
SECRETARY

April 21, 2015

MEMORANDUM TO: Elmo Vance
Project Development - Western Region/Turnpike
Project Development and Environmental Analysis

FROM: Keith G. Dixon
Western Traffic Forecasting Group
Transportation Planning Branch

SUBJECT: Traffic Forecast for I-5714 / I-5715
Mecklenburg County
Interchange Improvements at I-77 / SR 2136-Gilead Rd and I-77 / NC 73-Sam Furr Rd

Please find attached the 2015 / 2020 / 2040 traffic forecast for I-5714 / I-5715. This forecast concerns improvements to the I-77 interchanges at SR 2136-Gilead Rd and NC 73-Sam Furr Rd.

This forecast was requested by Elmo Vance, of Project Development, on October 23, 2014. A delivery date of April 23, 2015 was established based upon Transportation Planning Branch standards.

This is the first known traffic forecast for I-5714 and I-5715.

This project is located within the Charlotte Regional Transportation Planning Organization (CRTPO) area.

A traffic forecast scoping meeting was held with the forecast requestor on Tuesday, November 4th, 2014. Also present at this meeting was Peter Trencansky, of Patriot Transportation Engineering; Teresa Gresham, of Kimley-Horn; and Jim Dunlop, of NCDOT Congestion Management.

At this meeting it was decided to proceed with the collection of counts and the forecast prior to the opening of I-485 due to various scheduling issues. Also, it was decided to use the Metrolina Regional Travel Demand Model, 2014, Version 1.0 (MRM14v1.0) to estimate the effects of the opening of I-485, Section E, in 2015.

Additionally, it was explained that none of the specific design improvements are to be included in the forecast. Therefore, all of the traffic forecast scenarios are essentially No Build scenarios. Congestion Management intends to use TransModeler to create Build scenarios from the No Build forecasts; TPB is just forecasting travel demand.

MAILING ADDRESS:
NC DEPARTMENT OF TRANSPORTATION
TRANSPORTATION PLANNING BRANCH
1554 MAIL SERVICE CENTER
RALEIGH NC 27699-1554

NCDOT TPB
TRANSPORTATION PLANNING BRANCH
http://ncdot.org/doh/preconstruct/tpb/

LOCATION:
TRANSPORTATION BUILDING
1 SOUTH WILMINGTON STREET
RALEIGH, NC 27601
Phone: 919-707-0900
Fax: 919-733-9794

Based upon this information the following forecast scenarios were agreed to:

- 2015 No Build
- 2015 No Build with I-485, Section E
- 2020 No Build without Westmoreland Rd Interchange
- 2020 No Build with Westmoreland Rd Interchange
- 2040 No Build without Westmoreland Rd Interchange
- 2040 No Build with Westmoreland Rd Interchange

Note: All of the 2020 and 2040 scenarios include the I-77 managed lanes and ramp volumes for the ingress and egress points. The ingress and egress point are consistent with documentation provided by Cintra and I-77 Mobility Partners on November 19, 2014.

The following people were contacted during the development of this traffic forecast:

- Anil Panicker, NCDOT CRTPO Planning Coordinator
- Stuart Basham, NCDOT Division 10 Planning Engineer
- David Peete, Principal Planner, Town of Huntersville
- Wayne Herron, Planning Director, Town of Cornelius
- Bill Coxe, Transportation Planner, Town of Huntersville
- Caroline Sawyer, Planning Technician, Town of Huntersville
- Scott Kieger, Design Resource Group, Apartments at Holly Crest

Interpolation:

To estimate AADT for intermediate years, a straight-line interpolation of traffic volumes may be used between the 2015 No Build with I-485, Section E, and the 2020 and 2040 No Build without Westmoreland Interchange forecast scenarios, and between the 2020 and 2040 No Build with Westmoreland Interchange scenarios.

Certain Assumptions were made during the development of this forecast.

Fiscal Constraint:

For projects falling inside an MPO, forecasts are fiscally constrained to the MPO's Metropolitan Transportation Plan (MTP). This means that only projects scheduled in the MTP are considered constructed and open to traffic in the future year.

In the 2020 scenarios, all projects documented in the CRTPO 2040 MTP that are scheduled to be complete and open to traffic by 2020 are included in the Metrolina Regional Model 2014, Version 1.0 (MRM14v1.0) runs used to produce the forecast.

In the 2040 scenarios, all projects documented in the CRTPO 2040 MTP that are scheduled to be complete and open to traffic by 2040 are included in the MRM14v1.0 runs used to produce the forecast.

Development Activity:

The Apartments at Holly Crest is currently under construction with 402 units and will be accessed via Holly Point Drive and Rich Hatchett Road. No units are currently available. This development is considered to be complete and open by 2020 and is included in the 2020 and 2040 forecast scenarios.

There are currently no other specific plans for any substantial development within the forecast area beyond the development and growth estimated in the 2025 and 2040 SE data used with the MRM14v1.0.

Note: The Augustalee development was not specifically added to the adopted SE Data used to produce this forecast.

Forecast Methodology:

2015 No Build traffic volumes and traffic factor estimates are based upon current counts and historic AADT trends projected to 2015.

AADT volumes in the 2020 and 2040 scenarios were estimated based upon annual growth rates derived from the MRM14v1.0 output.

If it is determined that any of these assumptions have become inconsistent with the project and surrounding area activity, please request an updated forecast at this location.

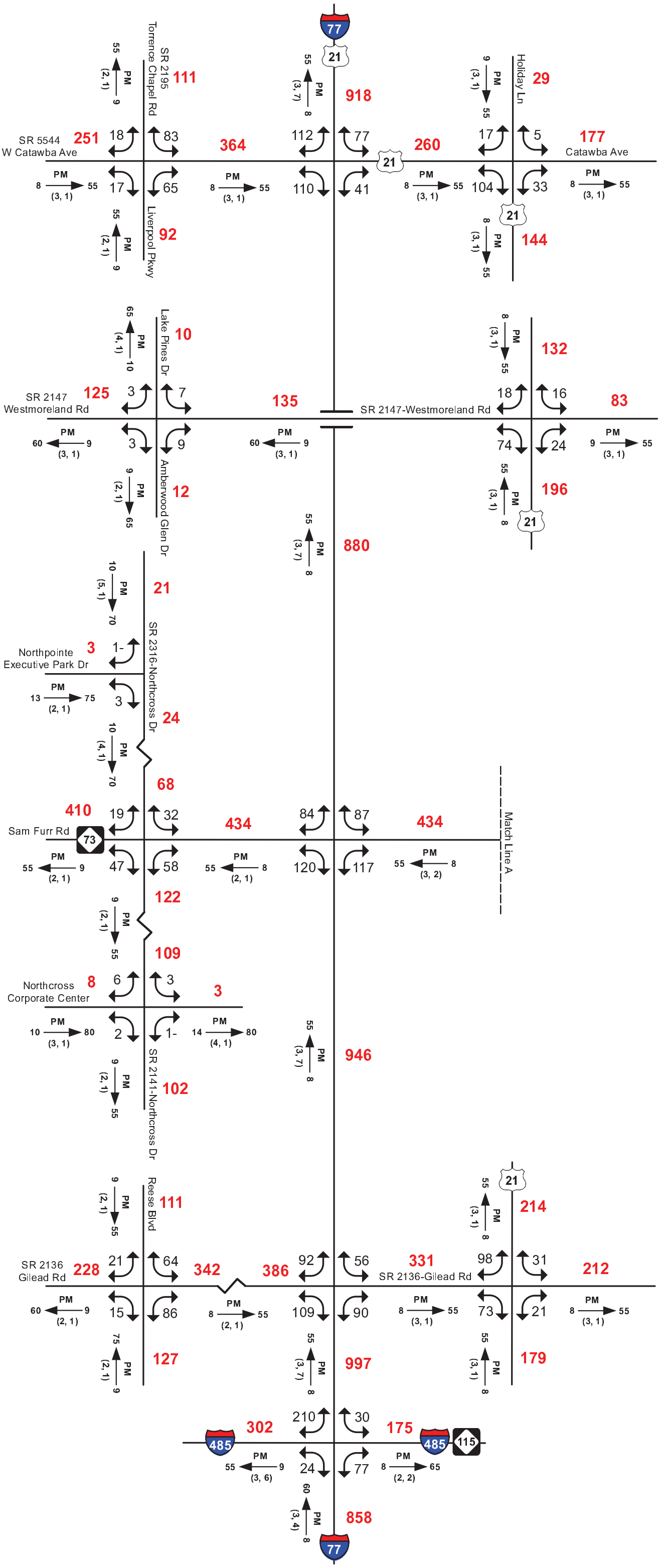
For future reference, this forecast will be saved in Project Store under I5714 and I-5715 in the LongRangePlanning\Traffic Forecasts folder.

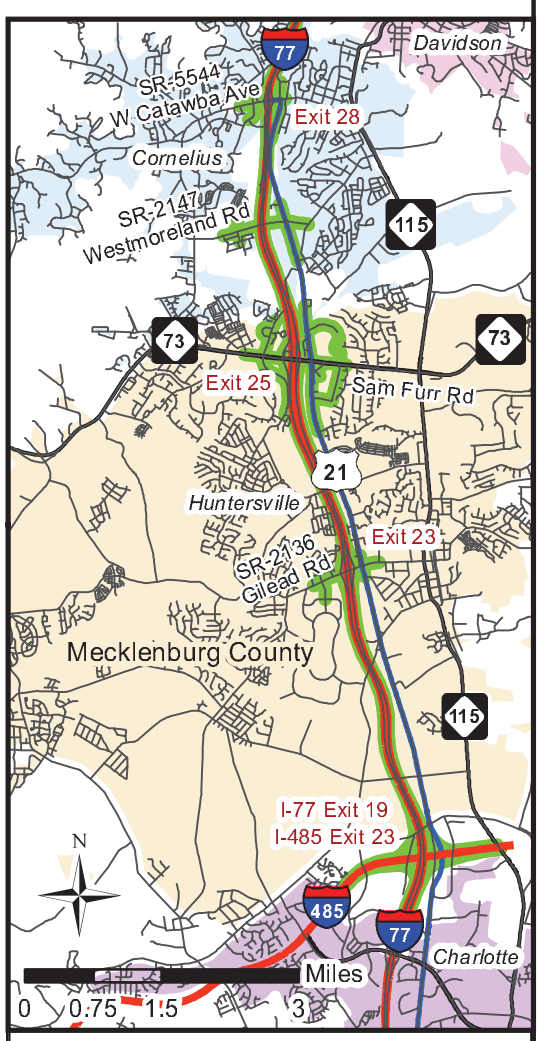
If we can be of any further assistance on this project please do not hesitate to contact me at 919-707-0984, email: kdixon1@ncdot.gov or Michael Orr at 919-707-0982, email: mlorr@ncdot.gov.

CC (with Attachments):

Glen Mumford, PE, Roadway Design
Jamal Alavi, PE, Transportation Planning Branch
James Dunlop, PE, Congestion Management
Clark Morrison, PhD, PE, Pavement Management
Stuart Basham, Division 10 Planning Engineer
Robert W. Cook, AICP, CRTPO Secretary
Anil Panicker, NCDOT CRTPO Coordinator
State Traffic Forecast Engineer, Transportation Planning Branch

File Copy: I-5714 / I-5715 Mecklenburg County





2015 ANNUAL AVERAGE DAILY TRAFFIC

No Build
without I-485, Section E
(R-2248E)

SHEET 1 - 1

L E G E N D

DHV — PM (d, t) → D

###	No. of Vehicles Per Day (VPD) in 100s
1-	Less than 50 VPD
X	Movement Prohibited
------	Roadway
DHV	Design Hourly Volume
PM	PM Peak Period
D	Peak Hour Directional Split Indicates Direction of D
(d,t)	Duals, TT-STs (%)

TIP: I-5714 / I-5715 | **WBS:** 50127.1.FS1 50128.1.FS1

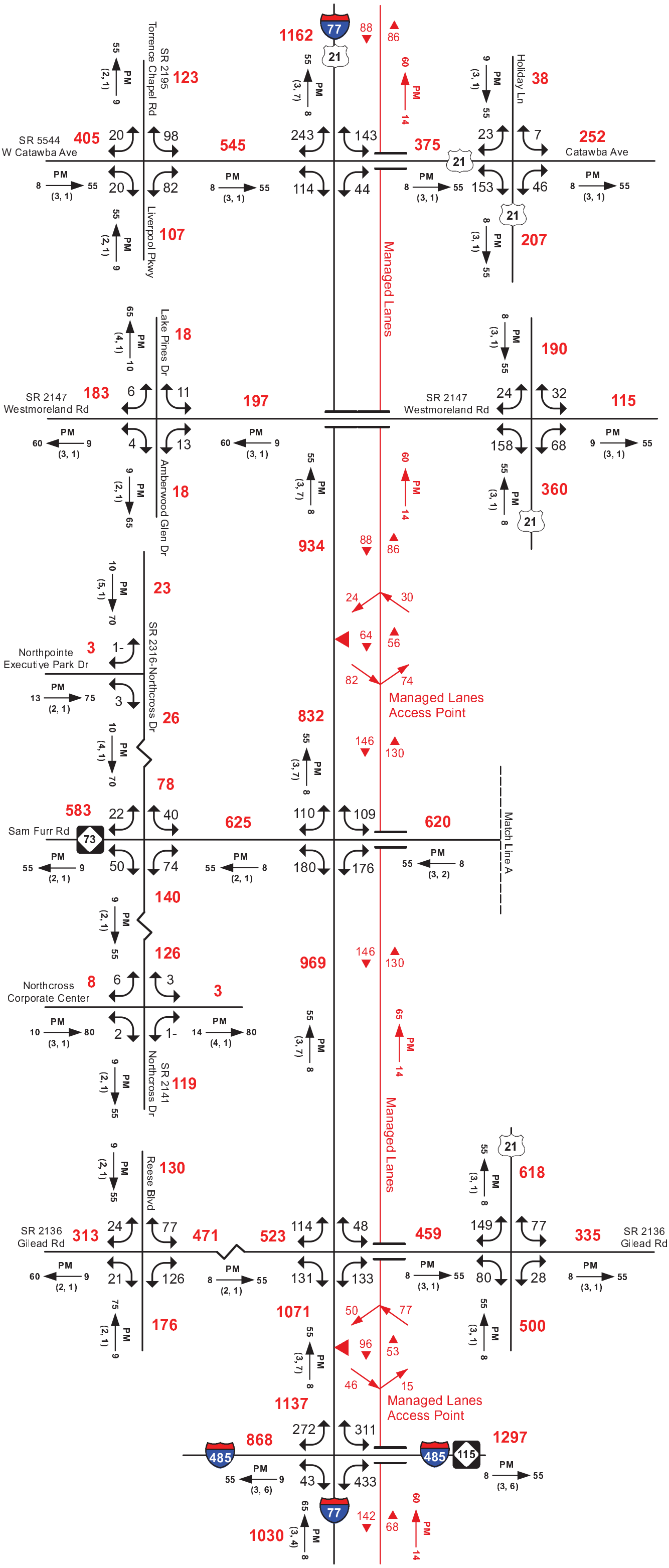
COUNTY: Mecklenburg | **DIVISION:** 10

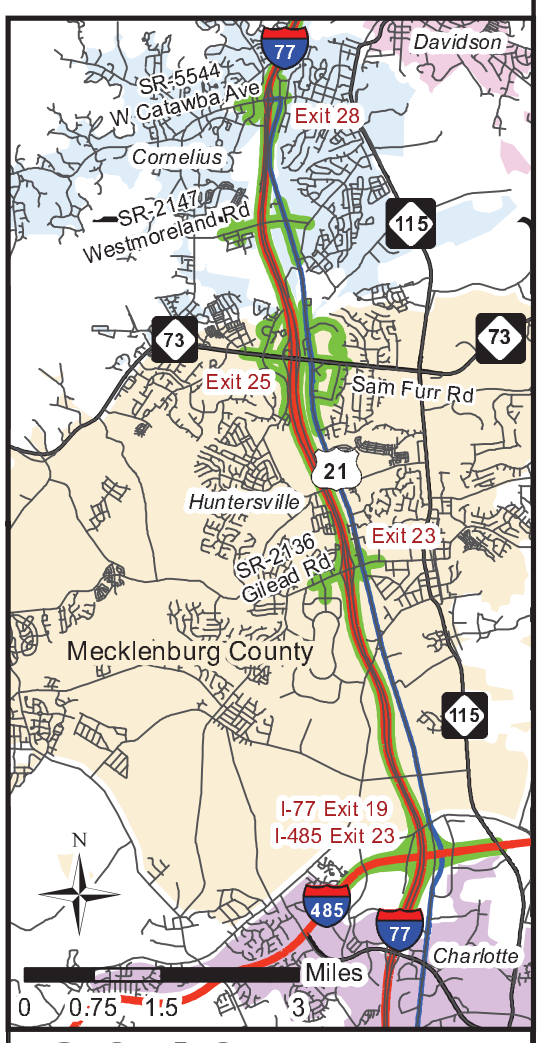
DATE: 04-21-2015

PREPARED BY: Keith Dixon

LOCATION:
I-77 Corridor from I-485 to Catawba Ave

PROJECT: Interchange Improvements at NC 73 and Gilead Rd





2040 ANNUAL AVERAGE DAILY TRAFFIC

No Build
without Westmoreland Interchange

SHEET 5 - 1

L E G E N D

DHV — PM (d, t) — D

###	No. of Vehicles Per Day (VPD) in 100s
1-	Less than 50 VPD
X	Movement Prohibited
------	Roadway
DHV	Design Hourly Volume
PM	PM Peak Period
D	Peak Hour Directional Split Indicates Direction of D
(d,t)	Duals, TT-STs (%)

TIP: I-5714 / I-5715 | **WBS:** 50127.1.FS1, 50128.1.FS1

COUNTY: Mecklenburg | **DIVISION:** 10

DATE: 04-21-2015

PREPARED BY: Keith Dixon

LOCATION:
I-77 Corridor from I-485 to Catawba Ave

PROJECT: Interchange Improvements at NC 73 and Gilead Rd

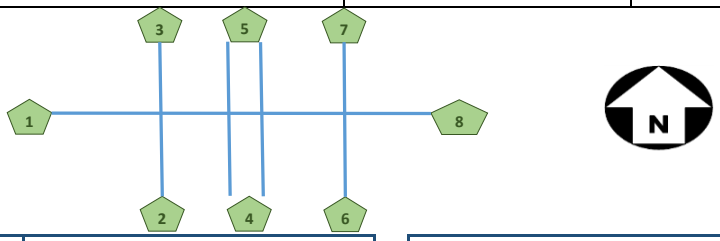
APPENDIX B:

INTERSECTION ANALYSIS UTILITY OUTPUT

AND

ORIGIN-DESTINATION MATRICES

TIP No.	I-5714	WBS No.	50127.1.FS1	County:	Mecklenburg	Division:	10
Route No.	I-77		Cross Street/Limits	Gilead Road			



Manual ODME Volumes

2015

AM Peak O-D Matrix

	1	2	3	4	5	6	7	8	Total
1	0	142	153	239	171	129	150	245	1229
2	34	0	78	44	32	24	28	45	285
3	77	164	0	53	38	29	34	55	450
4	161	124	72	0	2966	69	81	132	3605
5	142	110	63	3679	0	46	54	86	4180
6	81	63	36	70	36	0	292	72	650
7	125	97	56	108	56	387	0	122	951
8	204	159	91	175	93	97	123	0	942
Total	824	859	549	4368	3392	781	762	757	12292

PM Peak O-D Matrix

	1	2	3	4	5	6	7	8	Total
1	0	34	77	161	142	81	125	204	824
2	142	0	164	124	110	63	97	159	859
3	153	78	0	71	63	37	56	92	550
4	239	44	53	0	3679	70	108	175	4368
5	171	32	38	2966	0	36	56	93	3392
6	129	24	29	70	46	0	387	97	782
7	150	28	34	81	54	292	0	123	762
8	245	45	55	132	86	72	122	0	757
Total	1229	285	450	3605	4180	651	951	943	12294

Calibrated Matrices

2015

AM Peak O-D Matrix

	1	2	3	4	5	6	7	8	Total
1		28	11	624	150	135	51	239	1238
2	5		40	66	39	26	11	21	208
3	0	134		150	62	49	16	36	447
4	129	134	51		2952	112	152	117	3647
5	28	63	0	3153		93	12	36	3385
6	21	20	12	14	78		242	25	412
7	79	104	0	341	21	440		37	1022
8	140	129	6	260	146	117	73		871
Total	402	612	120	4608	3448	972	557	511	11230

PM Peak O-D Matrix

	1	2	3	4	5	6	7	8	Total
1		20	114	226	109	101	67	254	891
2	127		191	129	146	60	76	109	838
3	130	48		104	83	60	35	89	549
4	213	70	67		3121	94	192	127	3884
5	240	30	61	2977		38	110	148	3604
6	78	12	25	5	101		329	25	575
7	136	36	7	148	21	340		127	815
8	296	39	20	147	129	44	216		891
Total	1220	255	485	3736	3710	737	1025	879	12047

Calibrated Matrices factored to match ODME Totals

2015

AM Peak O-D Matrix

	1	2	3	4	5	6	7	8	Total
1	0	31	12	683	164	148	56	262	1356
2	5	0	44	72	43	28	12	23	227
3	0	147	0	164	68	54	18	39	490
4	141	147	56	0	3231	123	166	128	3992
5	31	69	0	3451	0	102	13	39	3705
6	23	22	13	15	85	0	265	27	450
7	86	114	0	373	23	482	0	40	1118
8	153	141	7	285	160	128	80	0	954
Total	439	671	132	5043	3774	1065	610	558	12292

PM Peak O-D Matrix

	1	2	3	4	5	6	7	8	Total
1	0	20	116	231	111	103	68	259	908
2	130	0	195	132	149	61	78	111	856
3	133	49	0	106	85	61	36	91	561
4	217	71	68	0	3185	96	196	130	3963
5	245	31	62	3038	0	39	112	151	3678
6	80	12	26	5	103	0	336	26	588
7	139	37	7	151	21	347	0	130	832
8	302	40	20	150	132	45	220	0	909
Total	1246	260	494	3813	3786	752	1046	898	12295

Average of ODME and Calibrated Matrices

2015

AM Peak O-D Matrix

	1	2	3	4	5	6	7	8	Total
1	0	87	83	461	168	139	103	254	1295
2	20	0	61	58	38	26	20	34	257
3	39	156	0	109	53	42	26	47	472
4	151	136	64	0	3099	96	124	130	3800
5	87	90	32	3565	0	74	34	63	3945
6	52	43	25	43	61	0	279	50	553
7	106	106	28	241	40	435	0	81	1037
8	179	150	49	230	127	113	102	0	950
Total	634	768	342	4707	3586	925	688	659	12309

PM Peak O-D Matrix

	1	2	3	4	5	6	7	8	Total
1	0	27	97	196	127	92	97	232	868
2	136	0	180	128	130	62	88	135	859
3	143	64	0	89	74	49	46	92	557
4	228	58	61	0	3432	83	152	153	4167
5	208	32	50	3002	0	38	84	122	3536
6	105	18	28	38	75	0	362	62	688
7	145	33	21	116	38	320	0	127	800
8	274	43	38	141	109	59	171	0	835
Total	1239	275	475	3710	3985	703	1000	923	12310

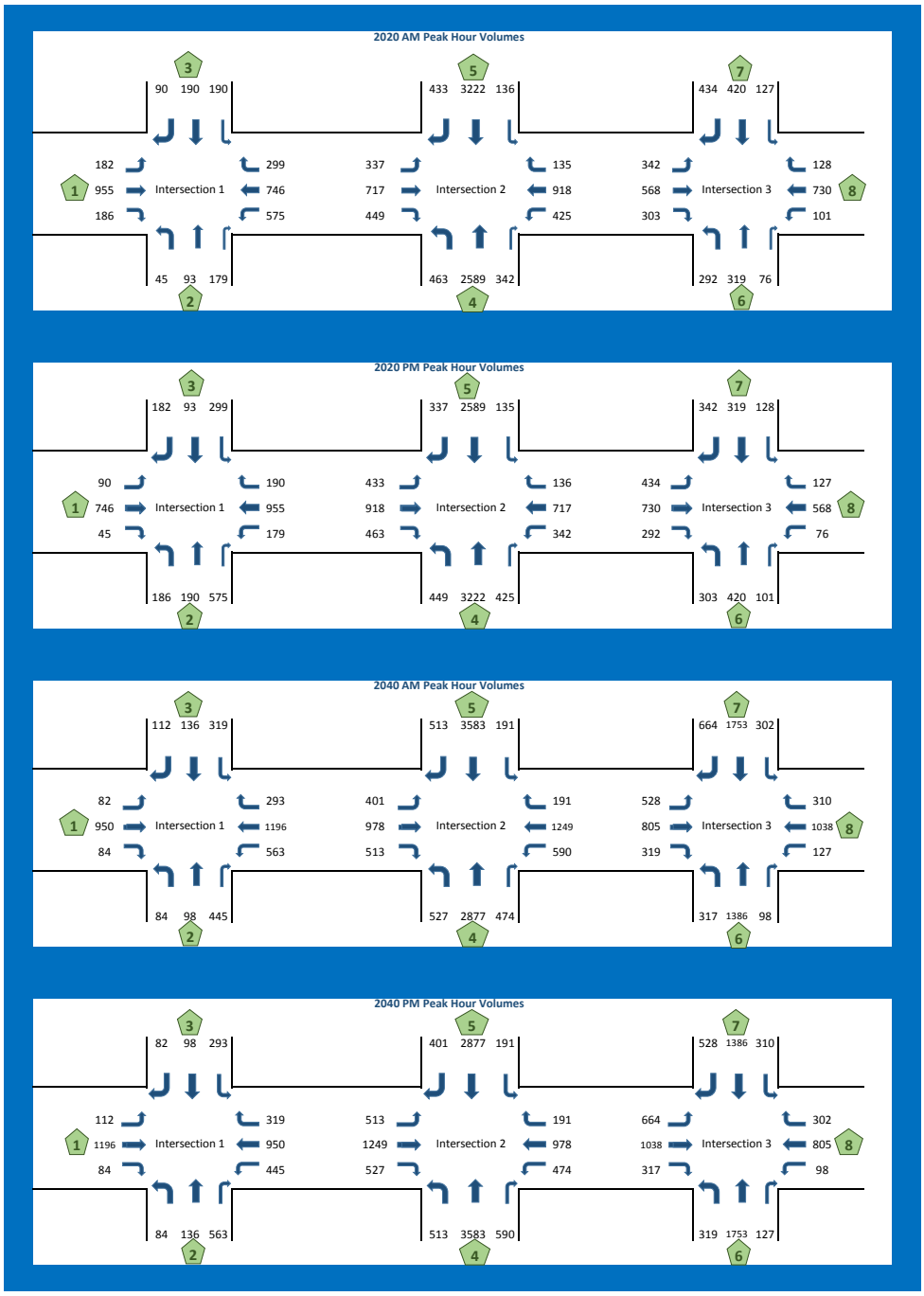
PATRIOT TRANSPORTATION ENGINEERING, PLLC

STIP Project I-5714

I-77/Gilead Road Improvements

Origin-Destination Volumes

IAU OUTPUT BEFORE ODME



PATRIOT TRANSPORTATION ENGINEERING, PLLC

STIP Project I-5714

I-77/Gilead Road Improvements

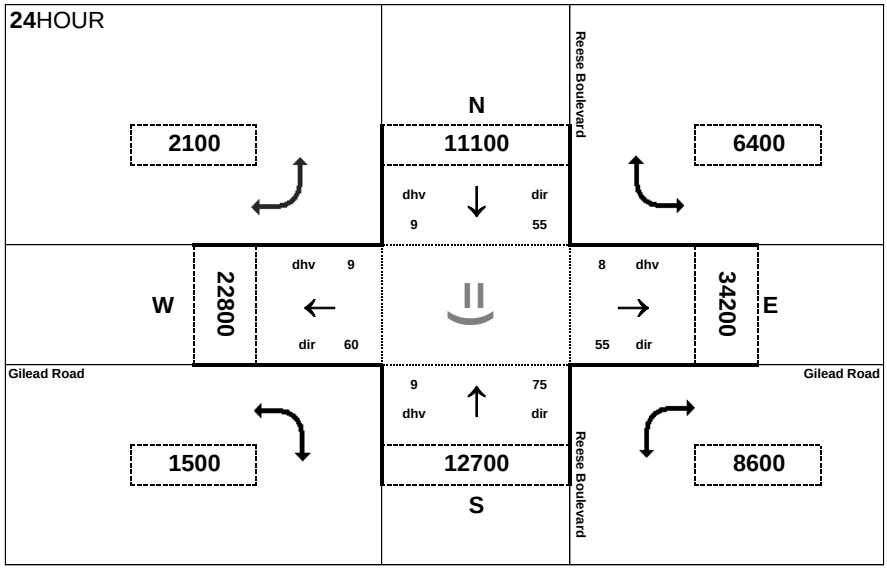
IAU Output before ODME

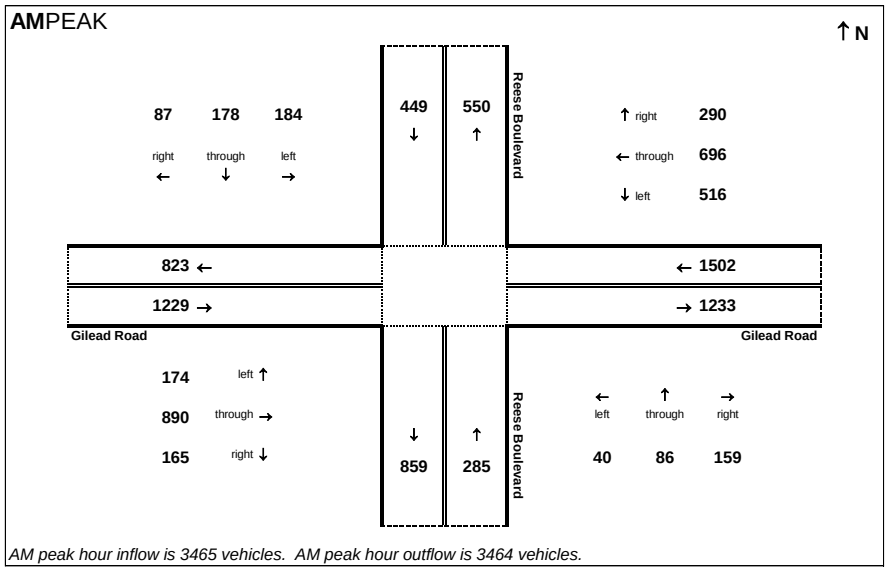
Peak Hour Volume Breakouts Report:
I-77/Gilead Road Interchange Improvements

Traffic Forecast Release Date:
April-15

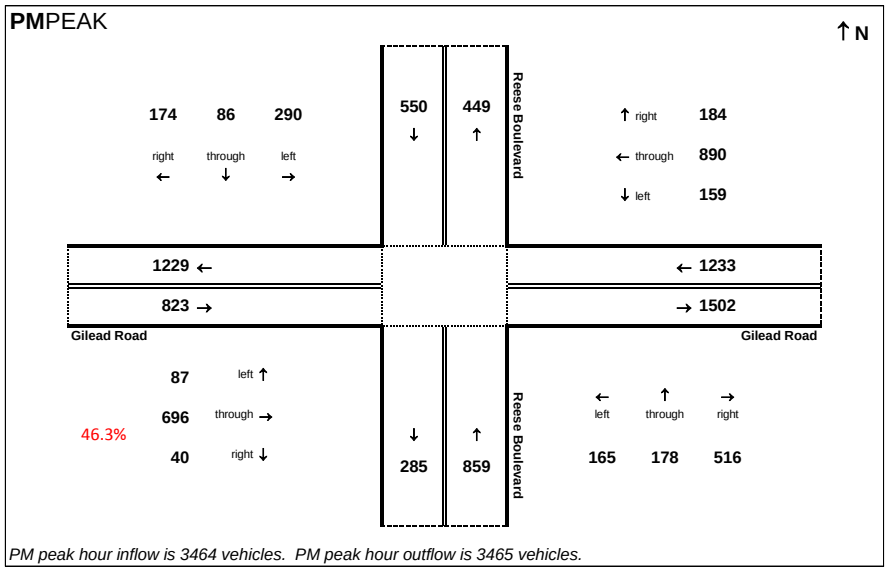
Traffic Data Year:
2015 No-Build

Project:
I-5714





AM peak hour inflow is 3465 vehicles. AM peak hour outflow is 3464 vehicles.



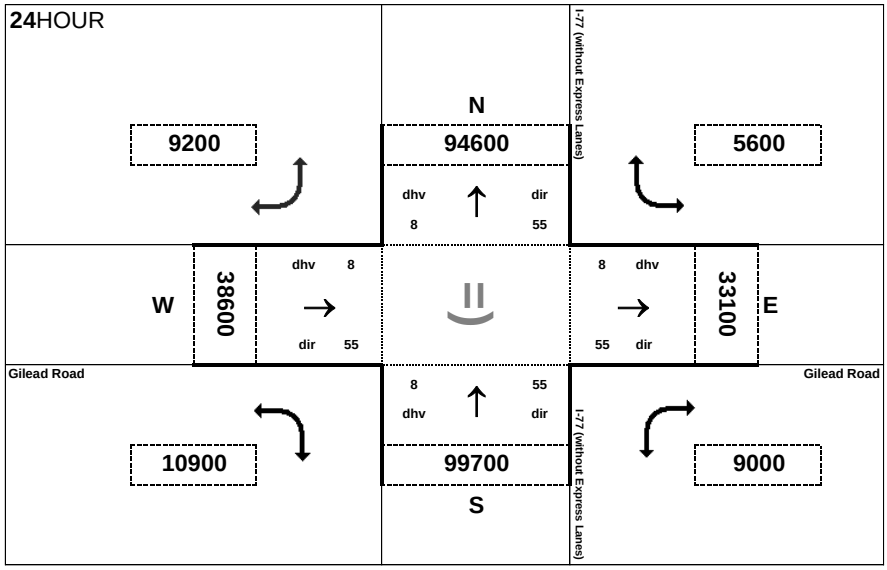
PM peak hour inflow is 3464 vehicles. PM peak hour outflow is 3465 vehicles.

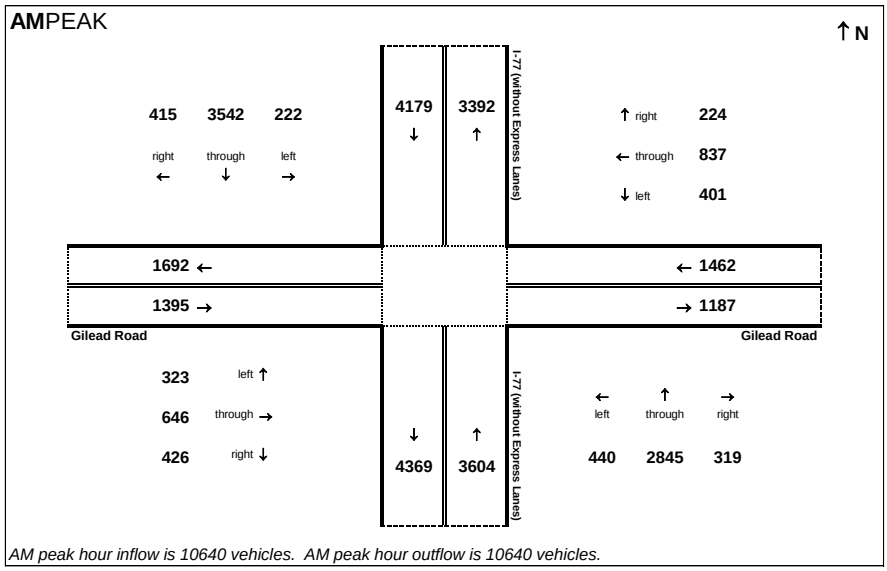
Peak Hour Volume Breakouts Report:
I-77/Gilead Road Interchange Improvements

Traffic Forecast Release Date:
April-15

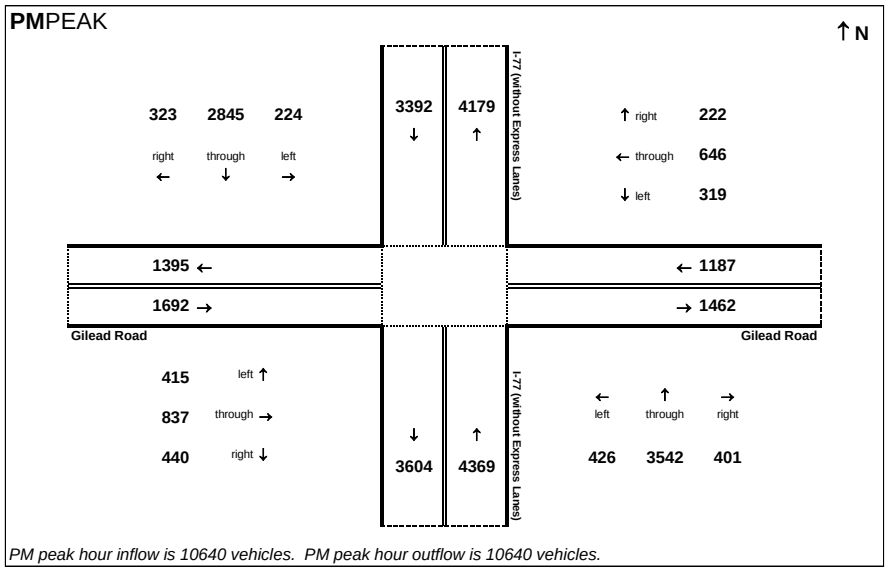
Traffic Data Year:
2015 No-Build

Project:
I-5714





AM peak hour inflow is 10640 vehicles. AM peak hour outflow is 10640 vehicles.



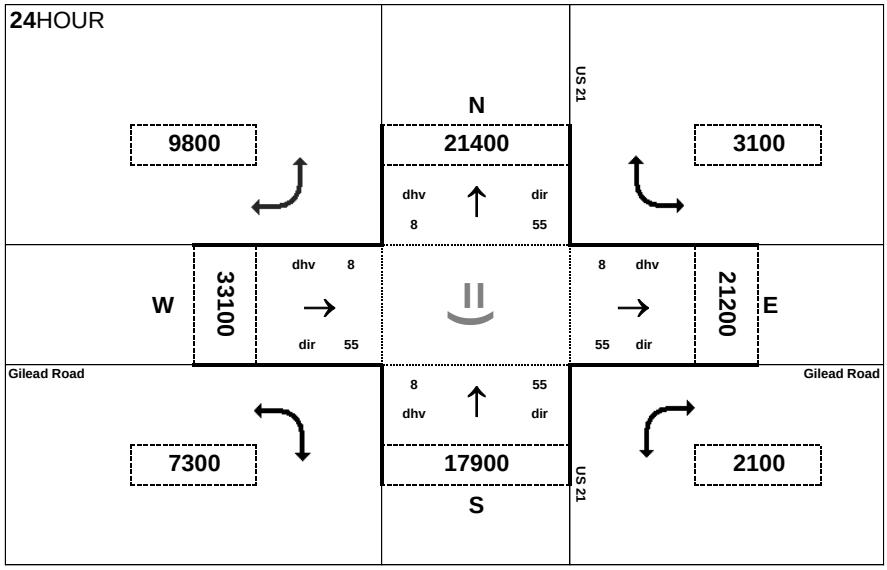
PM peak hour inflow is 10640 vehicles. PM peak hour outflow is 10640 vehicles.

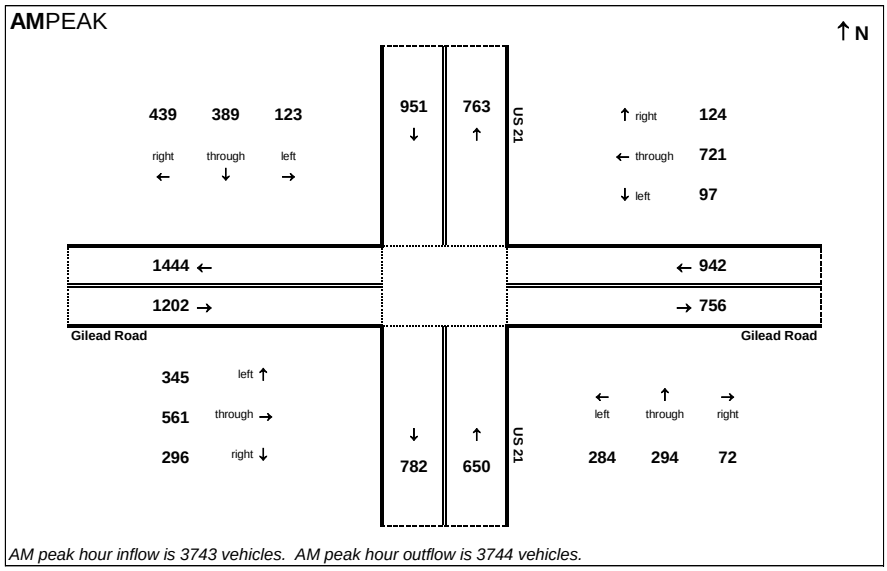
Peak Hour Volume Breakouts Report:
I-77/Gilead Road Interchange Improvements

Traffic Forecast Release Date:
April-15

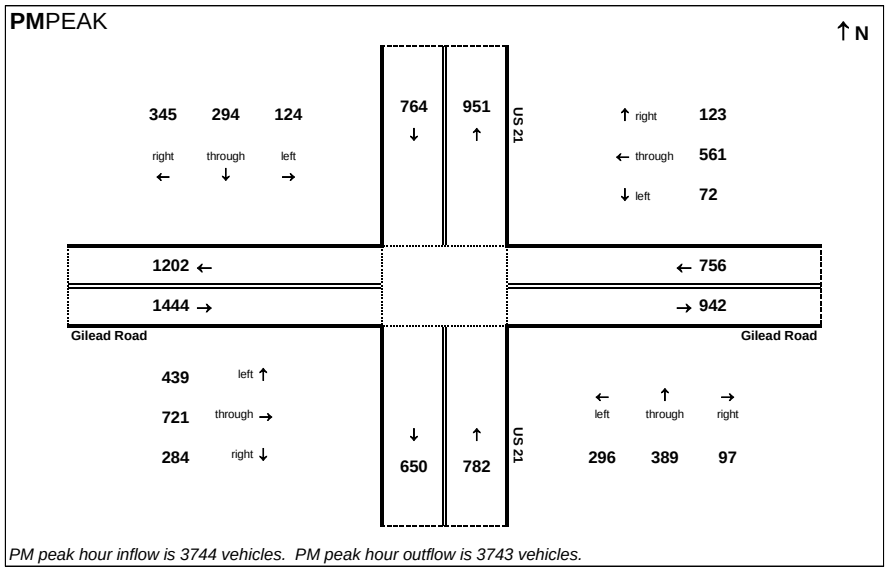
Traffic Data Year:
2015 No-Build

Project:
I-5714



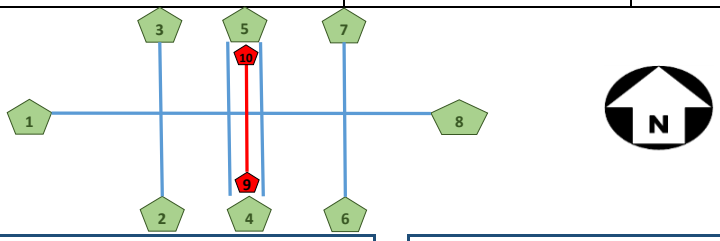


AM peak hour inflow is 3743 vehicles. AM peak hour outflow is 3744 vehicles.



PM peak hour inflow is 3744 vehicles. PM peak hour outflow is 3743 vehicles.

TIP No.	I-5714	WBS No.	50127.1.FS1	County:	Mecklenburg	Division:	10
Route No.	I-77		Cross Street/Limits	Gilead Road			



Manual ODME Volumes

2020

AM Peak O-D Matrix

	1	2	3	4	5	6	7	8	Total
1	0	161	162	262	179	140	158	263	1325
2	38	0	85	51	35	27	31	51	318
3	80	176	0	56	38	30	34	56	470
4	176	142	75	0	2696	77	87	145	3398
5	149	121	65	3347	0	28	31	53	3794
6	88	70	38	75	22	0	319	76	688
7	131	104	56	112	33	419	0	127	982
8	218	176	94	188	55	101	128	0	960
Total	880	950	575	4091	3058	822	788	771	11935

PM Peak O-D Matrix

	1	2	3	4	5	6	7	8	Total
1	0	38	80	176	149	88	131	218	880
2	161	0	176	142	121	70	104	176	950
3	162	85	0	75	65	38	55	94	574
4	262	51	56	0	3347	75	112	188	4091
5	179	35	38	2696	0	22	33	55	3058
6	140	27	30	77	28	0	419	101	822
7	158	31	34	87	31	319	0	128	788
8	263	51	56	144	53	76	127	0	770
Total	1325	318	470	3397	3794	688	981	960	11933

2040

AM Peak O-D Matrix

	1	2	3	4	5	6	7	8	Total
1	0	71	71	229	165	112	185	282	1115
2	71	0	87	110	79	54	89	136	626
3	98	122	0	81	59	40	66	100	566
4	250	121	64	0	3009	83	137	210	3874
5	224	108	57	3733	0	31	51	78	4282
6	117	57	31	85	25	0	1386	98	1799
7	247	119	64	177	53	1754	0	303	2717
8	387	187	99	278	83	128	312	0	1474
Total	1394	785	473	4693	3473	2202	2226	1207	16453

PM Peak O-D Matrix

	1	2	3	4	5	6	7	8	Total
1	0	71	98	250	224	117	247	387	1394
2	71	0	122	121	108	57	119	187	785
3	71	87	0	64	57	31	64	99	473
4	229	110	81	0	3733	85	177	278	4693
5	165	79	59	3009	0	25	53	83	3473
6	112	54	40	83	31	0	1754	128	2202
7	185	89	66	137	51	1386	0	312	2226
8	282	136	100	210	78	98	303	0	1207
Total	1115	626	566	3874	4282	1799	2717	1474	16453

Reallocated Manual ODME Volumes Based on Calibrated BY Matrix

2020

AM Peak O-D Matrix

	1	2	3	4	5	6	7	8	9	10	Total
1	0	161	162	262	179	140	138	283			1325
2	38	0	85	51	35	22	26	61			318
3	80	176	0	56	38	25	29	66			470
4	176	142	75	0	2696	87	117	105			3398
5	149	121	65	3347	0	28	31	53			3794
6	83	55	28	60	67	0	319	76			688
7	136	104	66	127	3	419	0	127			982
8	218	191	94	188	40	101	128	0			960
9									1039		1039
10									1984		1984
Total	880	950	575	4091	3058	822	788	771	1984	1039	14958

PM Peak O-D Matrix

	1	2	3	4	5	6	7	8	9	10	Total
1	0	38	80	176	149	83	121	233			880
2	161	0	176	142	121	60	94	196			950
3	162	85	0	75	65	33	45	109			574
4	262	51	56	0	3347	95	142	138			4091
5	179	35	38	2696	0	22	33	55			3058
6	135	12	20	62	73	0	419	101			822
7	163	31	44	97	6	319	0	128			788
8	263	66	56	149	33	76	127	0			770
9									1929		1929
10									1068		1068
Total	1325	318	470	3397	3794	688	981	960	1068	1929	14930

2040

AM Peak O-D Matrix

	1	2	3	4	5	6	7	8	9	10	Total
1	0	71	71	229	165	112	165	302			1115
2	71	0	87	110	79	49	84	146			626
3	98	122	0	81	59	35	61	110			566
4	250	121	64	0	3009	93	167	170			3874
5	224	108	57	3733	0	31	51	78			4282
6	112	42	21	70	70	0	1386	98			1799
7	252	119	74	192	23	1754	0	303			2717
8	387	202	99	278	68	128	312	0			1474
9									1274		1274
10										2657	2657
Total	1394	785	473	4693	3473	2202	2226	1207	1274	2657	20384

PM Peak O-D Matrix

	1	2	3	4	5	6	7	8	9	10	Total
1	0	71	98	250	224	112	237	402			1394
2	71	0	122	121	108	47	109	207			785
3	71	87	0	64	57	26	54	114			473
4	229	110	81	0	3733	105	207	228			4693
5	165	79	59	3009	0	25	53	83			3473
6	107	39	30	68	76	0	1754	128			2202
7	190	89	76	147	26	1386	0	312			2226
8	282	151	100	215	58	98	303	0			1207
9									1431		1431
10										2366	2366
Total	1115	626	566	3874	4282	1799	2717	1474	1431	2366	20250

Interim Year Matrices - Interpolated

2025

AM Peak O-D Matrix

	1	2	3	4	5	6	7	8	9	10	Total
1	0	139	139	254	176	133	145	288	0	0	1274
2	46	0	86	66	46	29	41	82	0	0	396
3	85	163	0	62	43	28	37	77	0	0	495
4	195	137	72	0	2774	89	130	121	0	0	3518
5	168	118	63	3444	0	29	36	59	0	0	3917
6	90	52	26	63	68	0	586	82	0	0	967
7	165	108	68	143	8	753	0	171	0	0	1416
8	260	194	95	211	47	108	174	0	0	0	1089
9	0	0	0	0	0	0	0	0	1098		1098
10	0	0	0	0	0	0	0	0	2152	0	2152
Total	1009	911	549	4243	3162	1169	1149	880	2152	1098	16322

PM Peak O-D Matrix

	1	2	3	4	5	6	7	8	9	10	Total
1	0	46	85	195	168	90	150	275	0	0	1009
2	139	0	163	137	118	57	98	199	0	0	911
3	139	86	0	72	63	31	47	110	0	0	548
4	254	66	62	0	3444	98	158	161	0	0	4243
5	176	46	43	2774	0	23	38	62	0	0	3162
6	128	19	23	64	74	0	753	108	0	0	1169
7	170	46	52	110	11	586	0	174	0	0	1149
8	268	87	67	166	39	82	171	0	0	0	880
9	0	0	0	0	0	0	0	0	2038		2038
10	0	0	0	0	0	0	0	0	1159	0	1159
Total	1274	396	495	3518	3917	967	1415	1089	1159	2038	16268

2030

AM Peak O-D Matrix

	1	2	3	4	5	6	7	8	9	10	Total
1	0	116	117	246	172	126	152	293	0	0	1222
2	55	0	86	81	57	36	55	104	0	0	474
3	89	149	0	69	49	30	45	88	0	0	519
4	213	132	70	0	2853	90	142	138	0	0	3638
5	187	115	61	3540	0	30	41	66	0	0	4040
6	98	49	25	65	69	0	853	87	0	0	1246
7	194	112	70	160	13	1087	0	215	0	0	1851
8	303	197	97	233	54	115	220	0	0	0	1219
9	0	0	0	0	0	0	0	0	1157		1157
10	0	0	0	0	0	0	0	0	2321	0	2321
Total	1139	870	526	4394	3267	1514	1508	991	2321	1157	17687

PM Peak O-D Matrix

	1	2	3	4	5	6	7	8	9	10	Total
1	0	55	89	213	187	98	179	318	0	0	1139
2	116	0	149	132	115	54	102	202	0	0	870
3	117	86	0	70	61	30	50	112	0	0	526
4	246	81	69	0	3540	100	175	183	0	0	4394
5	172	57	49	2853	0	24	43	69	0	0	3267
6	121	26	25	65	75	0	1087	115	0	0	1514
7	177	60	60	122	16	853	0	220	0	0	1508
8	273	109	78	182	46	87	215	0	0	0	990
9	0	0	0	0	0	0	0	0	2148		2148
10	0	0	0	0	0	0	0	0	1250	0	1250
Total	1222	474	519	3637	4040	1246	1851	1219	1250	2148	17606

2035

AM Peak O-D Matrix

	1	2	3	4	5	6	7	8	9	10	Total
1	0	94	94	237	169	119	158	297	0	0	1168
2	63	0	87	95	68	42	70	125	0	0	550
3	94	136	0	75	54	33	53	99	0	0	544
4	232	126	67	0	2931	92	155	154	0	0	3757
5	205	111	59	3637	0	30	46	72	0	0	4160
6	105	45	23	68	69	0	1119	93	0	0	1522
7	223	115	72	176	18	1420	0	259	0	0	2283
8	345	199	98	256	61	121	266	0	0	0	1346
9	0	0	0	0	0	0	0	0	1215		1215
10	0	0	0	0	0	0	0	0	2489	0	2489
Total	1267	826	500	4544	3370	1857	1867	1099	2489	1215	19034

PM Peak O-D Matrix

	1	2	3	4	5	6	7	8	9	10	Total
1	0	63	94	232	205	105	208	360	0	0	1267
2	94	0	136	126	111	50	105	204	0	0	826
3	94	87	0	67	59	28	52	113	0	0	500
4	237	95	75	0	3637	103	191	206	0	0	4544
5	169	68	54	2931	0	24	48	76	0	0	3370
6	114	32	28	67	75	0	1420	121	0	0	1857
7	183	75	68	135	21	1119	0	266	0	0	1867
8	277	130	89	199	52	93	259	0	0	0	1099
9	0	0	0	0	0	0	0	0	2257		2257
10	0	0	0	0	0	0	0	0	1340	0	1340
Total	1168	550	544	3757	4160	1522	2283	1346	1340	2257	18927

2040

AM Peak O-D Matrix

	1	2	3	4	5	6	7	8	9	10	Total
1	0	71	71	229	165	112	165	302	0	0	1115
2	71	0	87	110	79	49	84	146	0	0	626
3	98	122	0	81	59	35	61	110	0	0	566
4	250	121	64	0	3009	93	167	170	0	0	3874
5	224	108	57	3733	0	31	51	78	0	0	4282
6	112	42	21	70	70	0	1386	98	0	0	1799
7	252	119	74	192	23	1754	0	303	0	0	2717
8	387	202	99	278	68	128	312	0	0	0	1474
9	0	0	0	0	0	0	0	0	2657	0	2657
10	0	0	0	0	0	0	0	0	1431	0	1431
Total	1394	785	473	4693	3473	2202	2226	1207	2657	1274	20384

PM Peak O-D Matrix

	1	2	3	4	5	6	7	8	9	10	Total
1	0	71	98	250	224	112	237	402	0	0	1394
2	71	0	122	121	108	47	109	207	0	0	785
3	71	87	0	64	57	26	54	114	0	0	473
4	229	110	81	0	3733	105	207	228	0	0	4693
5	165	79	59	3009	0	25	53	83	0	0	3473
6	107	39	30	68	76	0	1754	128	0	0	2202
7	190	89	76	147	26	1386	0	312	0	0	2226
8	282	151	100	215	58	98	303	0	0	0	1207
9	0	0	0	0	0	0	0	0	1431	0	1431
10	0	0	0	0	0	0	0	0	0	2366	2366
Total	1115	626	566	3874	4282	1799	2717	1474	1431	2366	20250

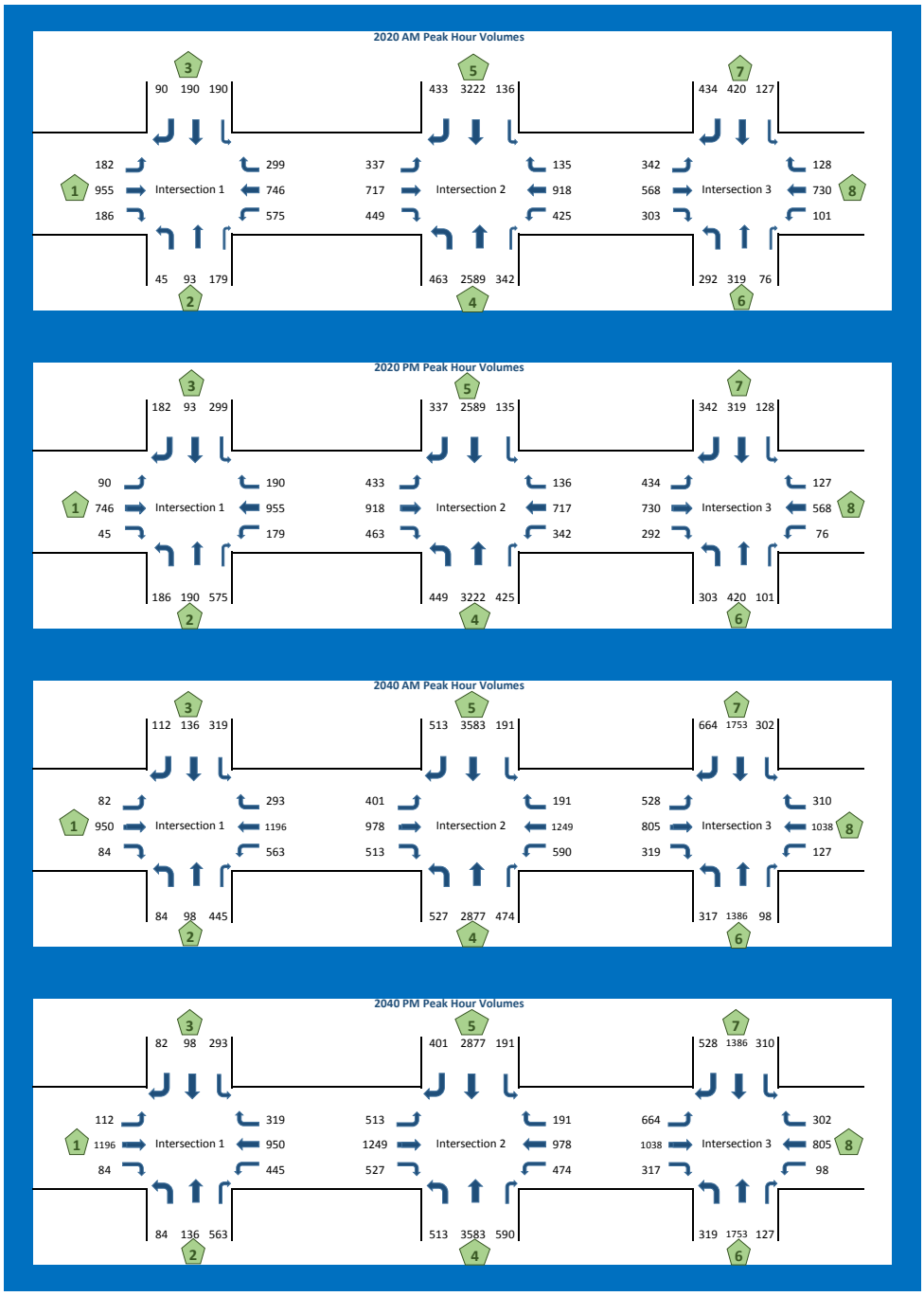
PATRIOT TRANSPORTATION ENGINEERING, PLLC

STIP Project I-5714

I-77/Gilead Road Improvements

Origin-Destination Volumes

IAU OUTPUT BEFORE ODME

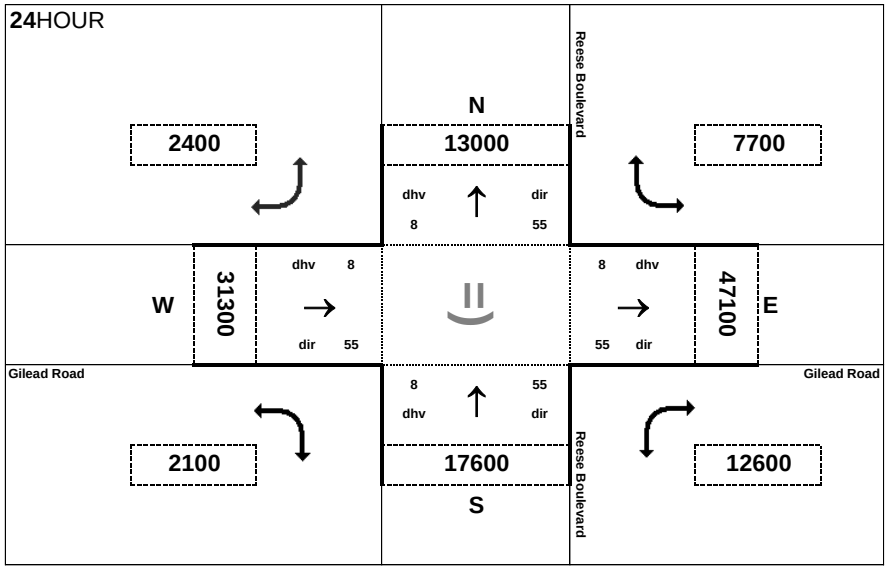


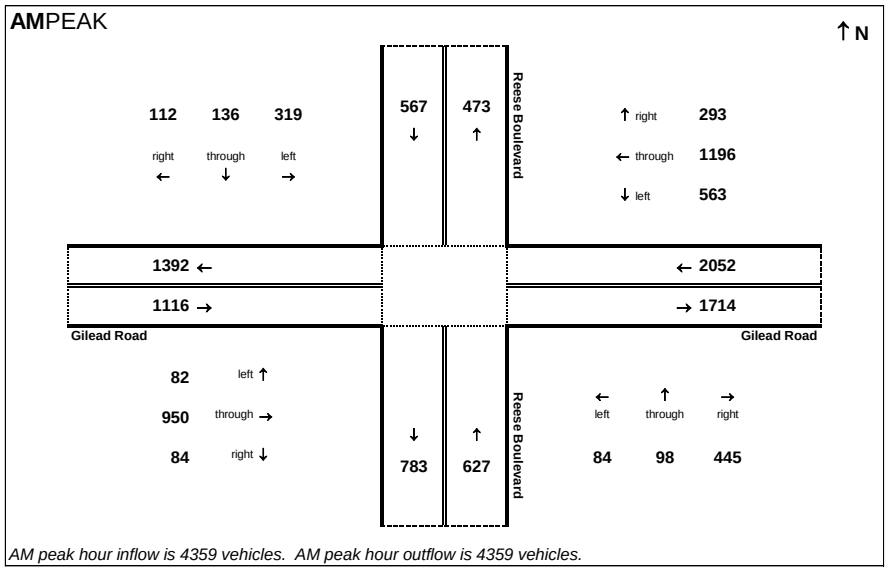
PATRIOT TRANSPORTATION ENGINEERING, PLLC

STIP Project I-5714

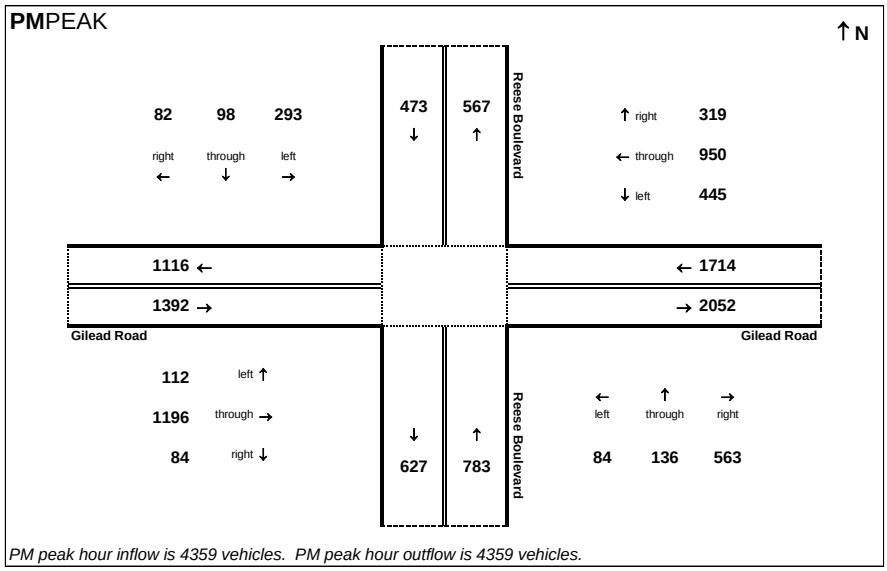
I-77/Gilead Road Improvements

IAU Output before ODME





AM peak hour inflow is 4359 vehicles. AM peak hour outflow is 4359 vehicles.



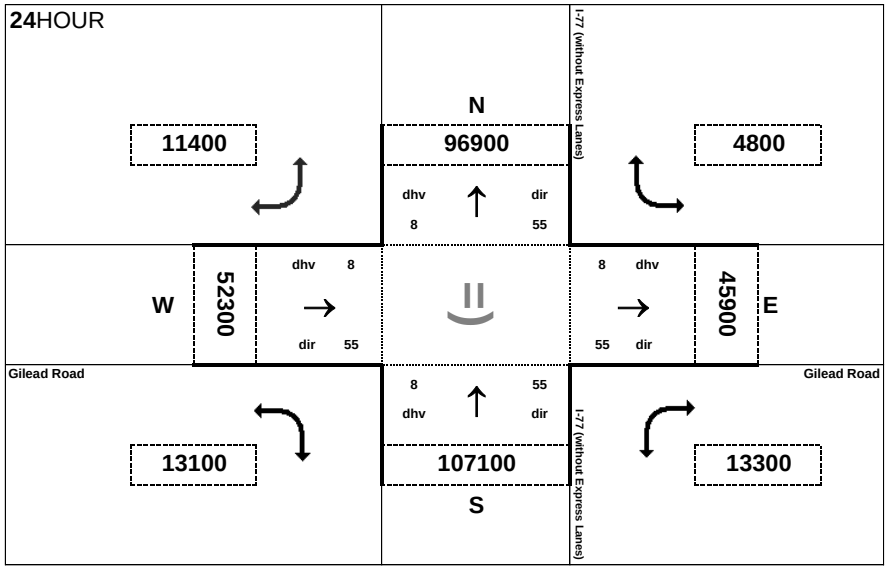
PM peak hour inflow is 4359 vehicles. PM peak hour outflow is 4359 vehicles.

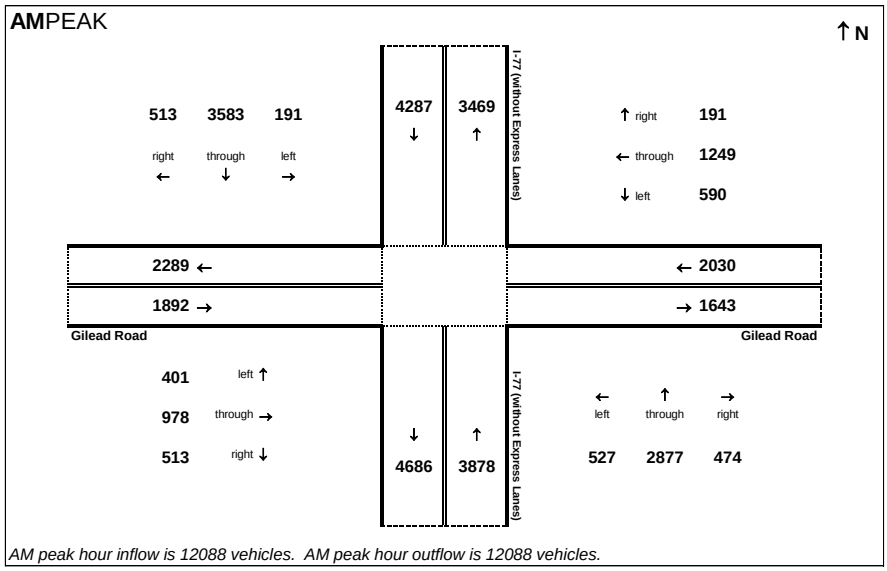
Peak Hour Volume Breakouts Report:
I-77/Gilead Road Interchange Improvements

Traffic Forecast Release Date:
April-15

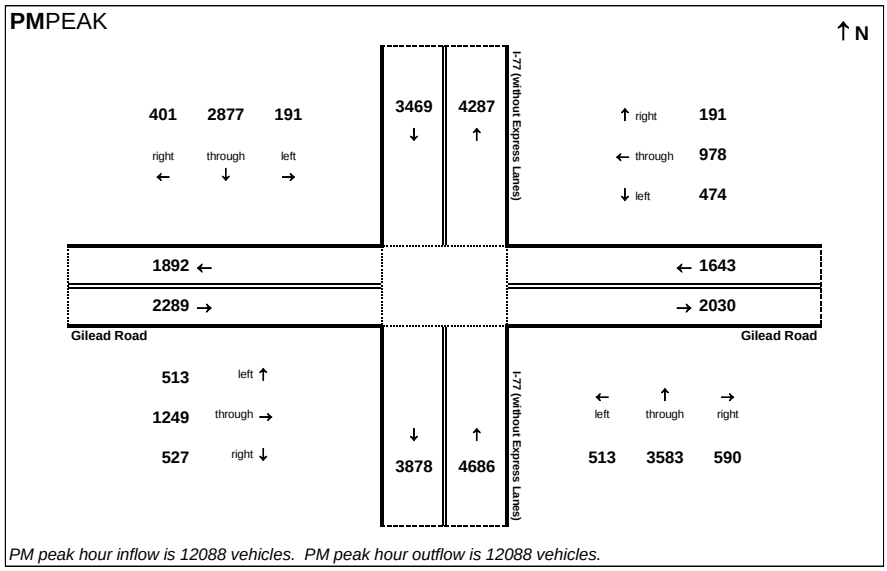
Traffic Data Year:
2040 No-Build/Build

Project:
I-5714





AM peak hour inflow is 12088 vehicles. AM peak hour outflow is 12088 vehicles.



PM peak hour inflow is 12088 vehicles. PM peak hour outflow is 12088 vehicles.

Peak Hour Volume Breakouts Report:
I-77/Gilead Road Interchange Improvements

Traffic Forecast Release Date:
April-15

Traffic Data Year:
2040 No-Build/Build

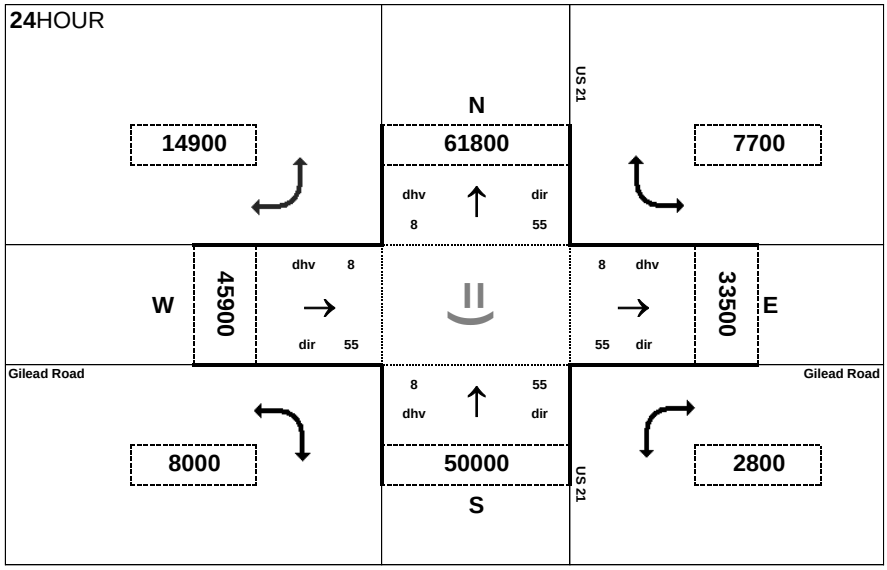
Project:
I-5714

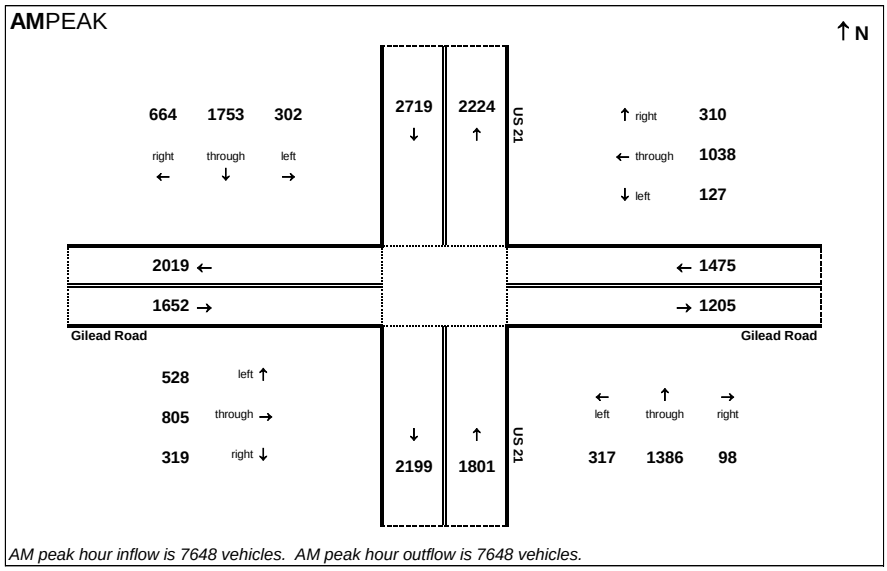
Peak Hour Volume Breakouts Report:
I-77/Gilead Road Interchange Improvements

Traffic Forecast Release Date:
April-15

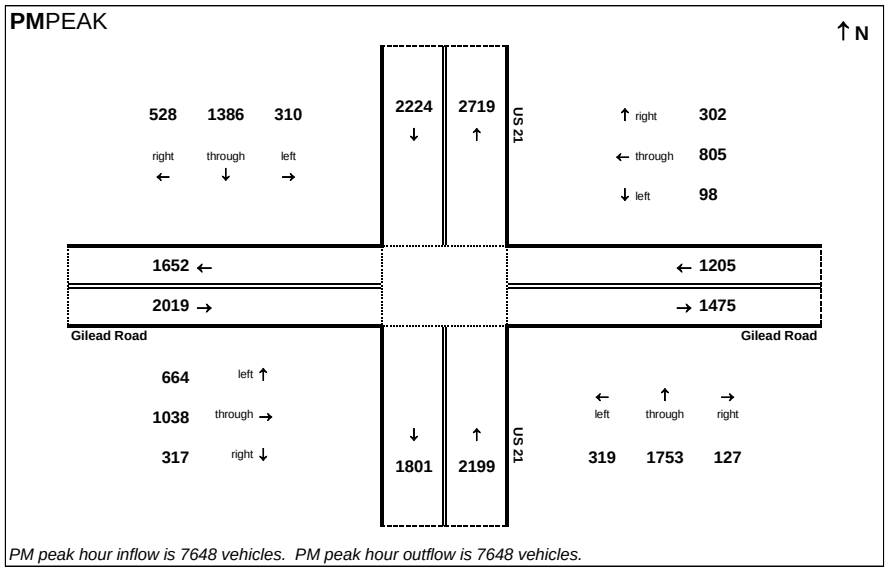
Traffic Data Year:
2040 No-Build/Build

Project:
I-5714





AM peak hour inflow is 7648 vehicles. AM peak hour outflow is 7648 vehicles.



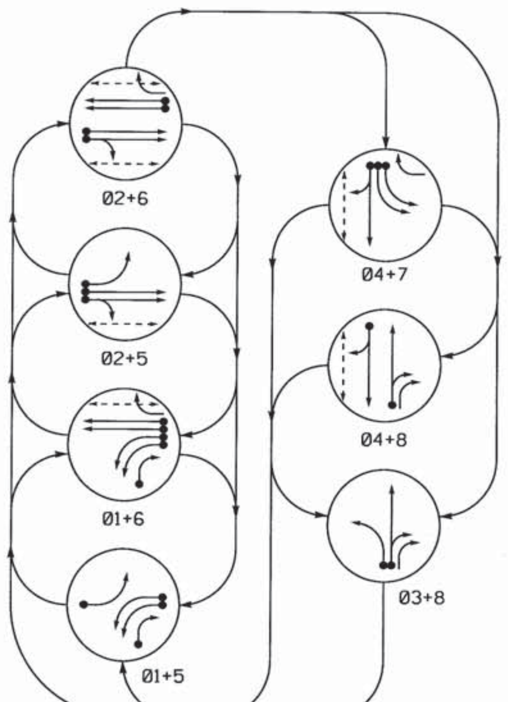
PM peak hour inflow is 7648 vehicles. PM peak hour outflow is 7648 vehicles.

APPENDIX C:

SIGNAL DESIGN PLANS

PROJECT REFERENCE NO.	SHEET NO.
N/A	Sig. 1

PHASING DIAGRAM



PHASING DIAGRAM DETECTION LEGEND

- DETECTED MOVEMENT
- UNDETECTED MOVEMENT (OVERLAP)
- UNSIGNALIZED MOVEMENT
- PEDESTRIAN MOVEMENT

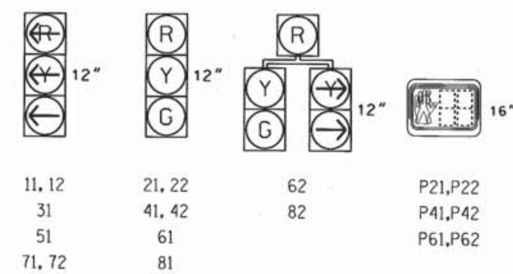
TABLE OF OPERATION

SIGNAL FACE	PHASE Ø1+5	Ø1+6	Ø2+5	Ø2+6	Ø4+7	Ø4+8	Ø3+8	FLASH
11,12	←	←	←R	←R	←R	←R	←R	←R
21,22	R	R	G	G	R	R	R	Y
31	←R	←R	←R	←R	←R	←R	←	←R
41,42	R	R	R	R	G	G	R	R
51	←	←R	←	←R	←R	←R	←R	←R
61	R	G	R	G	R	R	R	Y
62	R	G	R	G	R/→	R	R	Y
71,72	←R	←R	←R	←R	←	←R	←R	←R
81	R	R	R	R	R	G	G	R
82	R/→	R/→	R	R	R	G	G	R
P21,P22	DW	DW	W	W	DW	DW	DW	DRK
P41,P42	DW	DW	DW	DW	W	W	DW	DRK
P61,P62	DW	W	DW	W	DW	DW	DW	DRK

W - Walk
DW - Don't Walk
DRK - Dark

SIGNAL FACE I.D.

All Heads L.E.D.



OASIS 2070L DETECTION INSTALLATION CHART

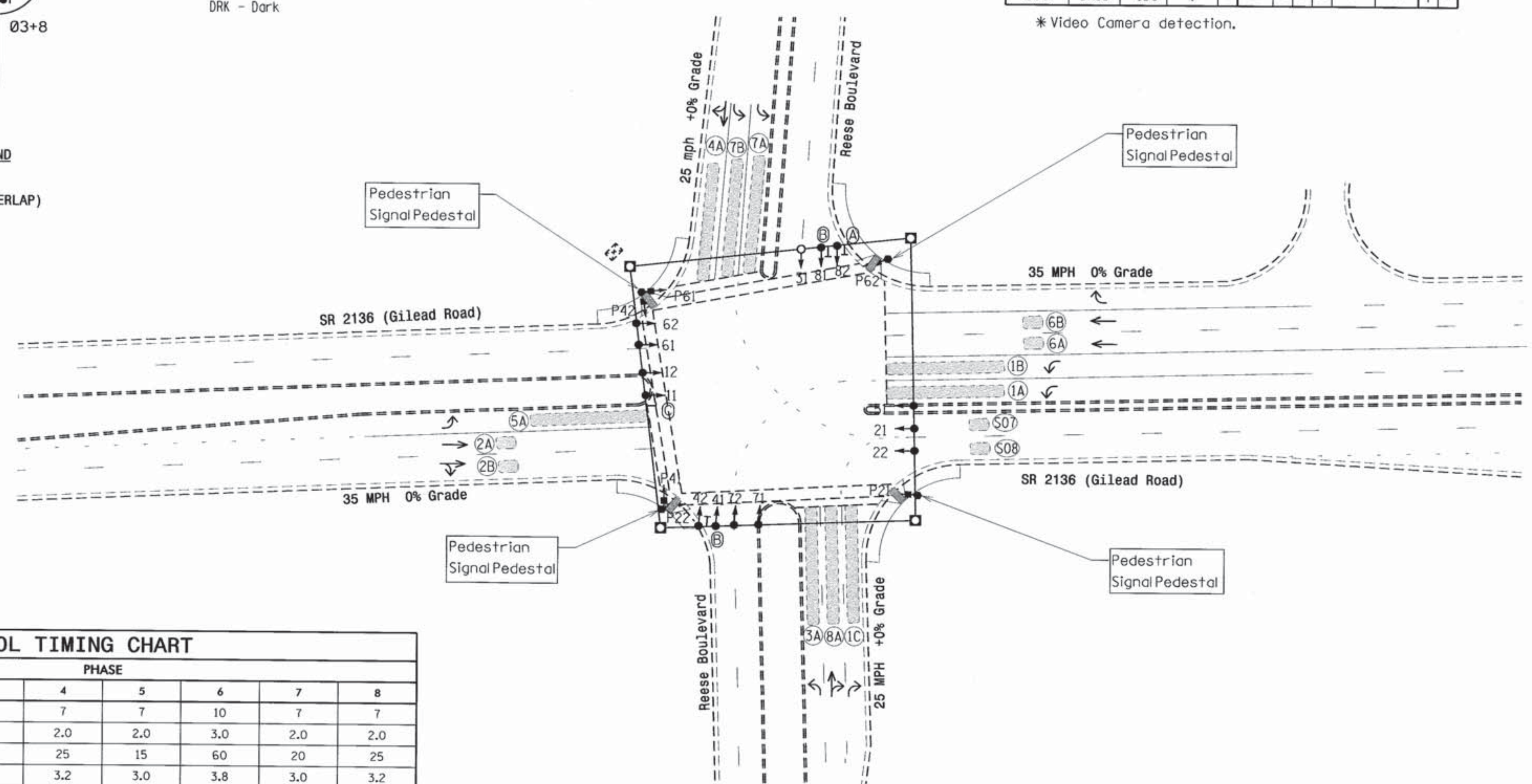
DETECTION ZONE					DETECTOR PROGRAMMING							
ZONE No.	SIZE (FT)	DISTANCE FROM STOPBAR (FT)	TURNS	NEW ZONE	PHASE	CALLING	EXTENSION	FULL TIME DELAY	STRETCH TIME	DELAY TIME	SYSTEM LOOP	NEW CARD
1A	6X60	0	*	-	1	Y	Y	-	-	-	-	-
1B	6X60	0	*	-	1	Y	Y	-	-	-	-	-
1C	6X60	0	*	-	1	Y	Y	-	-	15	-	-
2A	6X10	70	*	-	2	Y	Y	-	-	-	-	-
2B	6X10	70	*	-	2	Y	Y	-	-	-	-	-
3A	6X60	0	*	-	3	Y	Y	-	-	-	-	-
4A	6X60	0	*	-	4	Y	Y	-	-	10	-	-
5A	6X60	0	*	-	5	Y	Y	-	-	-	-	-
6A	6X10	70	*	-	6	Y	Y	-	-	-	-	-
6B	6X10	70	*	-	6	Y	Y	-	-	-	-	-
7A	6X60	0	*	-	7	Y	Y	-	-	-	-	-
7B	6X60	0	*	-	7	Y	Y	-	-	-	-	-
8A	6X60	0	*	-	8	Y	Y	-	-	10	-	-
S07	6X10	+150	*	-	-	-	-	-	-	-	Y	-
S08	6X10	+150	*	-	-	-	-	-	-	-	Y	-

* Video Camera detection.

7 Phase
Fully Actuated
Gilead Road Closed Loop System

NOTES

1. Refer to "Roadway Standard Drawings NCDOT" dated July 2006 and "Standard Specifications for Roads and Structures" dated July 2006.
2. Do not program signal for late night flashing operation unless otherwise directed by the Engineer.
3. Phase 1 and/or phase 5 may be lagged.
4. The order of phase 3 and phase 7 may be reversed.
5. Set all detector units to presence mode.
6. Omit "WALK" and flashing "DON'T WALK" with no pedestrian calls.
7. Program pedestrian heads to countdown the flashing "Don't Walk" time only.
8. Existing "Left Turn Yield on Green" ball sign(s)-(R10-12) shall remove.
9. Pavement markings are existing.
10. Maximum times shown in timing chart are for free-run operation only. Coordinated signal system timing values supersede these values.
11. Closed loop system data: Controller Asset #1753.



LEGEND

PROPOSED		EXISTING
	Traffic Signal Head	
	Modified Signal Head	N/A
	Sign	
	Pedestrian Signal Head With Push Button & Sign	
	Signal Pole with Guy	
	Signal Pole with Sidewalk Guy	
	Video Detection Area	
	Controller & Cabinet	
	Junction Box	
	2-in Underground Conduit	
N/A	Right of Way	
	Directional Arrow	
	Signal Pedestal	
	Metal Strain Pole	
Ⓐ	Right Arrow "ONLY" Sign (R3-5R)	Ⓐ
Ⓑ	Combined Through and Right Arrow Sign (R3-6R)	Ⓑ
Ⓒ	U-Turn "MUST YIELD" Sign (R3-27)	Ⓒ

OASIS 2070L TIMING CHART

FEATURE	PHASE 1	2	3	4	5	6	7	8
Min Green 1 *	7	10	7	7	7	10	7	7
Extension 1 *	2.0	3.0	2.0	2.0	2.0	3.0	2.0	2.0
Max Green 1 *	30	60	15	25	15	60	20	25
Yellow Clearance	3.0	3.8	3.0	3.2	3.0	3.8	3.0	3.2
Red Clearance	3.3	2.3	3.3	3.0	3.2	2.3	3.5	3.1
Walk 1 *	-	7	-	7	-	7	-	-
Don't Walk 1	-	28	-	24	-	28	-	-
Seconds Per Actuation *	-	-	-	-	-	-	-	-
Max Variable Initial *	-	-	-	-	-	-	-	-
Time Before Reduction *	-	-	-	-	-	-	-	-
Time To Reduce *	-	-	-	-	-	-	-	-
Minimum Gap	-	-	-	-	-	-	-	-
Recall Mode	-	MIN RECALL	-	-	-	MIN RECALL	-	-
Vehicle Call Memory	-	YELLOW	-	-	-	YELLOW	-	-
Dual Entry	-	-	-	-	-	-	-	-
Simultaneous Gap	ON	ON	ON	ON	ON	ON	ON	ON

* These values may be field adjusted. Do not adjust Min Green and Extension times for phases 2 and 6 lower than what is shown. Min Green for all other phases should not be lower than 4 seconds.

Signal Upgrade

Prepared In the Offices of: Transportation Mobility and Safety Division, Signal Design Section
750 N.Greenfield Pkwy,Garner,NC 27529

SR 2136 (Gilead Road)
at
Reese Boulevard

Division 10 Mecklenburg County Huntersville

PLAN DATE: March 2011 | REVIEWED BY:
PREPARED BY: M. Mahbooba | REVIEWED BY:

SCALE 0 40 1"=40'

REVISIONS | INIT. | DATE

SEAL: NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 24393 TIMOTHY J. WILLIAMS

SIGNATURE 4/19/11 DATE

SIG. INVENTORY NO. 10-1753

18-APR-2011 09:14
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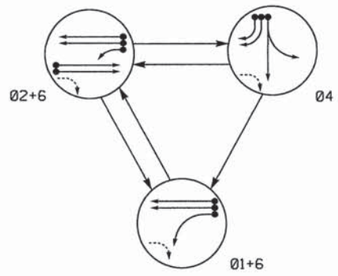
mmahbooba

PROJECT REFERENCE NO.	SHEET NO.
M0E	Sig.

PHASING DIAGRAM



PHASING DIAGRAM DETECTION LEGEND

- DETECTED MOVEMENT
- UNDETECTED MOVEMENT (OVERLAP)
- UNSIGNALIZED MOVEMENT
- PEDESTRIAN MOVEMENT

TABLE OF OPERATION

SIGNAL FACE	PHASE Ø1+6	Ø2+6	Ø4	FLASH
11	←, F Y	~~←~~, ~~F Y~~	~~R~~	~~Y~~
21,22	R	G	R	Y
41,42	R	R	G	R
43,44	~~R~~	~~R~~	→, ~~R~~	~~R~~
61,62	G	G	R	Y

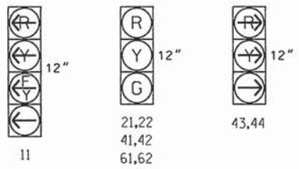
STANDARD SIGNAL FACE CLEARANCES FOR FLASHING LEFT TURN SIGNAL

FROM \ TO	←	F Y 1	F Y 2	→	R 1	R 2
←		~~←~~	~~←~~	~~R~~	~~R~~	~~R~~
F Y 1	F Y	F Y	F Y	F Y	~~R~~	~~R~~
F Y 2	F Y	F Y	F Y	F Y	~~R~~	~~R~~
→	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~

F Y = Flashing Yellow Arrow

SIGNAL FACE I.D.

All Heads L.E.D.



OASIS 2070L LOOP & DETECTOR INSTALLATION CHART

LOOP	SIZE (FT)	DISTANCE FROM STOPBAR (FT)	TURNS	NEW LOOP	DETECTOR PROGRAMMING: PHASE	CALLING	EXTENSION	FULL TIME DELAY	STRETCH TIME	DELAY TIME	SYSTEM LOOP	NEW CARD
1A	6X40	0	2-4-2	Y	1	Y	Y	-	-	15	-	Y
					6	Y	Y	-	-	-	-	Y
2A	6X6	70	3	Y	2	Y	Y	-	-	-	-	Y
2B	6X6	70	3	Y	2	Y	Y	-	-	-	-	Y
4A	6X40	0	2-4-2	Y	4	Y	Y	-	-	-	-	Y
4B	6X40	0	2-4-2	Y	4	Y	Y	-	-	15	-	Y
4C	6X40	0	2-4-2	Y	4	Y	Y	-	-	15	-	Y
6A	6X6	70	4	Y	6	Y	Y	-	-	-	-	Y
6B	6X6	70	4	Y	6	Y	Y	-	-	-	-	Y
S05	6X6	+170	3	Y	-	-	-	-	-	-	Y	Y
S06	6X6	+170	3	Y	-	-	-	-	-	-	Y	Y

3 Phase
Fully Actuated
Gilead Road Closed Loop System

NOTES

1. Refer to "Roadway Standard Drawings NCDOT" dated July 2006 and "Standard Specifications for Roads and Structures" dated July 2006.
2. Do not program signal for late night flashing operation unless otherwise directed by the Engineer.
3. Reposition existing signal heads numbered 62.
4. Set all detector units to presence mode.
5. Pavement markings are existing.
6. Locate new cabinet so as not to obstruct sight distance of vehicles turning right on red.
7. Maximum times shown in timing chart are for free-run operation only. Coordinated signal system timing values supersede these values.
8. Closed loop system data: Controller Asset #: 1106.

LEGEND

PROPOSED		EXISTING
○→	Traffic Signal Head	●→
◐→	Modified Signal Head	N/A
⊣	Sign	⊣
▯↓	Pedestrian Signal Head With Push Button & Sign	■↓
○)	Signal Pole with Guy	●)
○⤵	Signal Pole with Sidewalk Guy	●⤵
▭	Inductive Loop Detector	▭
⊠	Controller & Cabinet	⊠
□	Junction Box	■
-----	2-in Underground Conduit	-----
N/A	Right of Way	-----
→	Directional Arrow	→
N/A	Guardrail	⊥⊥
Ⓐ	"YIELD" Sign (R1-2)	Ⓐ
Ⓑ	No Right Turn Sign (R3-1)	Ⓑ
Ⓒ	No Left Turn Sign (R3-2)	Ⓒ

OASIS 2070L TIMING CHART

FEATURE	PHASE 1	2	4	6
Min Green 1 *	7	10	7	10
Extension 1 *	1.0	3.0	1.0	3.0
Max Green 1 *	30	60	25	75
Yellow Clearance	3.0	4.0	3.1	4.0
Red Clearance	2.4	2.1	2.6	2.1
Walk 1 *	-	-	-	-
Don't Walk 1	-	-	-	-
Seconds Per Actuation *	-	-	-	-
Max Variable Initial *	-	-	-	-
Time Before Reduction *	-	-	-	-
Time To Reduce *	-	-	-	-
Minimum Gap	-	-	-	-
Recall Mode	-	MIN RECALL	-	MIN RECALL
Vehicle Call Memory	-	YELLOW	-	YELLOW
Dual Entry	-	-	-	-
Simultaneous Gap	ON	ON	ON	ON

* These values may be field adjusted. Do not adjust Min Green and Extension times for phases 2 and 6 lower than what is shown. Min Green for all other phases should not be lower than 4 seconds.

Signal Upgrade

Prepared In the Offices of:
Transportation Mobility and Safety Division
North Carolina Department of Transportation
Signal Design Section
750 N.Greenfield Pkwy.,Garner,NC 27529

SR 2136 (Gilead Road) at I-77 SB Ramps

Division 10 Mecklenburg County Huntersville

PLAN DATE: March 2010 REVIEWED BY: M. Wahbooba
PREPARED BY: B.E. Wynn REVIEWED BY:

SCALE 0 30 1"=30'

REVISIONS	INIT.	DATE

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 30530 ENGINEER ZACHARY M. KITTLE
SIGNATURE DATE 3/24/10
SIG. INVENTORY NO. 10-1106

24-MAR-2010 11:08
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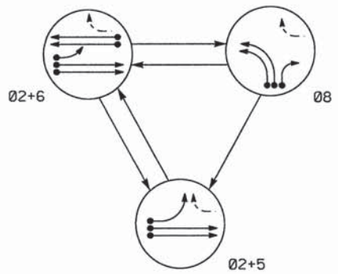
bwynn

PROJECT REFERENCE NO.	SHEET NO.
MOE	Sig. 1

3 Phase
Fully Actuated
Gilead Road Closed Loop System

PHASING DIAGRAM



PHASING DIAGRAM DETECTION LEGEND

- DETECTED MOVEMENT
- UNDETECTED MOVEMENT (OVERLAP)
- UNSIGNALIZED MOVEMENT
- PEDESTRIAN MOVEMENT

TABLE OF OPERATION

SIGNAL FACE	PHASE Ø2+5	PHASE Ø2+6	PHASE Ø8	PHASE FLASH
21,22	G	G	R	Y
51	←	↓	R	Y
61,62	R	G	R	Y
81,82,83	R	R	G	R

STANDARD SIGNAL FACE CLEARANCES FOR FLASHING LEFT TURN SIGNAL

FROM	TO ← 1	TO ← 2	TO ↓ 1	TO ↓ 2	TO → 1	TO → 2
←	←	←	↓	↓	R	R
↓	↓	↓	↓	↓	R	R
R	R	R	R	R	R	R

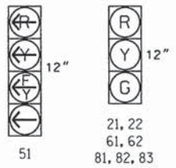
↓ = Flashing Yellow Arrow

OASIS 2070L LOOP & DETECTOR INSTALLATION CHART

INDUCTIVE LOOPS					DETECTOR PROGRAMMING							
LOOP	SIZE (FT)	DISTANCE FROM STOPBAR (FT)	TURNS	NEW LOOP	PHASE	CALLING	EXTENSION	FULL TIME DELAY	STRETCH TIME	DELAY TIME	SYSTEM LOOP	NEW CARD
2A	6X6	70	3	Y	2	Y	Y	-	-	-	-	Y
2B	6X6	70	3	Y	2	Y	Y	-	-	-	-	Y
5A	6X40	0	2-4-2	Y	5	Y	Y	-	-	15	-	Y
					2	Y	Y	-	-	-	-	Y
6A	6X6	70	3	Y	6	Y	Y	-	-	-	-	Y
6B	6X6	70	3	Y	6	Y	Y	-	-	-	-	Y
8A	6X40	0	2-4-2	Y	8	Y	Y	-	-	-	-	Y
8B	6X40	0	2-4-2	Y	8	Y	Y	-	-	-	-	Y
8C	6X40	0	2-4-2	Y	8	Y	Y	-	-	15	-	Y
S03	6X6	+190	3	Y	-	-	-	-	-	-	Y	Y
S04	6X6	+190	3	Y	-	-	-	-	-	-	Y	Y

SIGNAL FACE I.D.

All Heads L.E.D.



NOTES

1. Refer to "Roadway Standard Drawings NCDOT" dated July 2006 and "Standard Specifications for Roads and Structures" dated July 2006.
2. Do not program signal for late night flashing operation unless otherwise directed by the Engineer.
3. Phase 5 may be lagged.
4. Reposition existing signal head numbered 22.
5. Set all detector units to presence mode.
6. Locate new cabinet so as not to obstruct sight distance of vehicles turning right on red.
7. Pavement markings are existing.
8. Maximum times shown in timing chart are for free-run operation only. Coordinated signal system timing values supersede these values.
9. Closed loop system data: Controller Asset # 1619.

LEGEND

PROPOSED		EXISTING
○→	Traffic Signal Head	●→
◐→	Modified Signal Head	N/A
⊣	Sign	⊣
□↓	Pedestrian Signal Head With Push Button & Sign	■↓
○→	Signal Pole with Guy	●→
○↷	Signal Pole with Sidewalk Guy	●↷
▭	Inductive Loop Detector	▭
⊠	Controller & Cabinet	⊠
□	Junction Box	■
----------	2-in Underground Conduit	----------
N/A	Right of Way	----------
→	Directional Arrow	→
N/A	Guardrail	⊥—⊥
Ⓐ	"YIELD" Sign (R1-2)	Ⓐ
Ⓑ	Left Arrow "ONLY" Sign (R3-5L)	Ⓑ
Ⓒ	No Right Turn Sign (R3-1)	Ⓒ
Ⓓ	No Left Turn Sign (R3-2)	Ⓓ

OASIS 2070L TIMING CHART

FEATURE	PHASE 2	PHASE 5	PHASE 6	PHASE 8
Min Green 1 *	10	7	10	7
Extension 1 *	3.0	2.0	3.0	2.0
Max Green 1 *	75	20	60	20
Yellow Clearance	4.0	3.0	4.0	3.0
Red Clearance	3.0	3.5	3.0	2.4
Walk 1 *	-	-	-	-
Don't Walk 1	-	-	-	-
Seconds Per Actuation *	-	-	-	-
Max Variable Initial *	-	-	-	-
Time Before Reduction *	-	-	-	-
Time To Reduce *	-	-	-	-
Minimum Gap	-	-	-	-
Recall Mode	MIN RECALL	-	MIN RECALL	-
Vehicle Call Memory	YELLOW	-	YELLOW	-
Dual Entry	-	-	-	-
Simultaneous Gap	ON	ON	ON	ON

* These values may be field adjusted. Do not adjust Min Green and Extension times for phases 2 and 6 lower than what is shown. Min Green for all other phases should not be lower than 4 seconds.

Signal Upgrade

Prepared in the Offices of:
Transportation Mobility and Safety Division
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
Signal Design Section
750 N.Greenfield Pkwy.Garner,NC 27529

SR 2136 (Gilead Road) at I-77 NB Ramps

Division 10 Mecklenburg County Huntersville

PLAN DATE: March 2010 REVIEWED BY: M. Mahbooba

PREPARED BY: B.E. Wynn REVIEWED BY:

REVISIONS	INIT.	DATE

SCALE 0 20 1"=20'

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 24393 ENGINEER TIMOTHY J. WILLIAMS
SIGNATURE 3/25/10. DATE

SIG. INVENTORY NO. 10-1619

25-MAR-2010 08:32
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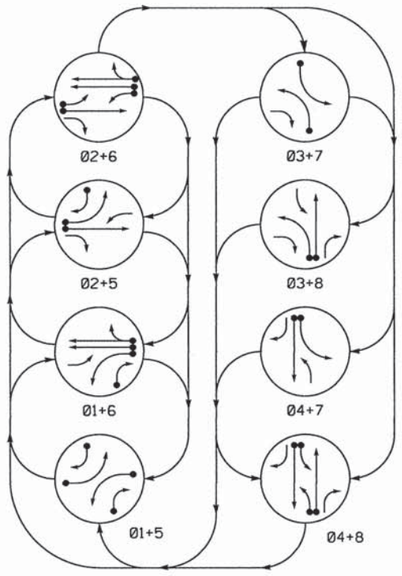
mahbooba

PROJECT REFERENCE NO.	SHEET NO.
M0E	Sig. 1

8 Phase Fully Actuated Gilead Road Closed Loop System

PHASING DIAGRAM



PHASING DIAGRAM DETECTION LEGEND

- DETECTED MOVEMENT
- UNDETECTED MOVEMENT (OVERLAP)
- UNSIGNALIZED MOVEMENT
- PEDESTRIAN MOVEMENT

TABLE OF OPERATION

SIGNAL FACE	PHASE 01+5	01+6	02+5	02+6	03+7	03+8	04+7	04+8	FLASH
11	←	←	F	F	R	R	R	R	R
21	R	R	G	G	R	R	R	R	Y
22	R	R	G	G	R/→	R/→	R	R	Y
31	R	R	R	R	←	←	F	F	R
41	R	R	R	R	R	R	G	G	R
42	R/→	R	R/→	R	R	R	G	G	R
51	←	F	←	F	R	R	R	R	R
61,62	R	G	R	G	R	R	R	R	Y
71	R	R	R	R	←	F	←	F	R
81	R	R	R	R	R	G	R	G	R
82	R/→	R/→	R	R	R	G	R	G	R

F = Flashing Yellow Arrow

STANDARD SIGNAL FACE CLEARANCES FOR FLASHING LEFT TURN SIGNAL

FROM \ TO	← 1	← 2	F 1	F 2	R 1	R 2
←	←	←	R	R	R	R
F	R	R	F	F	R	R
R	R	R	R	R	R	R

F = Flashing Yellow Arrow

OASIS 2070L LOOP & DETECTOR INSTALLATION CHART

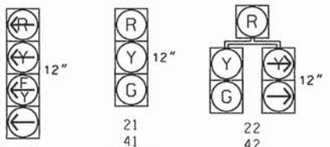
INDUCTIVE LOOPS: LOOP	SIZE (FT)	DISTANCE FROM STOPBAR (FT)	TURNS	NEW LOOP	DETECTOR PROGRAMMING: PHASE	CALLING	EXTENSION	FULL TIME DELAY	STRETCH TIME	DELAY TIME	SYSTEM LOOP	NEW CARD
1A	6X40	0	2-4-2	Y	1	Y	Y	-	-	15	-	Y
					6	Y	Y	-	-	-	-	Y
1B	6X40	0	2-4-2	Y	1	Y	Y	-	-	15		Y
2A	6X6	70	3	Y	2	Y	Y	-	-	-	-	Y
3A	6X40	0	2-4-2	Y	3	Y	Y	-	-	15	-	Y
					8	Y	Y	-	-	3	-	Y
4A	6X40	0	2-4-2	Y	4	Y	Y	-	-	-	-	Y
5A	6X40	0	2-4-2	Y	5	Y	Y	-	-	15	-	Y
					2	Y	Y	-	-	-	-	Y
5B	6X40	0	2-4-2	Y	5	Y	Y	-	-	15	-	Y
6A	6X6	70	3	Y	6	Y	Y	-	-	-	-	Y
6B	6X6	70	3	Y	6	Y	Y	-	-	-	-	Y
7A	6X40	0	2-4-2	Y	7	Y	Y	-	-	15	-	Y
					4	Y	Y	-	-	3	-	Y
8A	6X40	+5	2-4-2	Y	8	Y	Y	-	-	-	-	Y
S01	6X6	+170	3	Y	-	-	-	-	-	-	Y	Y
S02	6X6	+170	3	Y	-	-	-	-	-	-	Y	Y

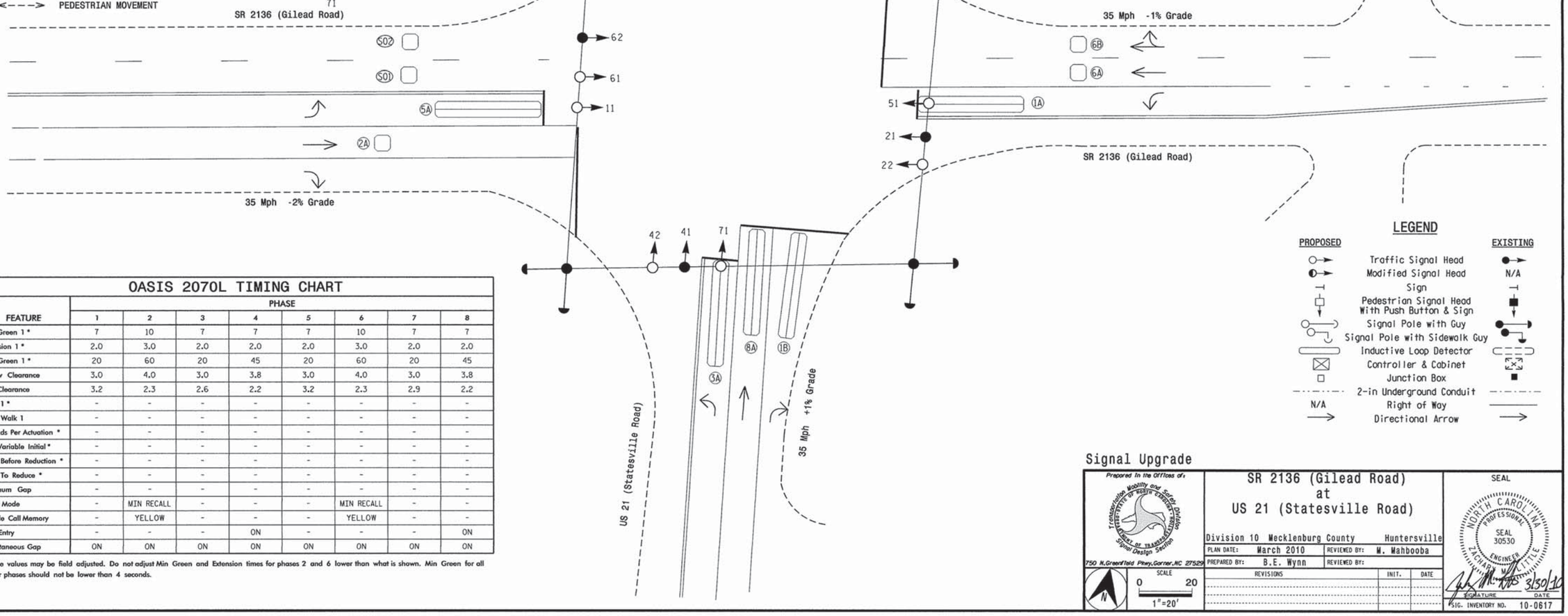
NOTES

1. Refer to "Roadway Standard Drawings NCDOT" dated July 2006 and "Standard Specifications for Roads and Structures" dated July 2006.
2. Do not program signal for late night flashing operation unless otherwise directed by the Engineer.
3. Phase 1 and/or phase 5 may be lagged.
4. Phase 3 and/or phase 7 may be lagged.
5. Reposition existing signal heads numbered 21, 41, 62 & 81.
6. Set all detector units to presence mode.
7. Locate new cabinet so as not to obstruct sight distance of vehicles turning right on red.
8. Pavement markings are existing.
9. Maximum times shown in timing chart are for free-run operation only. Coordinated signal system timing values supersede these values.
10. Closed loop system data: Controller Asset #0617.

SIGNAL FACE I.D.

All Heads L.E.D.





LEGEND

PROPOSED		EXISTING
○→	Traffic Signal Head	●→
◐→	Modified Signal Head	N/A
⊣	Sign	⊣
⊓	Pedestrian Signal Head With Push Button & Sign	■
○	Signal Pole with Guy	●
○	Signal Pole with Sidewalk Guy	●
▭	Inductive Loop Detector	▭
⊠	Controller & Cabinet	⊠
□	Junction Box	■
N/A	2-in Underground Conduit	N/A
N/A	Right of Way	N/A
→	Directional Arrow	→

OASIS 2070L TIMING CHART

FEATURE	PHASE 1	2	3	4	5	6	7	8
Min Green 1 *	7	10	7	7	7	10	7	7
Extension 1 *	2.0	3.0	2.0	2.0	2.0	3.0	2.0	2.0
Max Green 1 *	20	60	20	45	20	60	20	45
Yellow Clearance	3.0	4.0	3.0	3.8	3.0	4.0	3.0	3.8
Red Clearance	3.2	2.3	2.6	2.2	3.2	2.3	2.9	2.2
Walk 1 *	-	-	-	-	-	-	-	-
Don't Walk 1	-	-	-	-	-	-	-	-
Seconds Per Actuation *	-	-	-	-	-	-	-	-
Max Variable Initial *	-	-	-	-	-	-	-	-
Time Before Reduction *	-	-	-	-	-	-	-	-
Time To Reduce *	-	-	-	-	-	-	-	-
Minimum Gap	-	-	-	-	-	-	-	-
Recall Mode	-	MIN RECALL	-	-	-	MIN RECALL	-	-
Vehicle Call Memory	-	YELLOW	-	-	-	YELLOW	-	-
Dual Entry	-	-	-	ON	-	-	-	ON
Simultaneous Gap	ON	ON	ON	ON	ON	ON	ON	ON

* These values may be field adjusted. Do not adjust Min Green and Extension times for phases 2 and 6 lower than what is shown. Min Green for all other phases should not be lower than 4 seconds.

Signal Upgrade

Prepared In the Offices of: Transportation Mobility and Safety Division, NC Department of Transportation, Signal Design Section
750 N.Greenfield Pkwy,Garner,NC 27529

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Division 10 Mecklenburg County Huntersville

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REVISIONS	INIT.	DATE

SEAL: NORTH CAROLINA PROFESSIONAL SEAL 30530 ENGINEER — ZACHARY W. LITTLE

SIGNATURE 3/30/10 DATE

SIG. INVENTORY NO. 10-0617

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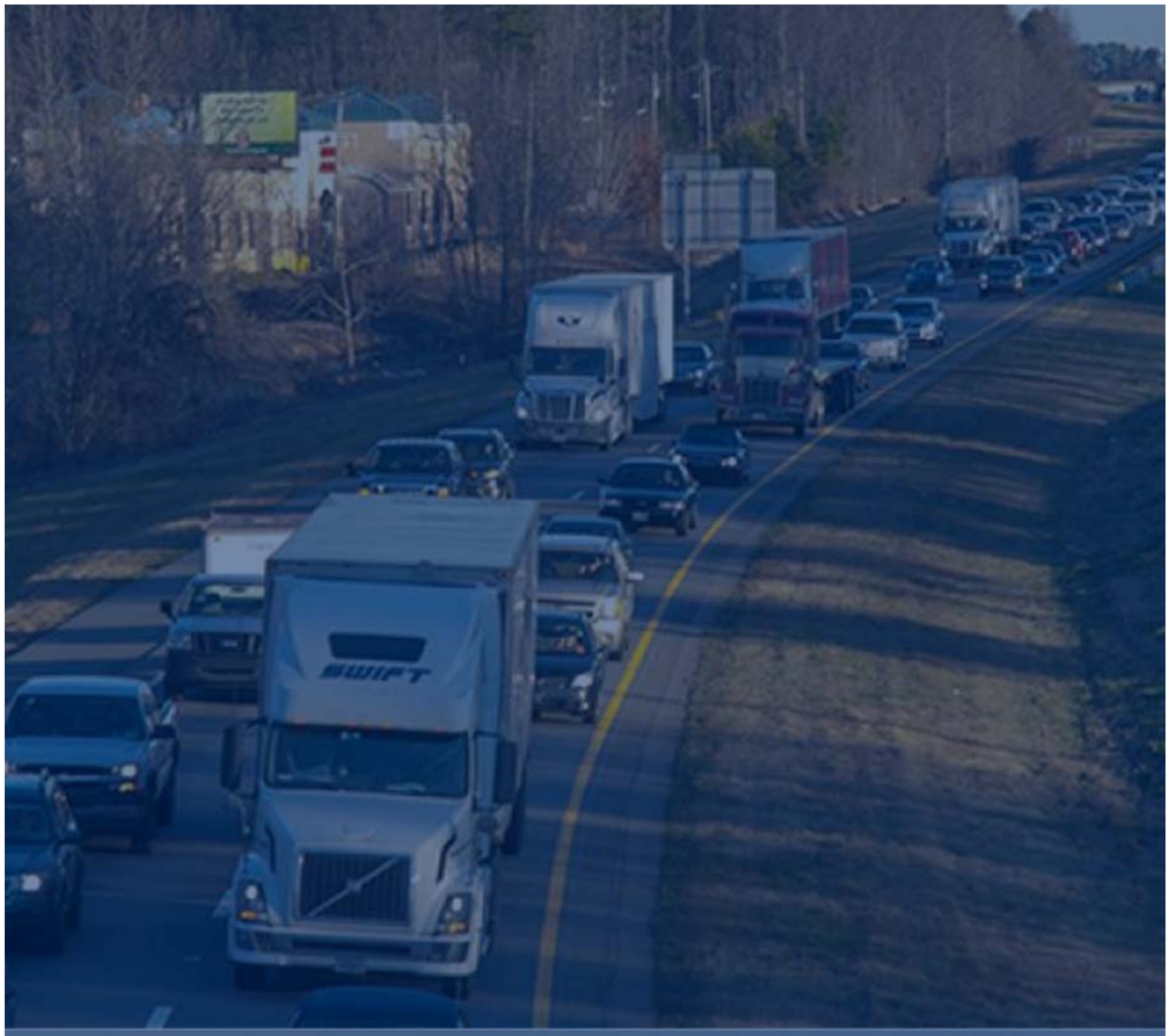

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