FEASIBILITY STUDY

I-77 from I-85 to Griffith Street

Mecklenburg County

Division 10

FS-0810B

Task Order No. 1

I-77 Widening and HOV Lane Extension

Project Report

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N.C. Department of Transportation

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1.0 INTRODUCTION

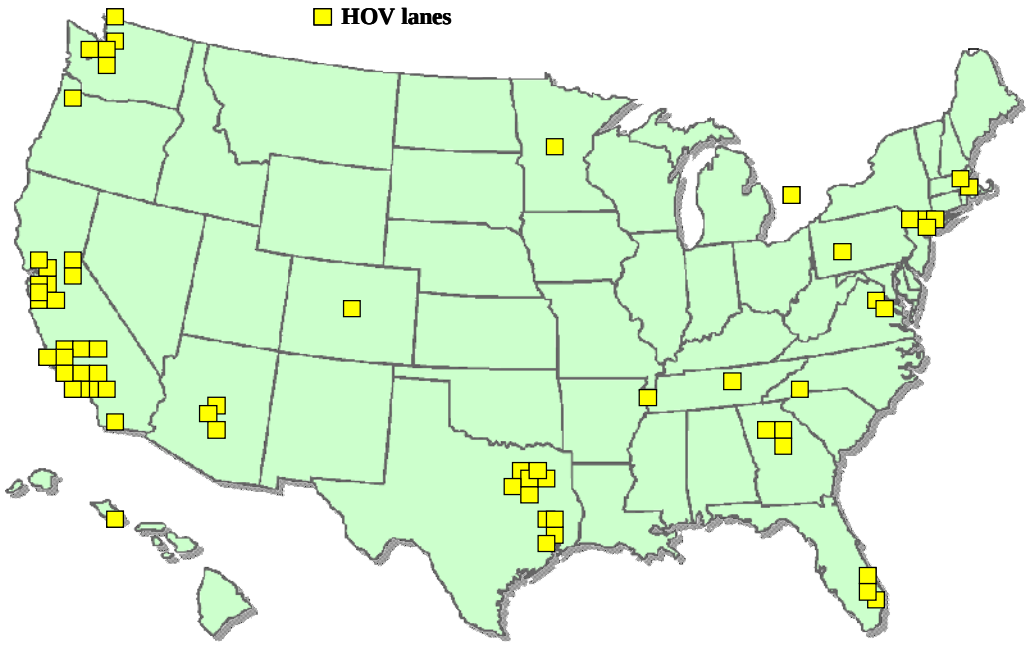
1.1 Purpose of Task Order No. 1

The purpose of Task Order No. 1 of the I-77 Feasibility Study was to analyze the feasibility of widening I-77 to eight lanes, including the extension of the existing high-occupancy vehicle (HOV) lanes, from the current terminus located at I-485 (Exit 19) to Griffith Street (SR-2158), which is Exit 30 in Davidson. The Task Order also examined the feasibility of widening I-77 to six lanes in this area by simply extending the HOV lane between Exits 19 and 30. The Task Order identified issues, design modifications, benefits and costs associated with I-77 widening, which included HOV facility extension, for both six and eight-lane alternatives.

1.2 National Context

In highly congested corridors where traditional strategies for improving mobility and roadway capacity cannot address unmet demand, specially-designated lanes are often implemented to more aggressively manage use of these lanes so as to improve roadway efficiency. This strategy provides a choice to motorists who otherwise would have to deal with traffic congestion. In the late 1960s, managed lanes began as restricted, often curbside lanes for buses on streets and a few expressways. By the mid-1970s, carpools and vanpools, usually with 3 or more persons, were allowed to use some dedicated lanes, which were termed HOV lanes. In the late-1980s, changes in federal policies allowed local governments to open HOV lanes to carpools with two or more persons. By the mid-1990s, congestion pricing was tested on several HOV lanes, and the term high-occupancy toll (HOT) lane originated. There are currently over 3000 lane-miles of HOV or HOT lanes on freeways in North America plus a wide number of lanes primarily reserved for buses on arterials. Practically all HOV or HOT lanes are located in highly congested metropolitan areas where they provide a travel time advantage over adjacent lanes. **Figure 1-1** shows the urban areas in the United States where HOV lanes have been implemented/ considered.

Figure 1-1: HOV Lanes in the USA



1.2.1 HOV Lanes

Managed lanes over the past 30 years have generally been designated as HOV lanes with eligibility for carpools and vanpools. The following definition for HOV facilities explains the purpose of these facilities:

> *HOV Facility: A lane or roadway dedicated to the exclusive use of specific high-occupancy vehicles, including buses, carpools, vanpools or a combination thereof, for at least a portion of the day.*

By offering a reserved lane for multi-person vehicles, HOV lanes emphasize *person movement* rather than traditional *vehicle movement,* thus improving the roadway's ability to move more people in fewer vehicles (**Figure 1-2**). This approach only works when an assured level of service in the HOV lane is preserved and time savings that encourage mode shifts to transit, vanpooling and carpooling are realized. To provide this benefit, the dedicated lanes are managed at a vehicle flow rate that is below traditionally defined lane capacity so that the lane does not become congested. HOV facilities enable transportation agencies to better manage freeway capacity and offer an alternative to congestion. When operated and managed at a high level of service, HOV lanes save peak-period travel time over adjacent mixed-flow lanes and have a theoretical capacity to move substantially more commuters than general use lanes during peak demand periods when priority must be assigned to the highest and best use. During these periods, HOV lanes provide significant benefits to those choosing to ride a bus or travel in a vanpool or carpool.

Figure 1-2: Example HOV Lane

The primary tools used to manage HOV lane use are eligibility and access. Eligibility restricts lane use to vehicles with a minimum number of persons traveling in each vehicle. Access has sometimes been restricted to specific access or egress points in order to manage demand and promote better traffic flow.

HOV lanes make the most sense when:

- Adjacent general-purpose lanes are heavily congested during peak periods.
- Sufficient demand exists among transit and rideshare users to justify a dedicated lane.
- Travel benefits are enough to cause solo commuters to shift to transit or ridesharing.
- Resources are limited for expanding roadway capacity to meet future demand conventionally.

Analysis of HOV lanes has shown that they can have a positive impact on corridor transit and rideshare use. Various before/after studies have shown that about 40 percent of HOV users come from previous carpoolers who have shifted from adjacent lanes or other routes into the HOV lane (called "spatial shifts"); another 40 percent are newly formed carpools and vanpools and transit riders who previously drove alone (called "mode shifts"); and the balance were new trips in the corridor often created because the dedicated lane provided a superior way of commuting.

1.3 Managed Lanes Planning in the Charlotte Region

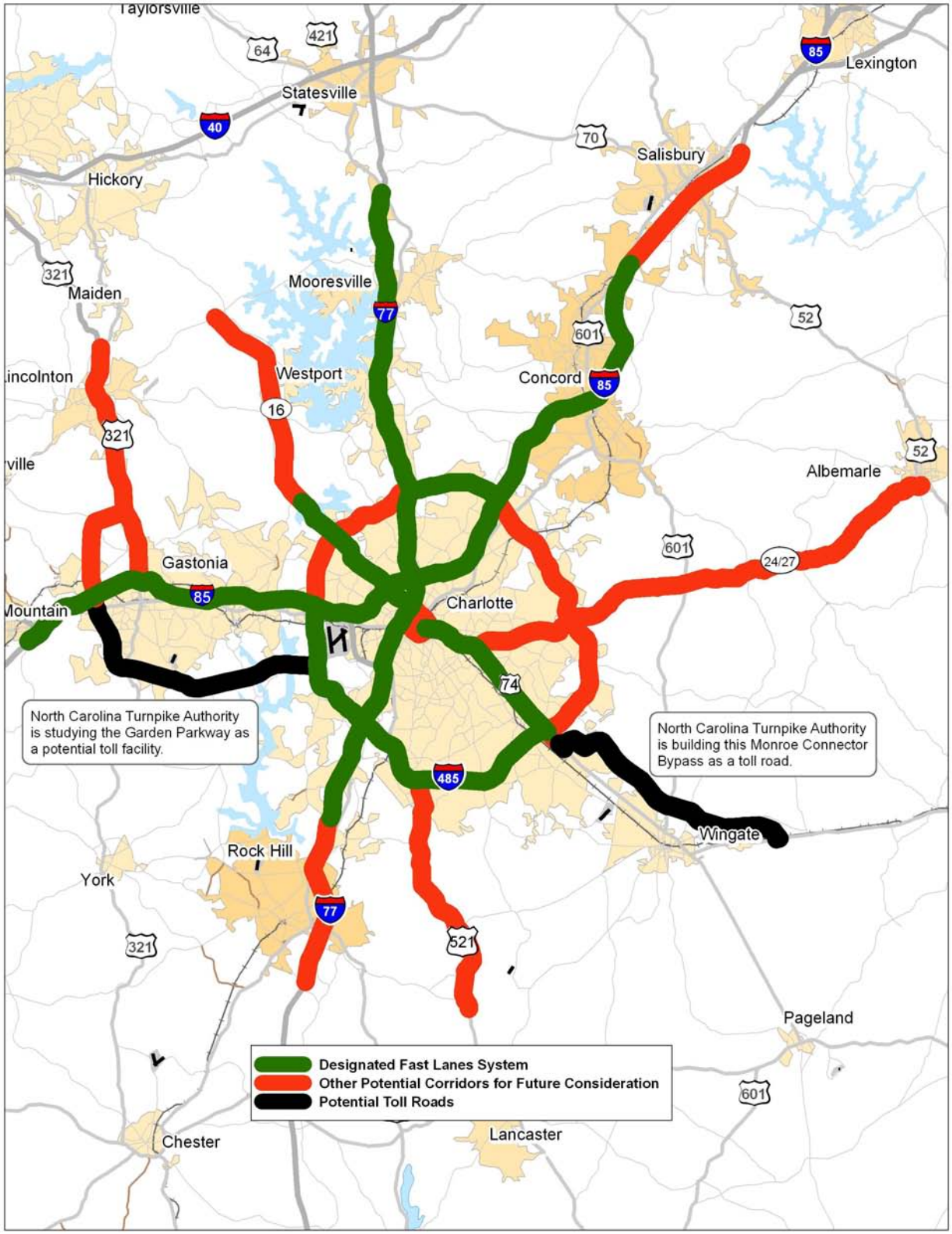
From 2007 to 2009, the North Carolina Department of Transportation (NCDOT) and local governments in the Charlotte region examined the existing and planned major highways throughout a 10-county area to identify where managed lanes could improve roadway capacity. The Charlotte Region *Fast Lanes* Study covered 12 primary corridors, totaling about 334 miles of freeways and arterials. The study used a two-phase process to determine which regional highways showed the greatest promise for managed lanes treatments. **Figure 1-3** indicates the corridors evaluated in this regional planning effort, highlighting those corridors, including I-77 North, which advanced into Phase 2.

1.3.1 Regional Goals and Objectives

The Charlotte Region *Fast Lanes* Study identified the following goals for implementing managed lanes, such as HOV facilities:

- Maintaining mobility
- Improving roadway operation efficiency, safety and reliability
- Promoting transit and ridesharing
- Improving safety
- Providing travel options to meet user needs, such as "time-sensitive" travel, and
- Generating revenue to offset capital and operating expenses
- Improving air quality

Figure 1-3: *Fast Lanes* –Corridor Screening



Regional and/or corridor objectives for managed lanes include:

- Increasing person-moving capacity of the roadway
- Promoting transit and ridesharing mode split
- Optimizing vehicle-carrying capacity
- Promoting travel time savings, reliability, or efficiency for selected travel modes
- Promoting air quality by increasing ridesharing and transit as part of a conformity plan
- Increasing funding opportunities for new mobility improvements
- Enhancing existing transit investments and services in the region/corridor
- Providing a greater choice in serving multi-modal needs (people, goods, services)
- Improving the movement of commerce (goods and services movements)
- Supporting community land use and development goals, particularly to major areas of employment

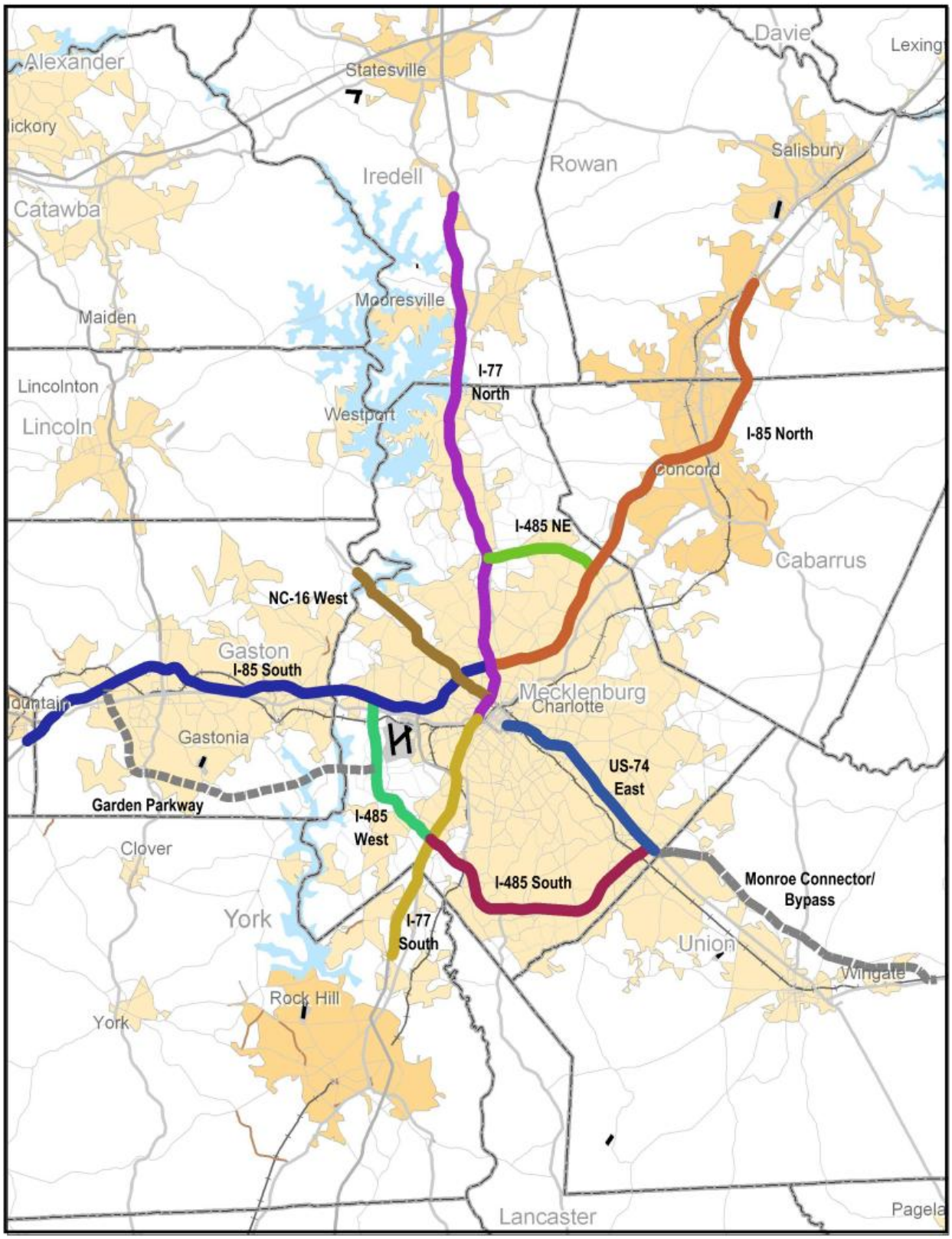
Fundamental to these goals and objectives is an implicit set of conditions that should exist for HOV lanes to be considered viable. These conditions include the following:

- A recurring congestion problem with traffic operating at level of service D or worse within a corridor or region for a significant period of time each weekday
- A significant backlog of unmet travel demand, and/or lack of available resources (right-of-way, funding, regional consensus or environmental issues) to address capacity deficiencies in a more conventional means through adding roadway or transit capacity
- An interest and ability to minimally increase roadway capacity by managing its use to specific dedicated purposes to ensure that a high level of service can be provided as an alternative to recurring congestion

1.3.2 Conclusions for the I-77 from Charlotte Region *Fast Lanes* Study

The travel demand for managed lanes in the I-77 North corridor, as shown in **Figure 1-4**, ranked near the top of corridors assessed in Phase 2 of the regional study. The forecasted travel time savings for managed lanes users in 2030 would exceed the industry rule-of-thumb of a half-minute per mile savings. These results were based on development of a regional managed lanes network. The *Fast Lanes* study concluded that I-77 North should be analyzed at the individual corridor level for managed lanes implementation.

Figure 1-4: *Fast Lanes* – Phase 2 Corridor Evaluation



1.4 I-77 HOV Facility Objectives

The objectives established in 2003 during the initial implementation of I-77 HOV lanes included:

- Move more people by increasing the number of persons per vehicle.
- Reduce travel time and ensure reliable trip times for HOVs using the I-77 managed lanes.
- Operate a safe HOV facility and not unduly impact the safety of the I-77 general purpose lanes.
- Maintain or improve public support for the I-77 HOV facility.

Experience since the I-77 HOV lanes opened in 2004 indicates that another objective that should be considered is managing violations that are present on the HOV lanes in order to help maintain public respect and acceptance. The ability to enforce HOV compliance along I-77 is limited by the facility's design (the HOV lanes are not physically separated from adjacent traffic) and by the lack of dedicated enforcement for I-77 HOV lane operations beyond the start-up period in 2004-2005. Enforcement experience along I-77 prompts the addition of another performance measure in order to monitor and improve compliance of HOV lane regulations.

The objectives for the proposed extension of HOV lanes along I-77 are:

- ***Increase mobility in the I-77 corridor*** by moving more persons per vehicle and more vehicles than the number presently being carried in the HOV lanes.
- Reduce travel time and ensure reliable trip times for all eligible users for an HOV lane extension.
- Operate a safe managed lane facility and preserve the safety of the I-77 general purpose lanes.
- Test acceptance and maintain or improve public support for an HOV lane extension.
- Improve enforcement compliance.

1.5 HOV Facility Enabling Legislation and Penalties

General Statute 20-146.2 (a) authorizes HOV lanes in North Carolina. This statute was revised in 2003 to reflect updated vehicle occupancy and eligibility requirements, and the law became effective on December 1, 2003.

HOV Lanes. – The Department of Transportation may designate one or more travel lanes as high occupancy vehicle (HOV) lanes on streets and highways on the State Highway System and cities may designate one or more travel lanes as high occupancy vehicle (HOV) lanes on streets in the Municipal Street System. HOV lanes shall be reserved for vehicles with a specified number of passengers as determined by the Department of Transportation or the city having jurisdiction over the street or highway. When HOV lanes have been designated, and have been appropriately marked with signs or other markers, they shall be reserved for privately or publicly operated buses, and automobiles or other vehicles containing the specified number of persons. Where access restrictions are applied on HOV lanes through designated signing and pavement markings, vehicles shall only cross into or out of an HOV lane at designated openings. A motor vehicle shall not travel in a designated HOV lane if the motor vehicle has more than three axles, regardless of the number of occupants. HOV lane restrictions shall not apply to motorcycles or vehicles designed to transport 15 or more

passengers, regardless of the number of occupants. HOV lane restrictions shall not apply to emergency vehicles. As used in this subsection, the term "emergency vehicle" means any law enforcement, fire, police, or other government vehicle, and any public and privately owned ambulance or emergency service vehicle, when responding to an emergency.

G.S. 20-176(b) states the penalty of HOV lane violations:

Unless a specific penalty is otherwise provided by law, a person found responsible for an infraction contained in this Article may be ordered to pay a penalty of not more than one hundred dollars ($100.00).

G.S. 20-16 covers the charging of driver's license points for HOV lane violations. Because HOV lane offenses are not specified in the statute, violations would be included in the category of "All other moving violations" with a penalty of two points.

1.6 Organization and Content

This task order's report includes the following:

- Chapter 2 – Project Context – reviews the existing I-77 HOV lanes, identifies other proposed projects and plans for the corridor, and highlights current traffic management operations for I-77. The chapter also summarizes traffic projections for the general purpose lanes and extended HOV lanes and reviews current and forecasted deficiencies. This chapter reviews traffic estimates at the termini of the HOV lanes based on CORSIM simulation results.
- Chapter 3 – Agency Coordination – discusses coordination efforts among agency partners during the performance of Task Order No. 1.
- Chapter 4 – Freeway Design and Access – describes the modifications and improvements at a conceptual level for extending the general purpose and/or HOV lanes north of Exit 23, Gilead Road. This chapter reviews elements such as design principles, typical section, signing and marking concepts, access, lane transitions and costs.
- Chapter 5 – Operations Policies – reviews eligibility policies, operating hours, and access policies.
- Chapter 6 – Maintenance – identifies potential maintenance issues associated with the adding of general purpose and HOV lanes to I-77, including estimated costs.
- Chapter 7 – Traffic Management, Enforcement and Incident Management – recommends changes to existing I-77 HOV lanes interfaces with NCDOT's Metrolina Regional Traffic Management Center (MRTMC) if the facility is lengthened. The chapter also reviews enforcement needs and coordination with current incident management plans, including estimated costs.
- Chapter 8 – Appendices – includes a series of lane diagrams that depict the results of the CORSIM traffic simulation analyses along the corridor and the typical signing plan for extending the HOV facility north of I-485.

2.0 PROJECT CONTEXT

This chapter reviews history and the design and operational features of the I-77 HOV lanes opened by NCDOT in 2004. It also highlights existing traffic and transit operations along the corridor and summarizes traffic volumes and capacity deficiencies, both now and in the future.

2.1 Project History

In 2001, NCDOT began widening I-77 from its interchange with I-85 north to the proposed Charlotte Outer Loop (I-485). This project, known as I-3311A, involved widening the existing four-lane interstate facility to an eight-lane freeway. The project also included widening and strengthening the outside shoulders to meet current design standards and to accommodate traffic shifts during construction. A later project (I-3311B) was programmed to improve the section of I-77 from I-485 to NC-73 (Sam Furr Road).

Also in 2001, NCDOT completed the *I-77 Sub-Area Study.* This study analyzed the feasibility of including HOV lanes as the inside (median) lanes of project I-3311A, resulting in three general purpose lanes plus one HOV lane in each direction. Based on the recommendations of this study, the Mecklenburg-Union Metropolitan Planning Organization (MUMPO) added in January 2002 an HOV project along I-77 to the urban area's Immediate Project Needs list.

In 2002, the Federal Highway Administration (FHWA) approved an environmental document prepared by NCDOT that proposed designating two of the additional lanes constructed north of the I-85 interchange for HOVs. The HOV lane on southbound I-77 would extend from I-85 through the Brookshire Freeway (I-277) interchange (a total HOV lane length of 10 miles) while the northbound HOV lane would extend north of the I-85 interchange through W. T. Harris Boulevard (a total HOV lane length of about five miles).

In 2003, NCDOT approved HOV lane construction as an addition to the I-77 widening design-build project that was already underway. The HOV facility was opened in December 2004.

2.2 Existing Facility Design and Operations

The current I-77 HOV facility consists of a concurrent flow lane located next to the median in each direction of the interstate. A diamond symbol used both in pavement markings and on overhead signs, designates the HOV facility. To ensure safety for all travelers, access into the HOV lanes is permitted at selected locations along the corridor. Those locations are designated by appropriate signing and a wide white skip line on the pavement. HOV signing also is included to identify these access areas. Double solid white pavement lines indicate where HOV lane access is prohibited. **Figure 2-1** and **Figure 2-2** show how pavement markings are used to designate facility access.

Figure 2-1: HOV Pavement Markings (no access)

Figure 2-2: HOV Pavement Markings (open access)

2.2.1 Southbound HOV Facility Access

HOVs traveling southbound are prohibited from accessing the HOV lane at two locations:

- At the beginning of HOV lanes near I-77's interchange with I-485
- Just north of the I-85 interchange, where the southbound I-77 HOV lane separates from the main roadway on its own ramp and rejoins I-85 further south. This connecting ramp provides HOVs the opportunity to bypass ramp traffic from I-85 (shown in **Figure 2-3**).

The HOV lane ends south of the general purpose exit ramp for I-277 (Brookshire Freeway), a location where I-77 traffic volumes are lower, improving safety of the HOV merge into general purpose traffic lanes.

Figure 2-3: I-77 HOV Bypass of I-85 Interchange

2.2.2 Northbound HOV Facility Access

The northbound I-77 HOV lane begins ½-mile north of the I-85 interchange and ends at the I-485 interchange location, a distance of about 5 miles. The northbound freeway cross-section is three general-purpose lanes plus a concurrent flow HOV lane.

Designation of the median lane as an HOV lane begins far enough north of the I-77 entrance ramp from I-85 so that vehicles, particularly trucks, can safely merge from this lane into the leftmost general purpose lane. Eligible vehicles have continuous access to the northbound HOV lane until access is restricted just south of the I-77/Harris Boulevard interchange. The HOV designation for the northbound median lane extends beyond Harris Boulevard and is dropped prior to the I-485 interchange. The HOV lane becomes one of four general purpose lanes at this point, and this lane is dropped into two general purpose lanes in the vicinity of the I-485 interchange.

2.2.3 User Requirements

The I-77 HOV facility is open to vehicles with two or more occupants with the following exceptions:

- **Motorcycles.** Federal law requires HOV lanes to be open to motorcycles regardless of the number of riders.
- **Emergency Vehicles.** The term "emergency vehicle" means any law enforcement, fire, police, or other government vehicle, and any public or privately owned ambulance or emergency service vehicle, when responding to an emergency.
- **Buses**. Any vehicle designed to transport 15 or more passengers, regardless of the actual number of occupants.
- **Trucks.** A motor vehicle with three or more axles, regardless of the number of occupants, is prohibited from using I-77 HOV lanes.

2.2.4 Hours of Operation

The I-77 HOV lanes are restricted to HOVs 24 hours a day, seven days a week. This determination was made to ensure safe operation of the HOV lanes, especially as the southbound HOV lane approaches the I-85 interchange. At this location, the HOV lane is carried over I-85 on a separate ramp and rejoins I-85 further south. This HOV ramp provides carpools, vanpools, transit vehicles, and emergency vehicles a bypass around I-85 traffic. If the HOV lane was operated only part-time and opened to other traffic during off-peak hours, use of the separate HOV ramp could cause motorist confusion and create the potential for accidents. To reduce this likelihood, the HOV ramp would have to be closed and gated during non-operating periods. Closure procedures would likely require traffic to be forced out of the leftmost lane north of the I-77/I-85 interchange.

National HOV guidance urges consistency whenever possible when developing HOV operating policies. The northbound HOV lane has 24-hour operation to be consistent with southbound HOV lane operations and to simplify enforcement requirements. Because the vehicle occupancy requirement is always in effect, motorists know they should not use the lane unless they have the appropriate number of people in their vehicle. Although projected HOV volumes do not warrant 24-hour operation of the northbound HOV lane, congestion in the general purpose lanes during off-peak periods is less likely so minimal travel benefits would materialize for others if the northbound HOV lane was opened to all vehicles.

Twenty-four hour operation simplifies facility signing. The U.S. Manual on Uniform Traffic Control Devices (MUTCD) requires posting of projects operating during peak periods not only at entrances but also along the lane. Projects with 24-hour operation need only to post hours of operation at entrance and exit locations.

An additional benefit of 24-hour operation is use of the facility by recreational trips, which generally occur in off-peak periods and often are 2+ vehicles. Off-peak use by tourists or travelers to Lake Norman may help to increase peak-period commuter use.

2.2.5 Enforcement

The North Carolina State Highway Patrol (NCSHP) randomly conducts enforcement along the I-77 HOV lanes in concert with normal enforcement duties. There have been no major issues associated with HOV lane enforcement. Motorcycle divisions of both NCSHP and

Charlotte-Mecklenburg Police Department (CMPD) have the greatest involvement in lane enforcement because they can park on the inside shoulder. According to NCSHP personnel, a significant number of citations were initially issued because motorists claimed that they were unaware of occupancy requirement. But that has not been a problem for a while as HOV lane awareness as grown.

2.2.6 Performance Monitoring

A Performance Monitoring Plan was developed for the I-77 HOV facility in 2004 prior to its opening. The Plan's purpose was to respond to HOV lane project objectives and track performance of the I-77 HOV operation in response to those objectives. Another purpose of performance monitoring is to fine-tune the facility's operation, design, rules and regulations through a modest data collection effort. In 2006, a report was prepared to document the effectiveness and impacts of North Carolina's first HOV lane project. Data was collected by various agencies both before and after the I-77 HOV facility was implemented. Information in this report was compared to baseline data collected in October 2004 to indicate how well the lanes were meeting approved objectives.

2.3 Other I-77 Corridor Projects or Plans

NCDOT's Project No. I-3311B involves widening I-77 from the end of the current eight-lane section near I-485 to Exit 25 (NC-73 or Sam Furr Road). This project is not scheduled for construction prior to 2015. This project extends the current Intelligent Transportation Systems (ITS) along I-77 north to Exit 25.

Augustalee, a major proposed mixed-use development in Cornelius, includes the widening on I-77 from four to six lanes from south of Exit 23 (Gilead Road) to Exit 28 (Catawba Avenue). On April 29, 2009, MUMPO amended the Transportation Improvement Program (TIP) to include I-77 widening related to the Augustalee project. MUMPO's approval of the TIP amendment included the preference that the new I-77 lanes be constructed as managed lanes. Another transportation improvement included in this new development is construction of a new interchange on I-77 at Westmoreland Road. The developer is responsible for preparing the required Interchange Justification Report (IJR) for approval by the FHWA and NCDOT.

In 2003, NCDOT completed a feasibility study for the proposed widening of I-77 from the I-3311B project, which ends at Exit 25 (NC-73) in Huntersville, to I-40 near Statesville in Iredell County. This study addressed interstate widening from the four-lane existing freeway to an eight-lane facility. NCDOT Division 10 staff also has analyzed adding one general purpose lane in each direction between the end of the existing widening at Exit 23 and Exit 30 by widening into the median. There is enough space in the median to accommodate this widening of the interstate.

NCDOT has two additional planning and environmental studies underway along I-77 south of I-85:

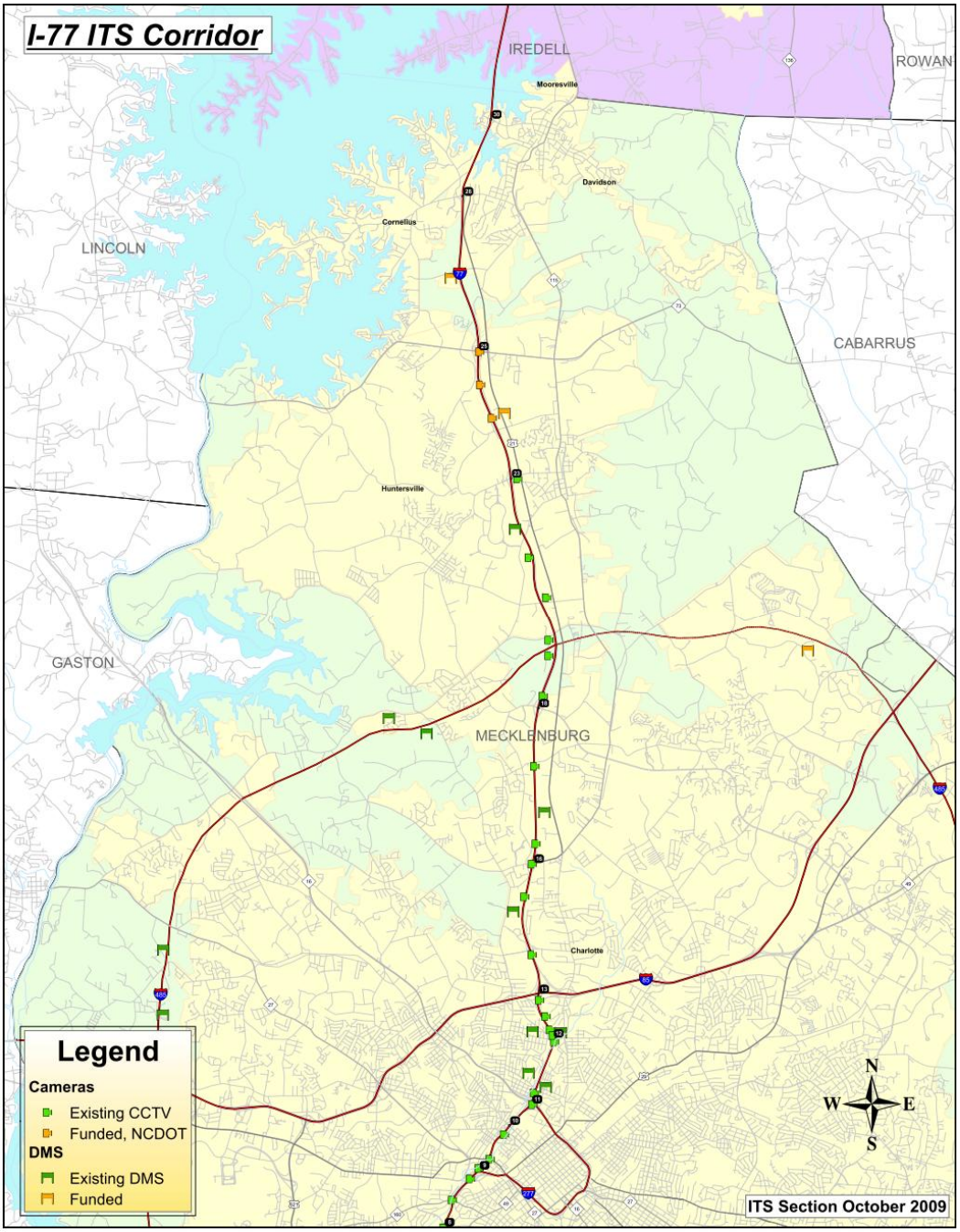
- Widening of lanes and shoulders between the I-77/I-85 interchange and I-277 (Brookshire Freeway) to re-establish full design standards for this freeway section. The southbound lanes and shoulders were reduced in 2004 to implement the HOV facility.
- Physical feasibility study for extending the I-77 HOV lanes between the I-77/I-85 interchange and Fifth Street in Center City Charlotte.
- Charlotte Area Transit System (CATS) has completed planning and conceptual design of a commuter rail line between Mooresville and Center City Charlotte. Although this rapid

transit line is parallel to I-77, it serves a different travel market and would not impact usage of the current HOV lanes or the potential facility extension.

2.4 Traffic Operations and Management

NCDOT's MRTMC monitors and manages traffic along the existing I-77 HOV facility using closed circuit television (CCTV) surveillance, out-of-pavement traffic detectors and dynamic message signs (DMS). **Figure 2-4** identifies the location of existing and funded ITS features along I-77. The current HOV lanes do not have unique incident management needs or protocols within the MRTMC.

Figure 2-4: Existing and Funded ITS Features



2.5 Corridor Transit Operations

Charlotte Area Transit System (CATS) currently operates four express bus routes along the I-77 HOV lanes (see **Figure 2-5**):

- **Route 48X, Huntersville Express.** Twelve AM peak period trips and 11 PM peak period trips on weekdays.
- **Route 53X, Northlake Express.** Four AM peak period trips and four PM peak period trips each weekday.
- **Route 77X, North Mecklenburg Express**. Seventeen morning trips and 18 afternoon/evening trips on weekdays.
- **Route 83X, Mooresville Express.** Four AM peak period trips and four PM peak period trips each weekday.

2.6 Traffic Operations

2.6.1 Existing and Projected Traffic Volumes

Table 2-1 shows a comparison of average annual daily traffic (AADT) volumes at key locations along the I-77 corridor. During the three years of available traffic count data, there was very little change in traffic volumes. In 2008, as a result of opening of I-485/I-77 interchange, traffic volumes along the corridor between I-85 and I-485 decreased from 3 to 5 percent. Traffic volumes south of I-85 grew at a very modest annual rate of less than 2 percent. **Table 2-1** also shows future traffic estimates from the regional travel demand model based on the no-build scenario of the long range transportation plan.

In general, the regional model's traffic forecasts indicate that I-77 traffic volumes will continue to increase. The segment of I-77 south of I-85 appears to have reached capacity; therefore, there is little ability to handle additional traffic. However, the northern section of I-77 between I-85 and the Iredell County line is estimated to experience significant traffic increases. In the short term (between 2008 and 2013), the northern section of the corridor is estimated to grow by more than 4 percent each year. In the long term (between 2008 and 2030), the northern section of the corridor is estimated to grow by 2-3 percent annually.

Table 2-1: Comparison of Annual Average Daily Traffic (AADT) Volumes

	2006	2007	2008	2013 No-Build	2030 No-Build
South of Iredell/ Mecklenburg CL	84,000	85,000	85,000	116,000	167,000
South of Westmoreland Road	87,000	84,000	81,000	116,000	133,000
North of Sunset Road	89,000	90,000	80,000	115,000	133,000
South of Sunset Road	113,000	115,000	106,000	132,000	152,000
South of I-85	151,000	152,000	155,000	156,000	177,000
South of Oaklawn Ave	163,000	164,000	169,000	170,000	180,000
1. 2006 through 2008 AADTs are based on NCDOT traffic counts. 2. 2013 and 2030 traffic forecasts are based on Metrolina Model results for a no-build scenario.					

Figure 2-5: North Mecklenburg Existing Transit Routes

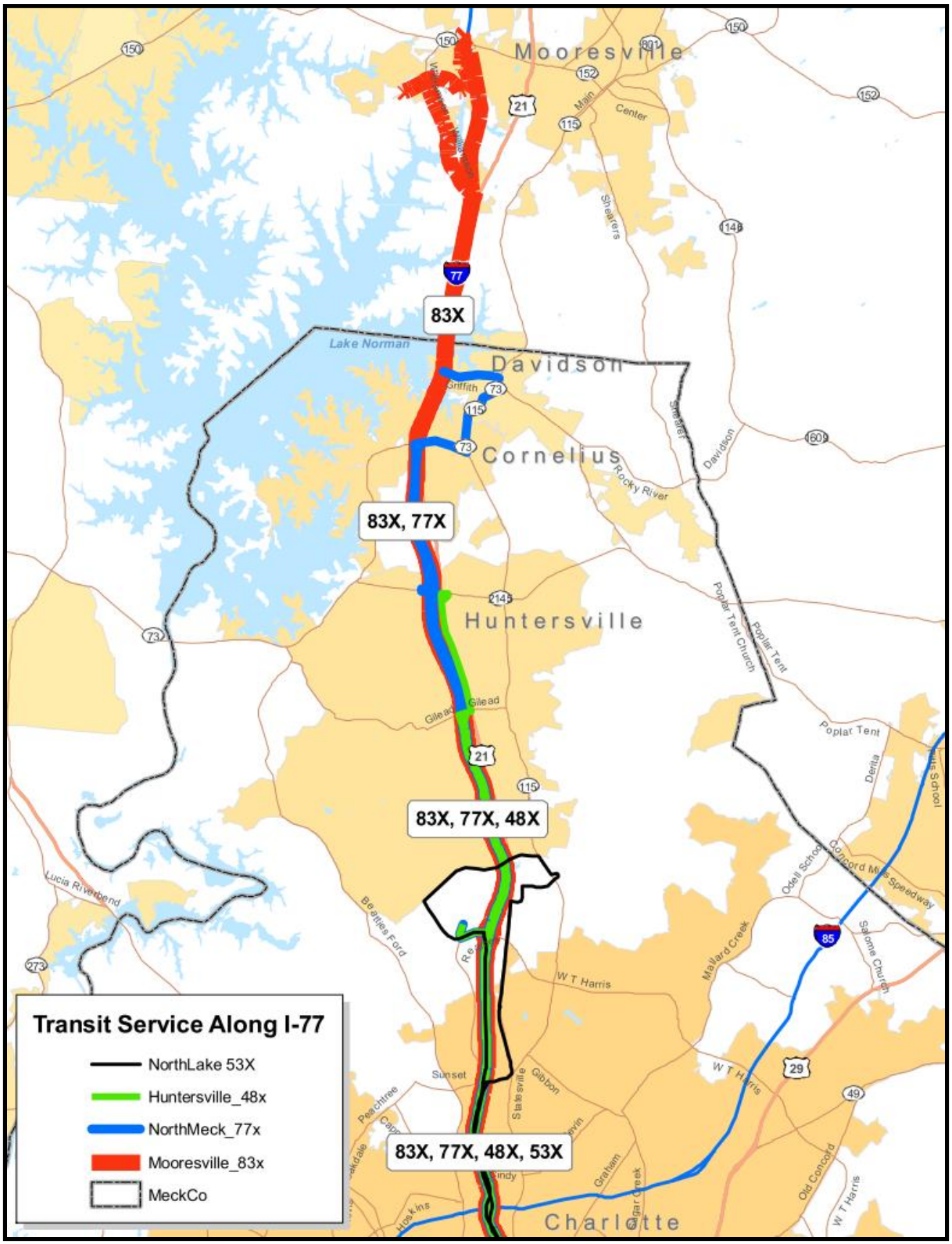


Figure 2-6 compares traffic projections from the Metrolina Travel Demand model at a location just south of the Westmoreland Road overpass. There were two future options explored as part of this task order:

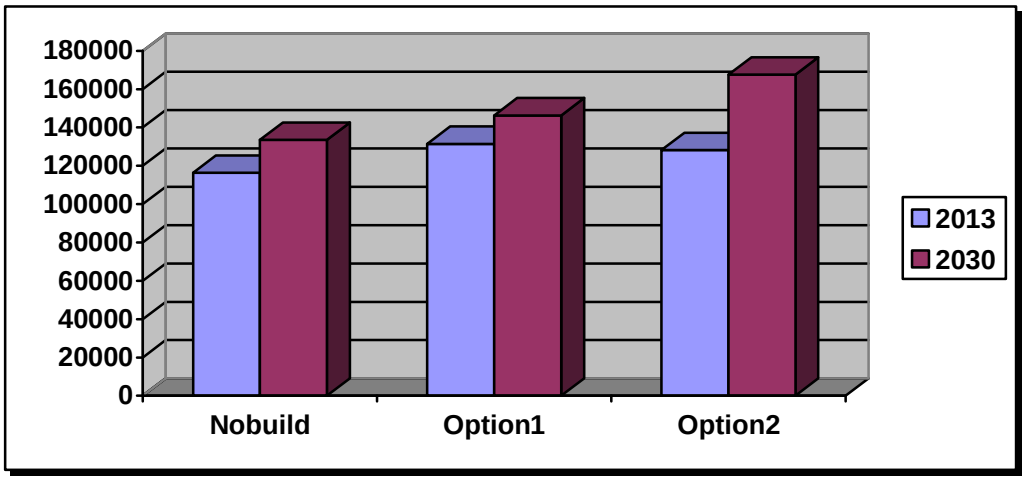
1. Extend the existing HOV lane in both directions north to Exit 28 (Catawba Avenue) and keep the existing general purpose lane cross section.

2. Implement the above improvements and add another general purpose lane in each direction between I-485 and Exit 31 (Langtree Road). This will provide a cross section north of I-485 matching the section where the HOV lane currently exists south of I-485.

The figure shows that traffic continues to increase between 2013 and 2030. The No-Build and Option 1 alternatives are expected to see similar growth of about 1 percent annually. Traffic volume under Option 2 is expected to grow at an annual growth of 2 percent between 2013 and 2030 because this alternative assumes addition of one lane of general purpose capacity in each direction.

Figure 2-6: Average Annual Daily Traffic Forecast

(for a location south of the Westmoreland Road overpass)



2.6.2 HOV Lane Volume

The existing I-77 HOV facility opened in 2004. The southbound HOV lane begins just north of the I-485 interchange and ends south past the LaSalle Avenue on-ramp, a distance of about 10 miles. The northbound HOV lane begins north of I-85 (near the Cindy Lane overpass) and extends for about five miles, ending just north of the I-485 interchange (around milepost 21). **Table 2-2** lists morning peak hour HOV lane volumes between 2005 and 2009 and projected HOV facility use in 2013 and 2030 based on the Metrolina Travel Demand Model. It also shows that extending the current HOV increases the use of HOV lane. In 2013, the HOV lane under Option 1 is expected to carry the most vehicles because general purpose capacity is constrained. However, in 2030, Option 2 is expected to carry more vehicles because higher congestion, despite the addition of another general purpose lane, makes the HOV lane more attractive.

Table 2-2: Peak Hour HOV Forecasts

(location south of W.T. Harris Boulevard near Lakeview Road overpass)

	Southbound AM Peak Hour			
	Vehicles	Persons		
HOV Count (2005) [1]	296	836		
HOV Count (2007) [1]	291	894		
HOV Count (2009) [1]	231	765		
HOV Options	**Southbound AM Peak Hour**		**Northbound PM Peak Hour**	
2013	Vehicles	Persons	Vehicles	Persons
2013 No build	832	1,944	511	1,201
2013 Option 1	998	2,339	636	1,496
2013 Option 2	1,010	2,363	732	1,720
2030				
2013 No build	1,264	2,936	957	2,225
2013 Option 1	1,456	3,393	1,074	2,502
2013 Option 2	1,472	3,428	1,173	2,734

[1] **Existing HOV counts were conducted by NCDOT or CDOT and performed from the Lakeview Road overpass. This count data is not directly comparable to the Metrolina Travel Demand Model traffic forecasts.**

2.6.3 Existing and Forecasted Capacity Deficiencies

Figure 2-7 and **Figure 2-8** and graphs estimated 2013 volume-to-capacity (V/C) ratios along the corridor during the morning and afternoon peak hours, for the general purpose lanes using results from the Metrolina Travel Demand Model. Both graphs show that all sections of the corridor will be operating at congestion (V/C ratio >1.0). Although Option 2 provides for additional capacity along the general purpose lanes north of I-485, it does not appear to significantly improve congestion in that section (V/C ratio between 0.9 and 1.0).

Figure 2-9 and **Figure 2-10** shows 2030 V/C ratios for the general purpose lanes during the morning and afternoon peak hours based on Metrolina model results. As expected, I-77 is forecast to operate at severe congestion throughout the corridor, including under Option 2.

Figure 2-7: 2013 AM Peak Hour V/C Ratio (Southbound General Purpose Lanes)

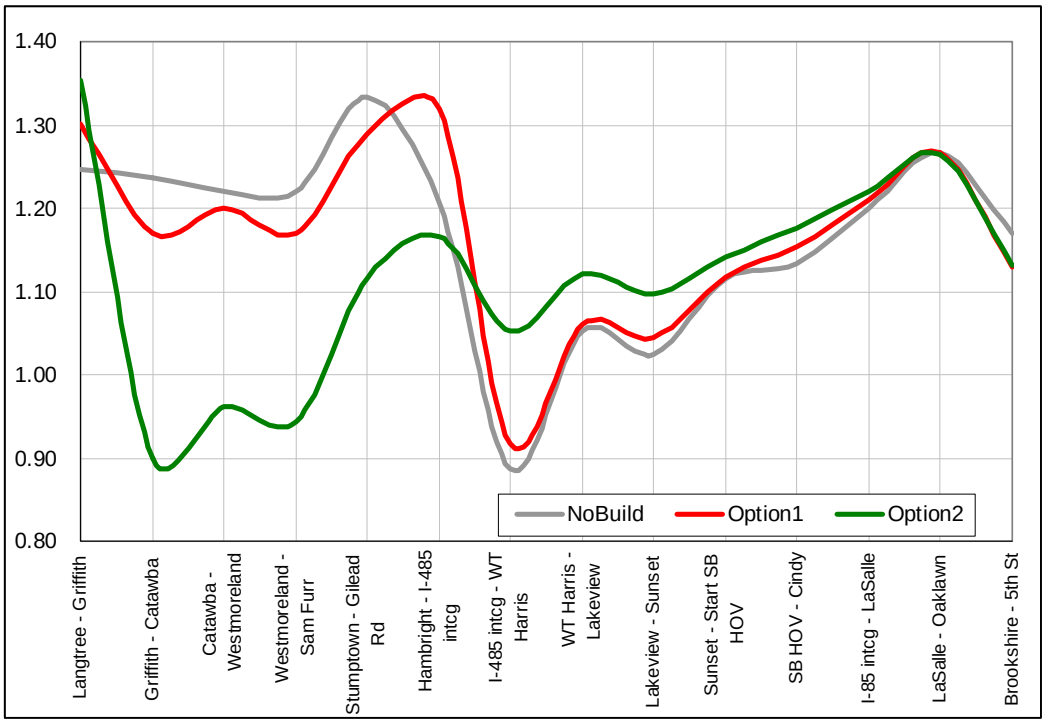


Figure 2-8: 2013 PM Peak Hour V/C Ratio (Northbound General Purpose Lanes)

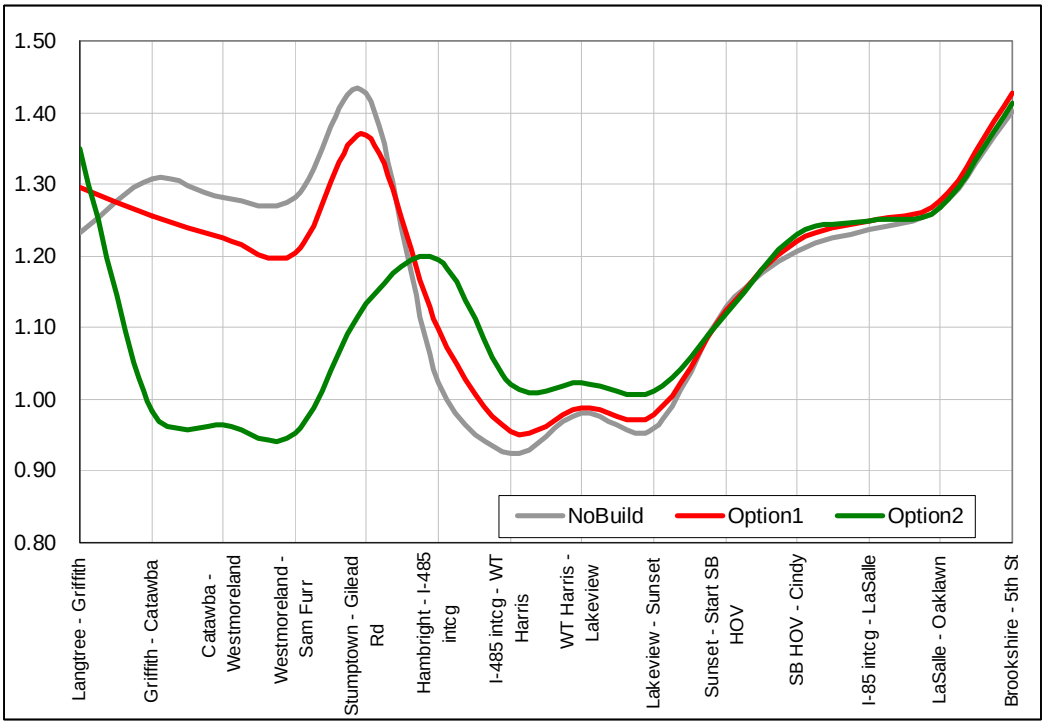


Figure 2-9: 2030 AM Peak Hour V/C Ratio (Southbound General Purpose Lanes)

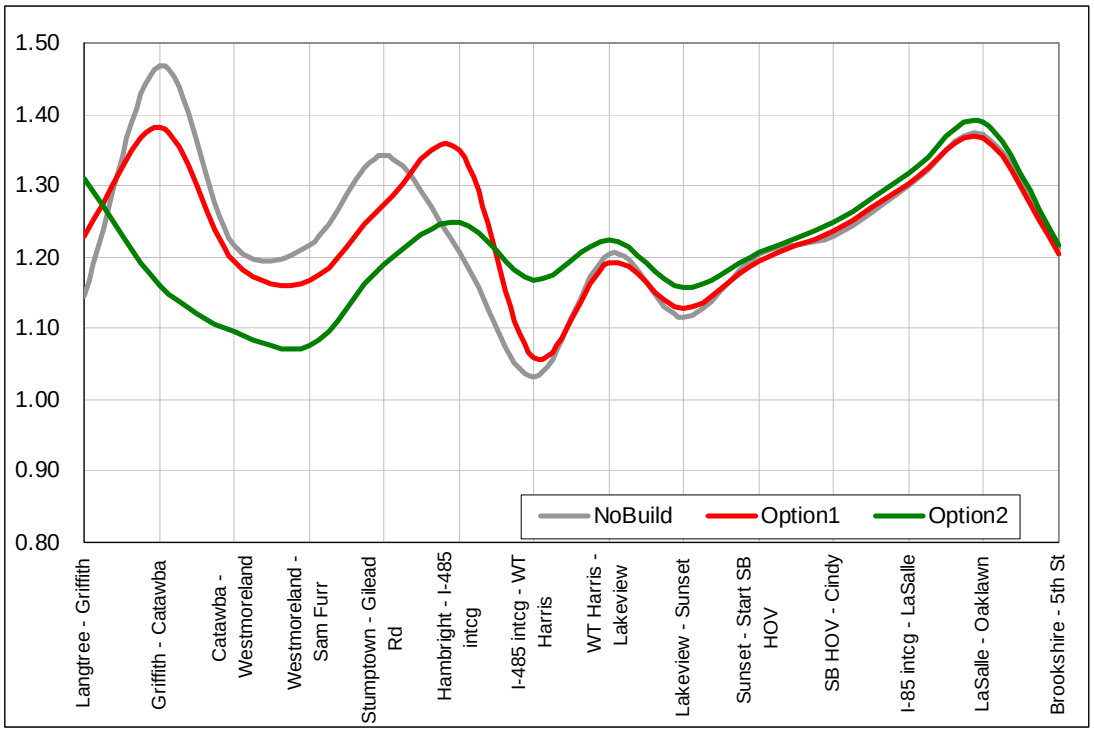
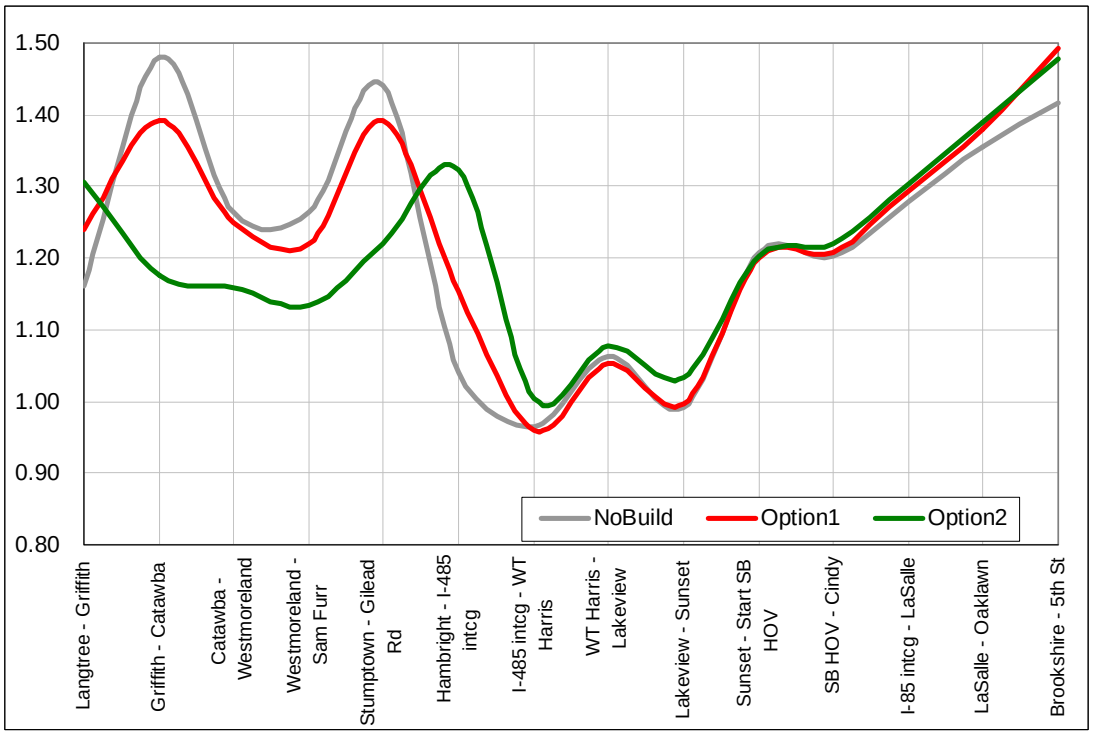


Figure 2-10: 2030 PM Peak Hour V/C Ratio (Northbound General Purpose Lanes)



The Metrolina model forecasts that HOV lanes will provide acceptable future levels of service (V/C ratios <1.0). There is no significant difference on HOV lane operations between Option 1 and Option 2. However, there are noticeable differences related to southbound and northbound HOV facility operations. Although access to the northbound HOV lanes currently starts north of I-85 (near Cindy Lane overpass), the No-Build condition, which is included in the 2030 LRTP, assumes a northbound HOV lane beginning south of the I-77/I-85 interchange.

Figure 2-11 and **Figure 2-12** shows peak hour V/C ratios for the HOV lanes for 2013 and 2030. It shows that southbound HOV lane during the AM peak hour has a higher demand than in the northbound PM peak hour. This observation is consistent with other locations in the country. These figures indicate that just 50 percent of HOV lane capacity is being used in 2013 and between 60 and 70 percent of HOV lane capacity is being used in 2030.

Figure 2-11: 2013 Peak Hour V/C Ratio for HOV Lanes

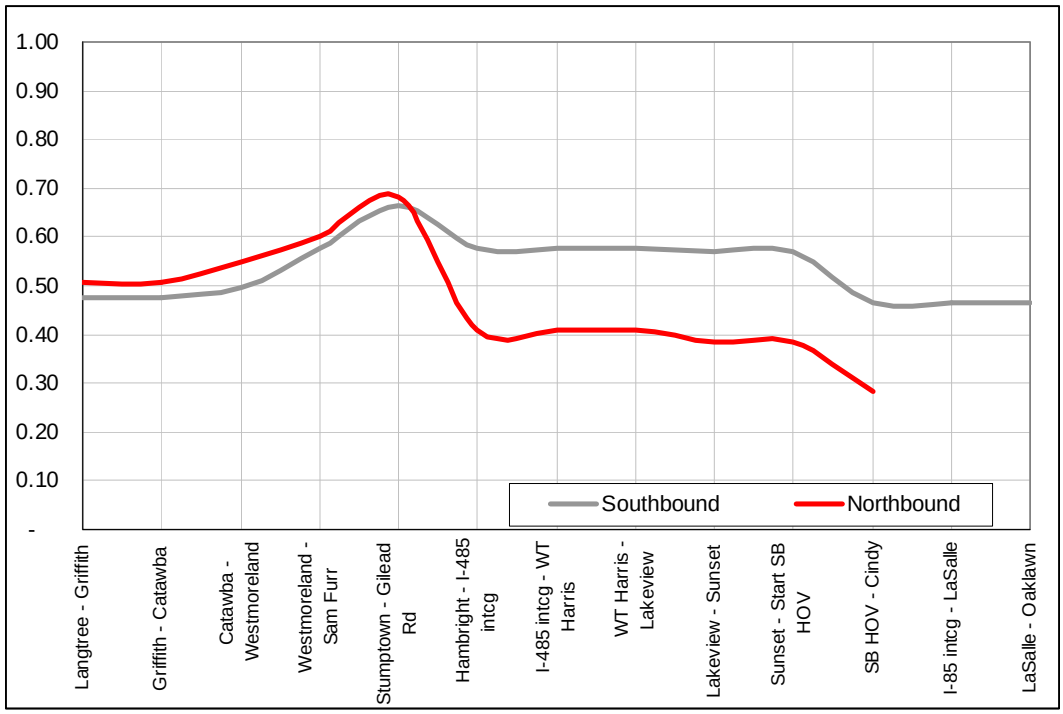
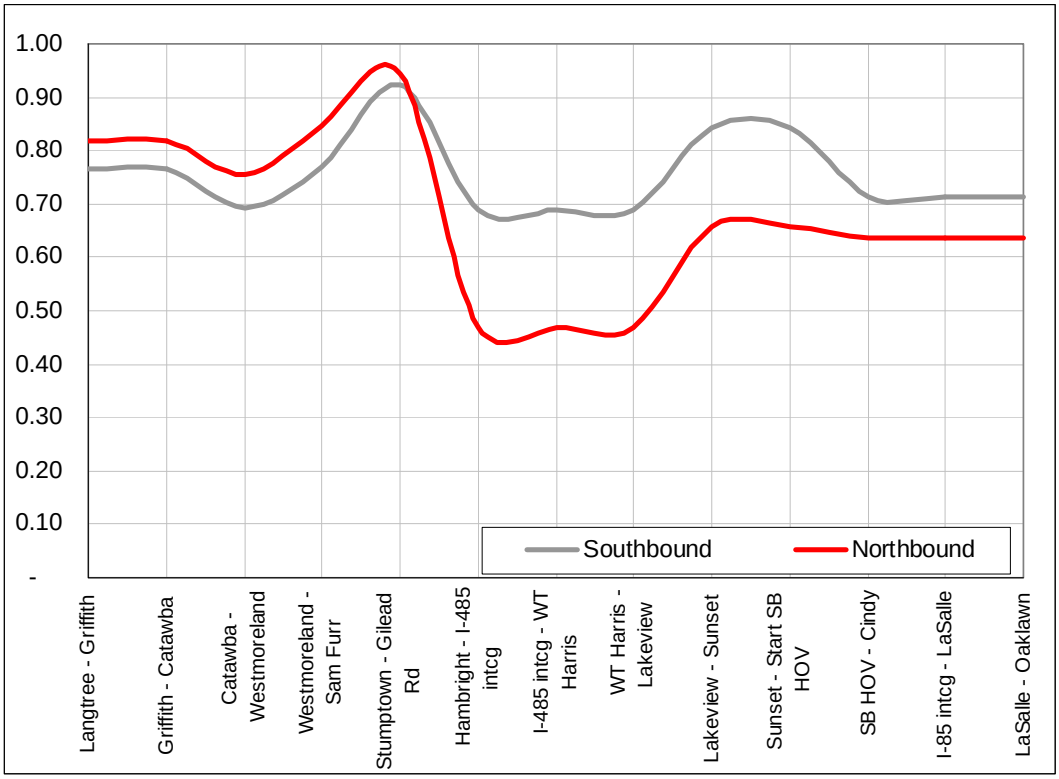


Figure 2-12: 2030 Peak Hour V/C Ratio for HOV Lanes



2.7 Traffic Operational Analysis

2.7.1 Methodology

Task Order No. 1 included traffic simulation along a freeway network consisting of the segment of I-77 between LaSalle Street (Exit 12) and Griffith Street (Exit 30) and the portion of I-85 between Beatties Ford Road (Exit 37) and Statesville Road (Exit 39). The traffic simulation and analysis package used for the analysis was CORSIM, which was developed for the FHWA. CORSIM has the capability to analyze traffic flows on both freeways and surface street systems and to indicate the effects of additional lanes, transit service, accidents, and on-street parking.

There were two HOV lane options analyzed as part of this task order:

- Option 1 - Extend the existing HOV lane in both directions north to Griffith Street (Exit 30) and keep the existing general purpose lane cross section.
- Option 2 - Implement the above improvements plus add another general purpose lane in each direction between Exits 19 and 30. This will provide a cross section north of I-485 matching the section where the HOV lane currently exists south of I-485.

CORSIM simulation package was used to:

- Assess the impact on freeway operations of the extension of the current HOV lanes as well as general purpose lanes through Griffith Street (Exit 30)
- Assess the system impacts on a comprehensive scale

- Determine freeway residual impacts, if any, resulting from the proposed freeway modifications

The CORSIM network for Task Order No. 1 was prepared from the base existing conditions network. Using the existing network, a HOV lane by itself or a HOV lane plus another general purpose lane was added through Griffith Street (Exit 30) in the northbound and southbound directions. The volumes for the two build options came from the Metrolina Regional Travel Demand Model. Traffic analysis was performed for the planning years of 2013 and 2030 for AM and PM peak hour conditions.

2.7.2 Results and Analysis

Option 1 - Extension of HOV Lane Only

2013 AM Peak Hour (Southbound) - When compared to No-Build conditions, the level of service would improve by two grades for southbound operations along the I-77 segment between LaSalle Street (Exit 12) and Griffith Street (Exit 30). The level of service will improve from a level of service “F” to a level of service “D” not only at on and off ramp locations but also for mainline southbound freeway operations.

The average speed for motorists traveling along I-77 in the AM peak hour would improve by six miles per hour (mph), from 42 mph to 48 mph. Overall vehicular delay time would decrease from 47 minutes to 37 minutes, a reduction of over 10 minutes (21 percent improvement).

2013 PM Peak Hour (Northbound) - The level of service for I-77 northbound operations will also improve by two levels when compared to No-Build conditions. Once again, the level of service will improve from a level of service “F” to a level of service “D” not only at on and off ramp locations but also for mainline northbound operations.

Average speeds in the PM peak hour will improve by seven mph, from 44 mph to 51 mph. Overall vehicular delay time along I-77 would decrease from 51 minutes to 35 minutes, a drop of nearly 16 minutes (31 percent reduction).

2030 AM Peak Hour (Southbound) - When compared to No-Build conditions, the level of service would improve by a single level for southbound operations along I-77 from LaSalle Street to Griffith Street. The level of service will improve from a level of service “F” to a level of service “E” at both ramp locations and for mainline operations.

To travel between Exit 30 and Exit 12, the average speed will improve by 13 mph, from 35 mph to 48 mph. Overall I-77 delay time would drop from 80 minutes to 41 minutes, a reduction of 39 minutes.

2030 PM Peak Hour (Northbound) - The level of service for I-77 northbound operations will improve by two levels when compared to No-Build conditions. The level of service improves from a level of service “F” to a level of service “E” at on and off ramp locations and from level of service “F” to level of service “D” for mainline freeway operations.

The average speed will improve by four mph, from 44 mph to 48 mph. Overall vehicular delay time is projected to decrease from 58 minutes to 42 minutes, about 16 minutes less representing a 28 percent reduction for I-77 travelers.

Northbound Lane Termini - Based on CORSIM analysis results, designation of the proposed HOV lane extension would end about ½-mile south of Exit 28. Traffic in the northbound general purpose lanes would merge to the leftmost lane ensuring that HOV lane users have priority when three northbound lanes are reduced to two lanes. The outside general purpose lane would drop at the exit ramp at Catawba Avenue (Exit 28).

The southbound HOV lane would begin south of the causeway between Exits 28 and 30.

Option 2 - Addition of HOV and General Purpose Lanes

2013 AM Peak Hour (Southbound) - When compared to No-Build conditions, the level of service would improve by three levels for southbound operations in the I-77 segment between LaSalle Street (Exit 12) and Griffith Street (Exit 30). The level of service will improve from a level of service "F" to a level of service "C" at on and off ramp locations and from level of service "F" to level of service "C/D" for mainline freeway operations.

Overall average travel speed will improve by four mph, from 42 mph to 46 mph. Overall vehicular delay time is expected to decrease from 47 minutes to 45 minutes, a reduction of three minutes for all vehicles traveling along I-77. The amount of traffic using I-77 under this build option is significantly higher than the volumes traveling along the freeway under No-Build conditions.

2013 PM Peak Hour (Northbound) - The level of service for I-77 northbound operations would also improve by three levels when compared to No-Build conditions. The level of service will improve from a level of service "F" to a level of service "C" not only at ramp locations but also for mainline northbound operations.

The average travel speed is projected to improve by 12 mph, from 44mph to 56 mph. This improvement in travel speeds means that overall vehicular delay will decrease from 51 minutes to 22 minutes, a drop of over 29 minutes (57 percent improvement) for vehicles using I-77.

2030 AM Peak Hour (Southbound) - When compared to No-Build conditions, the level of service would improve by two grades for southbound operations along the I-77 segment between Exit 12 and Exit 30. The level of service will improve from a level of service "F" to a level of service "D" for on and off ramp locations and from level of service "F" to level of service "E" for mainline operations.

The average speed will improve by 22 mph, from 35 mph to 57 mph. Overall vehicular delay time will decrease from 80 minutes to 36 minutes, a reduction of 44 minutes (55 percent reduction) for I-77 motorists.

2030 PM Peak Hour (Northbound) - The level of service for I-77 northbound operations will improve by two levels when compared to 2030 No-Build conditions. The level of service would improve from a level of service "F" to a level of service "E" at ramp locations and from level of service "F" to level of service "D" for mainline operations.

The average speed will increase by 12 mph, from 44 mph to 56 mph. Overall vehicular delay time will drop from 58 minutes to 33 minutes, 23 minutes less representing a 40 percent reduction for I-77 travelers.

Northbound Lane Termini - The CORSIM analysis for adding two lanes (one HOV lane and one general purpose lane) in each direction to I-77 indicated a need to widen the I-77 causeway between Griffith Street (Exit 30) and Langtree Road (Exit 31) in order to prevent a bottleneck from merging traffic in the afternoon peak period where the northbound HOV lane ends. HOV lane designation would end just north of Exit 30 but the new lane would continue north as a general purpose lane. One general purpose lane would drop at the off ramp at Exit 28, resulting in I-77 having three northbound lanes to Langtree Road (Exit 31) where another general purpose lane would end at this recently-completed interchange.

2.7.3 Recommendations/Comparative Analysis

Option 1 - Extension of HOV Lane Only

The extension of the HOV lane only would improve the level of service in 2013 from level of service "F" to level of service "D" at on and off ramp locations in the peak directions during both AM and PM peak hours. The levels of service on I-77 mainline operations for both peak periods will improve by a similar amount in 2013.

In the AM peak hour in 2030, the level of service for ramps in the southbound direction would improve from level of service "F" to level of service "E" when comparing the extension of a single HOV lane to the no-build option. In the PM peak hour, northbound mainline operations and ramps would improve from level of service "F" to level of service "D".

Option 2 - Addition of HOV and General Purpose Lanes

As expected, the extension of both a HOV lane and a general purpose lane in both directions north of I-485 would provide even greater traffic operations benefits as 2013 peak hour levels of service for mainline operations and ramps improve from level of service "F" to level of service "C". In 2030, traffic levels of service would change from level of service "F" to level of service "D" for mainline and ramp operations in the peak direction for both peak periods.

The CORSIM analysis indicated that extension of the HOV lane only between I-485 and Catawba Avenue would provide an acceptable level of traffic service through the year 2020. The traffic simulation results show that adding both a HOV lane and a general purpose lane will provide acceptable levels of service in both lane types through the horizon year of 2030. **Appendix A** includes a series of lane diagrams that depict the results of the CORSIM simulation analyses along the corridor.

Comparative Analysis

Table 2-3 lists the key operational improvements of the options as compared to the No-Build scenario. The measures shown in the table are typical benefit for the corridor. For example the travel time savings are between Exit 30 (Griffith Street) and Exit 19 (I-485). The level of service measure is also an average based on critical locations (for example south of Exit 28 (Catawba Avenue) and Exit 25 (NC-73). Both build options show dramatic improvements in travel time as a result of reduced congestion and improved levels of service from "F" to "C/D". Although there is some benefit in travel time by 2030, Option 1 (HOV lane extension only) level of service remains at "E/F".

Table 2-3: Comparative Analysis

Task Order No. 1, I-77 HOV Lane Extension												
Alt. Description	**2013**						**2030**					
	AM (Southbound)			**PM (Northbound)**			**AM (Southbound)**			**PM (Northbound)**		
	Speed	**Travel Time**	**LOS**	**Speed**	**Travel Time**	**LOS**	**Speed**	**Travel Time**	**LOS**	**Speed**	**Travel Time**	**LOS**
No - Build	18	33	F	35	24	F	16	36	F	28	30	F
Option - 1 (3 - Lane section)	60	10	D	60	10	D	35	18	F	50	15	E
Option - 2 (4 - Lane section)	62	10	C	62	10	C	60	10	D	62	10	C

3.0 AGENCY COORDINATION

The following federal, state and local agencies were involved in the work activities of Task Order No. 1 of the I-77 Feasibility Study:

- **NCDOT.** The agency is the owner, designer and operator of I-77 and directed Task Order No. 1 through the Feasibility Studies Unit of its Planning and Programming Branch. Staff members from various NCDOT branches and units participated in this planning project. NCDOT's MRTMC manages traffic operations along I-77, including response to traffic incidents and special events. NCDOT's Incident Management Assistance Program (IMAP) provides assistance to motorists involved in traffic accidents or vehicle break-downs. The North Carolina Turnpike Authority (NCTA) is the operating division of NCDOT authorized to collect tolls on turnpike projects.
- **FHWA.** This federal department is a partnering agency that is responsible for overseeing the design and operation of the federal aid highway system, which includes I-77.
- **NCSHP.** This state department is the primary enforcement agency for I-77 HOV lanes.
- **City of Charlotte.** The Charlotte Department of Transportation (CDOT) partners with NCDOT in highway operations and supports HOV facility implementation. CDOT played a significant role in the opening of the I-77 HOV lanes in 2004. Departmental staff provided input to the Operations Plan and served as the liaison with offices of the Mecklenburg County District Attorney and local judges. CATS operates vanpools and express bus service along the I-77 HOV lanes. The agency also oversees the region's Transportation Demand Management (TDM) program, which includes a ride matching program to increase carpooling. The City's Police Department assists NCSHP in HOV lane enforcement.
- **Towns of Huntersville, Cornelius and Davidson.** These towns, which are located within the I-77 study area, participated in the Charlotte Region *Fast Lanes* Study. The Huntersville Police Department attended HOV enforcement workshops prior to the opening of the I-77 HOV lanes in 2004.

3.1 Coordination during Task Order No. 1

Throughout Task Order No. 1, a technical team provided input on study results and recommendations. The Technical Study Committee (TSC) consisted of representatives of the following agencies:

- NCDOT
- FHWA
- CDOT

The TSC met during the task order to review progress, discuss preliminary recommendations and offer suggestions. Technical committee members also served as study liaisons to their respective agencies.

4.0 FACILITY DESIGN AND ACCESS

This chapter describes the design features of the extension of the I-77 HOV facility. As stated in Chapter 1.0, Task Order No. 1 examined two extension options:

- Adding only an HOV lane in each direction north of the current terminus of the managed lane facility.
- Continuation of the eight-lane cross-section which currently ends near milepost 21. This option includes adding an HOV lane and a general purpose lane in each direction along I-77.

4.1 Design Principles for HOV Facility Extension

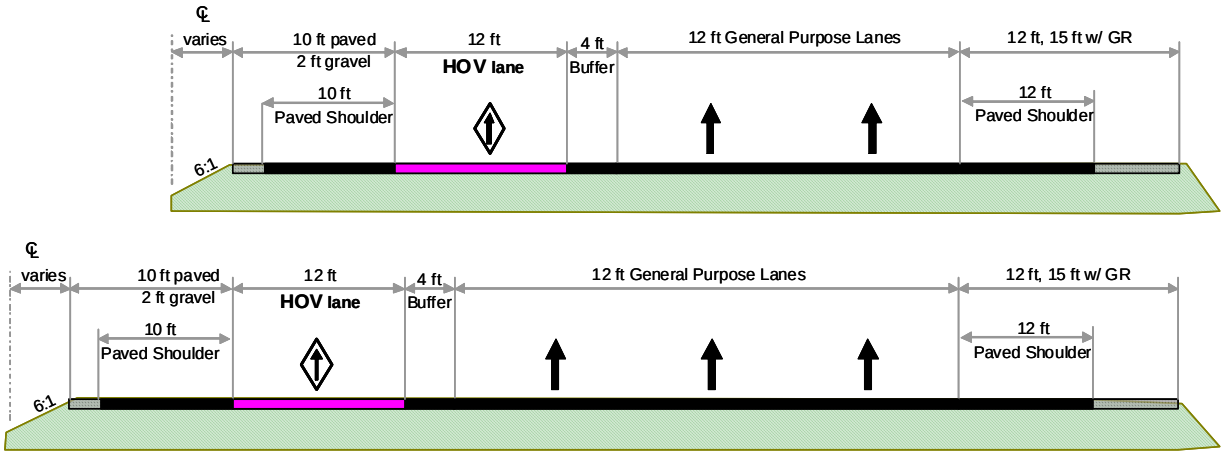
The design principles used for the I-77 HOV lane extension are similar to those employed for the existing facility south of I-485. The extension would consist of a concurrent flow lane located next to the median in each direction of the interstate. A diamond symbol used both in pavement markings and on overhead signs would designate the HOV facility. Locations where the HOV facility can be accessed would be designated by appropriate signing and a wide white skip line on the pavement. Double solid white pavement lines would show motorists where HOV lane access is prohibited.

A minimum weave distance of 1000 feet would be provided between right-side freeway ramps and areas where HOV lane access is permitted.

4.2 Typical Section

The new HOV and general purpose lanes would be 12-feet wide with a 4-foot buffer between the HOV and general purpose lanes. The inside paved shoulder's width would be 10 feet while the outside shoulder's width would be 12 feet. No reductions from full design widths would be necessary. **Figure 4-1** shows the typical sections for both build options.

Figure 4-1: Typical Cross Sections



4.3 Trade-offs in Accommodating Design Principles

Safety is a major consideration when evaluating trade-offs in HOV facility design elements. The buffer width used for the existing HOV lanes has not posed safety issues in the five years of facility operation. NCSHP and Charlotte police officers have safely used the 10-foot inside shoulder for enforcement purposes since the lanes opened in 2004.

4.4 Access and Termini Treatments

4.4.1 HOV Facility Access

Access to the HOV lane extension would be similar to the approach taken for the existing lanes south of I-485. Along the current HOV facility, motorists are permitted to enter or exit the HOV lanes except at facility termini and major interchanges.

The feasibility of providing direct connections to I-77 HOV lanes from the following overpasses was analyzed:

- Bailey Road Extension
- Stumptown Road
- Mt. Holly-Huntersville Road
- Lakeview Road

Using the Metrolina travel demand model, entry and exit volumes for the PM peak hour were forecast for both 2013 and 2030 at each location (see **Table 4-1**). As shown by this table, direct connections to the HOV facility from overpasses at Bailey Road Extension and Mt. Holly-Huntersville Road would serve the most vehicles.

Table 4-1: Direct Connector Traffic Projections

	Entry / Exit Vehicles During PM Peak Hour	
Direct Connectors	**YR 2013**	**YR 2030**
Bailey Rd Ext	220 / 720	450 / 950
Stumptown Rd	280 / 610	500 / 710
Mt. Holly-Huntersville	320 / 450	390 / 790
Lakeview Dr	290 / 460	540 / 600

4.4.2 Termini Treatments

The termini of the northbound lanes would vary based on whether the HOV lanes alone are extended in both directions (Option 1) or whether both the HOV facility and a general purpose lane (Option 2) are extended in both directions north of I-485.

HOV Lanes Only (Option 1)

Based on CORSIM analysis results, designation of the proposed HOV lane extension would end about ½-mile south of Exit 28. Traffic in the northbound general purpose lanes would merge to the leftmost lane ensuring that HOV lane users have priority when three northbound lanes are reduced to two lanes. The outside general purpose lane would drop at the exit ramp at Catawba Avenue (Exit 28).

The southbound HOV lane would begin south of the causeway between Exits 28 and 30.

HOV and General Purpose Lanes (Option 2)

The CORSIM analysis for adding two lanes in each direction to I-77 indicated a need to widen the I-77 causeway between Griffith Street (Exit 30) and Langtree Road (Exit 31) in order to prevent a bottleneck from merging traffic in the afternoon peak period where the northbound HOV lane ends. HOV lane designation would end just north of Exit 30 but the new lane would continue north as a general purpose lane. One general purpose lane would drop at the off ramp at Exit 28, resulting in I-77 having three northbound lanes to Langtree Road (Exit 31) where another general purpose lane would end at this recently-completed interchange.

4.5 Signing and Pavement Markings

HOV signing and pavement markings for the HOV facility extension would be identical to what is in place along the existing lanes. Signs and markings for the I-77 HOV facility may have to be revised when the MUTCD is updated to reflect new signage for managed lanes, including HOV facilities. **Appendix B** shows the typical signing plan for the extended HOV lanes.

4.6 Illumination

Additional lighting may be needed at the HOV lane drop on the northern end of the facility and at locations where enforcement patrols could be stationed for improved safety and visibility of the officers.

4.7 Capital Costs

4.7.1 Methodology Overview

Construction cost estimates for extending the existing I-77 HOV facility used cost data from NCDOT's latest construction cost index, and estimates are provided in current year dollars. NCDOT staff approved the construction cost estimates, projected quantities, and unit prices.

Estimates were prepared for the two build options described at the beginning of this chapter. As discussed in Section 4.1, no design exceptions were required under either alternative. No additional right-of-way is needed for freeway widening, and there are no impacts on utilities. A cost estimate was also prepared for a typical T-ramp direct connection as

discussed in Section 4.4.1. This cost could be applied to the proposed overpasses except for Lakeview Road, where the existing median is only 14 feet wide. Because of the limited median width at this location, a direct connection at the Lakeview Road overpass would require replacing the bridge and widening outside the existing general purpose lanes for T-ramp implementation.

4.7.2 Cost Estimates

Preliminary cost estimates have been prepared using NCDOT's functional design cost estimate index. All estimates are based on the functional design prepared for each alternative. In additional, a signing plan was developed based on the latest MUTCD guidelines and included in the estimate. The following tables show cost breakdown as follows:

Table 4-2 summarizes the construction costs estimated for the option of HOV facility extension only for two segments: 1) north to NC-73 or Sam Furr Road (Exit 25) and 2) between Exit 25 and Catawba Avenue (Exit 28). All costs are expressed in 2009 dollars.

Table 4-3 lists estimated construction costs for the alternative which adds two lanes – a HOV lane and a general purpose lane – in both directions of I-77 north to Langtree Road (Exit 31).

Table 4-4 shows that extension of the HOV lanes north of the current terminus in Huntersville could cost between $38 million and $74 million depending on decisions related to the endpoint of the extended facility and the addition of general purpose lanes.

Table 4-5 summarizes costs for a typical direct connection (a T-ramp with a single lane in each direction separated by a median barrier).

Table 4-2: HOV Lane Extension Only

Description	Mt. Holly-Huntersville Road to NC-73	NC-73 to Catawba Avenue	Total
Clearing and Grubbing	602,400	522,000	1,124,400
Earthwork	469,600	407,200	876,800
Drainage Existing Location	900,000	775,000	1,675,000
Fine Grading	226,200	196,200	422,400
Pavement Widening	5,662,800	4,914,000	10,576,800
Pavement Resurfacing	996,800	864,500	1,861,300
Subgrade Stabilization	653,400	567,000	1,220,400
Conc. Barrier Wall	-	256,000	256,000
Erosion Control	955,200	828,000	1,783,200
Signing Interchanges	-	-	-
HOV Signing	185,000	175,000	360,000
Traffic Control	1,260,000	1,085,000	2,345,000
Thermo and Markers	108,000	93,000	201,000
RC Box Culverts	-	-	-
Ex. 3@10x10-50'Extension-3'Fill-90Skew	-	108,000	108,000
Utility Construction	-	-	-
Misc. & Mob (15% Strs&Util)	-	16,500	16,500
Misc. & Mob (45% Functional)	5,410,000	4,810,000	10,220,000
Contract Cost	17,429,400	15,617,400	33,046,800
E. & C. 15%	2,614,410	2,342,610	4,957,020
Construction Cost	**$ 20,043,810**	**$ 17,960,010**	**$ 38,003,820**

Table 4-3: HOV Lane Extension and Additional General Purpose Lane

Description	Hambright Road to NC-73	NC-73 to Langtree Road	Total
Clearing and Grubbing	877,200	818,400	1,695,600
Earthwork	787,200	940,800	1,728,000
Drainage Existing Location	1,125,000	1,500,000	2,625,000
Fine Grading	358,050	390,600	748,650
Pavement Widening	9,687,600	11,492,000	21,179,600
Pavement Resurfacing	1,245,300	1,676,500	2,921,800
Subgrade Stabilization	1,117,800	1,326,000	2,443,800
Conc. Barrier Wall	-	2,536,000	2,536,000
Erosion Control	1,320,000	1,416,000	2,736,000
Signing Interchanges			
HOV Signing	185,000	215,000	400,000
Traffic Control	2,025,000	2,700,000	4,725,000
Thermo and Markers	180,000	240,000	420,000
RC Box Culverts			
Ex. 3@10x10-50'Extension-3'Fill-90Skew	-	180,000	180,000
Utility Construction	-	-	-
Misc. & Mob (15% Strs&Util)	-	27,500	27,500
Misc. & Mob (45% Functional)	8,508,700	11,370,000	19,878,700
Contract Cost	27,416,850	36,828,800	64,245,650
E. & C. 15%	4,112,528	5,524,320	9,636,848
Construction Cost	**$ 31,529,378**	**$ 42,353,120**	**$ 73,882,498**

Table 4-4: Summary of Estimated Costs

Alternative 1: HOV Lane Extension Only	**Cost in 2009 Dollars**	**Alternative 2: HOV Extension + Additional GP Lane**	**Cost in 2009 Dollars**
Mt. Holly-Huntersville to NC-73	$ 20,000,000	North of Hambright Rd. to NC-73	$ 31,500,000
NC-73 to Catawba Avenue	$ 18,000,000	NC-73 to Langtree Road	$ 42,400,000
TOTAL	**$ 38,000,000**	**TOTAL**	**$ 73,900,000**

Table 4-5: Direct HOV Facility Connection at I-77 Overpass

Description	**Amount**
Clearing and Grubbing	24,000
Earthwork	146,400
Drainage Existing Location	87,500
Fine Grading	14,400
New Pavement	301,600
Subgrade Stabilization	34,800
Conc. Barrier Wall	256,000
Fencing	
Erosion Control	24,000
Signing Interchanges	
Traffic Signal (New)	60,000
Traffic Control	157,500
Thermo and Markers	14,000
Structures	
MSE Retaining Wall	1,377,000
Utility Construction	
Misc. & Mob (15% Strs&Util)	206,550
Misc. & Mob (45% Functional)	504,090
Contract Cost	3,207,840
E. & C. 15%	481,176
Construction Cost	**3,689,016**

5.0 OPERATIONS POLICIES

This chapter presents the operating policies to be applied for the extended HOV facility. These policies are a continuation of those implemented in 2004 when the I-77 HOV lanes were opened.

5.1 User Requirements

The I-77 HOV facility will continue to be open to vehicles with two or more occupants with the following exceptions:

- **Motorcycles.** Federal law requires HOV lanes to be open to motorcycles regardless of the number of riders.
- **Emergency Vehicles.** The term “emergency vehicle” means any law enforcement, fire, police, or other government vehicle, and any public or privately owned ambulance or emergency service vehicle, when responding to an emergency.
- **Buses**. Any vehicle designed to transport 15 or more passengers, regardless of the actual number of occupants.
- **Trucks**. A motor vehicle with three or more axles, regardless of the number of occupants, is prohibited from using I-77 HOV lanes.

5.2 Hours of Operation

The existing operating hours for the I-77 HOV lanes will not change. The extended HOV facility will remain restricted to HOVs 24 hours a day, seven days a week.

5.3 Access Policy

The current I-77 HOV facility access policy will be continued when the lanes are extended northward. Access to the HOV lanes is permitted throughout the I-77 HOV lanes, only being restricted where there are operational or safety issues. Areas where ingress and/or egress to the HOV facility are designated by appropriate signing and a wide white skip line on the pavement. Double solid white pavement lines indicate where HOV lane access is prohibited.

6.0 MAINTENANCE

Chapter 6 summarizes briefly maintenance issues associated with the extension of the HOV lanes north of I-485. The chapter also reviews estimated maintenance costs for the lengthened facility.

6.1 Roadway Maintenance

NCDOT's Division 10 would be responsible for maintaining the new HOV and/or general purpose lanes similar to current operations for the existing I-77 HOV facility. Roadway maintenance cost estimates are based on a current State estimate of about $9,000 per lane-mile per year. This cost would cover surface upkeep, sign repair, snow removal, fence repair, landscaping and other related expenses. **Table 6-1** summarizes the annual roadway maintenance costs for each HOV option. These costs represent funding allocations from existing NCDOT sources.

Table 6-1: Roadway Maintenance Costs (2009 Dollars)

	Existing HOV	Extension to Exit 25	Extension to Exit 28	Extension to Exit 30	**Total System**
Roadway Maintenance	$118,800	$94,500	$52,200	$27,000	**$ 292,500**
Contingency (20%)	$23,760	$18,900	$10,440	$5,400	**$ 58,500**
Total Cost	**$142,560**	**$113,400**	**$62,640**	**$32,400**	**$ 351,000**
Cumulative Costs	**$142,560**	**$255,960**	**$318,600**	**$351,000**	

6.2 Maintenance Issues Identified

Median openings should be large enough to accommodate mowing equipment and ensure safe mowing operations.

7.0 TRAFFIC MANAGEMENT, ENFORCEMENT AND INCIDENT MANAGEMENT

This chapter highlights changes to existing interfaces between the I-77 HOV lanes and NCDOT's Metrolina Regional Traffic Management Center (MRTMC) if the HOV facility is extended. The chapter also reviews enforcement needs and coordination with current incident management plans.

7.1 Traffic Management Needs and Points of Interface

As discussed in Chapter 4, recommended treatments for the northern termini of the HOV and general purpose lanes are designed to accommodate projected traffic demand along I-77 during the afternoon peak period. Traffic signage for the lane extensions north of I-485 (Exit 19) will inform motorists of the end of HOV lane designation and the dropping of any extended general purpose lanes.

7.2 Traffic Management Center Interface

Figure 2-4 shows CCTV cameras and DMS locations along I-77 north of Gilead Road that are funded by NCDOT for future installation. Implementation of these ITS improvements will be integral to maintaining the interface between the MRTMC and the extended HOV and general purpose lanes. Additional CCTV surveillance and installation of more traffic detectors between NC-73 (Exit 25) and Langtree Road (Exit 31) would be helpful to ensure early identification of freeway incidents along any of the I-77 lanes.

7.3 Enforcement Needs

Extension of the HOV lanes to either Exit 28 or Exit 31 will heighten the need for enforcement of occupancy requirements and HOV facility access restrictions. The NCSHP should be consulted to identify preferred enforcement areas so design of the HOV facility's extension reflects this input. Law enforcement agencies in Cornelius and Davidson also should be contacted because of lane extension into their jurisdictions.

The average cost for an enforcement patrol was estimated at $105,000 per year based on input from the NCSHP. The equivalent of a patrol assigned to the corridor 50 percent of the time of HOV lane operations will be needed to monitor vehicle occupancy and the weaving in and out of the HOV lane where access is prohibited.

7.4 Incident Management

In addition to expanded enforcement, supplemental incident response service should be budgeted. For the Triangle Expressway, North Carolina's first toll facility which is currently under construction, the North Carolina Turnpike Authority (NCTA) will contract with the NCDOT's Incident Management Assistance Patrol (IMAP) for these services. NCTA's proposed contract for IMAP services equals about $11,400 per lane mile annually. A unit cost of 80 percent of this estimate was assumed for the I-77 corridor because service is already being provided along I-77 and the cost to increase service frequency would be less than operating service where it had not been previously provided. A unit cost of $9,200 per

year per lane-mile was assumed for IMAP service along the HOV lane facilities, as illustrated in **Table 7-1**. This table also includes estimated annual enforcement costs. These costs represent a suggested allocation of funding from existing revenue sources.

Table 7-1: Enforcement and Courtesy Patrol Cost Estimates (2009 Dollars)

	Existing HOV	Extension to Exit 25	Extension to Exit 28	Extension to Exit 30	**Total System**
Enforcement	$52,500	NA	NA	NA	**$ 52,500**
IMAP Payment	$121,800	$96,900	$53,500	$27,700	**$ 299,900**
Contingency (15%)	$26,100	$14,500	$8,000	$4,200	**$ 52,800**
Total Cost	**$200,400**	**$111,400**	**$61,500**	**$31,900**	**$ 405,200**
Cumulative Costs	**$200,400**	**$311,800**	**$373,300**	**$405,200**	

8.0 APPENDICES

Appendix A includes a series of lane diagrams that depict the results of the CORSIM simulation analyses along the corridor.

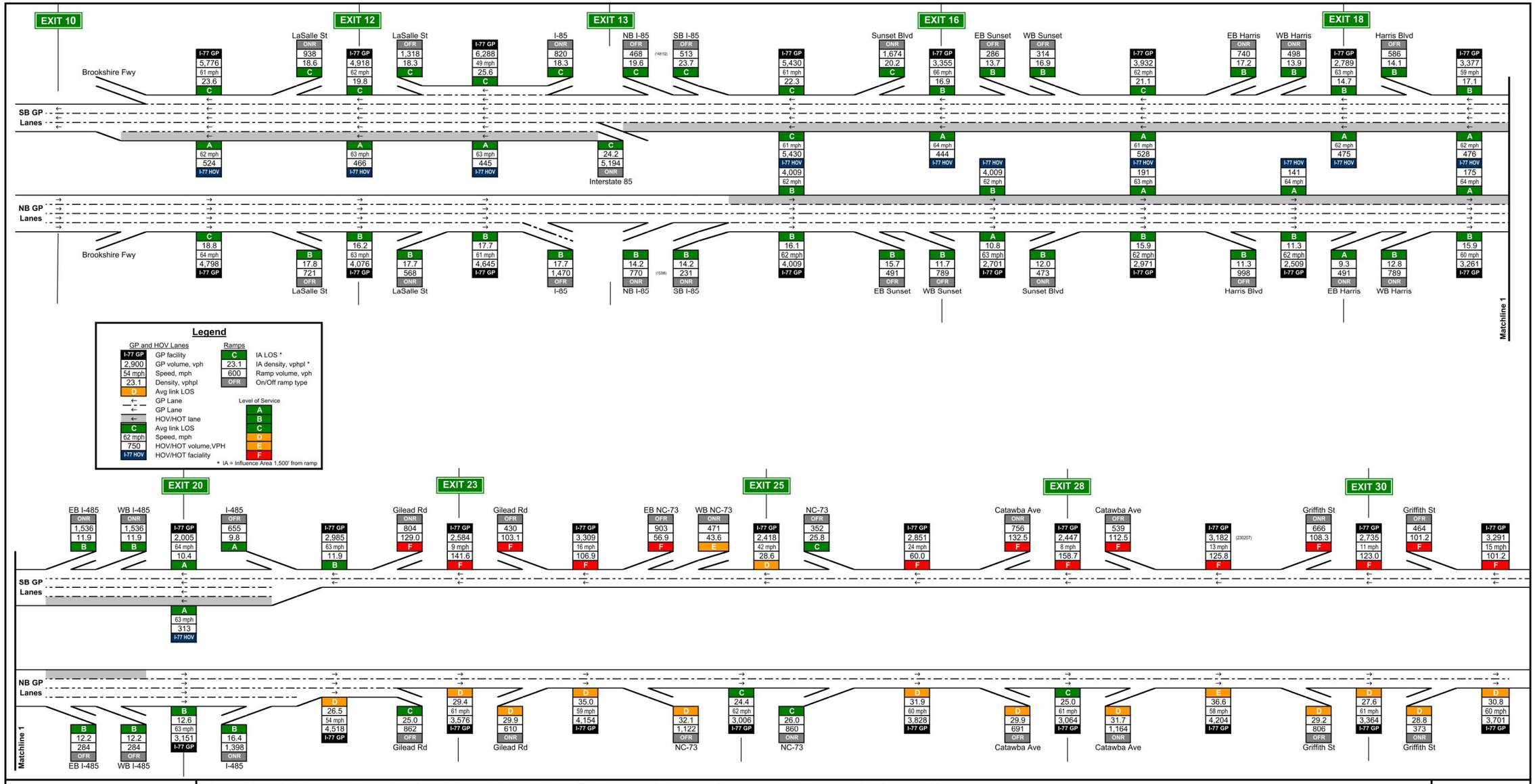
Appendix A

CORSIM Analysis for HOV Extension

Figures	Year	Peak	Cross-section
Figure A-1	2013	AM	NoBuild
Figure A-2	2013	PM	NoBuild
Figure A-3	2030	AM	NoBuild
Figure A-4	2030	PM	NoBuild
Figure A-5	2013	AM	3 Lanes (1 HOV & 2 GP)
Figure A-6	2013	PM	3 Lanes (1 HOV & 2 GP)
Figure A-7	2030	AM	3 Lanes (1 HOV & 2 GP)
Figure A-8	2030	PM	3 Lanes (1 HOV & 2 GP)
Figure A-9	2013	AM	4 Lanes (1 HOV & 3 GP)
Figure A-10	2013	PM	4 Lanes (1 HOV & 3 GP) (missing)
Figure A-11	2030	AM	4 Lanes (1 HOV & 3 GP)
Figure A-12	2030	PM	4 Lanes (1 HOV & 3 GP)

Appendix B shows a typical signing plan for the extended HOV lanes.

Appendix A: CORSIM Analysis Results



I-77 HOV Study: CORISIM Model Volume Density and Speed Results

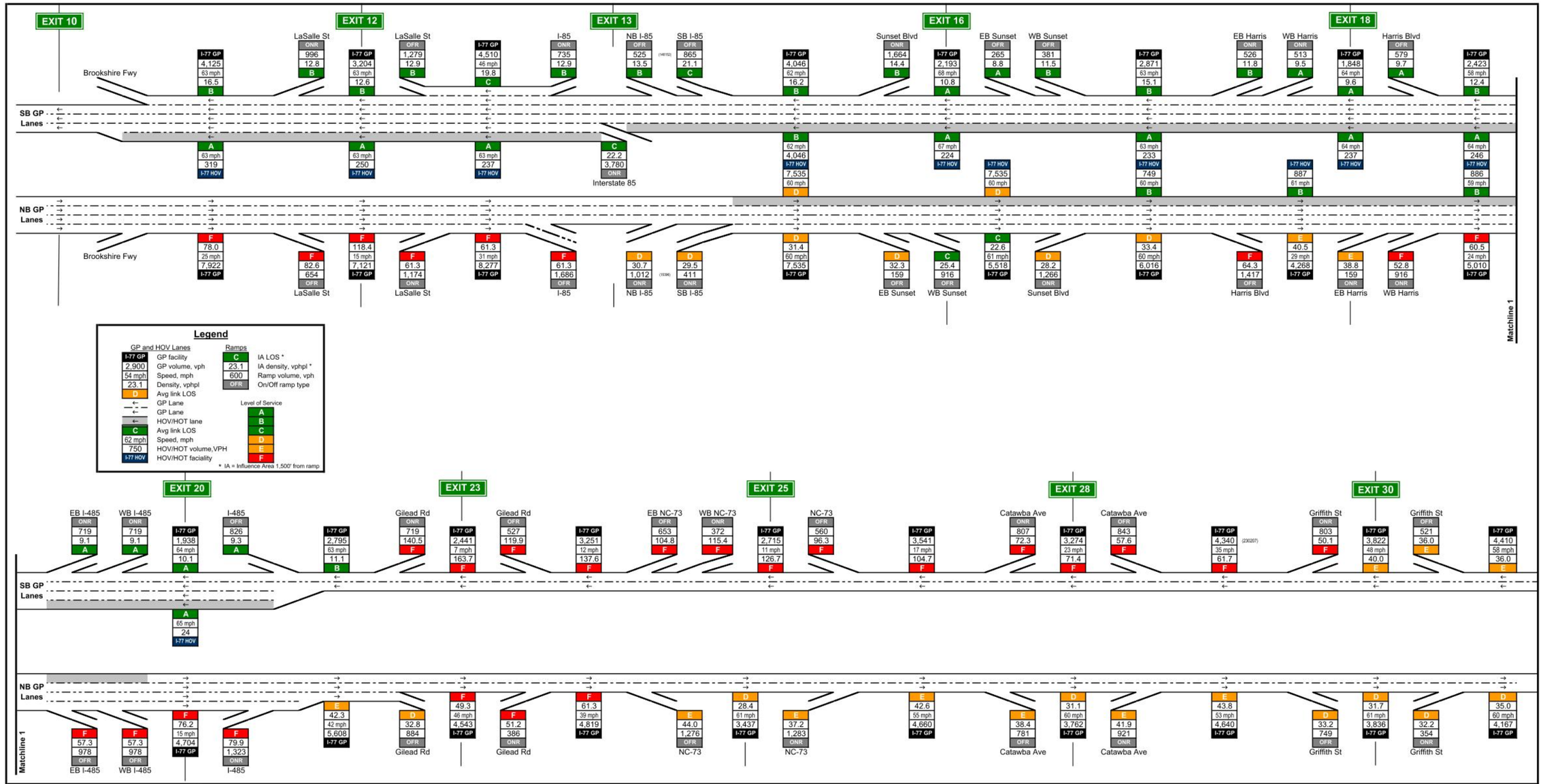
2013 AM No-Build

Figure A-1

Location : I-77 between Exit 10 (Brookshire Freeway) and Exit 30 (Griffith Street)
AM Peak Period (7:00 a.m. to 8:00 a.m.)

Date: October 20, 2009

Created by: Dhiraj Goverdhanam
Approved by: Jonathan Reid



I-77 HOV Study: CORISIM Model Volume Density and Speed Results

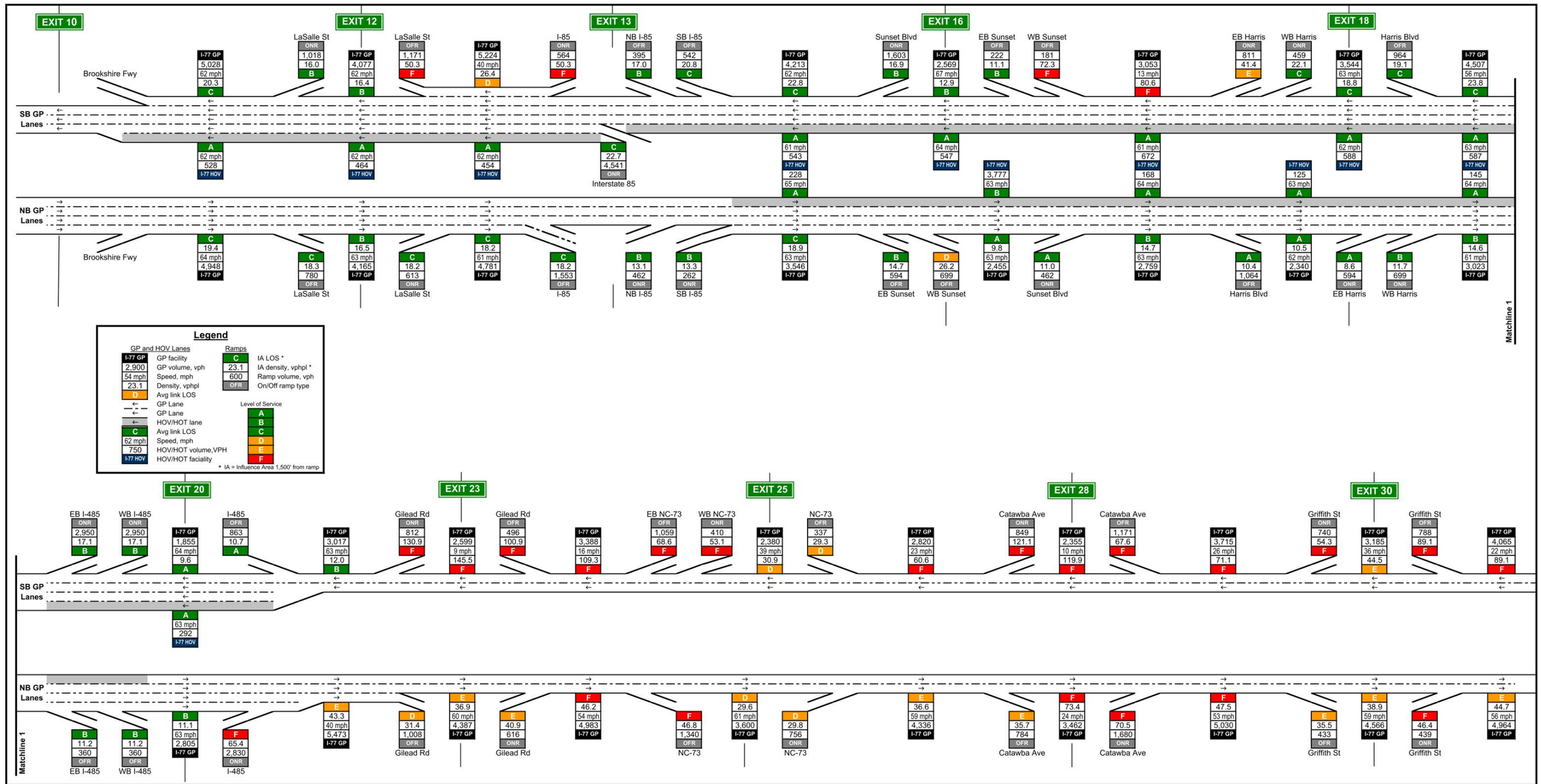
2013 PM No-Build

Figure A-2

Location : I-77 between Exit 10 (Brookshire Freeway) and Exit 30 (Griffith Street)
PM Peak Period (5:00 p.m. to 6:00 p.m.)

Date: October 20, 2009

Created by: Dhiraj Goverdhanam
Approved by: Jonathan Reid



I-77 HOV Study: CORISIM Model Volume Density and Speed Results

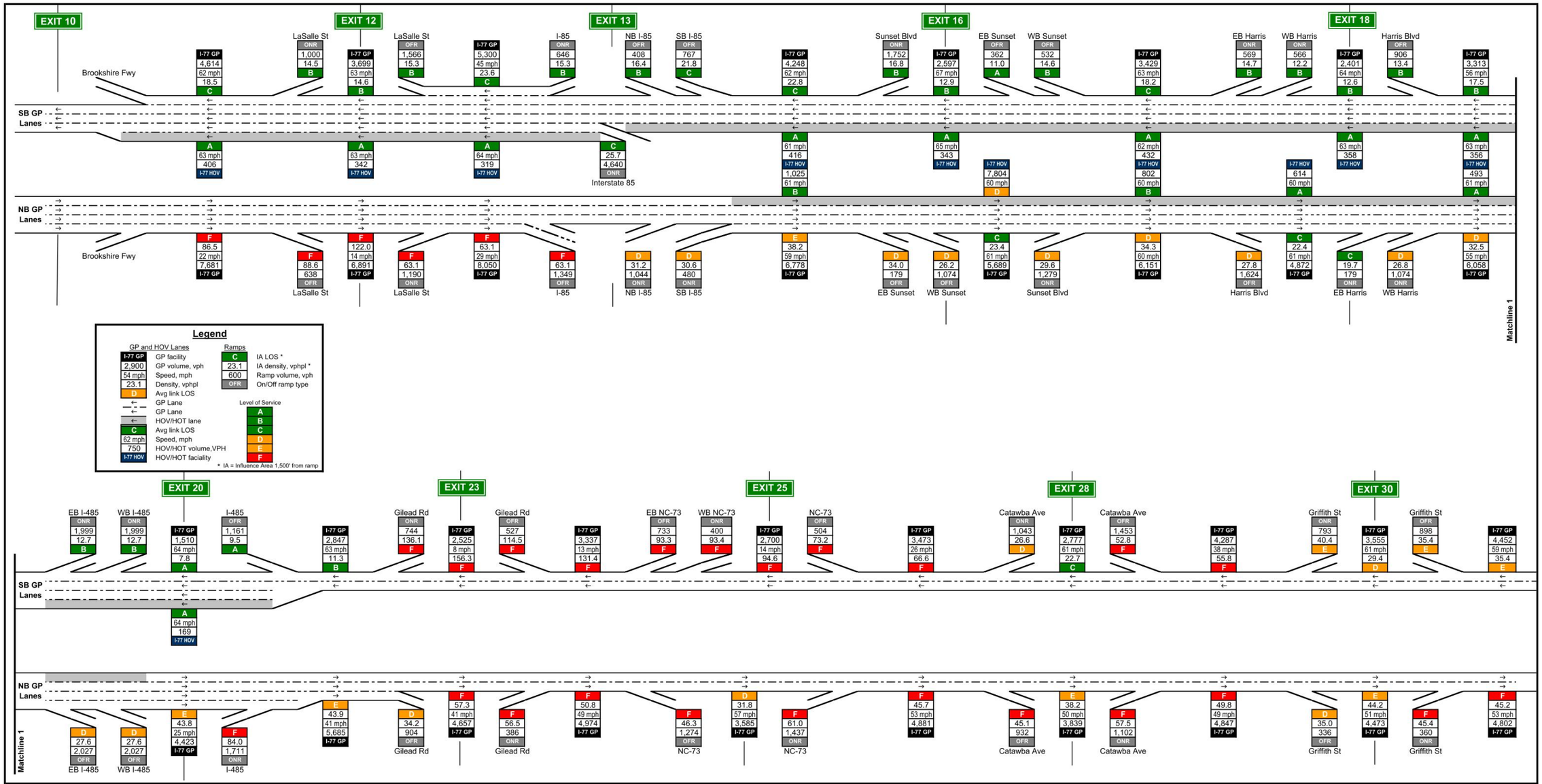
2030 AM No-Build

Figure A-3

Location : I-77 between Exit 10 (Brookshire Freeway) and Exit 30 (Griffith Street)
AM Peak Period (7:00 a.m. to 8:00 a.m.)

Date: October 20, 2009

Created by: Dhiraj Goverdhanam
Approved by: Jonathan Reid



I-77 HOV Study: CORISIM Model Volume Density and Speed Results

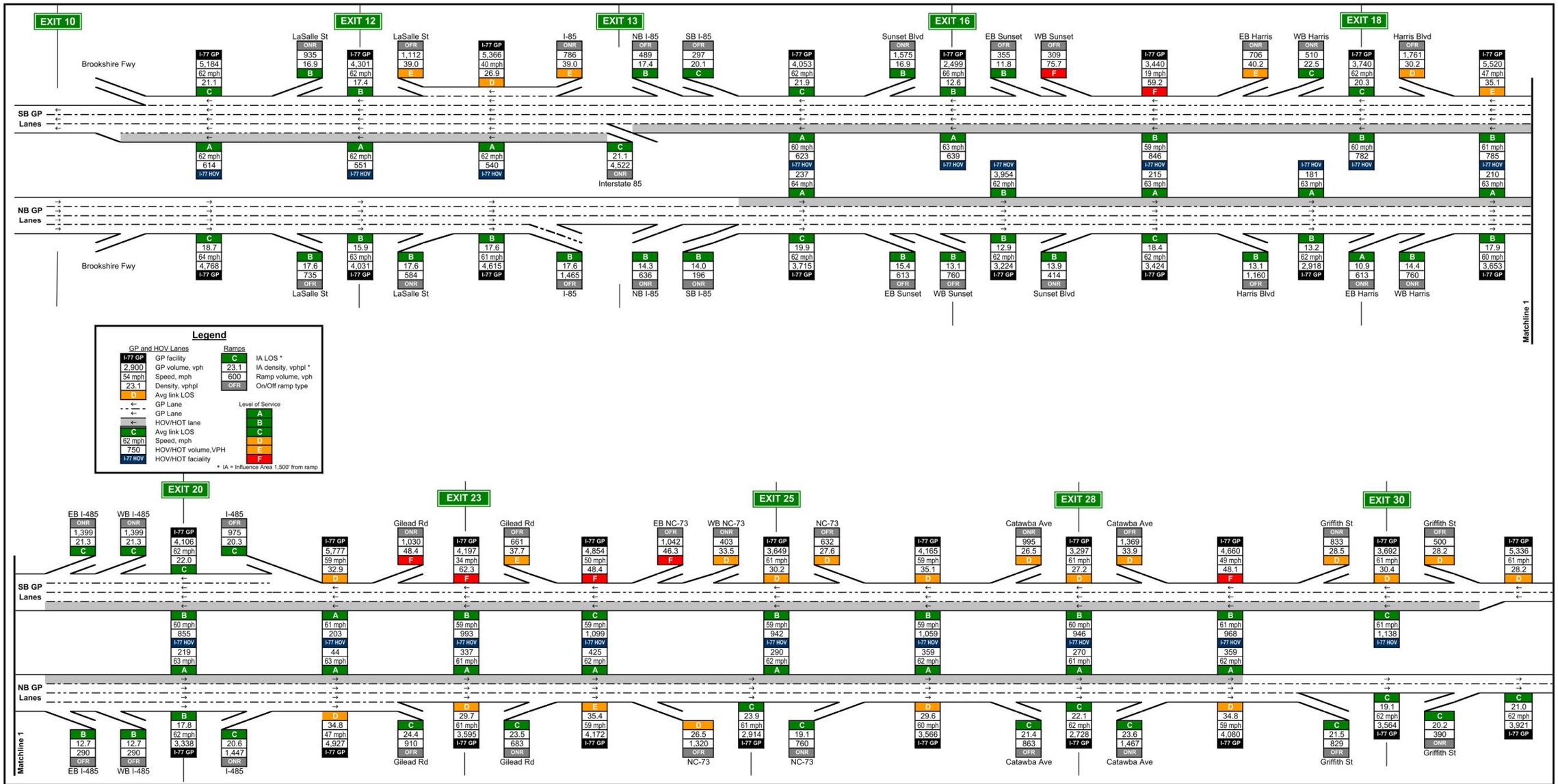
2030 PM No-Build

Figure A-4

Location : I-77 between Exit 10 (Brookshire Freeway) and Exit 30 (Griffith Street)
PM Peak Period (5:00 p.m. to 6:00 p.m.)

Date: October 20, 2009

Created by: Dhiraj Goverdhanam
Approved by: Jonathan Reid



I-77 HOV Study: CORISIM Model Volume Density and Speed Results

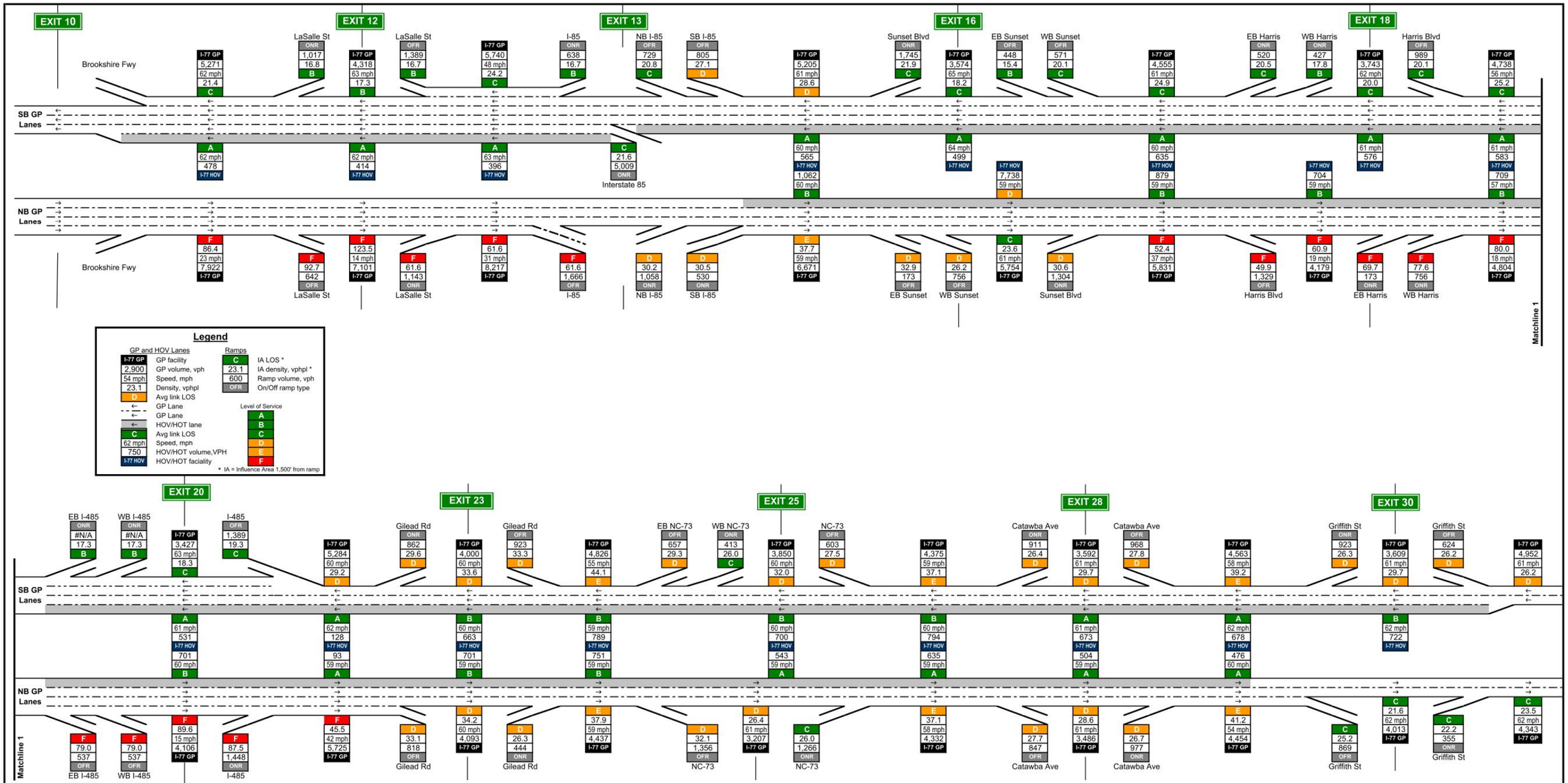
2013 AM (Alt # 2)

Figure A-5

Location : I-77 between Exit 10 (Brookshire Freeway) and Exit 30 (Griffith Street)
AM Peak Period (7:00 a.m. to 8:00 a.m.)

Date: October 21, 2009

Created by: Dhiraj Goverdhanam
Approved by: Jonathan Reid



I-77 HOV Study: CORISIM Model Volume Density and Speed Results

2013 PM (Alt # 2)

Figure A-6

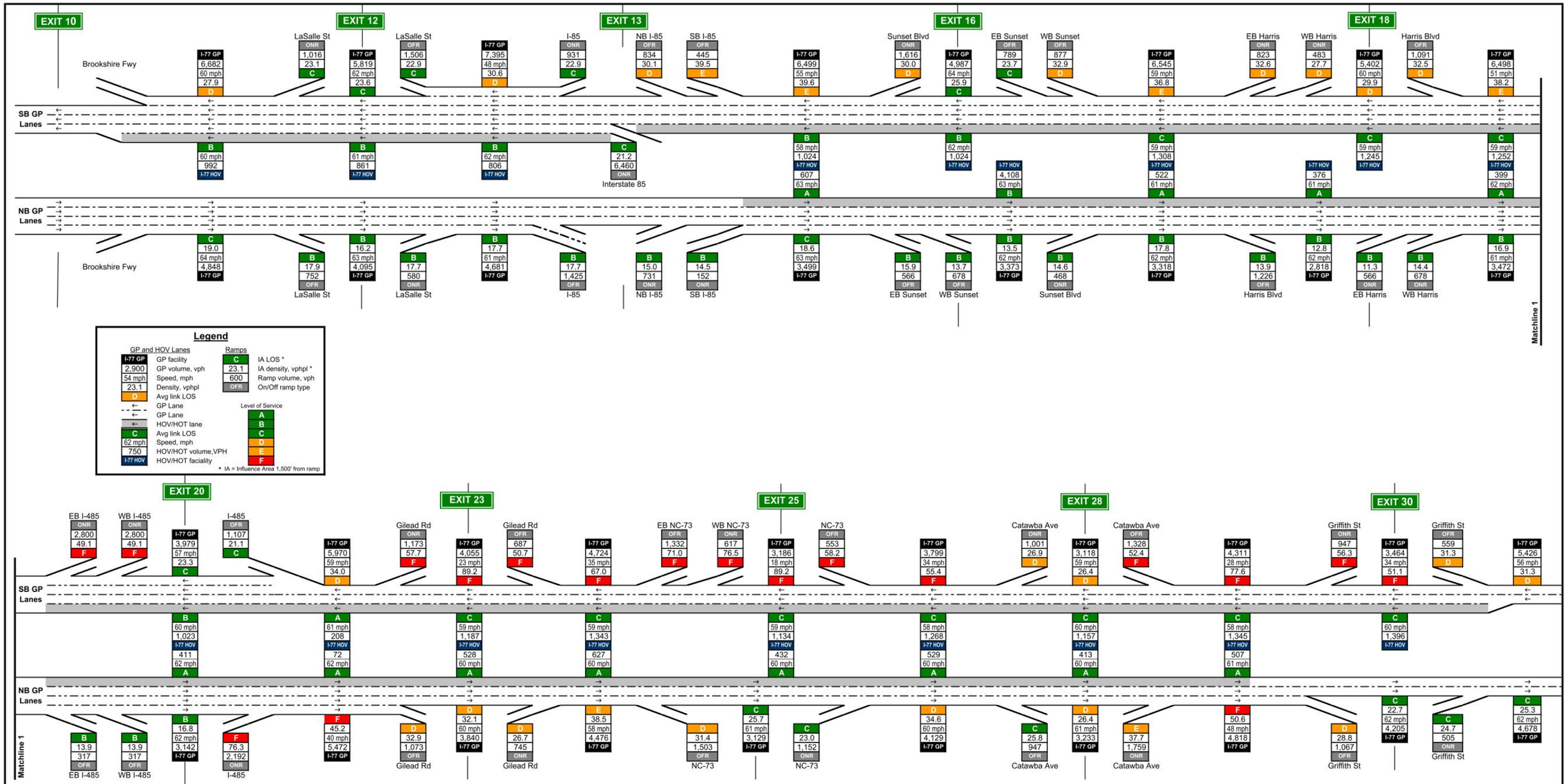
Location : I-77 between Exit 10 (Brookshire Freeway) and Exit 30 (Griffith Street)

PM Peak Period (5:00 p.m. to 6:00 p.m.)

Date: October 21, 2009

Created by: Dhiraj Goverdhanam

Approved by: Jonathan Reid



I-77 HOV Study: CORISIM Model Volume Density and Speed Results

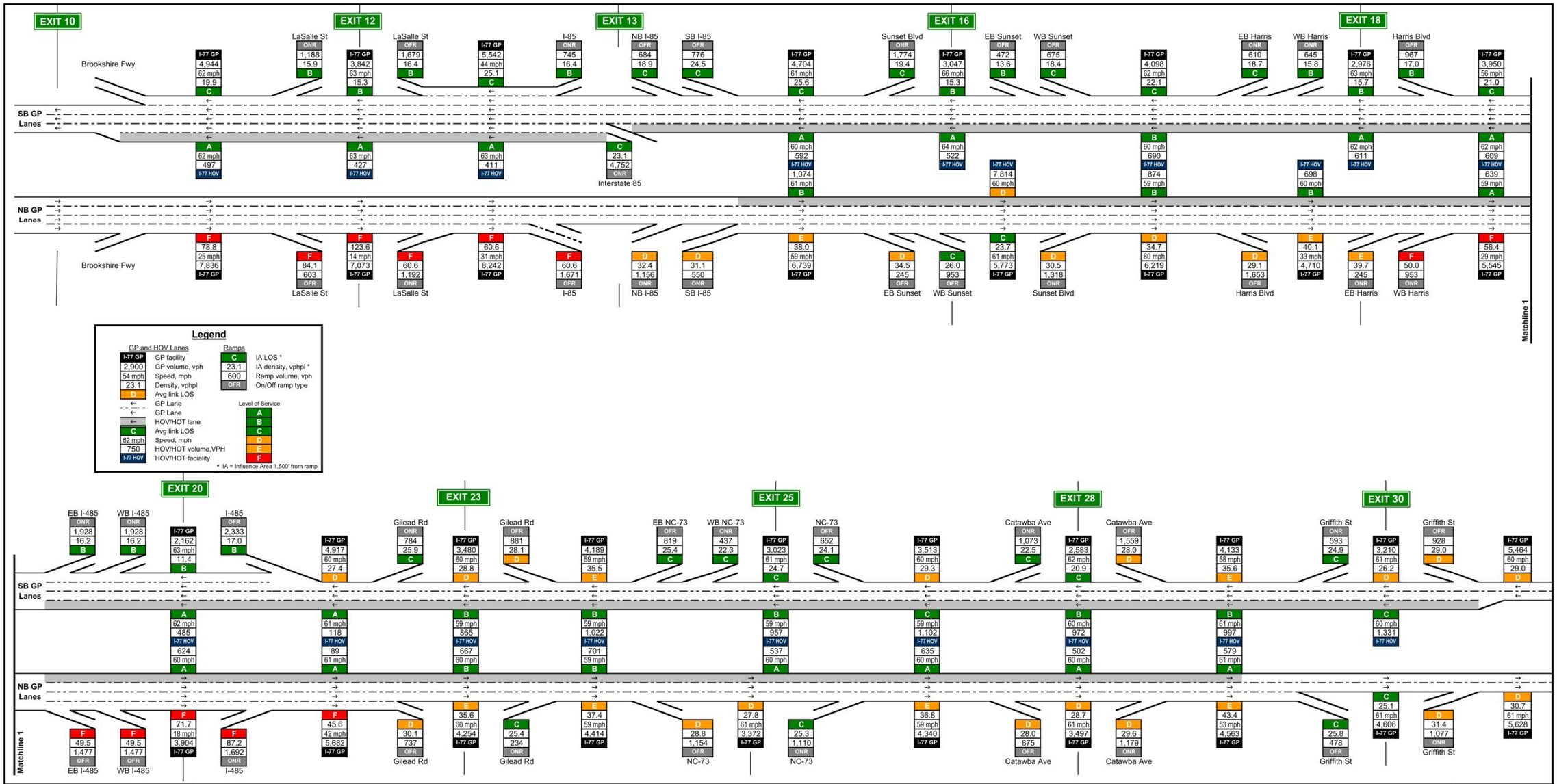
2030 AM (Alt # 2)

Figure A-7

Location : I-77 between Exit 10 (Brookshire Freeway) and Exit 30 (Griffith Street)
AM Peak Period (7:00 a.m. to 8:00 a.m.)

Date: October 21, 2009

Created by: Dhiraj Goverdhanam
Approved by: Jonathan Reid



I-77 HOV Study: CORISIM Model Volume Density and Speed Results

2030 PM (Alt # 2)

Figure A-8

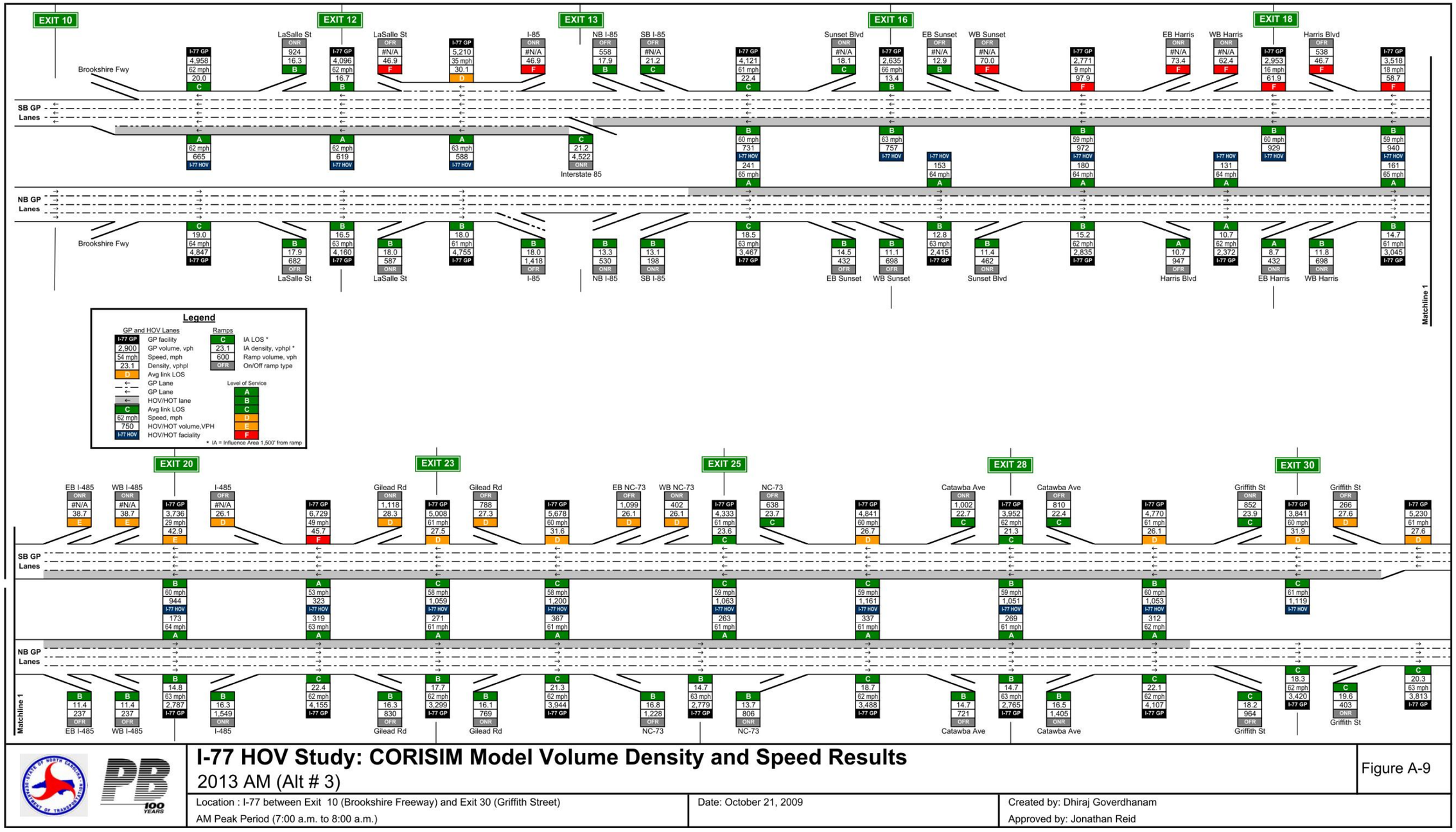
Location : I-77 between Exit 10 (Brookshire Freeway) and Exit 30 (Griffith Street)

PM Peak Period (5:00 p.m. to 6:00 p.m.)

Date: October 21, 2009

Created by: Dhiraj Goverdhanam

Approved by: Jonathan Reid



I-77 HOV Study: CORISIM Model Volume Density and Speed Results

2013 AM (Alt # 3)

Figure A-9

Location : I-77 between Exit 10 (Brookshire Freeway) and Exit 30 (Griffith Street)

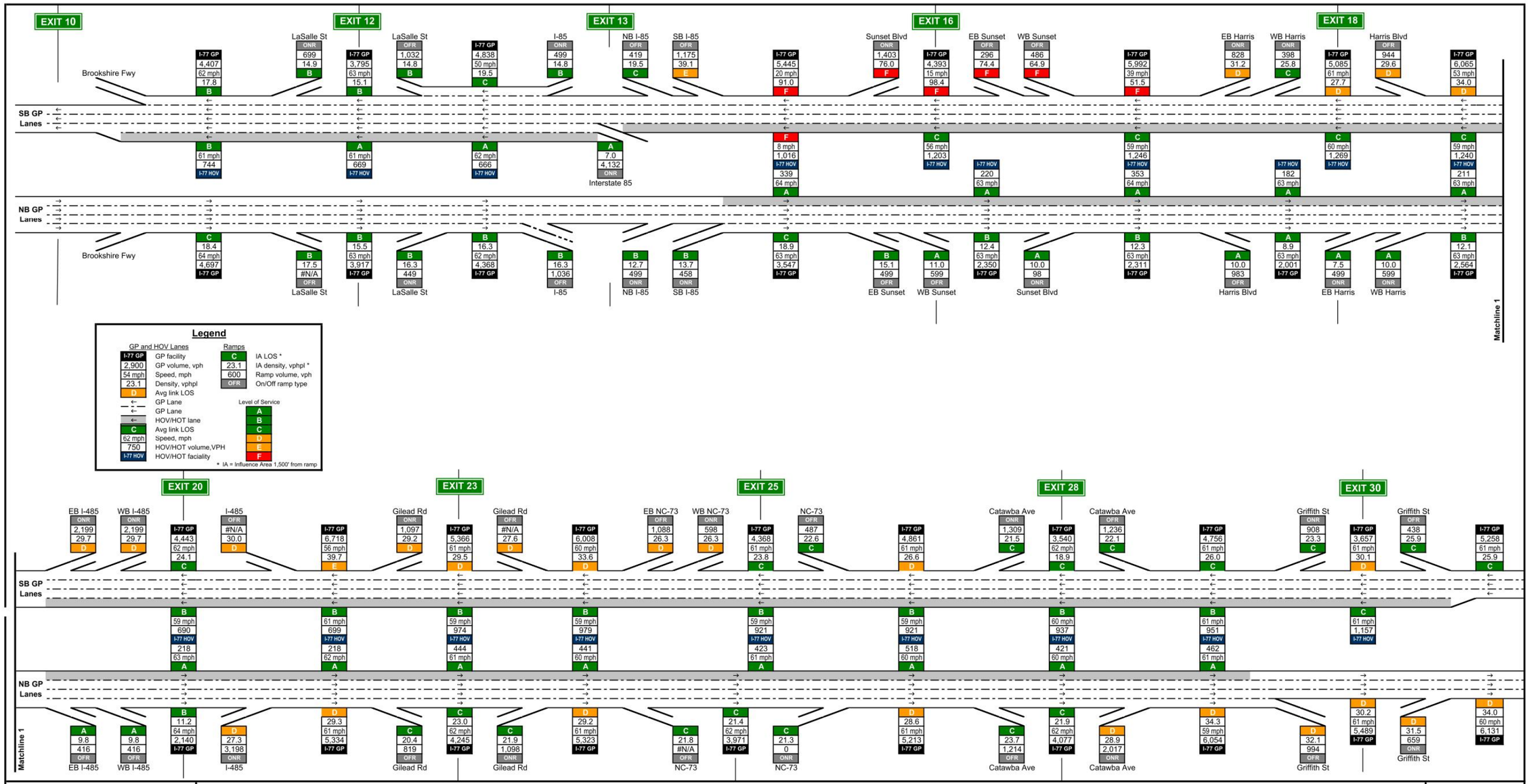
AM Peak Period (7:00 a.m. to 8:00 a.m.)

Date: October 21, 2009

Created by: Dhiraj Goverdhanam

Approved by: Jonathan Reid

Figure 10 is missing



I-77 HOV Study: CORISIM Model Volume Density and Speed Results

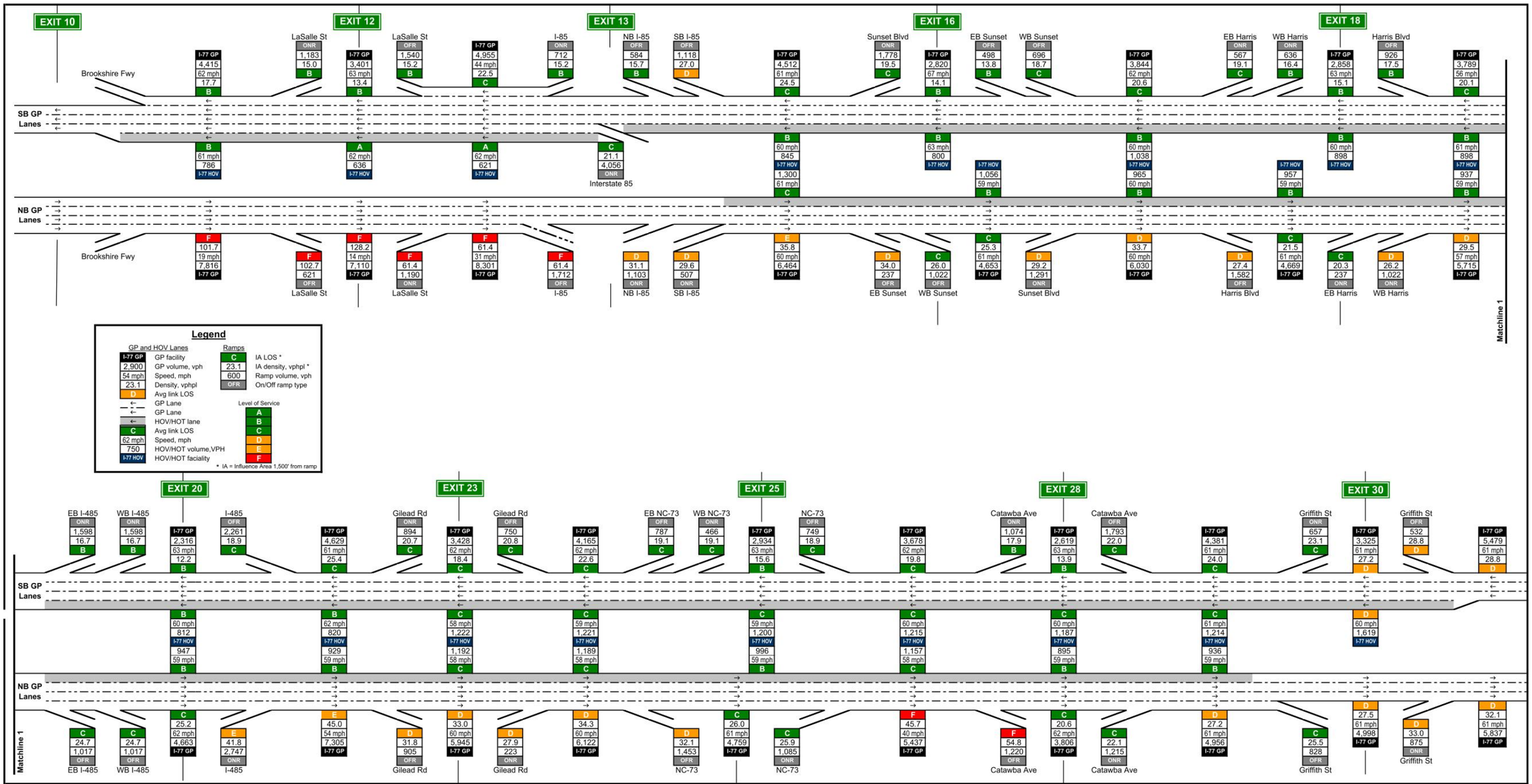
2030 AM (Alt # 3)

Figure A-11

Location : I-77 between Exit 10 (Brookshire Freeway) and Exit 30 (Griffith Street)
AM Peak Period (7:00 a.m. to 8:00 a.m.)

Date: October 21, 2009

Created by: Dhiraj Goverdhanam
Approved by: Jonathan Reid



I-77 HOV Study: CORISIM Model Volume Density and Speed Results

2030 PM (Alt # 3)

Figure A-12

Location : I-77 between Exit 10 (Brookshire Freeway) and Exit 30 (Griffith Street)

PM Peak Period (5:00 p.m. to 6:00 p.m.)

Date: October 21, 2009

Created by: Dhiraj Goverdhanam

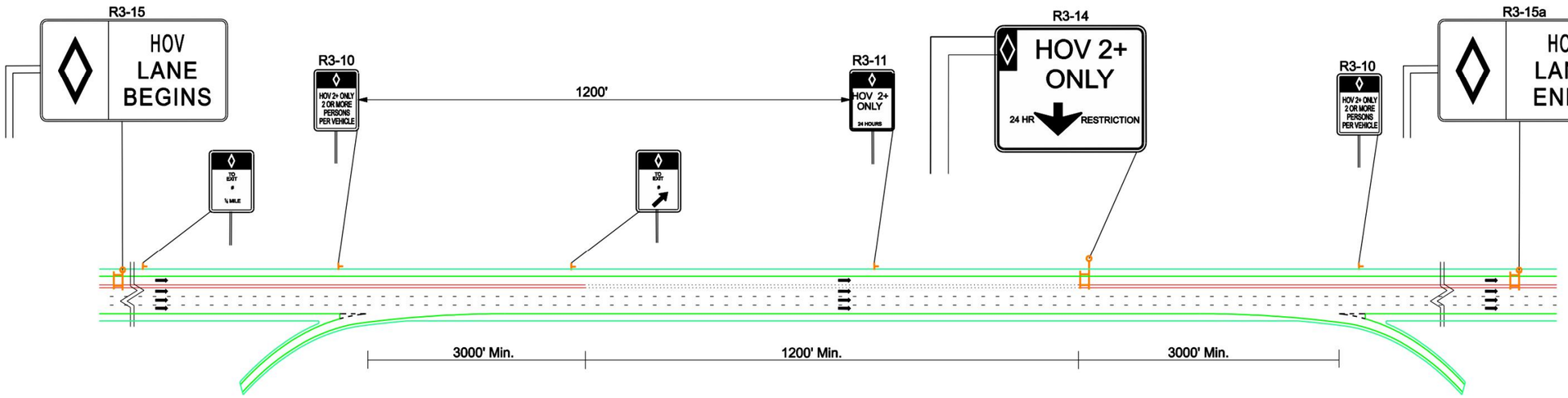
Approved by: Jonathan Reid

Appendix B: Typical Signing Plan HOV Extension

Prepared in the Office of:
PB
121 WEST TRADE STREET
SUITE 1950
CHARLOTTE, NC 28202

SHEET NO.

I-77 HOV LANES



HOV TYPICAL SIGNING PLAN

NOTES:
1. A cantilever R3-14 sign is placed at each point where the HOV restricted striping begins.
2. R3-10 barrier post-mount signs are placed along the corridor where there is restricted access at least one every 2,500 feet.
3. R3-11 signs and signs warning of the penalty for violating HOV lanes are placed throughout the corridor at least one every 2,400 feet , with at least one placed at the HOV ingress/egress points.
4. R3-15 and R3-15a are placed at the beginning and end of the corridors respectively.
5. HOV egress points are signed to indicate where drivers are to exit. The Exit with arrow sign is places at the location where the solid stripe is dropped and the skip-stripe access area begins. The ¼ mile Exit sign is places ¼ mile upstream of that.

I-77 HOV LANE SIGNAGE