North Carolina Department of Transportation

December 2001

I-77 Sub-Area Study Final Report

The Need for Congestion Management

Over the last ten years, the I-77 corridor has undergone significant change. Because of the corridor's proximity to Lake Norman and direct regional access via I-77 to several northern towns, the corridor has experienced tremendous growth in population and employment. I-77 has grown from a relatively non-congested freeway to one of the busiest roads in North Carolina.

PM peak hour congestion on I-77 north of I-85

Travel delays in the Charlotte region have increased and are projected to continue to grow. According to a recent study by the Texas Transportation Institute, Charlotte ranks 29th nationally in annual delay per person in a study of 68 urban areas in the United States.

The projected number of households in the I-77 north corridor will increase more than 50 percent between 2005 and 2025, from approximately 49,000 to 75,000. During this same 20-year period, employment in the corridor is expected to increase by 47 percent, from 84,000 in 2005 to 123,000 in 2025.

The I-77 corridor between Charlotte and Mooresville is one of the five major transportation and development corridors identified in the *Centers and Corridors Plan*. The *2025 Charlotte-Mecklenburg Integrated Transit/Land Use Plan* included transportation and land use recommendations for the portion of the I-77 corridor in Mecklenburg County. The land use portion of the 2025 Plan plays a critical role in developing options to solo commuting. While land use planning cannot dictate use of alternative transportation modes, it can provide a framework that makes these other modes more successful. Integrated transportation and land use planning can encourage an environment where activities and centers of interest are closely located and easily accessed.

No urban area has succeeded in curbing congestion with a "roads-only" strategy. New highway capacity generally only provides short-term relief. Within a few years, roads are again near full capacity because new growth shifts to the improved corridor and commuters shift their travel back to peak hours. Highway widening is a finite activity because of limited availability of land and significant negative impacts on adjoining homes or businesses.

There is a growing awareness in the Charlotte region that new approaches are needed to manage congestion. Residents of the region are beginning to understand that alternative transportation modes such as high occupancy vehicle (HOV) lanes, light rail transit (LRT), or bus rapid transit (BRT) provide reliable travel times as demand grows, in stark contrast to ever lengthening auto commute times as highway lanes become filled.

The I-77 Sub-area Study Process

The purpose of the I-77 Sub-area Study was to develop alternatives to address existing and projected traffic volumes during peak commute periods in the I-77 north corridor in Charlotte. This sub-area study evaluated freeway improvement alternatives such as adding general-purpose lanes, auxiliary lanes, upgrading interchanges and constructing HOV or "managed" lanes.

This study also examined:

- Strategies to maximize roadway capacity through Intelligent Transportation Systems (ITS) technologies and Transportation System Management (TSM)

- Feasibility of implementing concurrent flow, contra-flow, and reversible HOV lanes along various I-77 north segments
- Alternatives for providing HOV lanes between I-85 and Center City Charlotte
- Primary functions of I-77 and proposed guidelines to be considered when evaluating future improvements to the freeway

The study focused on the I-77 north corridor from exit 9 (I-277 or the John Belk Freeway) in Charlotte to exit 36 in Mooresville (the NC-150 interchange). The study area included current and proposed interchanges along I-77. It also included the interstate's primary parallel roadway, US-21, from I-277 (Brookshire Freeway) to Mooresville.

The I-77 Sub-area Study was conducted over nine months and consisted of five phases:

Phase	Activity
1	Study Initiation: start-up activities determination of problems, initial definition of transportation system alternatives, and the development of evaluation methods and measures.
2	Initial Technical Analysis: further development and definition of the alternatives and the preparation of initial technical results, such as travel projections, cost estimates, etc.
3	Refined Technical Analysis: updated and final technical analyses to support the evaluation of the alternatives;
4	Evaluation: framing the technical results as an evaluation of the alternatives using the measures identified in the first phase; and
5	Report Preparation: documenting study results and providing information to interested stakeholder groups.

Throughout the study, two committees reviewed technical products and provided advice on final recommendations. The I-77 Study Executive Committee included officials from the North Carolina Department of Transportation (NCDOT), the Mecklenburg-Union Metropolitan Planning Organization (MUMPO), the Town of Mooresville, and the three Chambers of Commerce covering the study area. The Technical Steering Committee was composed of technical staff from various NCDOT branches or units, MUMPO, and Mooresville.

I-77 Study Executive Committee Meeting

I-77 Functions

I-77 serves several functions as a major transportation artery in Mecklenburg and Iredell Counties.

Interstate Travel

I-77 is a major north-south interstate route that begins in Cleveland, Ohio and ends in Columbia, South Carolina. This interstate is one of the few north-south routes through the Appalachian Mountains. I-77 intersects several important east-west interstates including I-80/90 in northern Ohio, I-64, I-81, I-40, I-85 (in Charlotte) and I-20 in Columbia, South Carolina. I-77 provides access from West Virginia, southwestern Virginia, and the northern portion of the North Carolina Piedmont to Charlotte.

I-77 is a key component of the City of Charlotte's adopted truck network. This network supports the trucking industry, one of Charlotte's major industries. Over 300 trucking companies employing approximately 45,000 persons are located in the Charlotte region. The area near I-77's interchange with Sunset Road is the site of numerous trucking terminals while the I-77/Harris Boulevard interchange is close to several major industrial parks. Based on a 2001 vehicle classification

count, approximately 5 percent of the vehicles using I-77 during the peak hours are trucks.

Emergency Evacuation

I-77 serves as the primary evacuation route for Duke Power's McGuire Nuclear Station. This station is located on NC-73, west of I-77, in the Lake Norman area of Huntersville.

Commuting to Charlotte

Over the past ten years, the I-77 North Corridor has undergone significant change. The corridor's population has increased by 33 percent, from 62,000 persons in 1990 to 83,000 residents in 2000. The I-77 Corridor has emerged as one of the Charlotte region's strongest residential markets during the past five to seven years.

Growth in peak hour traffic volumes along I-77 north and parallel roadways has prompted Charlotte Area Transit System (CATS) to expand express bus services in the corridor. CATS has increased service on Route 77X, North Mecklenburg Express, on several occasions in the past three years and added a new express service, Route 83X, to Mooresville on October 29, 2001. CATS also is analyzing rapid transit options in the I-77 north corridor, including commuter rail service on the Norfolk Southern "O" line and BRT operations along I-77.

Local Travel

Following the rooftops, retail development in the I-77 north corridor has been strong over the past several years. Shopping center development has occurred almost exclusively along I-77, and the corridor's emergence as a regional retail center will be strengthened by the development of Northlake Mall at I-77 and Reames Road.

I-77 access and the abundance of affluent households around Lake Norman and in north Mecklenburg County have facilitated the beginning of an office core along I-77. Office tenants being attracted to the I-77 North corridor include some that are new to the Charlotte market and others that have relocated from Uptown Charlotte and other sub-markets.

New live-work units in downtown Cornelius

The aforementioned growth in retail and office development, occurring primarily along I-77, has resulted in more use of the freeway for local travel demand. Projected growth near existing and proposed I-77 interchanges over the next ten years will create greater demand for local access, with I-77, US-21, and NC-115 being the primary roadways to serve this function.

Guidelines for I-77 Improvements

I-77 is a key component of the region's Interstate Highway System. It is a primary route for emergency evacuation for McGuire Nuclear Station and should be designed to allow high speed, high volume traffic movements facilitating interstate and regional commerce, specifically long distance trips. Improvements to I-77 within the Mecklenburg–south Iredell sub-area also should be consistent with programmed or anticipated I-77 improvements beyond the study area.

The following should be a guide for future improvements to I-77:

- The maximum number of general-purpose lanes on I-77 within the study area (from I-85 to NC-150) will be eight lanes. There could be a need to provide auxiliary lanes between consecutive ramps of

interchanges in addition to the eight general-purpose lanes.

- The median or inside shoulders of I-77 should be strengthened and designed to permit future HOV lane operation (either concurrent flow HOV lanes or a two-lane reversible HOV facility).
- Additional access points to I-77 in the study area should only be provided for buses and other high occupancy vehicles. This excludes new interchanges or modifications to existing interchanges that are already programmed in the *2002-2008 STIP*.
- New non-freeway structures or modifications to existing non-freeway bridges over I-77 should be designed to accommodate pedestrian and bicycle travel.
- Outside shoulders along I-77 will be strengthened and designed to permit bus only operations during peak hours.

Key Recommendations

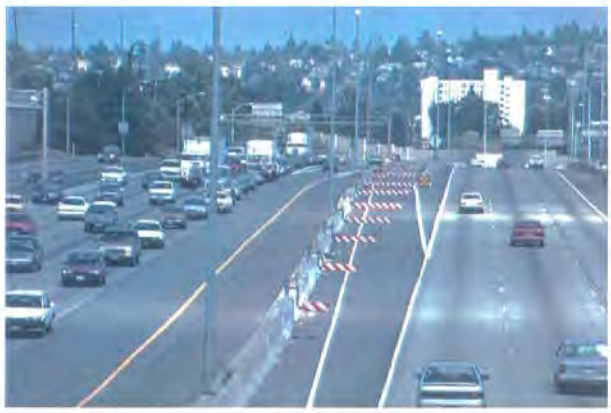
Figures E-1 and E-2 show the I-77 Sub-area Study recommendations described in the following sections.

HOV Lanes

- Designate the inside (median) lanes along I-77 as a concurrent flow, non-buffered separated HOV facility when NCDOT widens the segment between I-85 and I-485 from four to eight lanes. The improved section of I-77 would consist of three general-purpose lanes plus one HOV lane in each direction.
- In conjunction with NCDOT's widening of I-77 north of I-85, extend the southbound HOV lane through I-77's interchange with I-85 by constructing two new bridges and by reducing I-77 lane and shoulder widths between I-85 and Brookshire Freeway. This extension to Brookshire adds another 2.5 miles to the southbound HOV lane, making it 10 miles long. The southbound HOV lane would be restricted to 2+ carpools, vanpools, and transit buses during all hours. The northbound I-77 HOV lane would begin north of I-85 and is approximately 6.5 miles long. It would operate only during peak periods.

Buffer-separated concurrent-flow HOV lane

- A recommended mid-range HOV improvement involves construction of a direct connection to Fifth Street using a redundant ramp at this street's interchange with I-77.
- The ultimate I-77 HOV system between I-85 and Center City would be a reversible, dual-lane, barrier-separated facility. The system would include a reversible flyover to/from the I-85 median, forming a second reversible HOV lane and providing HOV incentives for I-85 traffic. This connection does not necessitate HOV improvements on this freeway because the proposed flyover could operate effectively as a queue bypass for high occupancy vehicles.



Use of gates at reversible HOV lane entrance/exit

- The fine for HOV lane violations under current North Carolina law should be re-examined and increased to provide a greater deterrent to improper use. The present fine is $10 plus court costs, which typically adds $90.

Traditional Capacity Improvements

Work during the I-77 Sub-area Study has confirmed the highway projects already programmed by NCDOT and the City of Charlotte as well as those identified in MUMPO's *Long Range Transportation Plan*. This study identified the need to widen I-77 to eight general-purpose lanes between I-485 and NC-150 in Iredell County. In addition, US-21 should be extended from Catawba Avenue (Exit 28) where it currently ends, across Lake Norman, to Exit 33 at Mount Mourne. These improvements to I-77 and US-21 would result in a need to widen the causeway across the lake.

During work on this study, the following highway and bridge improvements also have been identified to address congestion in this corridor:

- Convert US-21/I-77 interchange (Exit 33) to an urban diamond
- New bridge across I-77 between Alcove and Fairview Roads
- I-77 auxiliary lanes between I-85 and Sunset Road (both sides)
- Verhoeff Drive extension across I-77 from US-21 to Mt. Holly-Huntersville Road
- New bridge across I-77 between US-21 and west side frontage road south of I-77/Catawba Avenue interchange
- Reames Road extension from north of I-485 to Mt. Holly-Huntersville Road

Intelligent Transportation Systems

Intelligent Transportation Systems (ITS) involves the use of advanced traffic operations and communications technologies to help increase throughput on existing roadways, improve safety, and provide more accurate information to the public. Key ITS recommendations from the I-77 Sub-area Study include:

- Develop an integrated Regional Incident Management Program (improve coordination between NCDOT Incident Management Assistance Program (IMAP) and Charlotte/Mecklenburg, Huntersville, Cornelius, Davidson, and Mooresville police/fire/EMS and 911 dispatch centers); expand IMAP through study corridor.

NCDOT's Incident Management Patrol response vehicle

- Plan and design improvements to I-77 interchanges to permit future implementation of ramp metering, likely to occur around 2015. Ramp metering will require re-construction of I-77 on-ramps and signal timing changes on roadways crossing I-77 at interchanges.

Ramp metering controls freeway access (Atlanta, GA)

- Expand traveler information using NCDOT website to provide real-time information on travel times and transit arrival times.
- Study cost-effectiveness of implementing a three-lane reversible system on US-21 from Sunset Road to Harris Boulevard.

Transportation Systems Management

During the study, a number of short-range improvements were identified. Many of these improvements were first suggested in a December 2000 report, *Proposals to Relieve Congestion in the I-77 Corridor*, prepared by NCDOT.

- Re-stripe lanes on southbound I-85 at I-77 in order to improve movements between I-85 and I-77.
- Implement a two-lane connector from I-77 south to I-85 south through the use of re-striping and modest widening.
- Install closed loop signal systems at I-77 interchanges with:
  - Gilead Road (Exit 23) *4 signals*
  - NC-73 (Exit 25) *5 signals*
  - Catawba Avenue (Exit 28) *4 signals*
  - NC-150 (Exit 36) *6 signals*
- Improve US-21 intersections with:
  - Gilead – Add southbound right-turn lane and eastbound through/right-turn lanes.
  - Alexanderana – Add left-turn lanes on all approaches
  - Hambright – Add eastbound and westbound right-turn lanes
  - Stumptown – Add eastbound and westbound left-turn lanes
  - NC-73 - Extend eastbound through lane and add northbound left-turn lane
  - Westmoreland - Add left-turn lanes on all approaches
  - Catawba – Add right-turn lanes on all approaches
- Improve NC-115 intersections with:
  - Gilead - Add eastbound right-turn and northbound left-turn lanes
  - Alexanderana – Add left-turn lanes on all approaches
  - Hambright – Add northbound left-turn lane
  - Stumptown - Add eastbound and north-bound left-turn lanes and southbound right-turn lane
  - NC-73 – Add right-turn lanes all approaches

Land Use/Transportation Integration

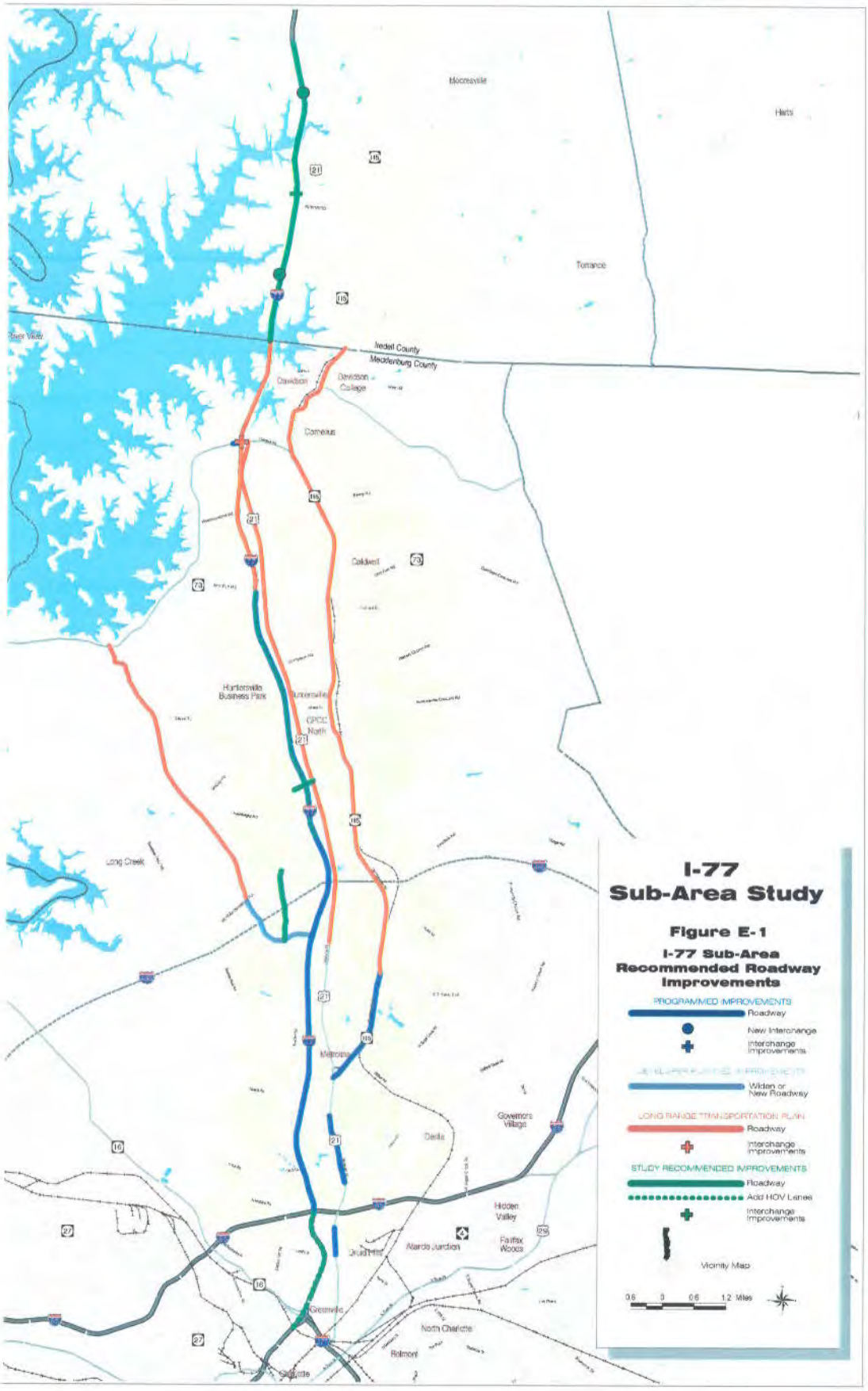
Because there are a number of land use/transportation initiatives already underway in the study area, this study recommends continuation of these planning efforts and implementation of strategies and land use tools evolving from them:

- Complete the North Corridor land use study and implement recommendations from the Preliminary Engineering / Environmental Impact Statement (EIS) phase.
- Implement land use recommendations of the Urban Land Institute (ULI) panel for the Charlotte-to-Mooresville segment of I-77.
- Adopt updated General Development Policies in the City of Charlotte.
- Develop new Transit-Oriented Zoning district for the City of Charlotte.
- Adopt new Joint Development Policy in the City of Charlotte.
- During review of development proposals, do not allow driveways, median openings, or crossovers within 1000 feet (minimum) of the end of an interchange ramp.

Next Steps

In order to introduce HOV operations on I-77 when the segment from I-85 to I-485 is completed in December 2003, work on the near-term HOV design concepts identified in the I-77 Sub-area Study should get underway as soon as possible. The additional improvements required for HOV implementation from this study should be considered by the Mecklenburg – Union Technical Coordinating Committee and MUMPO for inclusion in the urban area's Candidate Projects List for submission to NCDOT to obtain future funding.

The HOV-related work also will have to be studied with regard to environmental impacts. Because none of the proposed construction to implement HOV operations necessitates acquisition of additional right-of-way, a Categorical Exclusion is the most likely Federal requirement for environmental purposes.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Harts
Torrance
Iredell County
Mecklenburg County
Davidson
Davidson College
Cornelius
Caldwell
Huntersville Business Park
Huntersville
CPCC North
Long Creek
Metrolina
Governors Village
Derita
Hidden Valley
Fairfax Woods
Alando Junction
Greenville
North Charlotte
Belmont
I-77
Sub-Area Study
Figure E-1
I-77 Sub-Area Recommended Roadway Improvements
PROGRAMMED IMPROVEMENTS
Roadway
New Interchange
Interchange Improvements
Widen or New Roadway
LONG RANGE TRANSPORTATION PLAN
Roadway
Interchange Improvements
STUDY RECOMMENDED IMPROVEMENTS
Roadway
Add HOV Lanes
Interchange Improvements
Vicinity Map
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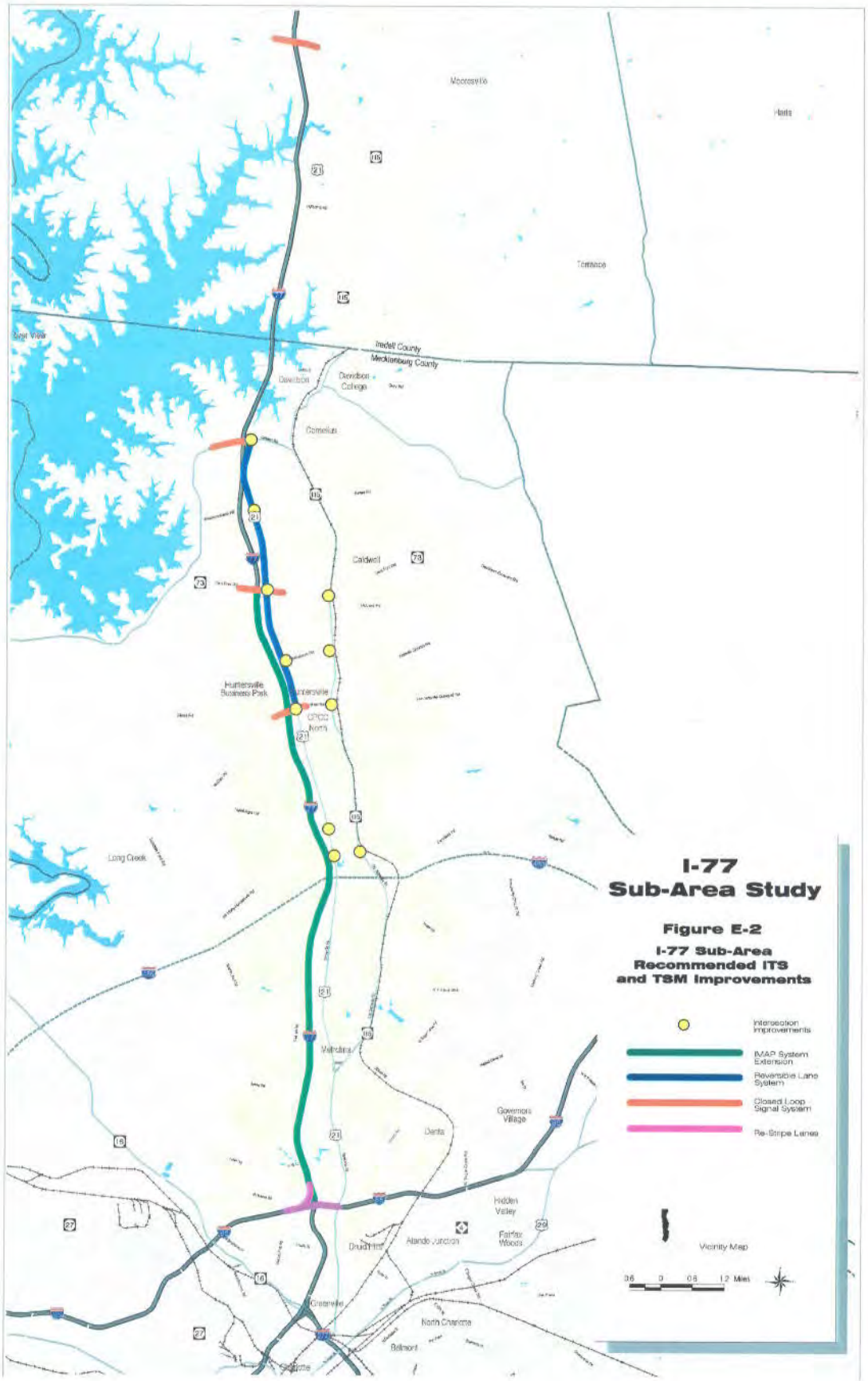
I-77
Sub-Area Study
Figure E-2
I-77 Sub-Area
Recommended ITS
and TSM Improvements
Intersection Improvements
BMP System Extension
Reversible Lane System
Closed Loop Signal System
Re-Stripe Lanes
Vicinity Map
0.6 0 0.6 1.2 Miles
Mooresville
Iredell County
Mecklenburg County
Davidson
Davidson College
Cornelius
Caldwell
Huntersville Business Park
Huntersville
CPCC North
Long Creek
Matthews
Governors Village
Derita
Hidden Valley
Fairfax Woods
Druid Hill
Alando Junction
Greenville
North Charlotte
Belmont
Charlotte

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1.0 INTRODUCTION

1.1 Study Purpose

The purpose of the I-77 Sub-area Study is to develop alternatives to address existing and projected traffic volumes during peak commute periods in the I-77 north corridor in Charlotte. This sub-area study evaluates freeway improvement alternatives such as adding general-purpose lanes, auxiliary lanes, upgrading interchanges and constructing high occupancy vehicle (HOV) or "managed" lanes.

This study also examines:

- Strategies to maximize roadway capacity through Intelligent Transportation Systems (ITS) technologies and Transportation System Management (TSM)
- Feasibility of implementing concurrent flow, contra-flow, and reversible HOV lanes along various I-77 north segments
- Alternatives for providing HOV lanes between I-85 and Center City Charlotte
- Primary functions of I-77 and proposed guidelines to be considered when evaluating future improvements to the freeway

1.2 Study Area

The study focuses on the I-77 north corridor from exit 9 (I-277 or the John Belk Freeway) in Charlotte to exit 36 in Mooresville (the NC-150 interchange). The study area includes current and proposed interchanges along I-77. It also includes the interstate's primary parallel roadway, US-21, from I-277 (Brookshire Freeway) to Mooresville. **Figure 1-1** illustrates the study area.

1.3 Study Approach

The study, conducted over a nine-month period, included technical analyses, stakeholder and executive committee meetings, and the framing of issues and trade-offs for a wide range of alternatives to address travel demand, mobility, and system performance in the I-77 sub-area. The approach consisted of five phases:

Phase	Activity
1	Study Initiation: start-up activities, determination of problems, initial definition of transportation system alternatives, and the development of evaluation methods and measures;
2	Initial Technical Analysis: further development and definition of the alternatives and the preparation of initial technical results, such as travel projections, cost estimates, etc.
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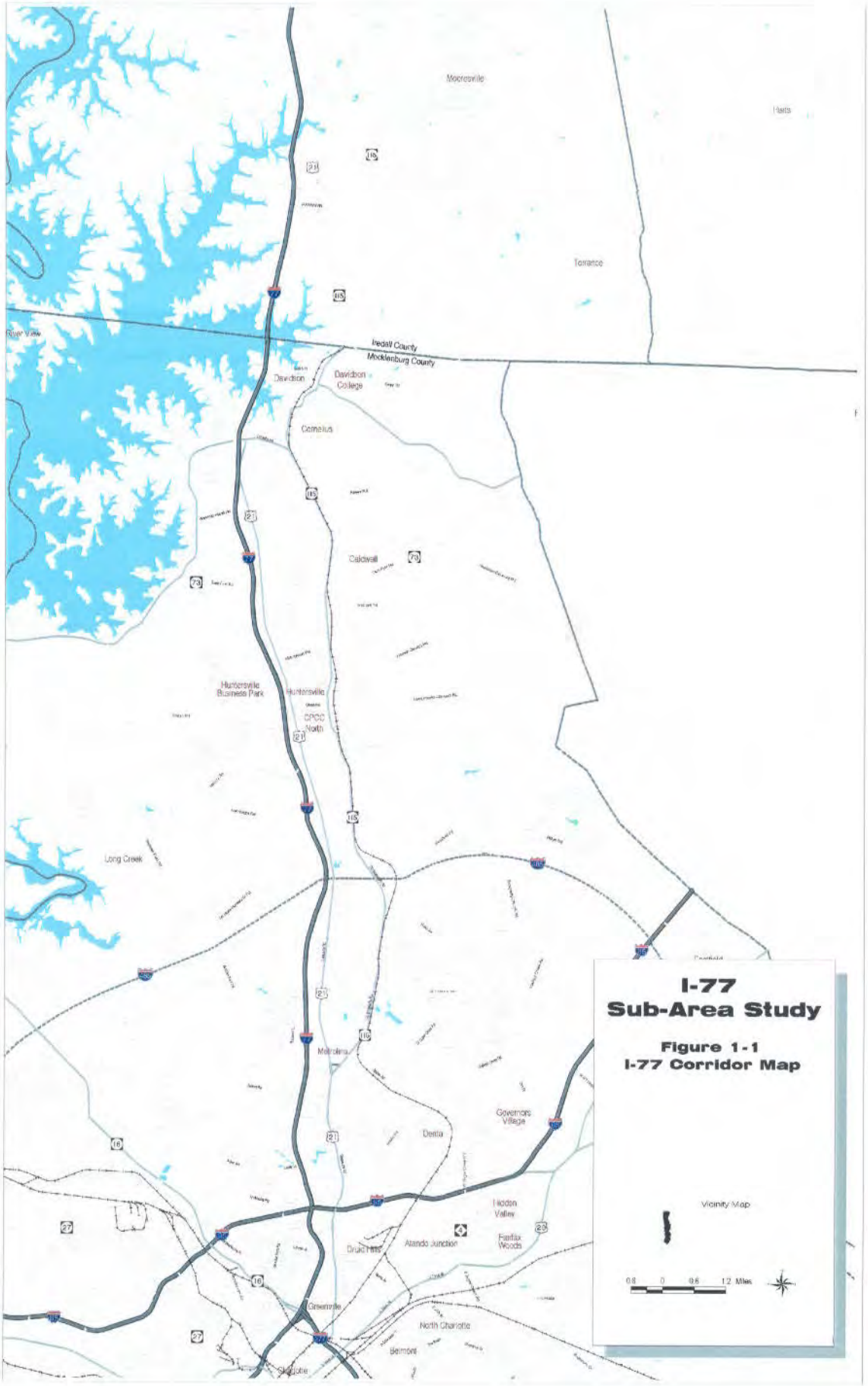

Mooresville
Harris
Torrance
River View
Iredell County
Mecklenburg County
Davidson
Davidson College
Cornelius
Caldwell
Huntersville Business Park
Huntersville
CPCC North
Long Creek
Matthews
Governors Village
Delta
Hidden Valley
Fairfax Woods
Druid Hills
Atando Junction
Greenville
North Charlotte
Belmont
Charlotte
I-77
Sub-Area Study
Figure 1-1
I-77 Corridor Map
Vicinity Map
0.6 0 0.6 1.2 Miles

1.4 Executive and Technical Committees

1.4.1 Executive Committee

Throughout the I-77 sub-area study, two committees reviewed technical products and provided advice on final recommendations.

The Executive Committee met four times during the study and included the following members:

Edward C. Dolby	Chairman, Member, N.C. Board of Transportation, Division 10
Al Jones	Mayor, Town of Mooresville
Lee Myers	Chairman, Mecklenburg/Union Metropolitan Planning Organization
Dan Wallace	Executive Director, Mooresville-South Iredell Chamber of Commerce
Steven R. Knox	Transportation Committee, Lake Norman Chamber of Commerce
Bob Morgan	Group Vice President for Public Policy, Charlotte Chamber
Benton Payne, PE	Division 10 Engineer, NCDOT
Janet D'Ignazio	Chief Planning and Environmental Officer, NCDOT

1.4.2 Technical Steering Committee

The Technical Steering Committee met five times over the nine-month study period and included representatives of Federal, State, and local agencies:

NCDOT

Frank Vick, PE	Feasibility Studies
Derrick Lewis, PE	Feasibility Studies
Roger Thomas, PE	Roadway Design
Terry Arellano, PE	Statewide Planning
Joseph Springer, PE	Statewide Planning
James Dunlop, PE	Congestion Management
Theresa Ellerby	Project Development & Environmental Analysis
Larry Gordon, PE	Division 10

Federal Highway Administration

Chris Gatchell, PE	Area Engineer

Town of Mooresville

Erskine Smith, Jr.	Assistant Town Manager

Mecklenburg/Union MPO

Tim Gibbs, AICP	Charlotte Area Transit System
Bill Finger, PE	Charlotte Department of Transportation
Bill Coxe	Town of Huntersville
Danny Rogers, PE	Charlotte-Mecklenburg Planning Commission

1.5 The Need for Congestion Management

Over the last ten years, the I-77 corridor has undergone significant change. Because of the corridor's proximity to Lake Norman and direct regional access via I-77 to several northern towns, the corridor has experienced tremendous growth in population and employment. I-77 has grown from a relatively non-congested freeway to one of the busiest roads in North Carolina.

Travel delays in the Charlotte region have increased and are projected to continue to grow. According to a recent study by the Texas Transportation Institute, Charlotte ranks 29th nationally in annual delay per person in a study of 68 urban areas in the United States.

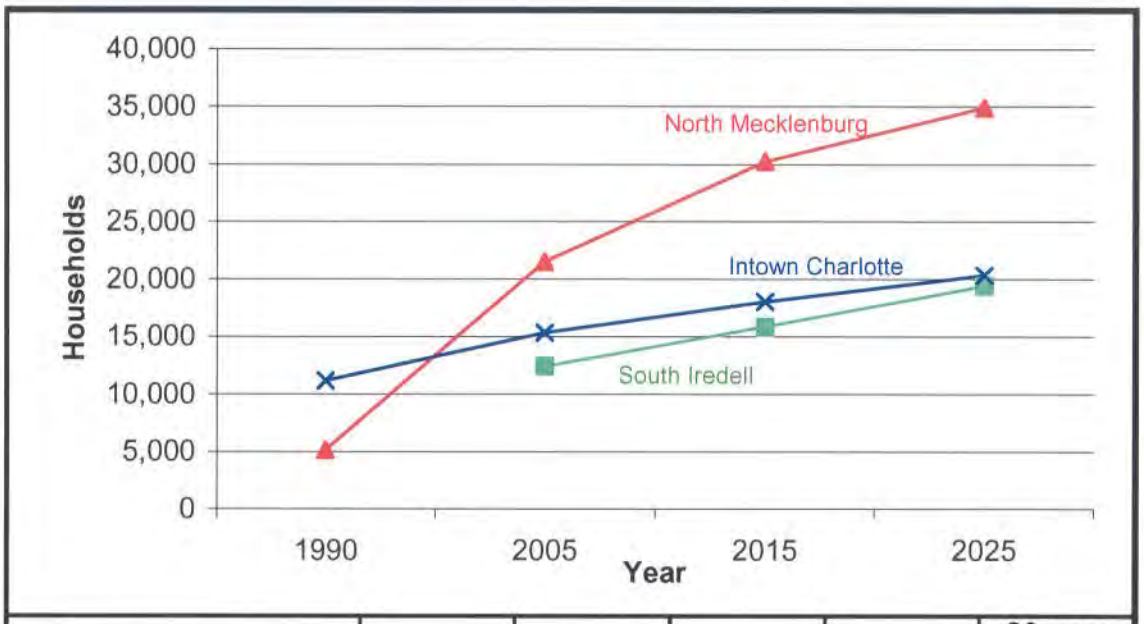
The projected number of households in the I-77 north corridor will increase by over 50 percent between 2005 and 2025, as illustrated by **Figure 1-2**. During this same 20-year period, employment in the I-77 north corridor is expected to increase by 47 percent, as illustrated in **Figure 1-3**.

The I-77 corridor between Charlotte and Mooresville is one of the five major transportation and development corridors identified in the *Centers and Corridors Plan*. The *2025 Charlotte-Mecklenburg Integrated Transit/Land Use Plan* included transportation and land use recommendations for the portion of the I-77 corridor in Mecklenburg County. The land use portion of the 2025 Plan plays a critical role in developing options to solo commuting. While land use planning cannot dictate use of alternative transportation modes, it can provide a framework that makes these other modes more successful. Integrated transportation and land use planning can encourage an environment where activities and centers of interest are closely located and easily accessed.

No urban area has succeeded in curbing congestion with a roads-only strategy. New highway capacity generally only provides short-term relief – within three years or so, roads are again close to full capacity because new growth shifts to the improved corridors and commuters shift their travel back to the peak hour. Highway widening is a finite activity because of limited availability of land and significant negative impacts on adjoining homes or businesses.

There is a growing awareness in the Charlotte region that new approaches are needed to manage congestion. Residents of the region are beginning to understand that alternative transportation modes such as HOV lanes, light rail transit, or bus rapid transit provide reliable travel times as demand grows, in stark contrast to ever lengthening auto commute times as highway lanes become filled.

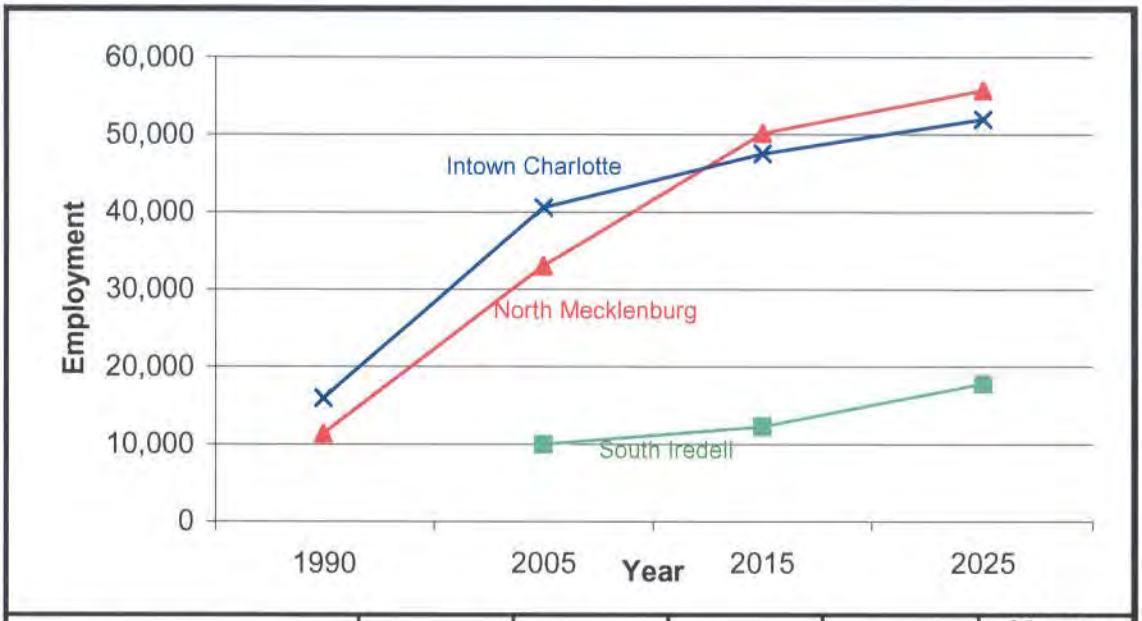
FIGURE 1-2. Population Growth Forecasts for the I-77 North Corridor



Market Segment	1990	2005	2015	2025	20-year increase
South Iredell		12,400	15,800	19,400	56%
North Mecklenburg	5,100	21,500	30,200	34,900	62%
Intown Charlotte	11,100	15,300	18,000	20,300	33%
Total North Corridor		49,200	64,000	74,500	51%

Source: ULI Advisory Services Report for the North Corridor, April 22-27, 2001

FIGURE 1-3. Employment Growth Forecasts for the I-77 North Corridor



Market Segment	1990	2005	2015	2025	20-year increase
South Iredell		9,900	12,200	17,800	80%
North Mecklenburg	11,300	33,000	50,100	55,700	69%
Intown Charlotte	15,900	40,500	47,500	51,900	28%
Total North Corridor		83,400	109,800	122,400	47%

Source: ULI Advisory Services Report for the North Corridor, April 22-27, 2001

2.0 REVIEW OF PREVIOUS STUDIES

2.1 Section Overview

This section reviews five previous planning efforts that are pertinent to the I-77 Sub-area Study and outlines additional developments and issues applicable to the study.

2.2 NCDOT Proposals to Relieve Congestion along the I-77 Corridor

In November 2000, the North Carolina Department of Transportation (NCDOT) initiated a planning effort designed to quickly develop proposals for improving travel conditions along I-77 and parallel roadways from Charlotte to Statesville. The department also created a web site designed to obtain input from the public. The study focused on highway improvements to address peak-hour congestion along I-77 because transit planning efforts were already underway in the corridor. NCDOT assembled a team composed of State personnel and transportation professionals from the Mecklenburg – Union Metropolitan Planning Organization (MUMPO) to perform the study.

The study team prioritized fifty potential improvements to the highway system, grouping the projects in three categories: short-term, mid-term, or long-term. All projects are either non-funded or need additional funding to accelerate their implementation.

The I-77 Sub-area Study was the number 1 priority on NCDOT's list of fifty projects when the draft report was released on December 27, 2000. The Sub-area Study reflects many of the NCDOT proposals to relieve congestion in its recommended projects, particularly in the areas of TSM and interchange improvements.

2.3 Metrolina ITS Strategic Deployment Plan

In 2001, NCDOT completed a *Statewide ITS Strategic Deployment Plan* to guide the future implementation of ITS technologies throughout North Carolina. The Metrolina Plan represents one of nine regional reports composing the Statewide Plan. Each of the independent but coordinated plans relied on input from over 1,500 stakeholders who have important influence on the State's transportation system. The Metrolina Plan reflects issues identified in previously-developed ITS area plans as well as multi-modal plans of local agencies.

The Metrolina ITS Plan concluded that this region, including Mecklenburg and Iredell Counties, has a very aggressive ITS deployment strategy over the next few years, including numerous projects that are in the State Transportation Improvement Program (STIP). By building upon ITS projects that are already in planning or design, the Metrolina Plan identified both short-term and long-term improvements for the five-county region. These projects meet the most urgent issues raised by Metrolina stakeholders that include traffic control, public transit management, archived data function, and pre-trip travel information. The I-77 Sub-area Study reflects consideration of the Metrolina ITS Plan recommendations.

2.4 Regional Transportation Infrastructure Inventory

The Centralina Council of Governments produced this report for the Business Community for Regional Transportation Solutions (BCRTS). The report, completed in January 2000, serves as

a sourcebook that identifies roads of significant importance, the road-building process for the region, and ongoing, planned (funded and non-funded) projects. Projects in the infrastructure inventory relevant to the study corridor are shown in **Table 2-1.**

TABLE 2-1. Projects Relevant to I-77 Corridor

PROJECT	PROJECT LIMITS	DESCRIPTION
I-77	I-85 to NC-73	Construct additional lanes.
I-485	Charlotte western outer loop, west of I-77 to I-85 north.	Construct freeway on a new location.

2.5 2025 Integrated Transit/Land Use Plan

This study, completed in October 1998, identified I-77 as one of the five major transportation corridors in the Charlotte region. After careful evaluation of bus options and rail alternatives, the study recommended both commuter rail and Bus Rapid Transit (BRT) for further investigation in this corridor.

According to the *2025 Integrated Transit/Land Use Plan*, commuter rail service would operate along the Norfolk Southern "O" line from Davidson to Center City Charlotte. BRT service would travel along Statesville Avenue between the Center City and I-85 and then use the outside shoulders on I-77 from just north of I-85 (Cindy Lane) to Exit 28 (Catawba Avenue). The shoulders would be widened and strengthened for use by buses during peak hours when congestion is most severe.

2.6 2020 Transportation Plan

On April 7, 1999, the MUMPO adopted the *2020 Transportation Plan,* a multi-modal plan with a twenty-year planning horizon, covering both Mecklenburg and northwest Union Counties. This plan meets the requirements of the Transportation Equity Act for the 21st Century (TEA-21) enacted on June 9, 1998.

The *2020 Transportation Plan* includes a priority list of non-funded roadway projects in the study area. The recommendations of the I-77 Sub-area Study include the highway and HOV projects proposed in the 2020 Plan. In particular, the implementation of HOV lanes within the I-77 sub-area is highly ranked among the 83 projects on MUMPO's financially constrained priority list:

- Priority #12: I-85 to NC-73
- Priority #13: I-277 (John Belk Freeway) to I-85
- Priority #30b: NC-73 to Iredell County line

2.7 North Corridor Major Investment Study

In May 2000, the Charlotte Area Transit System (CATS) began work on a Major Investment Study (MIS) in conjunction with the development of an integrated transit/land use plan for the North Corridor. The study limits of the MIS, from Charlotte to Mooresville, are identical to those for the I-77 Sub-area Study. Section 5-3 of this report reviews the rapid transit alternatives being considered for the North, or I-77, Corridor.

3.0 I-77 FUNCTIONS AND IMPROVEMENT GUIDELINES

3.1 Section Overview

I-77, as part of the country's Interstate Highway System, is a major transportation facility from numerous perspectives --- national, state, regional, and county. This section reviews I-77's primary functions. It also provides guidelines for future improvements to this freeway.

3.2 Functions

I-77 serves several functions as a major transportation artery in Mecklenburg and Iredell Counties.

3.2.1 Interstate Travel

Tourist Travel

I-77 is a major north-south interstate route that begins in Cleveland, Ohio and ends in Columbia, South Carolina. This interstate is one of the few north-south routes through the Appalachian Mountains. I-77 intersects several important east-west interstates including I-80/90 in northern Ohio, I-64, I-81, I-40, I-85 (in Charlotte) and I-20 in Columbia, South Carolina. I-77 provides access from West Virginia, southwestern Virginia, and the northern portion of the North Carolina Piedmont to Charlotte.

Freight Transportation

The Charlotte region comprises the sixth largest wholesale center in the country with annual wholesale volumes exceeding $30 billion. Charlotte's success as a major distribution center relies upon a supporting transportation network of highways, railroads, and an airport that provides convenient access to other markets.

I-77 is a key component of the City of Charlotte's adopted truck network. This network supports the trucking industry, one of Charlotte's major industries. Over 300 trucking companies employing approximately 45,000 persons are located in the Charlotte region. The area near I-77's interchange with Sunset Road is the site of numerous trucking terminals while the I-77/Harris Boulevard interchange is close to several major industrial parks. Based on vehicle classification counts performed in 2001, approximately 5 percent of the vehicles using I-77 during the peak hours are trucks.

3.2.2 Emergency Evacuation

I-77 serves as the primary evacuation route for Duke Power's McGuire Nuclear Station. This station is located on NC-73, west of I-77, in the Lake Norman area of Huntersville.

3.2.3 Commuting to Charlotte

Over the past ten years, the I-77 North Corridor has undergone significant change. As discussed in Section 1.5, the corridor's population has increased by 33 percent, from 62,000 persons in 1990 to 83,000 residents in 2000. The I-77 Corridor has emerged as one of the Charlotte region's strongest residential markets during the past five to seven years.

Growth in peak hour traffic volumes along I-77 North and parallel roadways has prompted CATS to expand express bus services in the corridor. CATS has increased service on Route 77X, North Mecklenburg Express, on several occasions in the past three years and added a new express service, Route 83X, to Mooresville on October 29, 2001. As mentioned in Section 2.7, CATS also is analyzing rapid transit options in the I-77 north corridor, including commuter rail service on the NS "O" line and BRT operations along I-77.

3.2.4 Local Travel

Following the rooftops, retail development in the I-77 North corridor has been strong over the past several years. Shopping center development has occurred almost exclusively along I-77, and the corridor's emergence as a regional retail center will be strengthened by the development of Northlake Mall at I-77 and Reames Road.

I-77 access and the abundance of affluent households around Lake Norman and in north Mecklenburg County have facilitated the beginning of an office core along I-77. Office tenants being attracted to the I-77 North corridor include some that are new to the Charlotte market and others that have relocated from Uptown Charlotte and other sub-markets.

The aforementioned growth in retail and office development, occurring primarily along I-77, has resulted in more use of the freeway for local travel demand. Projected growth near existing and proposed I-77 interchanges over the next ten years will create greater demand for local access, with I-77, US-21, and NC-115 being the primary roadways to serve this function.

3.3 Guidelines for I-77 Improvements

As discussed in the previous sections, I-77 should be regarded as a key component of the region's Interstate Highway System. It is a primary route for emergency evacuation for McGuire Nuclear Station and should be designed to allow high speed, high volume traffic movements facilitating interstate and regional commerce, specifically long distance trips. Improvements to I-77 within the Mecklenburg–south Iredell sub-area also should be consistent with programmed or anticipated I-77 improvements beyond the study area.

The following should guide future improvements to I-77:

- The maximum number of general-purpose lanes on I-77 within the study area (from I-85 to NC-150) will be eight lanes. There could be a need to provide auxiliary lanes between consecutive ramps of interchanges in addition to the eight general-purpose lanes.
- The median or inside shoulders of I-77 should be strengthened and designed to permit future HOV lane operation (either concurrent flow HOV lanes or a two-lane reversible HOV facility).
- Additional access points to I-77 within the study area should only be provided for buses and other high occupancy vehicles. This excludes new interchanges or modifications to existing interchanges that are already programmed in the *2002-2008 STIP*.
- New non-freeway structures or modifications to existing non-freeway bridges over I-77 will be designed to accommodate pedestrian and bicycle travel.
- Outside shoulders along I-77 will be strengthened and designed to permit bus only operations during peak hours.

4.0 HIGH OCCUPANCY VEHICLE LANES

4.1 Section Overview

A task of the I-77 Sub-area Study the involved development of a strategic plan to add high occupancy vehicle (HOV) lanes on I-77. As mentioned in Section 2.6, MUMPO ranked the implementation of HOV lanes on I-77 as high-priority in the *2020 Transportation Plan*. At NCDOT's request, the I-77 Sub-area Study included analysis of incorporating HOV lanes as part of the current I-77 widening project (NCDOT project I-3311A). This study also addressed short and long-term options for extending HOV lanes between I-85 and Center City Charlotte.

4.2 HOV Facility Descriptions

Various HOV lane treatments were considered for the I-77 north corridor. These included concurrent-flow and reversible HOV lanes. Contra-flow lanes (reversing flow on a lane in the opposite direction of travel during peak periods) were not considered viable for this corridor, as they typically provide benefits when there are major constraints on freeway widening. HOV design enhancements such as queue by-pass lane and T-ramps were studied as means to provide even greater timesaving for HOV users.

4.2.1 Concurrent Flow Facilities

A concurrent flow HOV lane can be described as a freeway lane in the same direction of travel, not physically separated from the general-purpose traffic lanes, designated for the exclusive use by HOVs for all or a portion of the day. Concurrent flow lanes are usually (though not always) located on the inside lane or shoulder and are usually open to buses, vanpools, and carpools. Paint striping is the most common means used to delineate these lanes in the form of two general types:

Non-buffer separated HOV lane

Buffer separated

With this treatment, the HOV lane is separated from adjacent freeway lanes with a designated buffer width of one foot or more. A four-foot wide median is very common. Ingress and egress to the HOV lane can occur by driving across the barrier at designated access points or by crossing the buffer at random locations.

Non-buffer separated

With this treatment, the HOV and mixed-use traffic are separated by a single solid or broken-line stripe. In most cases, HOV traffic is allowed to freely cross the stripe either into or out of the HOV lane, eliminating the need for specific ingress and egress points.

Buffer separated HOV lane

Studies on the advantages and disadvantages of buffer separated and non-buffer separated facilities have yielded varying results. Buffer separation removes HOV traffic from congested mainline traffic,

but potentially concentrates lane changes if ingress and egress points are formed. Buffer separated facilities have enforcement advantages. Of course, a wider buffer requires greater pavement width and/or right-of-way.

4.2.2 Reversible HOV Facilities

Reversible HOV facility

The other type of exclusive HOV treatment is a reversible lane. This approach involves a lane or lanes within the freeway right-of-way that are physically separated from the general-purpose freeway lanes (typically in the median) and are used exclusively by HOVs for all or a portion of the day. Reversible HOV lanes, which are separated from the general-purpose lanes by concrete barriers, are usually open to buses, vanpools and carpools. Exclusive reversible HOV facilities usually operate inbound toward the central business district (CBD) or other major activity center in the morning and outbound in the afternoon. Some type of daily set up is required with reversible facilities.

4.2.3 T-Ramps

T-ramps allow the HOV user to access the HOV facility on the inside (median) of a freeway facility, eliminating a weave across general-purpose lanes of traffic in a concurrent flow lane facility. T-ramps provide particular benefits to transit vehicles, as buses have a more difficult time in weaving from right access ramps to inside median HOV lanes in a concurrent flow system. In a barrier-separated system, T-ramps provide greater access control into the HOV facility and minimize the number of HOV access weaves with mainline freeway lanes. T-ramps at non-interchange, cross-streets also draw HOV users away from congested interchange roadways without overburdening the cross street. T-ramp locations are typically good locations to consider park and ride lot opportunities.

T-Ramp Access to Cross Street

Ramp queue by-pass lane

4.2.4 Queue Bypass Lanes

Another enhancement to HOV use is a queue bypass lane. HOV queue bypasses are short designated lanes that bypass a point-specific bottleneck. On an arterial, the bottleneck might be a congested traffic signal. On a freeway, queue bypasses are used at metered freeway entrance ramps and toll plazas. The potential benefits for queue bypasses cannot be underestimated. Queue bypass lanes are also common for providing transit priority, at locations such as signalized intersections or ramp-metered freeway access locations. Another form of a queue bypass is a median flyover connection from freeway to freeway, providing HOV users a timesaving advantage over right side freeway ramps.

4.3 Justification for HOV Lanes

Current industry rules-of-thumb regarding the implementation of new HOV facilities suggest that HOV lanes are suitable for implementation when lane utilization is estimated to be between 400-800 vehicles per hour per lane (vphpl) during the peak hours of expected usage (NCHRP Report 414, 1998). Where new facilities are being considered in areas with little or no previous experience with HOV designated lanes, it is strongly recommended that HOV lanes be selected for implementation only when demand estimates are in the higher end of the recommended utilization range, to avoid "empty lane syndrome".

For the I-77 Sub-area Study, these rules of thumb for the operation and planning of successful HOV facilities were accepted by the Executive Committee to apply towards effective HOV design for the I-77 corridor. These criteria are based on the experience of the Federal Highway Administration (FHWA) and numerous DOTs from across the nation, and include:

- There typically must be six or more general-purpose lanes in the corridor.
- Users must save five or more minutes per average commute trip in the HOV lane.
- There must be at least 500 HOVs per hour per lane during peak periods in the opening year (to avoid the "empty lane" syndrome which can lead to criticism from motorists sitting in congested traffic in the adjacent lanes).
- There must be 750 HOVs per hour per lane during peak periods in the design year in the peak direction.
- There should be the potential for express transit in the HOV lanes.
- It must be physically feasible to add HOV lanes within the available right-of-way.
- The minimum length of HOV lane operation in the corridor would be approximately six miles.

4.4 I-77 HOV Demand Analysis

Estimation of future HOV demand in the I-77 corridor was developed using volume and vehicle-occupancy data collected in the field, future regional model volume forecasts, and a planning model developed for HOV volume forecasts based on congestion and time savings in a corridor.

4.4.1 Data Collection

Traffic volume estimates for the I-77 corridor were estimated based on collected and historic traffic volumes. NCDOT provided both existing year volumes and future traffic projections based on linear growth models. CDOT provided results from its 2025 regional model that included capital improvements from the urban area's long-range transportation plan. In order to verify current count data, NCDOT's Metrolina Regional Transportation Management Center (MRTMC) collected volume data at two locations on I-77, including information on hourly volumes and directional splits.

4.4.2 Vehicle Occupancy Rates

Existing peak hour vehicle occupancy rates were collected in the field at two locations and averaged over a three-day period to represent typical commuting conditions in the corridor. The counts included truck and transit vehicle percentages and classified HOV observations into two

categories - vehicles with two persons and vehicles with three or more persons. I-77 peak hour vehicle-occupancy rates are shown in **Table 3-1**.

TABLE 3-1. Observed Vehicle Occupancy Rates in I-77 Corridor

Vehicle Occupancy Rate (VOR) Count Location	%2-person carpools observed	%3+ person carpools observed	%Trucks observed	%Bus observed
I-77 at LaSalle AM Peak (SB)	8.2	1.1	4.9	0.2
I-77 at LaSalle PM Peak (NB)	13.2	2.2	4.5	0.3
I-77 at Harris Blvd AM Peak (SB)	7.9	1.1	5.6	0.2
I-77 at Harris Blvd PM Peak (NB)	8.8	1.0	4.1	0.2

Source: Parsons Brinckerhoff

4.4.3 Segment Analysis

The I-77 north corridor, extending between Brookshire Freeway (Exit 11) and Gilead Road (Exit 23), was divided into six sections between the major interchanges. Corridor sections included:

- Brookshire Freeway to LaSalle Street
- LaSalle Street to I-85 (Exit 13)
- I-85 to Sunset Road (Exit 16)
- Sunset Road to Harris Blvd (Exit 18)
- Harris Blvd to I-485 (Exit 20)
- I-485 to Gilead Road (Exit 23)

4.4.4 HOV Lane Use Estimate Methodology

For each of these sections, an HOV percentage was estimated using the FHWA/Charles River Associates (CRA) "Methodology for Predicting Volume for HOV Priority". This methodology uses readily available traffic data to estimate modal changes resulting from implementing new HOV facilities. It is a sketch-modeling tool based on quantitative review of the before-and-after studies of several HOV facilities. This methodology can determine peak hour flows for mixed traffic lanes, existing HOVs, new HOVs and bus passengers on the HOV facility.

In analyzing HOV lane use for the I-77 corridor, it was assumed that the HOV lanes would be open to vehicles with two or more occupants. After an initial screening of the volume occupancy data showed only a small percentage of vehicles had three or more persons and because HOV is new to the I-77 corridor, it was assumed that 2+ HOVs would use the proposed facility. It was also assumed that the HOV lanes would be connected to the Center City between I-85 and the Brookshire Freeway.

4.4.5 Volume Estimates

Opening Year HOV Estimates (2005)

Estimates for opening year conditions were developed assuming that there are four general-purpose lanes and one concurrent-flow HOV lane south of I-85 to the Brookshire Freeway, and three general-purpose lanes plus one concurrent-flow HOV lane between I-85 and I-485. The speed limit for the HOV lanes would be identical to the general-purpose lanes.

The assumption of concurrent-flow HOV lanes implies that there would be friction between the HOVs and the general-purpose lanes once the facility is implemented. Actual speeds on the HOV lanes could be up to 20 mph higher than the speeds projected for the general-purpose lanes. If barrier separated HOV lanes were assumed, the expected speed on the HOV lanes should be equal to the speed limit. **Table 3-2** summarizes HOV volumes for 2005.

TABLE 3-2. 2005 HOV Volume Projections for I-77 North

Segment	AM Peak Hour Volumes				PM Peak Hour Volumes			
	Peak Direction (SB)		Off-Peak Direction		Peak Direction (NB)		Off-Peak Direction	
	Fwy Vol	HOV Vol	Fwy Vol	HOV Vol	Fwy Vol	HOV Vol	Fwy Vol	HOV Vol
Brookshire Fwy to LaSalle Street	8,570	**690**	5,710	**610**	8,570	**1,000**	5,710	**640**
LaSalle Street to I-85 (Exit 13)	8,570	**690**	5,710	**610**	8,570	**1,000**	5,710	**640**
I-85 to Sunset Road (Exit 16)	5,970	**900**	3,980	180	5,970	930	3,980	270
Sunset to Harris Blvd (Exit 18)	4,950	430	3,300	140	4,950	460	3,300	220
Harris Blvd to I-485 (Exit 20)	4,800	380	3,190	200	4,800	400	3,190	210
I-485 to Gilead Road (Exit 23)	4,800	380	3,190	200	4,800	400	3,190	210

Note: **Bold** numbers indicate HOV volumes within recommended range for successful operations.

Design-Year HOV Estimates (2010)

The same methodology used for year 2005 estimates was employed to generate year 2010 HOV demand estimates for the six corridor sections. The year 2010 was selected as the "design year" for HOV operations, as HOV lane use takes time to grow through encouraged carpool, vanpool and transit use. Successful HOV projects surpass an equilibrium point by the design year, where the HOV lane(s) move more *persons* per hour that the comparable general-purpose lanes (usually reached at 500-700 vph in the HOV lane).

Year 2010 average daily traffic (ADT) volumes (developed from the regional traffic model projections) were used to estimate future year HOV volumes. The same lane configuration of three general-purpose lanes and one concurrent flow HOV lane in each direction was assumed. Truck percentages, speed limit, and transit assumptions were unchanged from the 2005 analysis. **Table 3-3** indicates the year 2010 HOV demand results.

TABLE 3-3. 2010 HOV Volume Projections for I-77 North

Segment	AM Peak Hour Volumes				PM Peak Hour Volumes			
	Peak Direction (SB)		Off-Peak Direction		Peak Direction (NB)		Off-Peak Direction	
	Fwy Vol	HOV Vol	Fwy Vol	HOV Vol	Fwy Vol	HOV Vol	Fwy Vol	HOV Vol
Brookshire Fwy to LaSalle Street	9,540	**970**	6,360	**620**	9,540	**1,250**	6,360	**650**
LaSalle Street to I-85 (Exit 13)	9,540	**970**	6,360	**620**	9,540	**1,250**	6,360	**650**
I-85 to Sunset Road (Exit 16)	7,340	**950**	4,900	340	7,340	**1,000**	4,900	410
Sunset to Harris Blvd (Exit 18)	6,780	**760**	4,520	200	6,780	**800**	4,520	260
Harris Blvd to I-485 (Exit 20)	6,890	**770**	4,600	200	6,890	**810**	4,600	270
I-485 to Gilead Road (Exit 23)	6,890	**770**	4,600	200	6,890	**810**	4,600	270

Note: **Bold** numbers indicate HOV volumes within recommended range for successful operations.

4.5 I-77 HOV Plan Recommendations

4.5.1 HOV as Part of I-3311A

NCDOT has programmed the I-77 north corridor for widening from four to eight lanes as a design-build project (Project I-3311A) beginning in spring 2002. The limits of construction for the nine-mile widening project are from I-77's interchange with I-85 (Exit 13) north to the future I-485 interchange, terminating one mile south of the Gilead Road interchange (Exit 23). This sub-area study included a feasibility and operations analysis of including HOV lanes as the inside (median) lanes of construction, leaving three general-purpose plus one HOV lane in each direction.

4.5.2 HOV Lanes from I-85 to Center City

Because preliminary HOV volume projections for I-77 HOV lanes that terminated at the I-85 interchange – ending approximately two miles from Center City Charlotte – were below peak hour threshold volumes, the feasibility of implementing HOV lanes from I-85 to Center City Charlotte was studied. Section 3.4 presents the results of the HOV demand analysis for the extended corridor. Because this section of I-77 is not part of the I-3311A project, any improvements would require additional funding. The sub-area study identified both an interim design – adding an HOV lane using the existing inside shoulder and narrowing lanes – as well as a HOV system plan, to include a single or dual concurrent or reversible HOV lane segment in the median between I-85 and Uptown Charlotte.

4.5.3 Phase I – Interim HOV Plan

Figures 4-1 and 4-2 show the concept for extending an I-77 HOV facility from I-85 to Brookshire Freeway. These improvements would be undertaken in conjunction with I-3311A in order to maximize use of the I-77 HOV lanes north of I-85.

Southbound I-77

- From the northern I-3311A project limits to I-85, designate inside (4th) lane on I-77 southbound for HOV-2, providing a typical section of three general-purpose lanes plus one HOV lane for a distance of 7.5 miles. The HOV lane would be non-buffer separated (8-inch white line).
- Construct new southbound exclusive HOV roadway between the I-77 south off ramp to southbound I-85 and the I-77 south bridge over I-77 north. This includes:
  - Construct new bridge on the I-85 south ramp to I-77 south (ramp re-constructed as part of I-3311A project) allowing HOV roadway to pass under this ramp.
  - Construct new bridge over I-85 east of I-77 south mainline for exclusive HOV use.
  - Reduce lane width and/or use bridge shoulder to include a concurrent HOV lane on I-77 south bridge over I-77 north (no bridge reconstruction required).
- Add southbound concurrent flow HOV lane between I-85 and the Brookshire Freeway (HOV lane ends ¼ mile beyond I-77 southbound off-ramp to Brookshire) by resurfacing, narrowing lanes and reducing the inside shoulder width. No widening of the mainline is required. The outside breakdown shoulder is held at 10 feet throughout the design.
- Extension of the HOV system south from I-85 through the Brookshire Freeway provides another 2.5 miles of HOV lane, resulting in a total southbound HOV system length of 10 miles.

Northbound I-77

- From I-85 to approximately 1.5 miles south of the northern I-3311A project terminus, designate inside 4th lane on I-77 northbound for HOV-2. The typical section will be three general-purpose lanes plus one HOV lane from I-85 through the future I-485 interchange, a distance of 6.5 miles. The transition from four to two lanes will be the same as shown in the I-3311A design plans except the right lanes will transition to the left, giving priority to HOV lane traffic.

Note: Because the southbound I-77 HOV lane diverges from the mainline at the I-85 interchange, it is recommended that this lane be exclusive to HOV users at all times, rather than being restricted to HOV operations during peak hours. This precludes non-HOV motorists from using the HOV lane during off-peak hours. The northbound HOV lane could be operated during peak hours only, improving the left merge from I-85 northbound at its interchange with I-77 and the merging of traffic at the terminus of I-3311A where northbound lanes are reduced.

4.5.4 Phase II – Mid-Range System Improvements

Figure 4-3 illustrates a mid-range improvement that involves construction of a reversible HOV connection to Fifth Street. Note that the reversible lane will initially be used only in the southbound direction until Phase III when the northbound HOV lanes could be built between I-85 and Brookshire Freeway.

4.5.5 Phase III – Full System Implementation

Figures 4-4 and 4-5 display the ultimate I-77 HOV system between I-85 and Center City Charlotte. It includes:

- Construct reversible, barrier-separated, dual lane HOV system between I-85 and Brookshire Freeway in the median. This will require widening I-77 to the outside on the east side only and partial reconstruction of the LaSalle and Oaklawn bridges. Included is a reversible flyover to/from the I-85 median, forming a second reversible HOV lane and providing HOV incentives for I-85 traffic. This does not necessitate HOV improvements on I-85 (can operate effectively as an queue bypass for HOV), but it could encourage expansion of the HOV system to I-85.
- Construct the reversible HOV ramp connections to Brookshire Freeway.
- The dual HOV lanes when operating southbound (AM peak) will have three options at the southern HOV terminus: 1) exit to Brookshire Freeway, 2) exit to Fifth Street or 3) merge into I-77 south general-purpose lanes. The dual HOV lanes when northbound (PM peak) will split into single HOV lanes to I-77 north or I-85 north (via the flyover to I-85's median).

4.5.6 HOV Enforcement

Under current State law, violators of HOV facilities are fined $10 plus court costs, typically an additional $90. The fines for HOV lane violations should be re-examined and increased to provide a greater deterrent to improper use. State and local agencies also should look at innovative enforcement programs from other cities that have been successful in minimizing HOV lane abuse. Effective enforcement of HOV lanes (particularly with concurrent flow facilities) is critical element to ensuring the HOV lane success.

FIGURE 4-1. HOV Phase I – I-85 to LaSalle

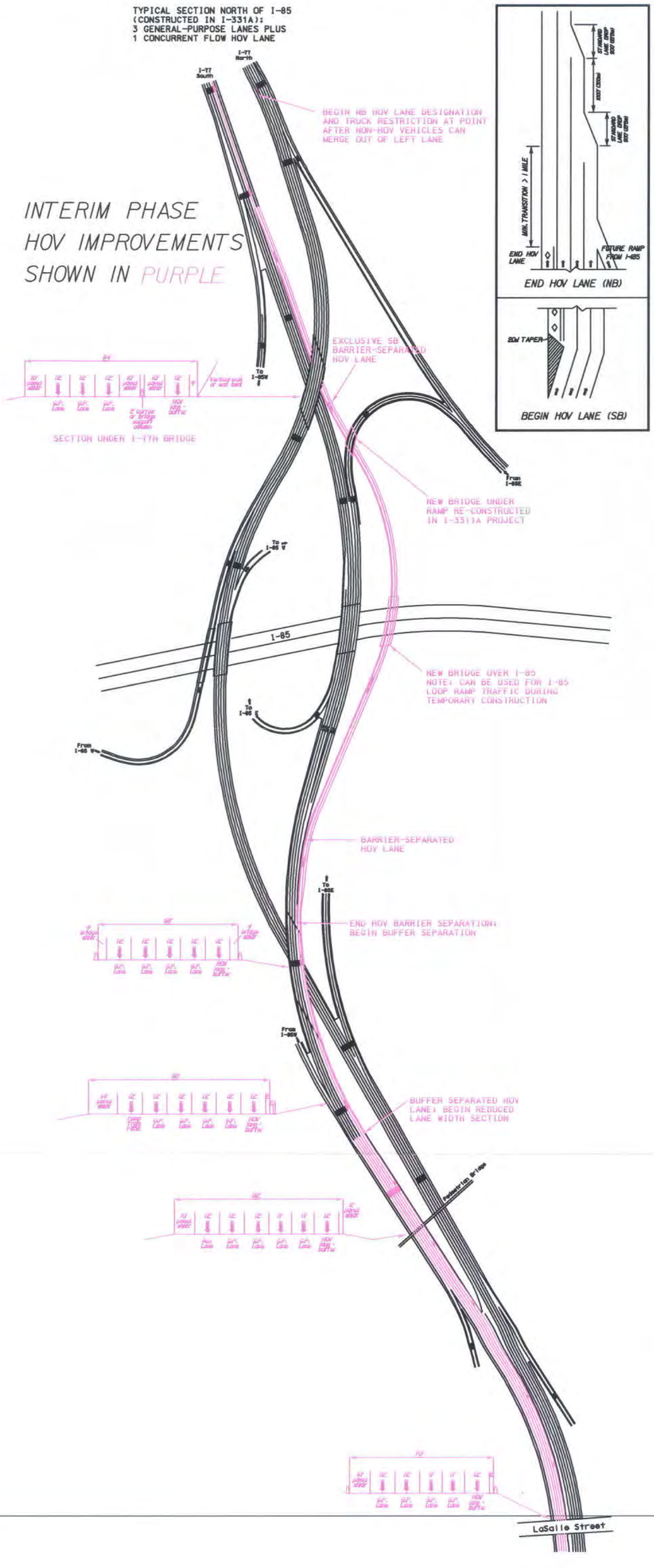


FIGURE 4-2. HOV Phase I – LaSalle to Brookshire

FIGURE 4-3. HOV Phase II – HOV Connection to Fifth

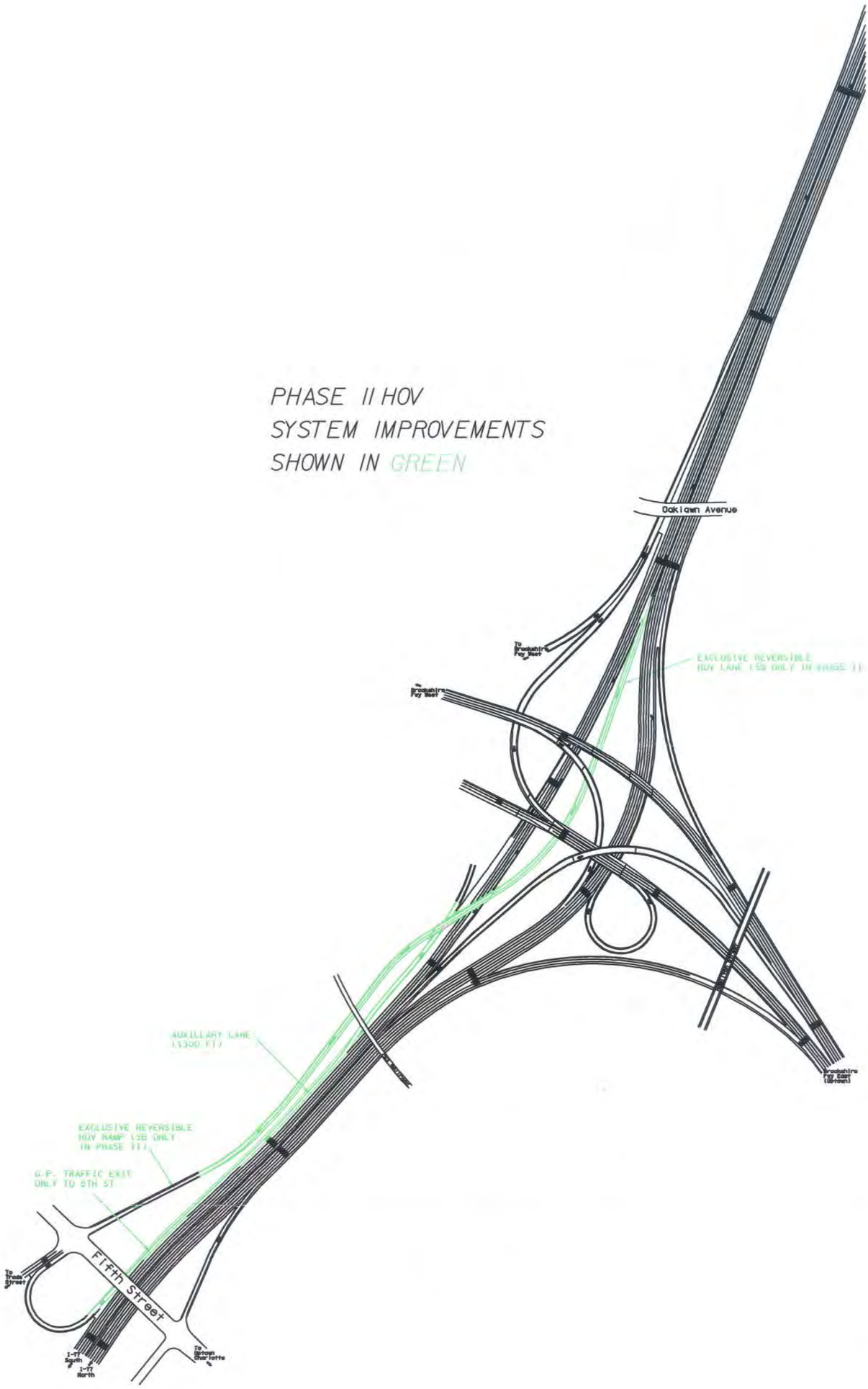


FIGURE 4-4. HOV Phase III – Dual Reversible System, I-85 to LaSalle

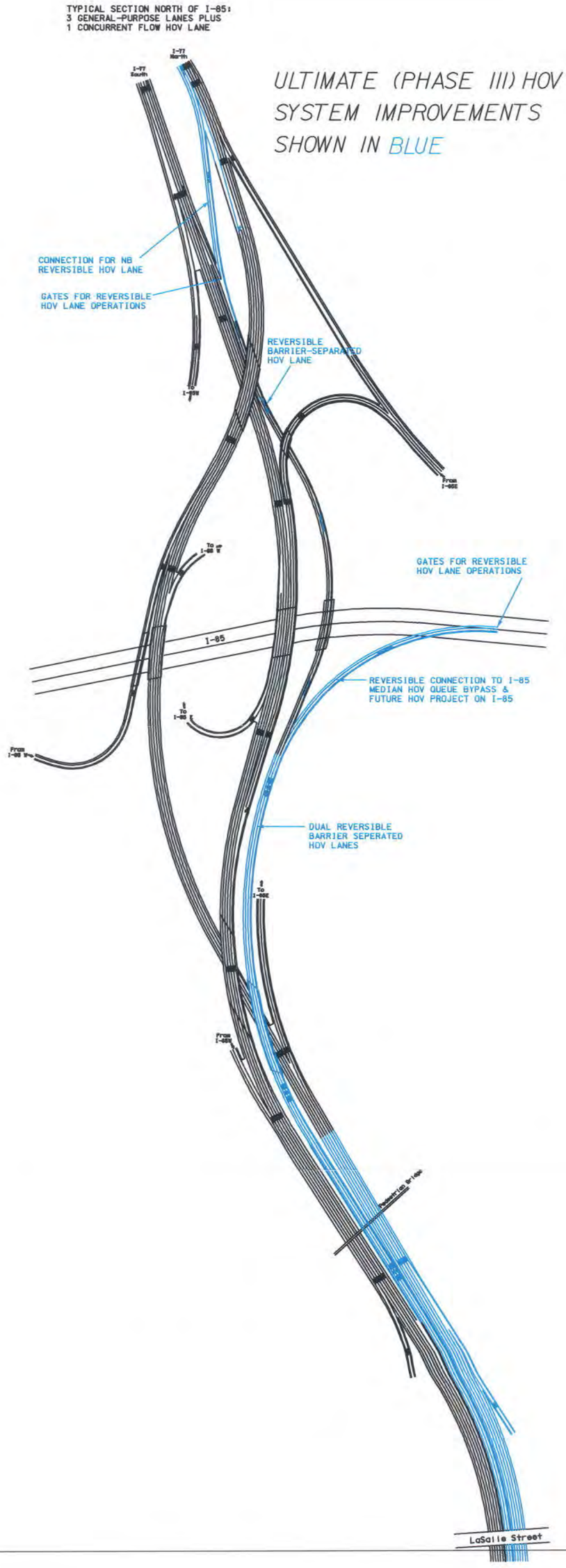
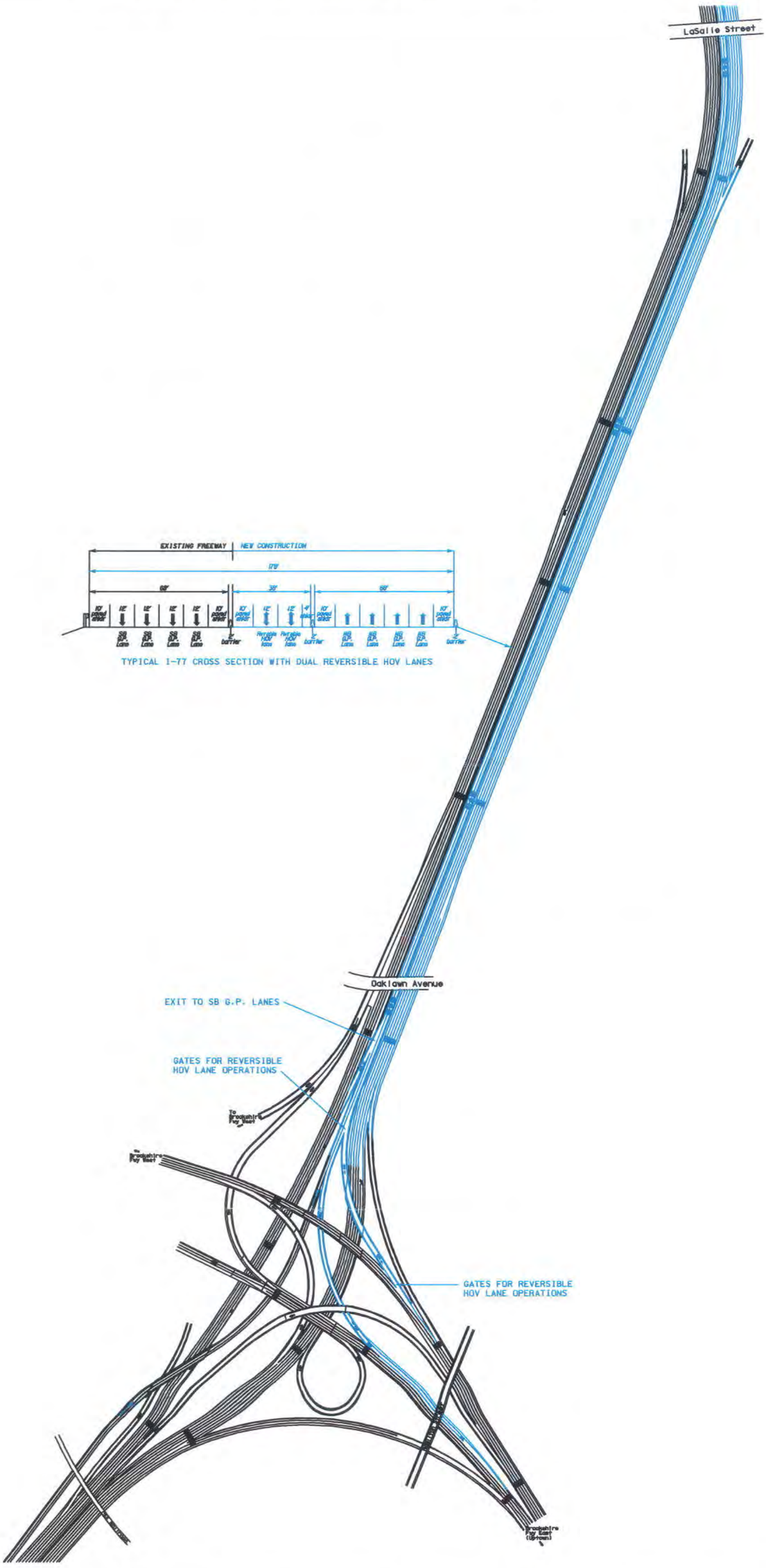


FIGURE 4-5. HOV Phase III – Dual Reversible System, LaSalle to Brookshire



5.0 OTHER RECOMMENDED STRATEGIES

5.1 Section Overview

In addition to HOV lanes, strategies from the following categories are recommended to address existing and future congestion in the I-77 corridor:

- Traditional Capacity Improvements
- ITS
- TSM
- Rapid Transit

This section describes each of these categories and the key findings and recommendations for the I-77 sub-area.

5.2 Traditional Capacity Improvements

5.2.1 What Are Traditional Capacity Improvements?

For purposes of this study, traditional capacity improvements involve both widening existing roadways and construction of new roadways oriented to I-77. It could involve both the construction of roads on new alignment and the widening of existing streets and highways. Interchange improvements and other major projects, such as the widening of a bridge, would be classified as a traditional capacity improvements.

Other elements of traditional capacity improvements are numerous smaller improvements – signal installations, intersection realignments and widening, and safety improvements. These are crucial elements of traditional capacity improvements and must be included. These items are categorized as TSM improvements in this study.

5.2.2 Programmed Improvements

NCDOT and the City of Charlotte have included certain highway improvement projects in the I-77 sub-area in their capital investment programs. Key funded projects include (NCDOT project numbers in parentheses):

- I-77 widening – I-85 to NC-73 (I-3311A & B)
- Catawba Avenue widening – NC-73 (Sam Furr Rd.) to Torrence Chapel Rd. (R-2555)
- Exit 33 Interchange upgrade – US-21 & I-77 (I-4410)
- New Langtree Road/I-77 interchange (I-4411)
- Brawley School Road widening and new I-77 interchange (R-3833)
- Statesville Road widening – Starita Road to Keith Drive (Charlotte CIP)
- Statesville Avenue widening – Newland Road to Hickory Lane (Charlotte CIP)
- NC-115 widening – US-21 to David Cox Road (Charlotte CIP)

NCDOT's Division 12 is scheduled to construct a new two-lane roadway between Gateway Boulevard and Fairview Road, near Exit 33 in Iredell County. This project involves the re-location of Center Church Road.

A private developer will improve two thoroughfares in the I-77 corridor as part of the construction of a regional mall:

- Reames Road/Vance Road widening – I-77 to I-485
- Reames Road extension – Vance Road across I-485

5.2.3 Planned Improvements

Long-range transportation plans for both the MUMPO and Mooresville-South Iredell study areas recommend roadway improvements for I-77 and parallel roadways. The following projects have been identified to provide needed highway capacity in the I-77 corridor:

- I-77 widening to 6 lanes (NC-73 to Iredell County line)
- US-21 widening to 4 lanes (Harris Boulevard to Catawba Avenue)
- NC-115 widening to 4 lanes (David Cox Road to Iredell County line)
- Vance Road widening to 4 lanes (I-485 to Mt. Holly – Huntersville Road)
- Vance Road extension (Mt. Holly – Huntersville Road to NC-73)
- I-77/Catawba Avenue interchange (Exit 28) conversion to an urban diamond

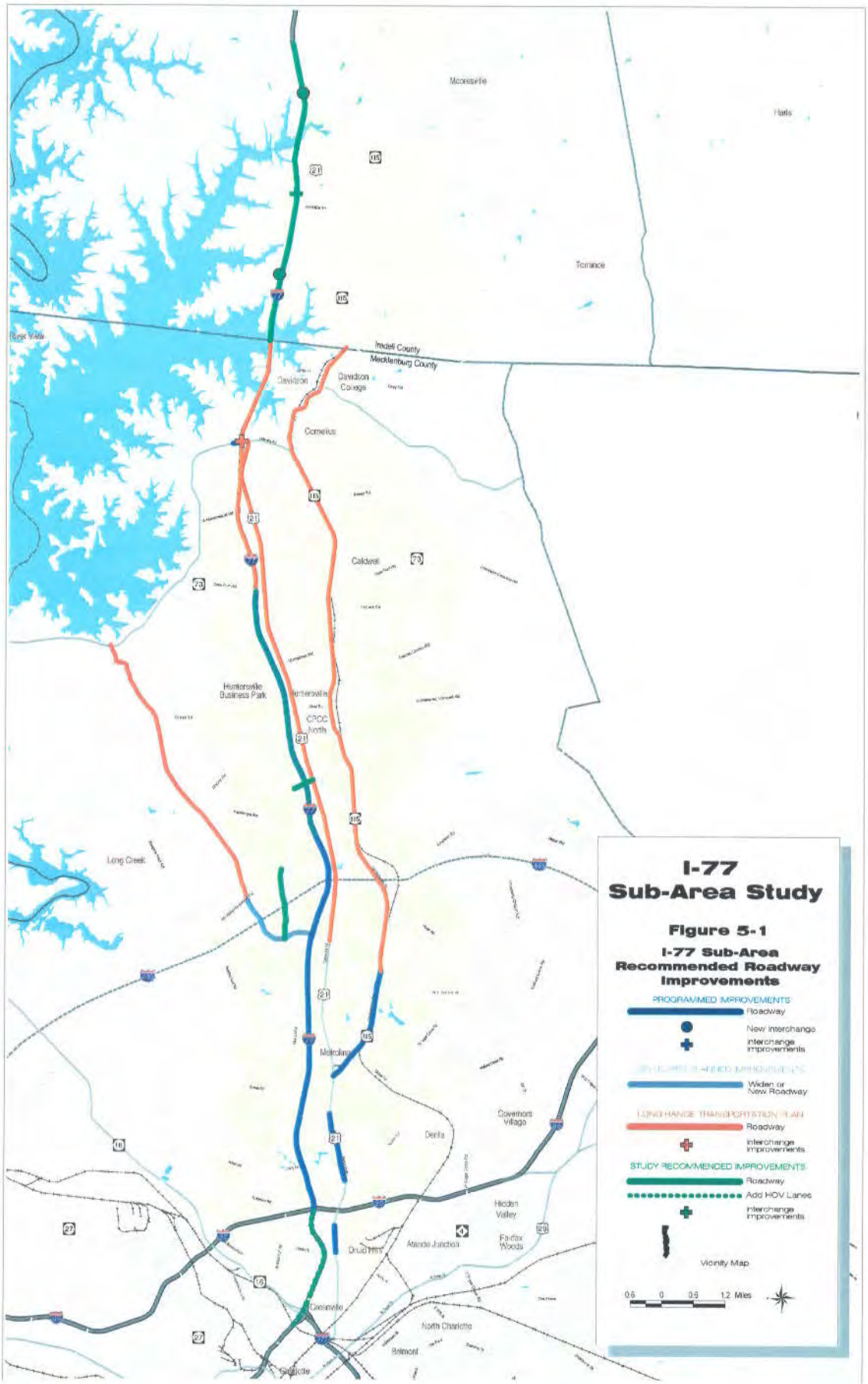
5.2.4 Key Findings and Recommendations

Work during this study has confirmed not only the need for the aforementioned planned capacity improvements but also the need to widen I-77 to eight general-purpose lanes between I-485 and NC-150 in Iredell County. In addition, US-21 should be extended from Catawba Avenue (Exit 28) where it currently ends, across Lake Norman, to Exit 33 at Mount Mourne. These improvements to I-77 and US-21 would result in a need to widen the causeway across the lake.

During work on this study, the following highway and bridge improvements also have been identified to address congestion in this corridor:

- US-21/I-77 interchange (Exit 33) conversion to an urban diamond
- New bridge across I-77 between Alcove and Fairview Roads
- I-77 auxiliary lanes between I-85 and Sunset Road (both sides)
- Verhoeff Drive extension across I-77 from US-21 to Mt. Holly-Huntersville Road
- New bridge across I-77 between US-21 and west side frontage road south of I-77/Catawba Avenue interchange
- Reames Road extension from north of I-485 to Mt. Holly-Huntersville Road

These recommendations are illustrated in **Figure 5-1**.


Mooresville
Harris
Torrance
Iredell County
Mecklenburg County
Davidson
Davidson College
Cornelius
Caldwell
Huntersville Business Park
Huntersville
CPCC North
Long Creek
Mineline
Covenors Village
Derita
Hidden Valley
Fairfax Woods
Druid Hills
Atando Junction
Greenville
North Charlotte
Belmont
I-77
Sub-Area Study
Figure 5-1
I-77 Sub-Area Recommended Roadway Improvements
PROGRAMMED IMPROVEMENTS
Roadway
New Interchange
Interchange Improvements
Widen or New Roadway
LONG RANGE TRANSPORTATION PLAN
Roadway
Interchange Improvements
STUDY RECOMMENDED IMPROVEMENTS
Roadway
Add HOV Lanes
Interchange Improvements
Vicinity Map
0.6 0 0.6 1.2 Miles

5.3 Rapid Transit

5.3.1 The Need for Transit

A public transportation system provides an alternative for communities with limited road expansion possibilities. While public transportation cannot realistically serve all person trips within the Charlotte region, it can compete effectively for market share in many situations.

A major objective of the Charlotte Corridor MIS is to analyze rapid transit technology options that best fit the travel patterns and mobility needs of the corridors and define transit's role in supporting the land use vision of for the region. The characteristics of a particular transit technology affects its ability to serve the various travel markets and trip patterns.

5.3.2 Overview of Charlotte Corridor MISs

The Charlotte Corridors MISs are the culmination of over a decade of land use and transportation planning by local officials and citizens.

In 1994, the City of Charlotte and Mecklenburg County approved the *Centers and Corridors* vision, a comprehensive guide for future land use and development in the region. As part of this plan, future development and redevelopment in the region would be focused along five major transportation corridors that were strong candidates for transit service and transit-oriented development. These recommendations were reaffirmed by MUMPO and included in its *2015 Transportation Plan* for the region.

In support of the *Centers and Corridors* vision, the *2025 Integrated Transit/Land-Use Plan* was completed in 1998. A key element of this plan was the development of a regional rapid transit system that would improve mobility, encourage balanced growth, and support the proposed land use initiatives in each of the region's five growth corridors. A wide range of alternative transit options and land use scenarios were evaluated for each of the five major corridors: South, North, Northeast (University), Southeast (Independent), and West (Airport). In November 1998, Mecklenburg County citizens approved a local sales and use tax (one-half percent) to support implementation of the *2025 Integrated Transit/Land-Use Plan*. In February 1999, Mecklenburg County, the City of Charlotte, and the Towns of Cornelius, Davidson, Huntersville, Matthews, Mint Hill, and Pineville entered into an Interlocal Agreement to plan, finance, and implement a regional transit system, now known as Charlotte Area Transit System (CATS).

During 1999, the City of Charlotte conducted a MIS of potential transit options in the South Corridor. Detailed analyses of ridership, costs, transportation issues, major environmental impacts, and land use issues were completed for the South Corridor transit alternatives identified in the *2025 Integrated Transit/Land-Use Plan*. The results of the MIS analysis reaffirmed the *2025 Plan's* findings. In February 2000, the Metropolitan Transit Commission (MTC) adopted light rail transit operating within the railroad alignment as the Locally Preferred Alternative (LPA) for a new fixed-guideway transit system serving the South Corridor.

In 2000, CATS began MISs in the other four corridors included in the *2025 Plan*. The primary purpose of the MISs is to provide the necessary land use and transportation technical analysis, stakeholder and public outreach, and framing of issues and trade-offs to support MTC selection of a LPA for each corridor. Each corridor MIS also is designed to fulfill the Federal requirements for a MIS under the FHWA/Federal Transit Administration (FTA) Metropolitan Planning

Regulations, particularly for a potential Federal capital funding of any project that may emerge from a MIS. While a National Environmental Policy Act (NEPA) Environmental Assessment (EA) or Environmental Impact Statement (EIS) would not be completed until preliminary engineering of the LPA is undertaken in each corridor, each MIS would initiate the NEPA scoping process, including publication of a Notice of Intent (NOI) in the *Federal Register*. Environmental analysis, conducted as an integral part of the MIS, should support eventual fulfillment of NEPA requirements for a Federally funded project, or one requiring a Federal action, that could emerge from a MIS.

The North Corridor matches the I-77 study area, from Center City Charlotte to Mooresville, approximately 26 miles. The MIS has involved analysis of three rapid transit technologies – commuter rail, light rail transit (LRT), and bus rapid transit (BRT). The MTC will be selecting a LPA for the North Corridor in April or May 2002.

5.3.3 Potential BRT Improvements in the I-77 Corridor

What is BRT?

BRT consists of buses operating in exclusive busways with on-line stations similar to LRT systems, or on roads with improvements to allow buses to bypass traffic congestion. A key attribute of a BRT system is the ability to employ express buses that combine feeder, line-haul and distribution functions. A range of vehicle technologies are available that can be matched to travel demand patterns, air quality and noise concerns.

Exclusive Busway in Ottawa

The typical operating regime consists of a line haul service that operates in both directions in the BRT busway right-of-way stopping at each station just like a rail service. The buses used on this service are usually specially identified articulated or double articulated low floor buses. New technology buses that could be used include hybrid diesel-electric and diesel-trolley buses that are much quieter and produce significantly less pollution than a standard city bus.

BRT Transfer Station (Ottawa)

The BRT stations are served by feeder buses and can include park and ride facilities just like a rail station. The key service difference between BRT and LRT is the ability of the BRT alignment to also accommodate express bus services that serve residential and employment/commercial centers beyond a convenient walking distance of the BRT right-of-way. These bus services travel to and from the BRT alignment on the local road system, enter, and leave the BRT right-of-way via an exclusive bus ramp. Once in the BRT right-of-way, these express buses may operate in a non-stop or limited stop mode to another exclusive ramp where they

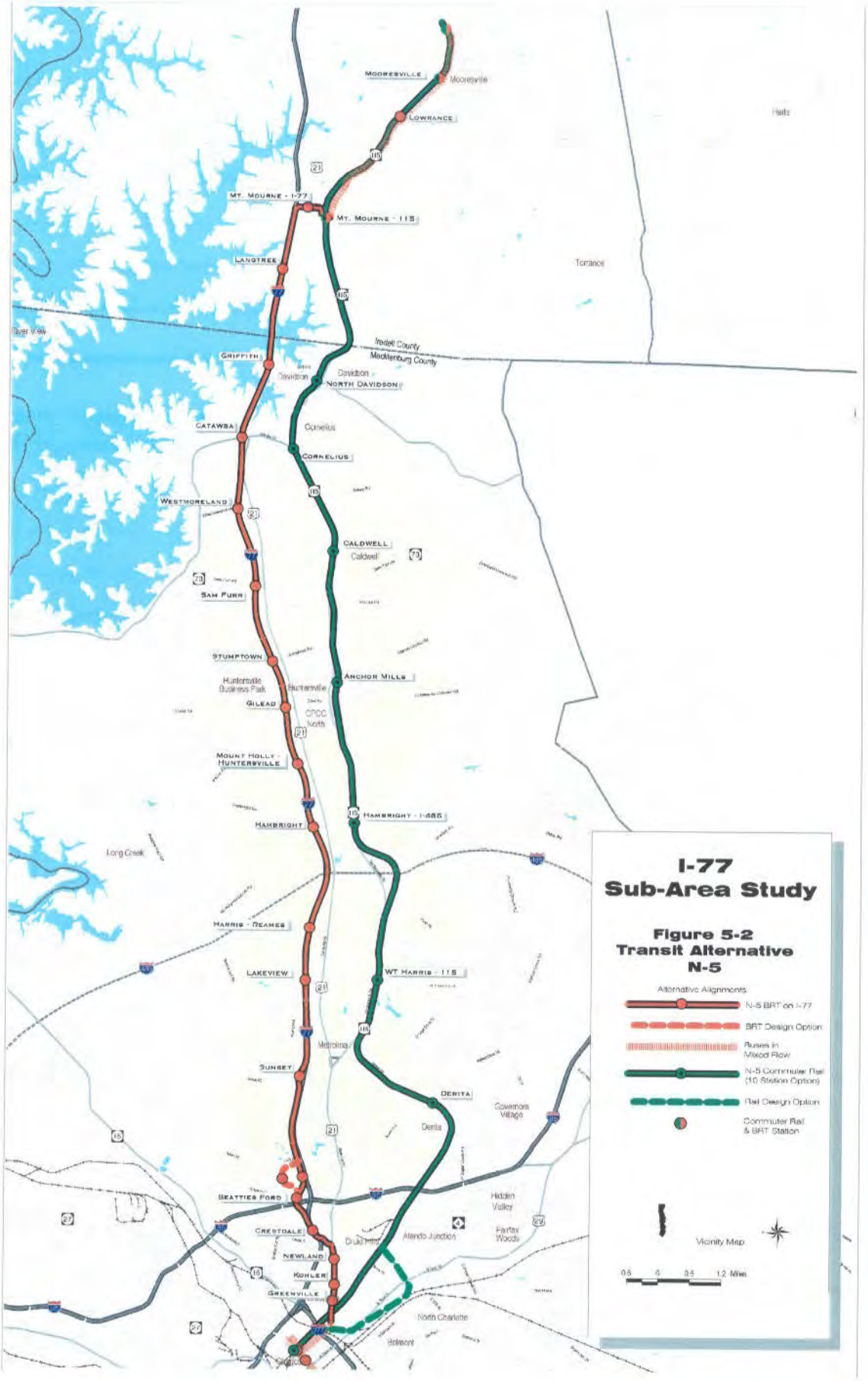
would again join the local road system.

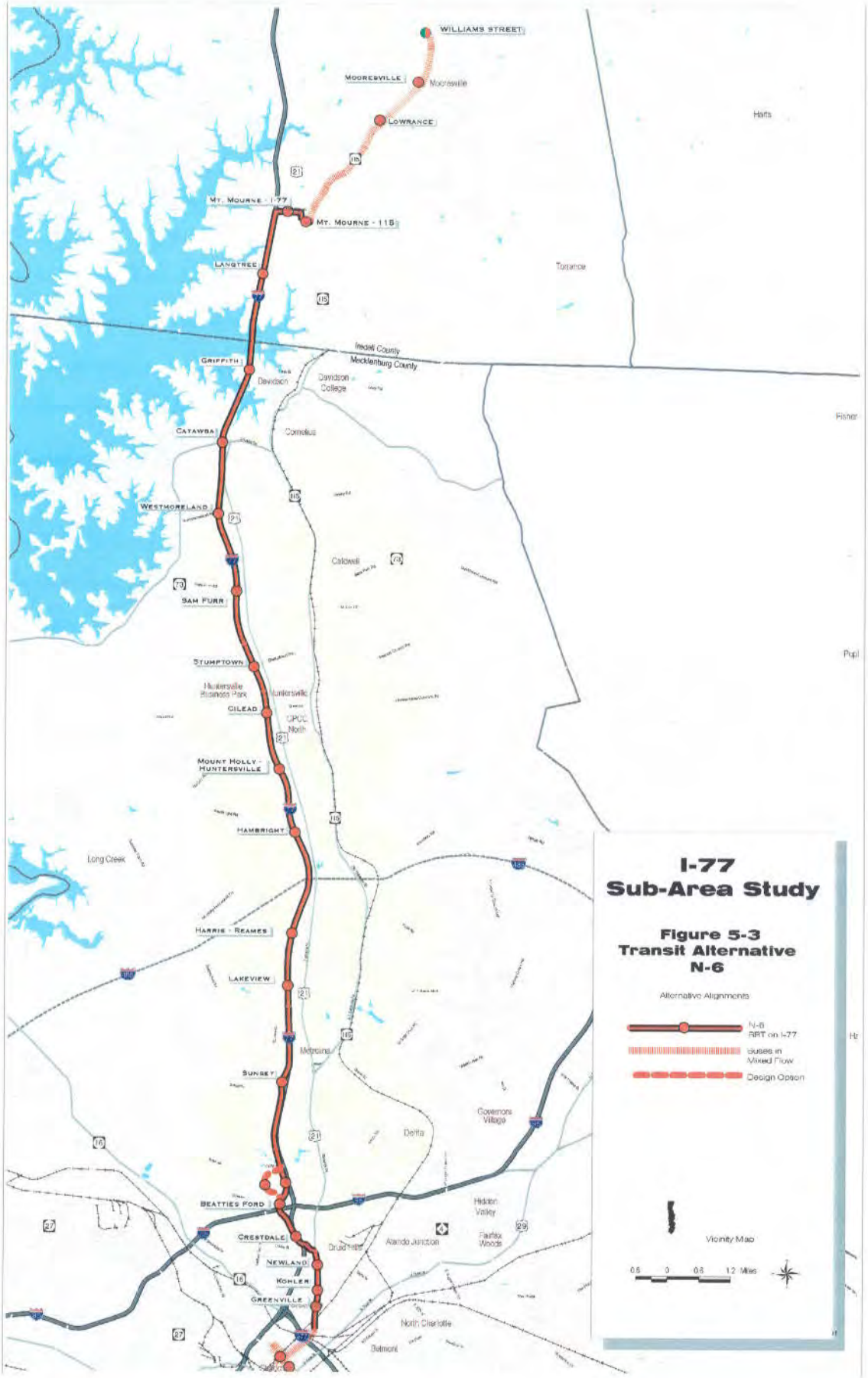
Rapid Bus is similar to the line-haul busway service. The only difference being that rather than operating in its own exclusive or semi-exclusive right-of-way, rapid bus vehicles operate on a street or highway in mixed traffic with minor bus lane or signal priority. The rapid bus stops are not usually fully developed stations as is the case for a BRT busway service but are more like specially designed bus stops at wider spacing than the normal bus stop spacing.

BRT Alternatives

Alternatives N-5 and N-6 in the North Corridor MIS involve BRT service operated along I-77 using primarily the freeway shoulders. South of the I-77/Sunset Road interchange, the BRT alignment would leave the interstate and connect to Center City Charlotte via a new exclusive busway on the west side of I-77. The busway would parallel LaSalle Street on the north, use the median on Statesville Road, and operate on North Graham Street in mixed traffic. The BRT alternative would travel from Sunset Road to Exit 33 on shoulder lanes on I-77 except for crossing Lake Norman. Buses would use the general-purpose lanes across the Lake Norman causeway. From Exit 33 to Mooresville, the BRT alternative would travel on NC-115 as rapid bus service. Alternatives N-5 and N-6 include 23 potential BRT stations.

Figures 5-2 and 5-3 illustrate Alternatives N-5 and N-6.


I-77
Sub-Area Study
Figure 5-2
Transit Alternative
N-5
Alternative Alignments
N-5 BRT on I-77
BRT Design Option
Buses in Mixed Flow
N-5 Commuter Rail (10 Station Option)
Rail Design Option
Commuter Rail & BRT Station
Vicinity Map
0.6 0 0.6 1.2 Miles
MOORESVILLE
Mooresville
LOWRANCE
MT. MOURNE - I-77
MT. MOURNE - I15
LANGTREE
GRIFFITH
Davidson
NORTH DAVIDSON
Iredell County
Mecklenburg County
CATAWBA
Cornelius
CORNELIUS
WESTMORELAND
CALDWELL
Caldwell
SAM FURR
STUMPTOWN
Huntersville Business Park
Huntersville
ANCHOR MILLS
GILEAD
CPCC North
MOUNT HOLLY - HUNTERSVILLE
HAMBRIGHT
HAMBRIGHT - I-485
Long Creek
HARRIS - REAMES
LAKEVIEW
WT HARRIS - I15
Metrolina
SUNSET
DERITA
Derita
Governors Village
BEATTIES FORD
Hidden Valley
CRESTDALE
Druid Hills
Atando Junction
Fairfax Woods
NEWLAND
KOHLER
GREENVILLE
North Charlotte
Belmont
Torrance
River View


WILLIAMS STREET
MOORESVILLE
Mooresville
LOWRANCE
MT. MOURNE - I-77
MT. MOURNE - 115
LANGTREE
Iredell County
Mecklenburg County
GRIFFITH
Davidson
Davidson College
CATAWBA
Cornelius
WESTMORELAND
Caldwell
SAM FURR
STUMPTOWN
Huntersville Business Park
Huntersville
GILEAD
CPCC North
MOUNT HOLLY - HUNTERSVILLE
HAMBRIGHT
Long Creek
HARRIS - REAMES
LAKEVIEW
Metrolina
SUNSET
Governors Village
Delta
BEATTIES FORD
Hidden Valley
CRESTDALE
Druid Hills
Alando Junction
Fairfax Woods
NEWLAND
KOHLER
GREENVILLE
North Charlotte
Belmont
Harris
Torrance
Fisher
Pupl
Hz
I-77
Sub-Area Study
Figure 5-3
Transit Alternative
N-6
Alternative Alignments
N-6 BRT on I-77
Buses in Mixed Flow
Design Option
Vicinity Map
0.6 0 0.6 1.2 Miles

5.3.4 Potential Commuter Rail Services in the I-77 Sub-area

What is Commuter Rail?

Commuter rail is typically characterized as express rail transit operating over conventional railroad tracks. Commuter rail can be trains of passenger coaches pulled or pushed by a diesel or electric locomotive, or advanced diesel multiple units (DMUs) where passenger cars powered by diesel motors on the cars. This system is often used to serve medium to lower density passenger environments. Lines are typically up to 30 miles in length with greater station spacing (two to five miles) that link city centers and mid-size towns with suburban surroundings. Trips tend to be longer, and are mostly journey-to-work trips. Therefore, in some corridors, commuter rail service is only provided during the peak commuting periods in the peak direction.

Locomotive and Passenger Cars (Baltimore)

DMU technology, although it has been around for several decades, has not been widely used in North America but it is seeing increased application in Europe. DMUs have operating characteristics that are a hybrid of commuter rail and light rail transit. DMUs typically serve lower density, longer distance suburban travel with relatively long station spacings in portions of a corridor, similar to commuter rail, and also serve higher density, shorter distance travel with closer station spacings in the urban portions of a corridor, typical of light rail transit.

Commuter rail is an attractive option where an available railroad exists and the tracks can be shared. While sharing trackage reduces the capital cost (as compared to building the new tracks) commuter rail train schedules and the amount of service provided can be compromised by having to share tracks with intercity passenger and rail freight trains. Commuter rail can operate at the same time as freight or intercity passenger trains, while some types of DMU may not have adequate vehicle strength (a safety requirement) to operate with other trains. Commuter service can have street crossings although it is desirable for safety and speed reasons to minimize such crossings.

Diesel Multiple Units (Baltimore)

Many metropolitan areas have commuter rail systems, such as Boston, New York/New Jersey/Connecticut, Philadelphia/Wilmington, Baltimore/Washington, Miami, Chicago, Dallas/Fort Worth, San Francisco, and Los Angeles. Numerous cities are considering commuter rail and several of these are considering the use of DMUs.

Commuter Rail Alternatives

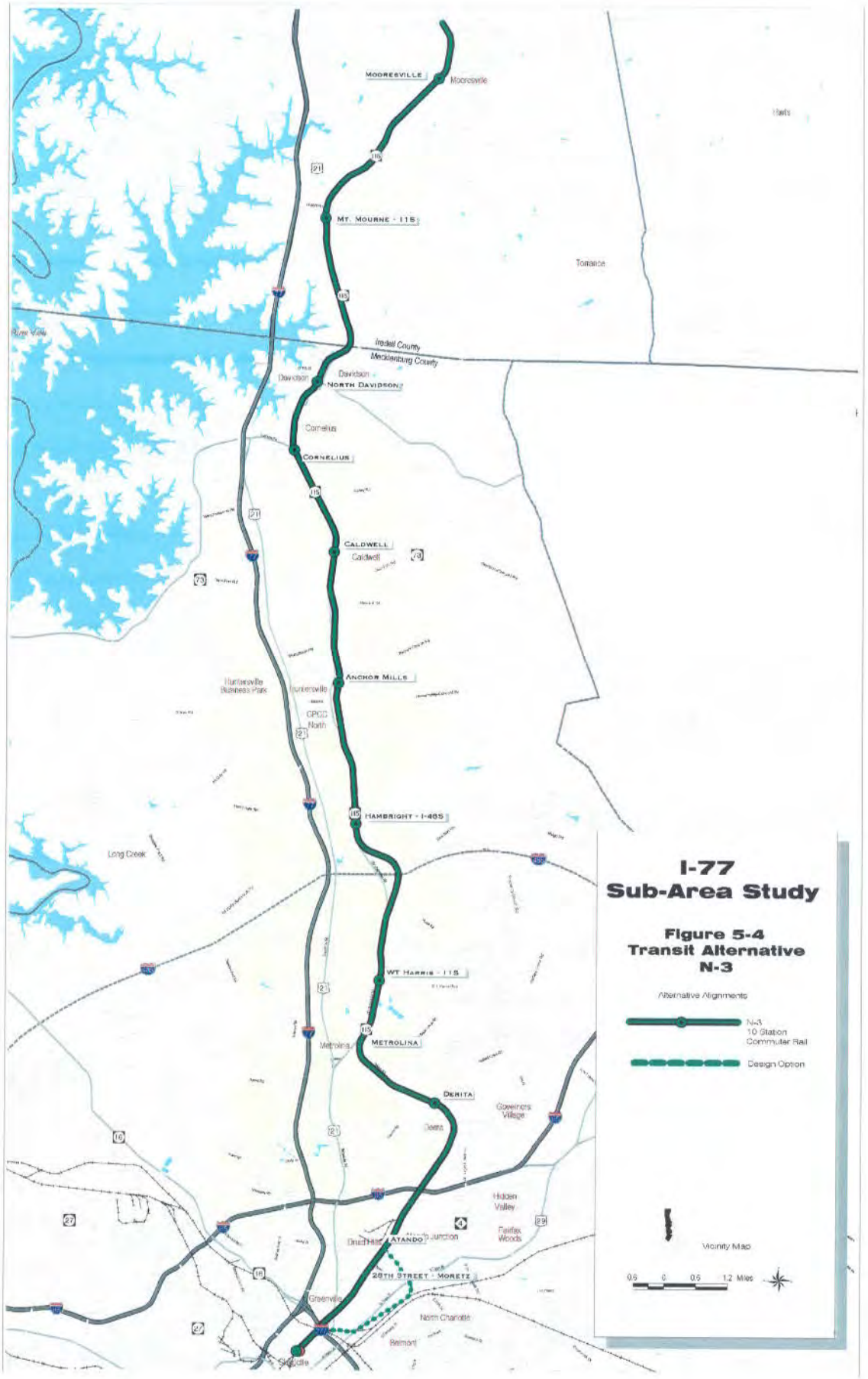
There are two commuter rail alternatives under consideration for the North Corridor:

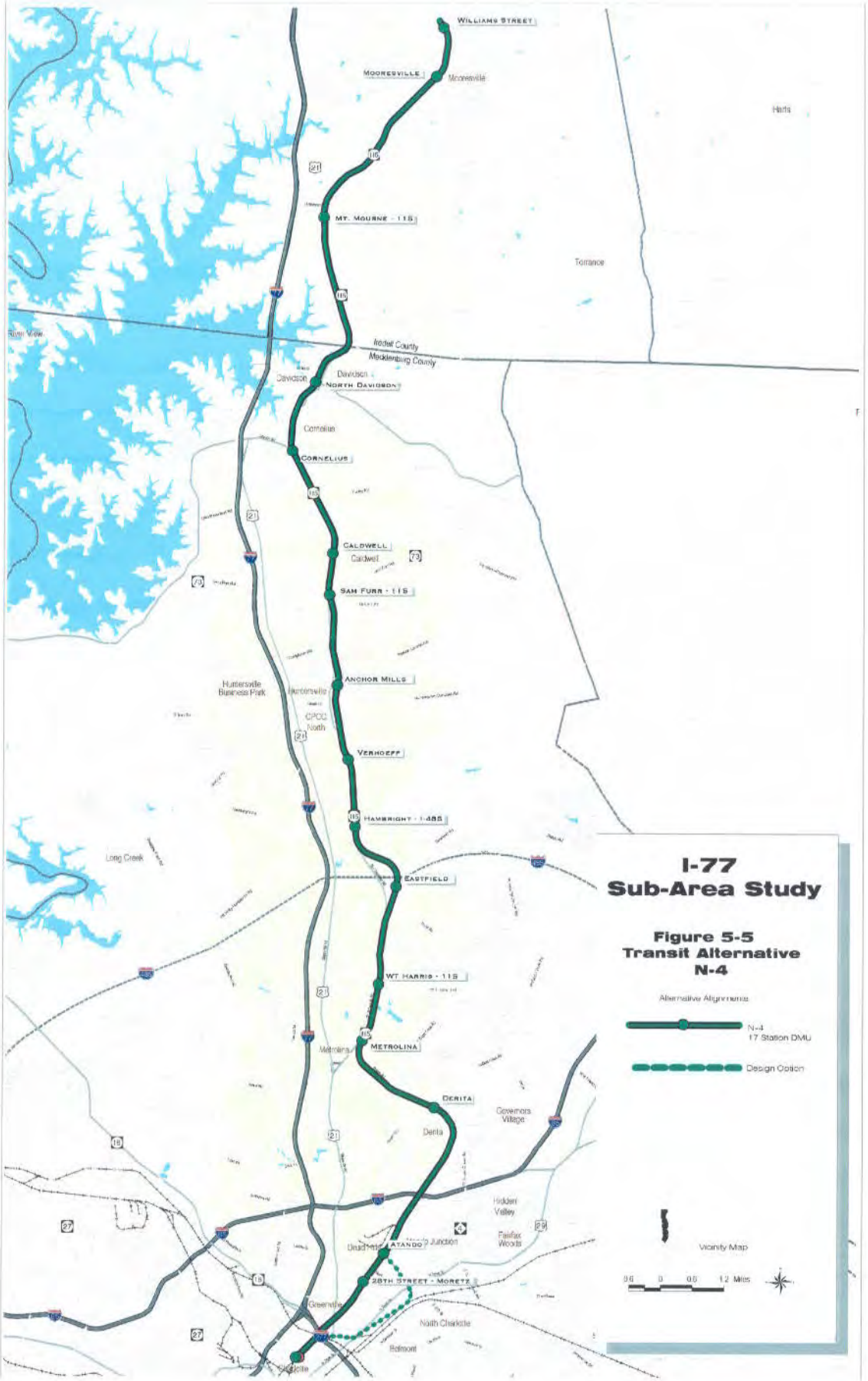
- Alternative N-3, Conventional Rail. This alternative begins at the proposed Multi-Modal Station on West Trade Street in Center City Charlotte, operating on a new track parallel to and just west of the Norfolk Southern main line to West 9th Street. At this location, the

alignment enters the Norfolk Southern "O" line. The route uses the "O" line to reach Mooresville, ending near NC-150. This option includes 10 potential commuter rail stations, supported by a feeder bus network.

- Alternative N-4, DMU. This alternative is identical to the conventional rail option except that DMUs are used instead of commuter rail locomotives and 17 station locations are proposed instead of 10. The use of DMU vehicles that do not comply with Federal Railroad Association (FRA) standards would require an agreement with Norfolk Southern to time-separate rail services.

Figures 5-4 and 5-5 show the two commuter rail options.


MOORESVILLE
Mooresville
MT. MOURNE - I15
Torrance
Iredell County
Mecklenburg County
Davidson
NORTH DAVIDSON
Cornelius
CORNELIUS
CALDWELL
Caldwell
ANCHOR MILLS
Huntersville
Huntersville Business Park
CPCC North
HAMBRIGHT - I-485
Long Creek
WT HARRIS - I15
METROLINA
Metrolina
DERITA
Derita
Governors Village
Hidden Valley
Fairfax Woods
ATANDO
Junction
28TH STREET - MORETZ
Greenville
North Charlotte
Belmont
I-77
Sub-Area Study
Figure 5-4
Transit Alternative
N-3
Alternative Alignments
N-3
10 Station
Commuter Rail
Design Option
Vicinity Map
0.6 0 0.6 1.2 Miles


WILLIAMS STREET
MOORESVILLE
Mooresville
Harris
MT. MOURNE - I-15
Torrance
Iredell County
Mecklenburg County
Davidson
NORTH DAVIDSON
Cornelius
CORNELIUS
CALDWELL
Caldwell
SAM FURR - I-15
ANCHOR MILLS
Huntersville Business Park
Huntersville
CPCC North
VERHOFF
HAMBRIGHT - I-485
Long Creek
EASTFIELD
WT. HARRIS - I-15
METROLINA
Metrolina
DERITA
Governors Village
Derita
Hidden Valley
Fairfax Woods
ATANDO
Atando Junction
28TH STREET - MORETZ
Greenville
North Charlotte
Belmont
I-77
Sub-Area Study
Figure 5-5
Transit Alternative
N-4
Alternative Alignments
N-4
17 Station DMU
Design Option
Vicinity Map
0.6 0 0.6 1.2 Miles

5.4 Intelligent Transportation Systems

5.4.1 What is ITS?

ITS is central elements of a modern, efficient transportation network. ITS is the use of advanced traffic operations and communications technologies to help increase throughput on existing facilities, improve safety, and provide better and more accurate traveler information to the public. ITS includes the use of these technologies as tools to:

- Gather accurate, real-time data on traffic conditions,
- Detect changes in traffic flow (such as incidents) that affect system capacity,
- Verify the nature of any detected incidents,
- Respond to that incident and restore normal traffic flow, and
- Inform the driving public of current traffic conditions.

Camera View of I-40 at Aviation Parkway – Online Updates Courtesy of WRAL-TV

Each element is necessary to operate the system, and any individual element has very little benefit in isolation. However, all the elements operating as a system have a significant impact on the transportation network.

Video Surveillance

Video surveillance verifies the location, severity and appropriate response for an incident. Surveillance of traffic is most commonly conducted with cable TV cameras remotely operated from a traffic control center. The Metrolina Regional Transportation Management Center (MRTMC) receives information from 26 closed circuit television (CCTV) cameras along I-77.

Detection of changes in traffic flow

There are several technologies available to detect traffic conditions including in-pavement loops, radar, microwave, and video imaging. I-77 has 27 traffic sensors.

Dynamic Message Signs (DMS)

DMS provides travelers with en-route travel and incident information while on the road. DMS are large signs mounted over the roadway with programmable letters and symbols that allow the operator to produce varied messages detailing current traffic conditions. The sign messages are developed through information provided by the ITS. Eleven DMS have been installed on I-77.

VMS Sign in Operation

Freeway service patrols

These patrols, now common incident management functions in most major U.S. cities, to provide vehicles equipped with gasoline, tire repair kits, first aid equipment, emergency supplies and trained drivers. These vehicles patrol freeway segments, respond to incidents, and assist stranded motorists. The service patrol operators have cellular phones so that they can be

alerted when an incident is detected by the freeway management system and can be quickly dispatched. NCDOT currently operates such a program on fifteen miles of I-77 and I-85 called the Incident Management Assistance Program (IMAP). IMAP also responds to incidents on an additional 45 miles of these freeways in Mecklenburg County and on I-85 in Cabarrus County.

Equipment to assist incident management personnel in implementing the program more efficiently includes: push bumpers on police cars, portable changeable message signs, and a highway referencing system. Portable changeable message signs may be placed temporarily in advance of a major incident to provide information on the incident and could suggest diversion routes if needed (NCDOT IMAP vehicles are equipped with these signs). A highway referencing system is the provision of reference signs placed along a freeway noting the roadway and identifying a unique location. When an incident occurs, the motorist can use the reference to report the location of the incident. The operator and response staff can respond quicker when the exact location of the incident is known.

Incident Management Assistance Program (IMAP) Response Vehicle

Emergency Management and Emergency Vehicle Preemption

Coordination of jurisdictions and emergency response agencies (local and state law enforcement, local fire and rescue agencies, ambulance and emergency medical agencies, and hazardous materials emergency response agencies) is undertaken in order to produce a response plan. This plan should define all coverage areas and emergency responsibilities for each agency.

Emergency vehicle preemption works with traffic signal systems by alerting the signals of their oncoming presence up to a half-mile away. This system greatly reduces the chances of a collision at an intersection that in turn saves costs in both emergency vehicle replacements and the legal liability when a motorist is injured. This signal preemption also allows emergency vehicles to reach their destination faster which can make a difference between life and death in many emergency situations.

Highway Advisory Radio (HAR)

This technology provides travelers with en-route travel and incident information. HAR is one or more low power radio transmitters placed along roadways that broadcast travel and incident related messages along travel corridors. Real-time information is obtained from the freeway management system and is rebroadcast in near real-time. I-77 in the Charlotte Region has four HAR transmitters.

Regional Traveler Information

These systems provide mechanisms for people to find out about travel conditions before they leave for their trip and while they are en-route. Many technologies are available, including internet web sites, telephone information system, traffic-oriented television stations or programs, traffic alert paging systems, a variety of auto PC traveler information applications, and traveler information applications for personal data assistants (PDAs). These systems are often provided in a cooperative venture between the public and private sectors. The data is provided by the public sector via freeway management and other systems and the private sector develops this data into traveler information and disseminates it through a variety of mechanisms, such as

those listed above. NCDOT has developed a MRTMC web site with a link status map and camera images. The agency has developed an agreement with Charlotte media to share video images from surveillance cameras. NCDOT also is developing a conceptual agreement to share traffic information with pager companies.

Ramp Metering

Ramp metering is an ITS element that is a low-cost means of controlling vehicle flow entering freeways, thereby providing a smooth and efficient flow on the freeway mainlines. It is used on freeways that are at or near a reduced flow condition.

Ramp metering is accomplished by placing a modified traffic signal at the end of a freeway entrance ramp. The signal allows individual vehicles to proceed at pre-timed intervals, at time intervals based on traffic conditions on the mainline, or at time intervals based on the length of the queue on the ramp itself. An additional lane can be added to allow buses and HOVs to bypass the ramp meter signal (referred to as HOV bypass lanes). Nationally there are many examples of successful ramp metering installations. Recently, Minnesota DOT installed freeway-to-freeway ramp meters to provide better operations on the freeway system in Minneapolis.

Ramp Metering in Atlanta, Georgia

Ramp metering is primarily a method to reduce freeway crashes and increase traffic throughput on the freeway system. Ramp metering also discourages drivers from using the freeway for very short trips and provides incentives for transit and HOV use through bypass lanes.

In order for metering to be effective, the lost time experienced on the ramp should be more than compensated for by improved freeway flow. Improvement can be in the form of improved normal flow as well as a reduction in crashes and crash-related delay. In addition, to be most effective, ramp metering should be implemented as a series of ramp metered interchanges. Isolated metered locations primarily offer safety and capacity benefits at the merge and provide limited benefits for greater portions of the mainline.

Ramp meters are placed at the end of the on-ramp in advance of the acceleration lane. At the meter, vehicles will be stopped. Therefore, typically the acceleration lane must be lengthened to provide sufficient distance for vehicles to reach a safe merging speed. It should be noted that the construction associated with ramp metering is minor and does not typically result in any inconvenience to motorists.

Ramp metering must be considered within the development of a larger freeway management system in order to take advantage of those same video cameras and in-pavement sensors for other purposes (i.e., incident management, variable speed control, and enforcement).

Aside from the typical engineering concerns, ramp metering faces three additional key issues:

- Public acceptance - In the case of ramp metering, public acceptance will require more effort in areas where the technology is less prevalent or absent entirely.
- Policy – Political support begins with the notion that the most effective system can be identified and will provide measurable benefits. Just as in other proposed improvements, those benefits must be weighed against total cost.

- Enforcement - When the meters are installed, enforcement is necessary to ensure the meters are having the intended effect of stopping vehicles. In some cases, the use of video cameras may alleviate the long-term burden on law enforcement. Note that the best enforcement is the perceived notion that the ramp meters are working as intended with reasonable compromises on cross-streets and improved freeway mainline flow. Regardless, with well-designed and actively managed ramp metering systems, violation rates are very low and enforcement is not an issue.

Potential Ramp Metering Benefits

Ramp metering reduces the number and frequency of interruptions on the mainline thereby facilitating smoother and more efficient mainline flow. It results in a reduction of crashes, especially rear-end collisions and crashes in the ramp merge areas. The crash reduction is typically in the 30 percent range for the times that metering is in operation. Metering also maximizes flow rates on the freeway mainline while not exceeding downstream capacity.

A survey of traffic management centers using ramp metering reported speed increases of 16 to 62 percent, travel time improvements up to 48 percent, and volume increases from 17 to 25 percent. Despite the increase in demand, ramp meters have successfully reduced accidents from 15 to 50 percent.

Table 5-1 summarizes some cases the impacts of ramp metering as cited in the Atlanta Region CMS Task 7 Report (PB-Farradyne, December 1996):

TABLE 5-1. Ramp Metering Impacts

LOCATION	BEFORE SPEED	AFTER SPEED	CHANGE IN...		
			TRAVEL TIME	CRASHES	VOLUME
Portland, OR	16 mph	41 mph	-61%	-43%	NA
Minneapolis	34 mph	46 mph	NA	-27%	+32%
Seattle	NA	NA	-48%	-39%	+62%
Denver	43 mph	50 mph	-37%	-5%	+19%
Long Island, NY	29 mph	35 mph	-20%	NA	0

Source: PB-Farradyne, December 1996

5.4.2 Current NCDOT Initiatives

NCDOT's I-77 widening project (I-3311) includes installation of 10 CCTVs, 3 DMSs, and fiber-optic cable and conduit from I-85 to NC-73. This project connects an additional 12 miles of the freeway to the MRTMC.

5.4.3 Recommendations

ITS strategies represent an opportunity to increase the capacity of I-77. Key recommendations include:

- Develop an integrated Regional Incident Management Program (improve coordination between NCDOT IMAP and Charlotte/Mecklenburg, Huntersville, Cornelius, Davidson, and Mooresville police/fire/EMS and 911 dispatch centers); expand IMAP through study corridor.

- Plan and design improvements to I-77 interchanges to permit future implementation of ramp metering, likely around 2015. Ramp metering will require re-construction of I-77 on-ramps and signal timing changes on roadways crossing I-77 at interchanges.
- Expand traveler information using NCDOT website to provide real-time information on estimated travel times and transit arrival times.
- Study the cost-effectiveness of implementing a three-lane reversible system on US-21 from Sunset Road to Harris Boulevard.

Figure 5-6 shows the location of the study's ITS recommendations.

5.5 Transportation Systems Management (TSM)

5.5.1 What is TSM?

TSM defined as modest physical or operational improvements to improve traffic performance, safety, and management. While these improvements are often installed as parts of larger projects, they also offer the potential of short-term improvements to be implemented quickly with limited funding sources. These projects typically do not involve large capital outlays; as a result most (but not all) projects with bridge improvements or substantial right-of-way acquisition are not considered TSM improvements. Potential projects can be both on a freeway system or oriented to arterial systems as shown in the **Table 5-2.**

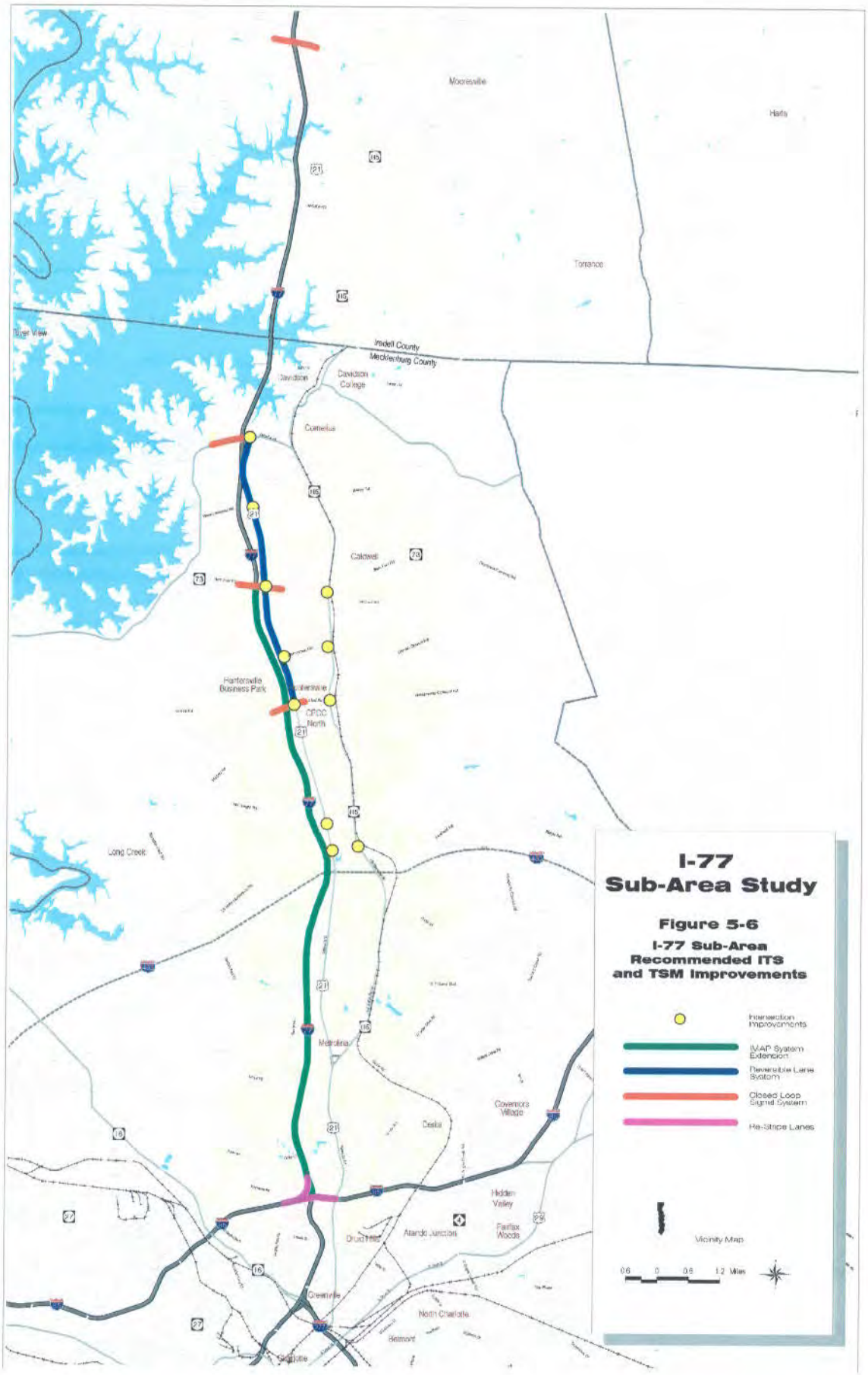
TABLE 5-2. Potential Improvement Projects

CANDIDATE FREEWAY EXAMPLES	CANDIDATE ARTERIAL EXAMPLES
Lengthening ramps (potentially providing auxiliary ramps)	Additional right/left turn lanes
Ramp revisions	Signalized intersections
New interchanges	Grade separations
Improved signing and lane markings	Continuous left-turn lanes
Improved illumination on shoulders	Shoulders (widen/improve) Bus turn-outs/shelters Reversible lanes

The application of these solutions depends upon the specific problem being observed in the field. Examples are listed in **Table 5-3.**

TABLE 5-3. General TSM Solutions

CANDIDATE PROBLEM	POTENTIAL APPLICATIONS
High accident site	Improve lighting Improve signing and pavement markings
Erratic weaving between sites	Re-orient ramp alignments Braid ramps (grade separate) Extend acceleration length Add auxiliary lane
Isolated congestion between on & off ramps	Add auxiliary lane Meter on-ramp (isolated treatment)
Queuing from intersection onto freeway mainlines	Add intersection approach lanes Re-time signal


I-77
Sub-Area Study
Figure 5-6
I-77 Sub-Area
Recommended ITS
and TSM Improvements
Intersection Improvements
IVAP System Extension
Reversible Lane System
Closed Loop Signal System
Re-Stripe Lanes
Vicinity Map
0.6 0 0.6 1.2 Miles
Mooresville
Harris
Torrance
River View
Iredell County
Mecklenburg County
Davidson
Davidson College
Cornelius
Caldwell
Huntersville Business Park
Huntersville
CPCC North
Long Creek
Metrolina
Governors Village
Cedar
Hidden Valley
Fairfax Woods
Druid Hills
Atando Junction
Greenville
North Charlotte
Belmont
Charlotte

The Charlotte region should continue to utilize traffic operations as a means of improving the efficiency of the transportation system. Such improvements include intersection and roadway widening, channelization, motorist assistance programs, traffic signal retiming/coordination, and computerized signal systems. In addition, ITS-based projects should continue to be explored in the region.

5.5.2 Consideration in Applying TSM

In applying TSM, the following must be considered:

Advantages

- Proven track record, cost effectiveness
- Can be applied as part of an incremental improvement
- Can be implemented in shorter term
- Can be applied to both freeways and arterial roadways that cross or parallel the freeway
- Amenable for any size urban area
- Usually the first means of addressing simple problems
- Usually applied to optimize higher investment strategies once improvements are implemented

Disadvantages

- Cannot solve major capacity problems associated with corridor congestion
- High level benefits require higher level of investment

5.5.3 Recommendations

During the study, a number of short-range improvements (see **Figure 5-6**) were identified. Many of these improvements were recommended in NCDOT's *Proposals to Relieve Congestion in the I-77 Corridor*, discussed in Section 2.2.

- Re-stripe lanes on southbound I-85 at I-77 in order to improve movements between I-85 and I-77.
- Implement a two-lane connector from I-77 south to I-85 south through the use of re-striping and modest widening.
- Install closed loop signal systems at I-77 interchanges with:
  - Gilead Road (Exit 23) *4 signals*
  - NC-73 (Exit 25) *5 signals*
  - Catawba Avenue (Exit 28) *4 signals*
  - NC-150 (Exit 36) *6 signals*
- Improve US-21 intersections with:
  - Gilead. Add southbound right-turn lane and eastbound through and right-turn lanes.
  - Alexanderana. Add left-turn lanes on all approaches.
  - Hambright. Add eastbound and westbound right-turn lanes.
  - Stumptown. Add eastbound and westbound left-turn lanes.

- NC-73. Extend eastbound through lane and add northbound left-turn lane.
- Westmoreland. Add left-turn lanes on all approaches.
- Catawba. Add right-turn lanes on all approaches.

- Improve NC-115 intersections with:
  - Gilead. Add eastbound right turn lane and northbound left turn lane.
  - Alexanderana. Add left-turn lanes on all approaches.
  - Hambright. Add northbound left-turn lane.
  - Stumptown. Add eastbound and northbound left-turn lanes and southbound right-turn lane.
  - NC-73. Add right-turn lanes on all approaches.

5.6 Land Use/Transportation Integration

5.6.1 Current Initiatives

There are a number of land use/transportation integration initiatives already underway in Mecklenburg and Iredell Counties. This study's recommendations are to continue these planning efforts and to implement the strategies and land development tools evolving from them.

5.6.2 Transit Oriented Planning Initiatives

The towns of Cornelius, Davidson, Huntersville and Mooresville have completed land use plans that recommend Transit Oriented Development (TOD) along the Norfolk Southern "O" line, to be served by future rail service.

CATS is currently determining how the public and private sectors can collaborate to implement transit station area plans. This effort involves identifying potential public investments and incentives and determining when and where these investments/incentives should be used. CATS expects to complete transit station joint development policies by February 2002.

The Charlotte-Mecklenburg Planning Commission is developing Transit Overlay Zoning Districts. This new zoning classification represents another tool for fostering preferred land uses in the I-77 north corridor.

5.6.3 ULI Panel Study for I-77 North

On April 22 – 27, 2001, the Business Committee for Regional Transportation Solutions (BCRTS) engaged the Urban Land Institute (ULI) to analyze the critical connection between transportation and land use in the I-77 north corridor from Center City Charlotte to Downtown Mooresville. An ULI-led panel including seven national experts focused on land uses within the corridor – particularly at key nodes – that would complement the character of existing communities, the transportation infrastructure, and potential transit investments.

Overall Recommendations

A summary of the ULI Panel's recommendations include:

Land Use: The panel suggested nine items in the land use area for the I-77 north corridor.

- Consider various categories of TOD in the North Corridor MIS.
- Implement TOD-friendly development standards and procedures.
- Design TOD projects wisely.
- Encourage public land assembly.
- Concentrate commercial and industrial development at interchanges.
- Conduct a retail development needs study.
- Develop and implement a corridor open-space protection program.
- Prepare sub-area plans for northern I-485 interchanges.
- Develop a corridor economic development strategy.

Transportation: The ULI panel also made recommendations in the transportation area:

- Purchase the Norfolk Southern "O" line right-of-way.
- Determine regional capital investment priorities.
- Implement a multi-modal park-and-ride system and improve east-west connectors.
- Maximize BRT/HOV opportunities.
- Invest in Uptown Charlotte transit connections.
- Provide comprehensive bus services.

6.0 COSTS AND TIMEFRAMES

6.1 Timeframes for Implementation

The recommended projects were categorized by three planning horizons:

- Short-Range (2002-2006)
- Mid-Range (2007-2015)
- Long-Range (2016-2025)

Tables 6-1 through 6-7 summarize proposed projects by strategy for each of the planning timeframes.

6.2 Estimated Project Costs

Tables 6-1 through 6-7 also provide estimated costs for the recommended projects by strategy. Cost estimates obtained from other sources or programs are cited in the table. All other estimates were developed as part of this study.

TABLE 6-1. Traditional Capacity Improvements: Short-Range (2002-2006)

PROJECT	ESTIMATED COST
Widen I-77 from I-85 to I-485 (I-3311A)	$68,400,000 (A)
Widen NC-73 from I-77 to Torrence Chapel Road (R-2555)	$13,250,000 (A)
Upgrade US-21/I-77 interchange (I-4410)	$4,000,000 (A)
Convert Langtree Rd. grade separation with I-77 to an interchange (I-4411)	$9,800,000 (A)
Center Church Road Re-location (new 2-lane rdwy) from Gateway to Fairview	$2,000,000
Widen Statesville Rd. to 4 lanes from Starita to Keith	$8,200,000
Widen Statesville Ave. to 4 lanes from Newland to Hickory	$5,800,000 (B)
Widen NC-115 to 4 lanes from US-21 to David Cox Rd.	$11,700,000 (B)
Widen Reames/Vance Road to 4 lanes from I-77 to I-485	$9,400,000
Extend Reames Rd. from Vance Rd. to a point north of I-485	By others

Notes: (A) 2002-2008 N.C. Transportation Improvement Program; (B) Charlotte Capital Improvement Program

TABLE 6-2. Transportation System Management (TSM): Short-Range (2002-2006)

PROJECT	ESTIMATED COST
Re-stripe lanes on I-85 to improve movements between I-85 and I-77	$275,000
Implement 2-lane connector from I-77 south to I-85 south using re-striping and modest widening	$80,000
Install closed loop signal systems at I-77 interchanges with:	
Gilead Road (Exit 23) – 4 signals	$ 400,000 (C)
NC-73 (Exit 25) – 5 signals	$ 500,000 (C)
Catawba Avenue (Exit 28) – 4 signals	$ 400,000
NC-150 (Exit 36) – 6 signals	$600,000 (C)
Improve US-21 intersections with:	
Gilead – southbound right turn lane and eastbound through and right turn lane	$450,000 (C)
Alexanderana – left turn lanes on all approaches	$ 600,000 (C)
Hambright – eastbound and westbound right turn lanes	$300,000 (C)
Stumptown – eastbound and westbound left turn lanes	$ 300,000 (C)
NC-73 – eastbound through lane extension and northbound left turn lane	$ 300,000
Westmoreland – left turn lanes on all approaches	$ 600,000 (C)
Catawba – right turn lanes on all approaches	$600,000 (C)
Improve NC-115 intersections with:	
Alexanderana – left turn lanes on all approaches	$ 600,000
Hambright – northbound left turn lane	$ 150,000 (C)
Gilead – eastbound right turn lane and northbound left turn lane	$ 300,000
NC-73 – right turn lanes on all approaches	$ 600,000 (C)
Stumptown – eastbound and northbound left turn lanes, southbound right turn lane	$450,000 (C)

Notes: (C) NCDOT's Proposals to Relieve Congestion in the I-77 Corridor (December 2000)

TABLE 6-3. Intelligent Transportation Systems (ITS): Short-Range (2002-2006)

PROJECT	ESTIMATED COST
Install 6 CCTV cameras, 2 DMS, and fiber-optic cable/conduit from I-85 to I-485	$3,935,450 (D) *Included in I-3311A*
Implement detection, surveillance and traveler information along I-85 from I-77 to Brookshire Freeway	$500,000
Develop an integrated Regional Incident Management Program (improve coordination between NCDOT IMAP and Charlotte/Mecklenburg, Huntersville, Cornelius, Davidson, and Mooresville police/fire/EMS/911 dispatch centers); expand IMAP to study corridor	$200,000 (study)
Expand the Traveler Information System to provide real – time information on estimated travel times and transit arrival times. Includes integration and web site development	$200,000
Perform reversible lane study for US-21 widening from Sunset to Harris	$100,000

Notes: (D) NCDOT's Metrolina ITS Plan

TABLE 6-4. HOV Lanes & Rapid Transit: Short-Range (2002-2006)

PROJECT	ESTIMATED COST
Complete North Corridor Major Investment Study (MIS); perform preliminary engineering for Locally Preferred Alternative (LPA)	$ 6,000,000
Designate lanes 7 and 8 from I-3311A widening for HOV use (2+ HOVs & transit vehicles) including striping and signing	$ 500,000
Resurface and re-stripe lanes on I-77 between I-85 and Brookshire to include interim HOV lane through the Brookshire interchange	$675,000
Construct I-77 HOV bypass lane through I-85 interchange; complete as near as possible to completion date for I-3311A (E)	$ 6,300,000

Note: (E) Cost includes constructing a bridge on the I-85 SB loop ramp that is being re-constructed as part of I-3311A.

TABLE 6-5. Land Use/Transportation Integration: Short-Range (2002-2006)

PROJECT	ESTIMATED COST
Complete North Corridor land use study and implement station area recommendations from PE/EIS phase	Underway
Implement land use recommendations of Urban Land Institute (ULI) Panel for Charlotte-to-Mooresville segment of I-77	Underway
Adopt updated General Development Policies in the City of Charlotte	Underway
Develop new Transit-Oriented Zoning district for the City of Charlotte	Underway
Adopt new Joint Development Policy in the City of Charlotte	Underway
During review of development proposals, do not allow driveways, median openings, or crossovers within 1000 feet (minimum) of an interchange ramp terminus	Not applicable

TABLE 6-6. Mid-Range Projects (2007-2015)

PROJECT	ESTIMATED COST
Widen I-77 from I-485 to NC-73 to 8 lanes, including HOV lanes in each direction (modification to I-3311B)	$ 30,500,000**
Install 4 CCTV cameras, 1 DMS & fiber-optic cable/conduit from I-485 to NC-73	$2,645,850 (D)
Widen Brawley School Road from River Loop Road to US-21 including interchange with I-77 (R-3833)	$33,500,000 (A)
Construct reversible HOV ramp to Fifth Street (using existing ramp) including bridge over SB I-77	$6,500,000
Construct dual lane reversible HOV system between I-85 and Uptown including connection to Brookshire Freeway and flyover to/from I-85 north	$22,500,000
Convert I-77/Catawba Avenue interchange (Exit 28) to an urban diamond	$18,000,000
Widen US-21 to 4 lanes from Harris to Sam Furr	$33,200,000
Add auxiliary lanes to I-77 between I-85 and Sunset Road (both sides)	$5,000,000

Notes: (A) 2002-2008 N.C. Transportation Improvement Program (D) NCDOT's Metrolina ITS Plan;
** I-3311B costs for 6-lane section do not include costs for study recommendation to implement HOV in lanes 7&8

TABLE 6-7. Long-Range Projects (2016-2025)

PROJECTS
Traditional Capacity Improvements
Convert I-77/US-21 interchange (Exit 33) to an urban diamond
Widen I-77 to 8 lanes from NC-73 to NC-150 in Iredell County ($200,000,000 to $225,000,000)
Widen NC-115 to 4 lanes from Harris to Verhoeff
Widen Vance Road to 4 lanes from I-485 to NC-73
Extend US-21 from Catawba Avenue (Exit 28) to Mt. Mourne (Exit 33) ($95,000,000 – using bridges over coves)
Extend Verhoeff Drive across I-77 from US-21 to Mt. Holly-Huntersville Road (opposite Reese Blvd.)
Construct new grade separation on I-77 south of Exit 28 between US-21 and west side frontage road
Extend Alcove Road across I-77 to connect with Fairview Road (south of Exit 33)
Extend Reames Road from I-485 to Mt. Holly-Huntersville Road
Intelligent Transportation Systems (ITS)
Implement detection, surveillance, and traveler information along I-77 from NC-73 to NC-150
Implement ramp metering in corridor
HOV Lanes
Construct concurrent HOV lanes on inside shoulders (lanes 9 and 10) or reversible HOV lane in median between I-85 and NC-150
Construct HOV and/or BRT direct access ramps to I-77 at Verhoeff Drive Extension and Westmoreland Road

7.0 STUDY RECOMMENDATIONS

7.1 Section Overview

This section reviews recommended projects for I-77 and US-21, the two primary roadways in the I-77 north corridor. The section also highlights the next steps to be undertaken by NCDOT, MUMPO and local governments to implement HOV lanes along I-77.

7.2 Recommended I-77 Improvements

7.2.1 HOV Strategic Plan (I-485 to Center City Charlotte)

A major product of the I-77 Sub-area Study is a strategic plan for developing HOV lanes along I-77, beginning in Center City Charlotte. Although the *2020 Transportation Plan* for the Mecklenburg-Union urban area includes I-77 north HOV lanes as high-priority projects, this study represented the first in-depth analysis of how a HOV facility could be implemented.

Phase I of the Strategic Plan

This study identified a preliminary concept to incorporate HOV lanes in the I-77 design/build project, I-3311A. The recommended approach involves designating the inside (median) lanes in both directions for HOVs with two and more passengers. This results in three general-purpose lanes and a HOV lane in each direction.

North of I-85, the HOV lanes would be non-buffer separated, marked by using an eight-inch white line, and extend the entire length of the corridor with transitions into general-purpose lanes. The northbound HOV lane would begin approximately one-half mile north of the I-85 interchange and extend for about 6.5 miles. The lane transition where I-3311A ends north of the future I-485 interchange would provide HOVs with priority treatment by dropping lanes from the right.

Because the I-77/I-85 interchange is a major bottleneck for southbound I-77 traffic, including buses, in the AM peak, this study determined a way to extend the southbound I-77 HOV lane through the I-85 interchange. This concept requires two new bridges to accommodate HOVs at the I-77/I-85 interchange. South of I-77's interchange with I-85, the southbound HOV lane could be constructed by narrowing existing lanes and reducing the shoulder width; therefore, no widening of the I-77 mainline is required. Total length of the I-77 southbound HOV lane is approximately 10 miles. Based on projected I-77 traffic volumes for that year, HOV volumes would range as high as 900 to 1000 vehicles in each direction during peak hours for selected I-77 segments.

This study recommends building Phase I of the strategic plan in conjunction with I-3311A in order that the HOV lanes can be opened when the highway widening work is completed in 2004.

Phase II of the Strategic Plan

In order to improve access for HOVs to the Center City, Phase II of the plan involves construction of a HOV-only connection to Fifth Street using an existing ramp at this street's interchange with I-77. Until Phase III of the plan is implemented, buses and HOVs would use this ramp in the southbound direction only. This ramp's construction, at an estimated cost of $6,500,000, provides HOVs with excellent access to Gateway Village located in the western

portion of Center City Charlotte. Although implementation of this phase is not critical to start-up of I-77 HOV services, it does provide for exclusive HOV access to Uptown Charlotte, making the facility more attractive to prospective users.

Phase III of the Plan

This final phase of providing HOV access to the Center City from the north involves widening I-77 between I-85 and Brookshire Freeway to provide a two-lane, barrier-separated reversible HOV facility. This phase could include a reversible flyover with I-85, providing a queue bypass ramp for I-85 traffic. A major element of this phase includes construction of reversible HOV connections to Brookshire Freeway, providing another means of exclusive access to the Center City. Based on I-77 traffic projections for 2010 and the completion of Phase III, northbound HOV volumes in the PM peak between Brookshire and I-85 could be as high as 1,250 vehicles.

Capacity Benefits of the HOV Strategic Plan

The section of I-77 between I-85 and Brookshire Freeway operates as a pipeline for commuter traffic for both I-77 and I-85 to (AM peak) and from (PM peak) Center City Charlotte. A reversible HOV system will increase the number of lanes in the peak direction by 50 percent with fewer impacts than widening the freeway to six lanes in both directions. An efficient HOV system could carry more person-trips through the corridor than two lanes set aside for general-purpose traffic.

The ultimate phasing of a reversible HOV system will provide peak hour lane balancing for commuters into Center City Charlotte. In the AM peak with the reversible lanes inbound, motorists from I-77 north will have three general-purpose lanes and one HOV lane between I-85 and the Brookshire Freeway, matching I-77 north lanes. I-85 will experience similar benefits between I-77 and Brookshire, including new HOV capacity from the center median of I-85 reducing the demand on the two-lane off ramp from I-85.

Phasing of HOV system construction - beginning with a southbound HOV lane only, then developing improved Center City connections, and finally creating a full reversible system - allows lane usage and trip incentives time to mature as each phase comes on line. This approach ensures that HOV usage will be optimal when the ultimate reversible system is completed.

7.2.2 Highway and HOV Recommendations (I-485 to NC-73)

NCDOT's current design concept for I-77 widening from I-485 to NC-73 (I-3311B) involves widening the freeway from four to six lanes. Based on the changes suggested for I-3311A, it is recommended that the cross-section of six general-purpose lanes and two HOV lanes used in I-3311A be extended for this second phase of interstate improvements. Following completion of I-3311B, the I-77 HOV facility would be over 13 miles.

7.2.3 Long-Range Highway and HOV Recommendations (I-85 to NC-150)

Long-term study recommendations for I-77 include:

- The maximum number of general-purpose lanes between I-85 and NC-150 will be eight lanes. There could be a need to provide auxiliary lanes between consecutive ramps of interchanges in addition to the eight main lanes.
- The median/inside shoulders should be strengthened and designed to permit HOV lane operation (either concurrent flow or a two-lane reversible HOV facility) once there is travel demand for eight general-purpose lanes.

- New and re-constructed bridges across I-77 should provide maximum flexibility in the design of future I-77 cross-sections. **Figure 7-1** shows possible freeway cross-sections. These structures also should accommodate pedestrian and bicycle travel. The following bridges or interchange modifications are proposed:
  - Convert US-21/I-77 interchange (Exit 33) to an urban diamond
  - New bridge across I-77 between Alcove and Fairview Roads
  - Verhoeff Drive extension across I-77 from US-21 to Mt. Holly-Huntersville Road
  - New bridge across I-77 between US-21 and west side frontage road south of I-77/Catawba Avenue interchange
- Outside shoulders will be strengthened and designed to permit BRT operations during peak hours.

7.2.4 ITS Recommendations

Project numbers I-3311A and B already include ITS elements such as CCTV cameras, DMS, and fiber-optic cable/conduit. Additional ITS recommendations for I-77 from this study are:

- Expand NCDOT's incident management program to the I-77 north corridor.
- Plan and design improvements to I-77 interchanges to permit future implementation of ramp metering.
- Implement detection, surveillance, and traveler information as the freeway is improved from NC-73 to NC-150.

7.3 Recommended US-21 Improvements

7.3.1 Traditional Capacity Improvements

The I-77 Sub-area Study recommends that US-21 be extended from its current terminus at Catawba Avenue (Exit 28 on I-77) to Exit 33 at Mount Mourne. This project, coupled with the recommended widening of I-77 across Lake Norman, would result in a need to widen the existing causeway or construct an additional causeway across the lake.

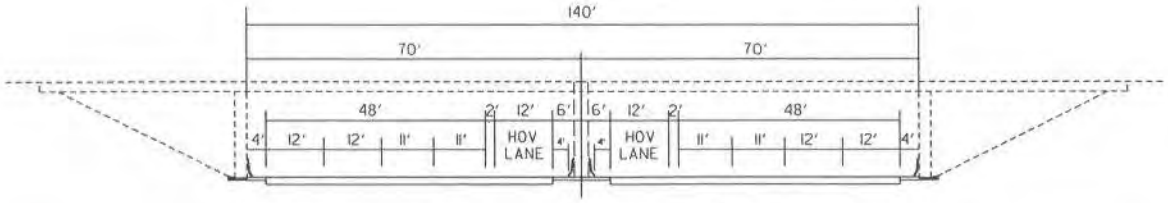
The proposed extension of US-21 provides additional capacity for local travel in the corridor between Mecklenburg and Iredell Counties. It also provides a more convenient detour route for I-77 traffic if there is a major traffic incident on the interstate. This becomes even more important when considering emergency evacuation routing for McGuire Nuclear Station.

A recommended improvement to be implemented in a shorter time frame includes widening US-21 to four lanes from Sunset Road to Sam Furr Road.

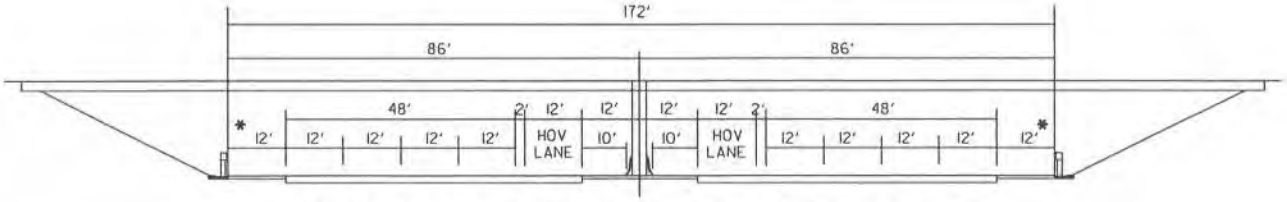
7.3.2 ITS and TSM Recommendations

As an interim step to the widening of the 2.5-mile segment of US-21 between Sunset Road and Harris Boulevard, it is recommended that the current three-lane cross-section be analyzed as to the benefits of reversible lane operation during peak periods. The City of Charlotte has successfully maintained reversible lane operations along a three-lane portion of Monroe Road for over a decade. This ITS technique could increase the peak-period capacity of US-21 until it can be widened to four lanes.

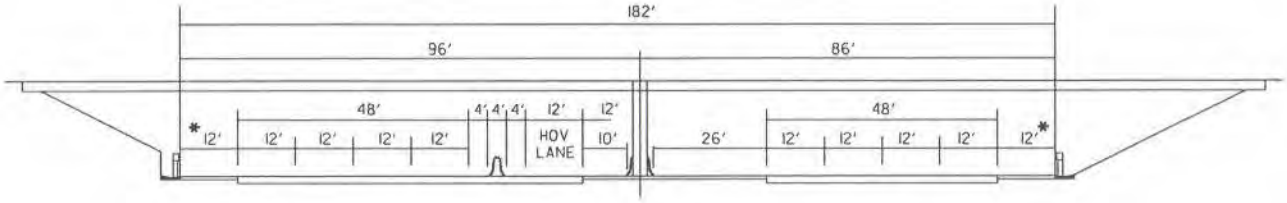
FIGURE 7-1. Future I-77 Cross-Sections



MINIMAL CONCURRENT HOV DESIGN
(RETROFIT BASIC 8-LANE SECTION UNDER 4-SPAN BRIDGE)



OPTIMAL CONCURRENT HOV DESIGN
UNDER TWO-SPAN BRIDGE



OPTIMAL DESIGN LEAVING ALL OPTIONS OPEN
INCLUDING REVERSIBLE HOV DESIGN (OFF SET
ONE SIDE OF TWO-SPAN BRIDGE CENTER PIER)

* NOTE: PREFERRED 18' SHOULDER WHEN ADT > 50,000

As a follow-up to NCDOT's *Proposals to Relieve Congestion in the I-77 Corridor*, completed in 2000, the following intersections along US-21 should be improved as TSM projects:

- Gilead Road – Add southbound right-turn lane and eastbound through, right-turn lanes.
- Alexanderana Road – Add left-turn lanes on all approaches.
- Hambright Road – Add eastbound and westbound right-turn lanes.
- Stumptown – Add eastbound and westbound left-turn lanes.
- NC-73 – Extend eastbound through lane and add northbound left-turn lane.
- Westmoreland Road – Add left-turn lanes on all approaches.
- Catawba – Add right-turn lanes on all approaches.

7.4 Next Steps

In order to introduce HOV operations on I-77 when I-3311A is completed in two years, work on the first phase of the I-77 strategic plan should get underway as soon as possible. The additional improvements required for HOV implementation as identified in this study should be considered by the Mecklenburg – Union Technical Coordinating Committee and MUMPO for inclusion in the urban area's Candidate Projects List for submission to NCDOT to obtain future funding.

The HOV-related work also will have to be studied with regard to environmental impacts. Because none of the proposed construction to implement HOV operations necessitates acquisition of additional right-of-way, a Categorical Exclusion is the most likely Federal requirement for environmental purposes.

As mentioned in Section 4.5.6, the current fine for improper use of a HOV lane is $10 plus court costs, which could be an additional $90. State and local agencies should begin efforts to change State statutes to increase the fine for HOV facility violations. A higher fine would provide a greater deterrent to illegal use of not only the proposed I-77 HOV lanes but also the reversible HOV facility currently under construction along Independence Boulevard (US-74) in east Charlotte.