Bus on Shoulder Systems (BOSS)
North Carolina Implementation and Operations Plan (IOP)

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INTRODUCTION

This document outlines an Implementation and Operations Plan (IOP) for the development of BOSS in North Carolina, beginning with a pilot project in the Research Triangle region. Given the extensive experience of Minnesota with bus on shoulder operations, this plan gratefully acknowledges the assistance and support of "Team Transit"– a partnership of regional transit agencies and the Minnesota Department of Transportation that provides overall coordination for bus on shoulder operations in the Minneapolis-St. Paul region.

OVERVIEW OF BUS ON SHOULDER OPERATION

A number of States have implemented policies that permit buses to operate on selected freeway and/or arterial shoulders in order to bypass congestion and maintain transit schedules, as noted in **Exhibit 1** below. These policies allow buses to use shoulders while traveling at slow speeds that are nonetheless faster than mainline traffic when travel is delayed due to a recurring or nonrecurring congestion event. Even under conditions where bus shoulder travel is permitted, however, the primary use of the shoulder: clear zone, clearing area for incidents, area for enforcement activity, vehicle breakdown, etc. remains unchanged. Bus on shoulder operation is a low-cost, fast-implementation treatment that can provide immediate benefits to transit whenever mainline travel is experiencing moderate to heavy degrees of congestion.

Exhibit 1 - States with Active Bus on Shoulder Operations

- Northeast/Mid-Atlantic region: NJ, DE, MD, VA
- South region: FL, GA
- Midwest region: OH, MN, IL, KS
- West region: CA, WA

Note: While the vast majority of bus on shoulder usage remains in the Twin Cities metropolitan area of Minnesota, the mileage in other states has grown over time. No State has ever discontinued the use of bus on shoulder operation for safety reasons once it has been established in the State.

Bus on shoulder operations were first implemented in Minnesota more than 20 years ago, with nearly 300 shoulder-miles of bus on shoulder operations in use today. Minnesota has identified a number of benefits with bus on shoulder operation, including:

- Shorter and more predictable and reliable transit times
- Fewer missed transfer connections
- Increased transit ridership
- Reduced driver overtime
- Decreased operational costs

In some cases, travel times have decreased enough to allow for schedules to be revised, and for a bus to be eliminated on a route.

OVERALL DEVELOPMENT OF BUS ON SHOULDER SYSTEMS (BOSS) IN NORTH CAROLINA

Applicable Statutes and Required Ordinances

Bus on shoulder operation is already permitted by law on freeways and expressways in North Carolina during peak traffic periods (ref: G.S. 20-146.2(b)). For the implementation of BOSS in North Carolina, peak traffic periods will be defined as when freeway or expressway traffic slows to 35 MPH. NCDOT will enact "no parking" ordinances as appropriate for any segments of freeway and expressway designated for BOSS. In addition, NCDOT will monitor the implementation of BOSS and, if warranted, will request potential modification of the General Statutes, NCDOT policies, or both. Note that based on current law, only facilities with full or partial control of access will be considered for BOSS operation in North Carolina. At the present time, NCDOT will only consider existing or proposed freeway and expressway facilities for BOSS operation.

Regional Partnership within a Statewide Framework

The implementation of BOSS in any area of the state must be initiated at the local or regional level and then developed by the transportation partners in the region in cooperation with the North Carolina Department of Transportation and the Federal Highway Administration. The policies and procedures in this statewide BOSS Implementation and Operations Plan (IOP) must be followed – but the specific implementation elements in a region must emerge from a cooperative process coordinated at the regional level. The North Carolina Department of Transportation is pleased to support the development of a BOSS pilot project in the Research Triangle region and, if successful, the expansion of BOSS in that region and in other warranted areas of the state.

Systems Approach to Implementation in each Region

While significant benefits to transit operation and ridership may be realized from deploying bus on shoulder operation for even a single roadway segment, regions that are considering bus on shoulder operations will be encouraged to examine the potential deployment of a system of bus on shoulder corridors in their area in order to accelerate the potential network benefits from these investments. To emphasize the importance of such a systems approach, this document makes extensive use of the term "Bus on Shoulder Systems (BOSS)" throughout the document.

Institutionalization of BOSS in North Carolina

At this time, the only area designated for Bus on Shoulder implementation is the Research Triangle region, and the only approved county for implementation is Durham. However, more counties and regions may be added over time. **Exhibit 2** below outlines the current list of bus on shoulder implementation areas across North Carolina. The exhibit outlines the effective dates in designated BOSS areas whereby new and reconstruction projects shall be examined for bus on shoulder potential.

Exhibit 2 – Institutionalization of BOSS in North Carolina

Region	Counties	Effective date of required consideration of BOSS
Research Triangle	Durham, Wake, Orange	(to be determined)
Other urban areas	All counties	(to be determined)
Rest of State	All other counties	(to be determined)

Note: BOSS should be considered for all projects on full- or partially-controlled access facilities with current or anticipated fixed route transit service slated for letting on or after the above effective date(s) in each region above, although incorporation into project design shall not be required until the completion and evaluation of a successful pilot project in the Research Triangle region. However, BOSS may be considered for any project that meets the above mentioned criteria in North Carolina at any time.

STATEWIDE OPERATIONAL POLICIES FOR BUS ON SHOULDER SYSTEMS IN NORTH CAROLINA

The core elements of bus on shoulder policies concern restrictions on shoulder usage during congested periods. **Exhibit 3** summarizes the primary operational policies – maximum operating speeds, utilization framework, vehicle restrictions, and driver training requirements – that the NC Department of Transportation has established for the implementation of BOSS in North Carolina.

Exhibit 3 - North Carolina Statewide Operational Policies for BOSS Corridors

Maximum Operating Speeds

1 – Maximum 35 MPH mainline speed in the direction of travel where bus on shoulder operations is permitted

2 – Maximum 35 MPH speed for buses using adjacent right shoulder

3 – Maximum 15 MPH speed differential between buses using shoulder and mainline travel speed

Utilization Framework

1 – Minimum number of buses to achieve a minimum time savings per mile must be established by region

2 – Voluntary usage of BOSS corridor by transit operators and drivers

3 – Transit vehicles must use four-way flashers (hazard signals) when traveling in shoulder

4 – No time-of-day restrictions, although transit agencies may voluntarily limit bus on shoulder operations to certain hours

5 – Mainline operating speeds in rightmost lane adjacent to shoulder in the direction of travel dictate when entry is permitted. If traffic in rightmost lane is stopped due to exit ramp being over capacity, bus should not use shoulder.

*See also policies for yielding right-of-way as shown in **Exhibit 5***

Vehicle Restrictions

1 – Buses of different sizes and designs other than the standard transit bus will not be allowed to operate on BOSS corridors

2 – Both fixed route and demand-responsive services are permitted, as long as the vehicles themselves are permitted under vehicle restrictions, are identifiable as a local or regional transit agency bus, and are using four-way (hazard) flashers

3 – Cut-away buses, charter buses, paratransit vans, and maintenance support trucks will not be allowed to operate on BOSS corridors at this time.

4 – No minimum number of passengers (e.g., “deadheading” permitted to remain on schedule)

Driver Training Requirements

1 – Transit agencies in each area must administer driver training program in collaboration with NCDOT

2 – Individual drivers must be trained on both overall BOSS operation and on an individual corridor basis

3 – Contractors to transit agencies permitted if above driver training requirements met

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The maximum operating speeds outlined above can be characterized as simply, “Buses can only travel on the shoulder when speeds in main lanes in the direction of travel are below 35 MPH, and buses cannot travel more than 15 MPH faster than other vehicles, or faster than 35 MPH.” **Exhibit 4** provides more detail on the specifics of these operating speed policies.

Exhibit 4 - Travel Speed Examples Associated with Maximum BOSS Operating Speeds

If travel speeds in main lanes in direction of travel are:	Then transit buses on adjacent right shoulder:
65 MPH, 55 MPH, even 35-40 MPH	N/A: Cannot travel on shoulder
20, 25, 30, 35 MPH	Can go up to 35 MPH
15 MPH	Can go up to 30 MPH
10 MPH	Can go up to 25 MPH
5 MPH	Can go up to 20 MPH
Stopped (0 MPH)	Can go up to 15 MPH

In addition to the operational policies outlined above, buses operating on shoulders in North Carolina will be required to safely exit the shoulder when necessary or otherwise yield to all obstructions (static or dynamic) in shoulder. This policy is amplified in **Exhibit 5**.

Exhibit 5 – Policy Affirming that Buses Must Exit Shoulder or Yield Right-of-Way to All Obstructions

1 - Buses must safely exit shoulder when trailing emergency or law enforcement vehicles approach in shoulder

2 - Buses must safely exit the shoulder when the shoulder is blocked, of inadequate width, or otherwise unavailable for any reason

3 - Buses must yield to all other vehicles in shoulder, such as the following:
- Any vehicle merging onto the highway via an entrance ramp
- Any vehicle leaving the highway via an exit ramp
- Any other vehicle that enters or occupies the shoulder (e.g., maintenance)
- A disabled vehicle
- Enforcement activities
- Incident clearing measures

When a transit vehicle must exit the shoulder and enter the mainline of travel, buses will be expected to perform the maneuver in a safe and expeditious manner. Since mainline travel vehicles are not currently required by statute to yield to buses reentering the mainline from shoulder, the Department will monitor the pilot implementation of BOSS and, if conditions warrant, may pursue implementation of a statutory change requiring such yielding of mainline vehicles to buses that are reentering the travel way from the shoulder.
Note: This statute is currently applicable in Minnesota, although based on a site visit there in November 2011, the consensus of transit professionals was that this statute was not widely known or enforced.

STATEWIDE DESIGN CRITERIA FOR BUS ON SHOULDER SYSTEMS

Geometric Design Criteria

Since the maximum speed for bus on shoulder operation is 35 MPH, most speed-related geometric design elements that would apply for a freeway or expressway section will function well for lower speed bus-on-shoulder operation. The primary geometric design criteria for bus on shoulder operation are those that are not specifically related to design or operating speed, including shoulder width, horizontal clearance (shy distance), vertical (overhead) clearance, and pavement strength. Bus on shoulder operational restrictions will be designated for all BOSS-prohibited segments with inadequate shoulder width, insufficient horizontal or vertical clearance, or inadequate bridge or pavement structural strength. **Exhibit 6** summarizes the primary design criteria that are being reviewed for use in North Carolina, with all design criteria contained in an **Appendix** at the end of this document.

Bus on shoulder implementation typically has a very low implementation cost (generally less than $0.5m / mile and sometimes much less) compared with the typical cost of fully grade-separated bus rapid transit, light rail, commuter rail, etc. The primary reason for the low implementation cost is the limited number of roadway changes required due to the lower operating speeds and associated design criteria.

Exhibit 6 – NCDOT Selected Design Criteria for Bus on Shoulder Systems Implementation

Controlling Geometric Design Criteria	Standard
Shoulder width on roadway or bridge	
- Minimum	10 feet
- Desired	12 feet
Horizontal clearance (shy distance)	
- Minimum	0 feet
- Desired	2 feet
Design speed	
- Maximum	35 MPH

Note: See Appendix for complete design criteria

Signage Elements

The North Carolina Department of Transportation has established overall guidance for BOSS signage that will provide direct information to motorists and bus operators, while minimizing sign clutter. **Exhibit 7** summarizes the primary elements of signage for BOSS implementation in North Carolina.

Exhibit 7 – Summary of NCDOT Signage, Pavement Marking, and Audible/Tactile Warning Device Elements for Bus on Shoulder Operation

Roadway	Location	Installation	Type	Legend (note)
Mainline	Begin bus on shoulder section	Post-mounted	Regulatory	"Begin / Shoulder / Authorized Buses Only"
Mainline	Along bus on shoulder section	Rumble strip	N/A	Longitudinal along or within 6" of pavement edge
Mainline	Along bus on shoulder section[1]	Post-mounted	Regulatory	"No Parking"
On-ramp	Entering bus on shoulder section[2]	Post-mounted	Warning	"Watch for Buses on Shoulder"
Mainline	After on-ramp merge[3]	Post-mounted	Regulatory	"Shoulder / Authorized Buses Only"
Mainline	Inadequate shoulder width ahead[4]	Post-mounted	Warning	Small icon sign for buses to exit shoulder ahead
Mainline	Inadequate shoulder width begins	Post-mounted	Warning	Type 3 object marker, CM3-R
Mainline	Guardrail or barrier begins[5]	Post-mounted	Warning	Type 3 object marker, CM3-R
Mainline	End of bus on shoulder section	Post-mounted	Regulatory	"End / Shoulder / Authorized Buses Only"

Notes on placement:

[1]Place "No Parking" signs along mainline as required by ordinance. A typical installation may alternate "No Parking Any Time" and "Shoulder / Authorized Buses Only"

[2]Place one sign approximately 200-400 ft upstream from merge point. May use on both sides of two-lane on-ramps.

[3]Place one sign approximately 300-1000 ft downstream of entrance gore

[4]Place one sign on mainline in advance of restricted shoulder width or permanent obstruction

[5]As needed

Courtesy Mn/DOT, Team Transit

Pavement Markings

Bus shoulders are continuous through exit ramps and entrance ramps on freeway and expressway segments, and continuous across acceleration and deceleration lanes. No pavement markings will be used as part of the initial pilot in the Research Triangle region. NCDOT will review the effectiveness of the delineation and either maintain, add, expand, modify, or delete them for future installations as appropriate.

Audible/Tactile Warning Devices

Longitudinal warning devices will be rumble strips located concurrent with, or within 6 inches of, pavement edge lines or audible longitudinal pavement markings to help separate traffic flow on the mainline from shoulder usage. A field inspection can help determine if existing longitudinal warning devices are suitable.

Intelligent Transportation Systems (ITS) and BOSS

ITS shall be integrated into BOSS operations where feasible. See **Exhibit 8** for sample messages for use on overhead dynamic message signs (DMS) in or in advance of BOSS implementation areas.

Exhibit 8 – Intelligent Transportation Systems and BOSS -- Sample Dynamic Message Sign (DMS) Messages

Panel 1

BUSES TRAVELING ON SHOULDER NEXT 15 MILES
BUS TRAVEL PERMITTED ON RIGHT SHOULDER
-CAUTION- AHEAD BUSES TRAVELING ON SHOULDER
SHOULDERS IN USE FOR TRANSIT BUS TRAVEL

STOPPING ON SHOULDER ONLY FOR EMERGENCIES
SHOULDER IN USE FOR AUTHORIZED TRANSIT BUSES
2 RIGHT LANES AND SHOULDER CLOSED AHEAD

RAPID TOWING ENFORCEMENT NOW IN EFFECT
BUS ON SHOULDER DRIVER TRAINING NOW IN EFFECT
TRAINING FOR BUS ON SHOULDER NOW IN EFFECT

Panel 2

SHOULDER USE FOR AUTHORIZED BUSES ONLY
BUS ON SHOULDER MAY MERGE WITH TRAFFIC AHEAD
STOPPING ON SHOULDER ONLY FOR EMERGENCIES
WATCH FOR BUSES MERGING WITH TRAFFIC

SHOULDER TRAVEL FOR AUTHORIZED BUSES ONLY
VEHICLES LEFT UNATTENDED WILL BE TOWED
ACCIDENT AHEAD: SHOULDER CLOSED TO BUS TRAVEL

ABANDONED VEHICLES WILL BE TOWED
BUS ON SHOULDER TRAINING NOW IN EFFECT
TRAINING NOW IN EFFECT FOR BUS ON SHOULDERS

NOTE: The above DMS messages are samples and optional. The display of travel time and other information on dynamic message signs may take priority over the above sample messages at various DMS locations along the corridor. Existing NCDOT policies, procedures, and priorities must be followed.

STATEWIDE BOSS ELIGIBILITY CRITERIA

The most common reason for considering bus on shoulder operations along any corridor in any region will likely be to provide a means for transit operators to avoid recurring congestion in order to improve the attractiveness and operations of transit service during commuting periods. However, any route can experience non-recurring congestion situations due to crashes, weather, road work, etc. – any of which could impact the overall reliability and attractiveness of transit service whenever the travel demand exceeds roadway capacity or otherwise creates unreliability in trip times. Therefore, since nearly 50% of congestion is non-recurring, the only absolute NCDOT requirements for considering BOSS along a freeway or expressway corridor shall be full or partial control of access and the presence of scheduled fixed-route transit service now or within a ten year planning horizon for that corridor, as shown in the simplified eligibility framework as outlined in **Exhibit 9**.

Exhibit 9 - North Carolina Statewide Minimum Eligibility Criteria for Potential BOSS Corridor Designation

Eligibility for potential immediate designation as a BOSS corridor

- Roadway must be an existing freeway or expressway
- Facility must have full or partial control of access
- At least one fixed-route transit bus must currently use the corridor each weekday

Eligibility for shoulder improvements to enable or enhance future BOSS service along a corridor

- Roadway must be an existing or proposed freeway or expressway
- Facility must have or be planned for full or partial control of access before BOSS implementation
- Corridor must be planned for scheduled public transit service within the next 10 years

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PILOT IMPLEMENTATION IN RESEARCH TRIANGLE REGION

I-40 Regional Partnership in the Research Triangle Region (I-40/Research Triangle)
The I-40 Regional Partnership in the Research Triangle region has served as the impetus for advancing BOSS in the area and provides an ongoing coordination mechanism through a regional BOSS Team. The members of the I-40 Regional Partnership in the Research Triangle region who have focused on the implementation of BOSS and other potential improvements to the I-40 corridor include:

- North Carolina Department of Transportation
- Federal Highway Administration
- Triangle Transit
- City of Durham / Durham Area Transit Authority
- City of Raleigh/ Capital Area Transit
- Town of Cary / C-Tran
- Town of Chapel Hill / Chapel Hill Transit
- NC State University Department of Civil Engineering
- NC State University / Wolfline
- Duke University / Duke Transit
- Raleigh-Durham Airport Authority
- Durham-Chapel Hill-Carrboro MPO
- Capital Area MPO
- Durham, Orange, Wake counties
- Research Triangle Foundation of North Carolina
- Regional Transportation Alliance (RTA)

In the Research Triangle pilot region, Triangle Transit, which serves as the area's regional transit agency, has had an existing short-term improvement plan that includes a demonstration bus on shoulder project (unfunded TIP project TD-4944). The I-40/Research Triangle Regional Partnership has been examining the potential for implementing a pilot implementation of Bus on Shoulder Systems (BOSS) since 2010. Representatives from the I-40 Regional Partnership visited the Twin Cities region at the end of October and beginning of November, 2011 to observe first-hand the operation of the bus shoulder system there.

The North Carolina Department of Transportation and Triangle Transit, in cooperation with several I-40 Regional Partnership members including the Federal Highway Administration, the Capital Area Metropolitan Planning Organization, the Durham-Chapel Hill-Carrboro Metropolitan Planning Organization, the Regional Transportation Alliance, and other local and regional partners, have worked together to develop a pilot installation of a Bus on Shoulder System (BOSS) in the Research Triangle area. The implementation of BOSS is expected to help provide transit vehicles and transit patrons in the Research Triangle region a cost-effective and time-efficient alternative to both recurring and non-recurring congestion along the pilot corridor.

The hard costs associated with the 2012 initial BOSS pilot implementation in Durham County are approximately $2,000 / shoulder-mile. The pilot will commence during 2012 and last at least a year. Should the pilot program in the Research Triangle region be successful, BOSS may be expanded to other warranted areas in North Carolina.

REGIONAL FRAMEWORK FOR DEPLOYMENT OF BUS ON SHOULDER SYSTEMS

Overall Implementation Process

The deployment of the pilot BOSS project for the Research Triangle region and for any future implementation in that region or elsewhere will follow a systematic approach. **Exhibit 10** outlines a suggested process, grouped into five focus areas, each with multiple elements. Of course, each region of the state is different and not every element or step of the process may be required or appropriate for each region. In addition, many of these focus areas and elements can occur simultaneously.

Exhibit 10 – Regional BOSS Implementation / Enhancement Process

1. INITIAL PREPARATIONS FOR REGIONAL BOSS IMPLEMENTATION

- Establishment or expansion of regional BOSS Implementation and Operations Team (BOSS Team)
- Review of BOSS North Carolina Implementation and Operations Plan (IOP) by regional BOSS Team
- Outreach to other areas with bus on shoulder operation for current lessons learned and guidance
- Update of BOSS North Carolina Implementation and Operations Plan (IOP) as needed
- Development of specific implementation plan and timeline for region
- Incorporation into regional and statewide transportation planning and programming processes as needed
- Incorporation into regional congestion management processes as needed

2. REGIONAL BOSS CORRIDOR SELECTION, PREPARATION, AND APPROVAL

- Statewide eligibility criteria
- Establishment of BOSS corridor prioritization criteria by regional BOSS Team
- Regional BOSS Team receives, compiles, reviews, and prioritizes requests for candidate corridors
- Field review and analysis of leading candidate BOSS corridors
- NCDOT determination of required infrastructure improvements and/or segment restrictions
- Funding review and implementation of needed infrastructure improvements
- Confirmation by NCDOT Division that all required improvements have been met and restrictions identified
- Final approval by NCDOT of corridor for BOSS operation
- Placement of signage, pavement markings, tactile warning devices, etc. along corridor, including locations of “pinch points” where bus on shoulder operation will be restricted

3. COOPERATIVE DEVELOPMENT/UPDATE OF REGIONAL BOSS IMPLEMENTATION STRATEGIES

- Operational policies, strategies, and procedures
- Maintenance policies, strategies, and procedures
- Enforcement policies, strategies, and procedures
- Public outreach policies, strategies, and procedures

4. DRIVER TRAINING FOR BUS ON SHOULDER OPERATION

- Development of BOSS driver training program in region and/or update for new BOSS corridors
- NCDOT collaboration of BOSS driver training program or program update
- Driver training for BOSS program and/or update for new BOSS corridors
- Agency approval of individual drivers for operation on specific BOSS corridors

5. IMPLEMENTATION AND MONITORING OF BOSS PROGRAM

- Implementation/enhancement of BOSS in region
- Operational, maintenance, enforcement, and public outreach adjustments as needed
- Recommendations for changes to BOSS statewide IOP
- Ongoing monitoring and review of regional BOSS program by BOSS Team

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REGIONAL FRAMEWORK FOR DEPLOYMENT OF BUS ON SHOULDER SYSTEMS:

1. INITIAL PREPARATIONS FOR REGIONAL BOSS IMPLEMENTATION – details of selected items

Establishment or Expansion of Regional BOSS Implementation and Operations Team (BOSS Team)
Implementation of BOSS in reach region shall be coordinated by a regional BOSS Implementation and Operations Team (BOSS Team), which will exhibit primary coordinating responsibility for several elements including corridor selection, implementation guidelines, and driver training. While the membership of each BOSS Team will vary depending on the needs of the region and the location of candidate BOSS corridors, a sample invitee list can be found in **Exhibit 11** below. A primary responsibility of the regional BOSS Team is to become familiar with this statewide BOSS Implementation and Operations Plan (IOP) – including the regional BOSS implementation / enhancement process outlined in Exhibit 10 – and then to establish an implementation timeline consistent with that process and this IOP. It will also be useful to reach out to other areas in North Carolina and elsewhere that utilize bus on shoulder operation for current lessons learned and guidance.

Exhibit 11: Potential Membership in Regional BOSS Team

-- NCDOT Division staff, including division engineer and assistants (operations and maintenance)
-- NCDOT Central office staff – roadway design, transportation mobility and safety including statewide operations, traffic safety, and signing, public transportation, etc. staff
-- NCDOT IMAP staff
-- NCDOT Statewide Transportation Operations Center (STOC) / Transportation Management Center (TMC) staff
-- NCDOT Communications / External Affairs staff
-- NCDOT Planning staff
-- Federal Highway Administration staff
-- Metropolitan Planning Organization (MPO) staff
-- Regional transit agency staff – operations, planning, and TDM, etc.
-- Any municipal, university, or community transit provider with interest in the program
-- State Highway Patrol
-- Any other law enforcement agency with jurisdiction on the pilot corridor
-- Any county government with interest in the program
-- Any appropriate private sector partners with interest in the program

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Incorporation into regional transportation planning processes and MPO congestion management process
Before a Bus on Shoulder System can be deployed or expanded in each region, BOSS must be incorporated into the Transportation Planning process for the area and the region's planned implementation of BOSS must result from that process. If incorporation into Long Range Transportation Plans (LRTPs) or Comprehensive Transportation Plans (CTPs) is required, those steps must be completed prior to implementation of BOSS on any corridor. In addition, for any BOSS segments that require infrastructure improvements, any corresponding projects should be included into the statewide Transportation Improvement Program (STIP) and/or metropolitan Transportation Improvement Programs (MTIP) where necessary.

Most metropolitan planning organizations (MPOs) in North Carolina have an active Congestion Management Process in place. BOSS is a tool that may serve as a response to the challenge of congestion in many of the state's growing regions, and incorporating BOSS into a region's existing Congestion Management Process will maximize the benefits of BOSS and improve harmonization with other congestion management techniques.

REGIONAL FRAMEWORK FOR DEPLOYMENT OF BUS ON SHOULDER SYSTEMS *(continued)***:**

2 – REGIONAL BOSS CORRIDOR SELECTION, PREPARATION, AND APPROVAL – details of selected items

Establishment of Regional BOSS Corridor Prioritization Criteria
While all freeway and expressway corridors with full- or partial-control of access and with fixed-route transit service are theoretically eligible as a BOSS corridor based on the statewide eligibility criteria discussed previously in Exhibit 9, that eligibility does not mean that a corridor will be immediately approved for bus on shoulder operation, and eligibility does not automatically translate into funding for any improvements needed to implement BOSS on a corridor. Since resources are necessarily limited and since the needs and characteristics of region are different, each region in the state that considers implementing and expanding BOSS should cooperatively develop a set of prioritization criteria or factors to help determine which corridors to evaluate in more detail**.** These criteria or factors could include degree of roadway congestion, level of existing/near term bus usage, current shoulder width and obstructions, cost for BOSS implementation, etc. A sample list of possible criteria or factors for potential corridor review and prioritization is shown in **Exhibit 12**. Each region can use some or all of the sample factors outlined in the Exhibit or choose other factors that they wish to use. Each region may choose whether or not to provide a specific fixed weight for each criteria or factor.

Exhibit 12 - Sample Regional Prioritization Criteria for Bus on Shoulder Corridor Designation (partial list)

Possible Prioritization Criteria
Assuming the corridor meets the eligibility criteria listed in Exhibit 9, regions may cooperatively prioritize eligible projects based on factors including the following:

- Duration of congestion each day
  -- *Freeway or expressway speeds below 35 MPH*
- Frequency of congestion per week
  -- *Days with congestion or backups*
- Number of buses per day, regardless of travel speed
- Cost to upgrade and ease of construction
- Length of continuous shoulder width of 10 feet or more
- Anticipated level of time savings, in seconds per mile per day
- Number of buses per day that experience congestion today or anticipated in future
- Connectivity to existing bus-on-shoulder segment to gain Bus on Shoulder Systems benefits
- Connectivity to transit hub, park-and-ride location, etc.
- Availability of funding

Regional BOSS Corridor Review and Prioritization
The regional BOSS Team shall then review and rank each eligible corridor based on the criteria and factors established for the region. A map showing all candidate corridors, with annotations showing individual bus routes or buses per day along the corridor, could be created to facilitate communication. The output of this process is a working priority list of potential regional BOSS corridors to examine further.

Note that project implementation may not occur in precisely the ranking order due to funding and other constraints and opportunities. For example, corridors with lower levels of transit service or recurring congestion could still be added sooner if the cost to upgrade is minimal, and/or corridors ranked as high priorities by a regional BOSS Team may have obstructions that render them infeasible for BOSS operation in the short-term.

Field Review and Analysis of Leading Candidate BOSS Corridors

Once a manageable list of potential BOSS corridors has been identified by the regional BOSS Team, NCDOT and appropriate partner agencies shall designate appropriate staff to conduct a field review and analysis of one or more priority corridors in cooperation with other partners. The following paragraphs provide examples of the possible scope of that work.

The appropriate transit agency or agencies shall provide the Department with current or expected daily transit use along the corridor.

NCDOT shall conduct a field review of the roadway elements along the proposed BOSS corridors including shoulder width, vertical clearance, shy distance, existing bridge and drainage structures, etc. in order to determine existing conditions and initial compatibility with statewide geometric design criteria for BOSS.

NCDOT shall Review the corridor for compliance with geometric design criteria. Additional analysis can occur as needed, for example, a review of structural design of bridges and drop inlets and an examination of possible drainage impacts due to an increase in overall impervious surface area associated with any potential shoulder width expansions or any related needs for right-of-way modifications, utility relocations, permits, etc.

The appropriate staff from NCDOT Transportation Mobility and Safety, the regional Transportation Management Center (TMC) and the Division Traffic Engineering staff shall examine the proposed BOSS corridors for potential traffic operational issues and opportunities that may emerge under BOSS operation. This may include a review of existing speed and congestion data and crash history, an examination of those locations that may require special attention under BOSS operation including interchange areas and restricted shoulder width areas, and other factors as appropriate. The potential for restriping mainline roadways in restricted shoulder width areas can be examined, along with the capacity, operational, and safety impacts of such a possible change. The review may also include the locations of existing or potential dynamic message signs, speed detection units, and other ITS devices.

NCDOT Determination of Required Infrastructure Improvements and/or Segment Restrictions

Upon completion of all field reviews and analyses for the proposed corridors, NCDOT Division and central office staff shall cooperatively compile a list of any required infrastructure improvements, pavement rehabilitation, drainage structure strengthening, relocations of existing signs or other roadside hazards as needed to avoid conflicts with bus mirrors, guardrail adjustments, restriping, permits, etc. that would be required in advance of any implementation of BOSS along the corridor.

The Department shall also identify specific recommended start and end points for the various segments and mark them with signing, and identify any locations where BOSS shall be restricted due to insufficient shoulder width or other factors. This information shall be provided to the regional BOSS Team for its information.

Funding Review and Implementation of Needed Infrastructure Improvements

Members of the regional BOSS Team shall explore funding opportunities for each of the improvements needed as well as additional improvements that may enhance the performance of the corridor. A review of existing or upcoming TIP projects could be one example of a potential funding opportunity. Once funding is secured, the Department will begin the implementation of the needed infrastructure improvements with the BOSS Team.

Placement of Signage, Pavement Markings, Tactile Warning Devices, etc. along Corridor, Including Restrictions
Whether or not a segment requires additional infrastructure improvements or has any BOSS-restricted locations, each segment will require the installation of signage and potentially audible and tactile warning devices, etc. before operation of BOSS. The Division Traffic Engineer and appropriate Transportation Mobility and Safety staff will determine the appropriate installation locations for signage and audible and tactile warning devices.

Confirmation by NCDOT and Corridor Approval for BOSS Implementation
The appropriate NCDOT Division staff will confirm that all required improvements have been implemented, signage and related traffic control devices installed, and restrictions identified. At that point, NCDOT will approve the corridor for BOSS implementation, pending the completion of other elements in the Regional BOSS Implementation / Enhancement Process outlined in **Exhibit 10**.

REGIONAL FRAMEWORK FOR DEPLOYMENT OF BUS ON SHOULDER SYSTEMS *(continued)***:**

3 – COOPERATIVE DEVELOPMENT OF REGIONAL BOSS IMPLEMENTATION STRATEGIES – details of selected items

Operational Policies, Strategies, and Procedures
Each region will need to establish policies and procedures – including interagency and intra-agency communication protocols – to ensure effective operation of BOSS under normal, congested, emergency situations, adverse weather, and other traffic incidents. Examples might include communicating about vehicles or debris in the shoulders, enforcement activity, other traffic incidents, trees or signs that are posing a hazard to bus operations, paving/striping projects, etc. The regional BOSS Team will establish, implement, monitor, and modify the operational policies, strategies, and procedures as needed. **Selected documents associated with the pilot BOSS installation shall be included as an appendix at the end of this document as they are developed.**

Maintenance Policies, Strategies, and Procedures
The regional BOSS Team will establish, implement, monitor, and modify the maintenance policies, strategies, and procedures as needed. These may include items such as:

- A shoulder cleaning strategy to ensure that the shoulder is kept clear of debris
- An inclement weather strategy to ensure safe operations of BOSS
- A pavement preventive maintenance strategy to ensure pavement integrity in a cost-effective manner

Enforcement Policies, Strategies, and Procedures
Members of the regional BOSS Team, including NCDOT, NC State Highway Patrol or other law enforcement agencies and the NCDOT Incident Management Assistance Patrol (IMAP) will coordinate concerning the implementation of an effective enforcement program to ensure the safe operation of freeway and arterial BOSS corridors. These may include items such as:

- Awareness of applicable statutes and operational policies
- Enforcement procedures for speeds, speed differentials, and yielding right-of-way
- Enforcement of unauthorized use of shoulders by motorists
- Enforcement of unauthorized bus on shoulder operation for shoulders not designated for BOSS, etc.
- Coordination with other emergency response vehicles and agencies

Public Outreach Policies, Strategies, and Procedures
As the BOSS pilot implementation in Durham County constitutes the first bus on shoulder installation within 200 miles of North Carolina, an effective public outreach campaign in advance of the pilot implementation as well as future expansion will be critical to the success of the BOSS program. Each regional campaign should be a cooperative effort of NCDOT, local and regional transit agencies, and other public and private partners in each region.

While the specifics of each program will depend on the region, each outreach program should utilize multiple communication channels well in advance of the implementation as well as upon commencement of BOSS operation or expansion. The regional BOSS Team will establish, implement, monitor, and modify the public outreach policies, strategies, and procedures as needed.

Selected documents associated with the pilot BOSS installation shall be included as an appendix at the end of this document as they are developed, including sample Frequently Asked Questions initially developed for the BOSS pilot implementation in Durham County.

REGIONAL FRAMEWORK FOR DEPLOYMENT OF BUS ON SHOULDER SYSTEMS *(continued)***:**

4 - DRIVER TRAINING FOR BUS ON SHOULDER OPERATION – details of selected items

The success of bus on shoulder operation in North Carolina will depend in large measure on the efforts of the individual professional transit drivers who will operate transit vehicles on the shoulder. Therefore, each agency or region must develop a driver training program in collaboration with NCDOT, and each bus driver must be trained on bus on shoulder operation on an overall policy basis as well as on an individual corridor basis. Each transit agency must provide for the training of its drivers. An example of the elements of a possible driver training program curriculum is shown in **Exhibit 13**. Individual agencies will approve their drivers for bus on shoulder operation on a corridor-by-corridor basis.

Exhibit 13 – Sample Bus on Shoulder Systems (BOSS) Driver Training Program Elements

Core Elements
- Purpose of bus on shoulder program
- Operating guidelines
  -- Speed and speed differential
  -- Yielding right-of-way
  -- Interchange areas
  -- Staying on paved shoulder
- Judging operating speeds of mainline traffic
- Signs, pavement markings, and audible warnings
  -- Motoring public
  -- Specific information for bus drivers
- Applicable statutes and enforcement
- Communications
  -- Intra-agency
  -- Inter-agency
  -- Driver to motorist/driver courtesy
- Emergency communication

Corridor-by-Corridor Elements
- Start and end points
- Interchange and/or intersection locations
- Shoulder widths
- Special attention locations
- Restricted locations

Additional Elements
- Agency-specific policies (e.g., evening operation)

As noted in the utilization framework outlined in the statewide operational policies from Exhibit 3, each approved driver still decides whether or not to travel on all or a portion of an available BOSS corridor on a trip-by-trip basis, and each agency can establish additional restrictions on BOSS usage – for example, on nighttime operation – as long as those additional policies are identified and included in initial or follow-up driver training.

REGIONAL FRAMEWORK FOR DEPLOYMENT OF BUS ON SHOULDER SYSTEMS *(continued)*:

5 - IMPLEMENTATION AND MONITORING OF BOSS PROGRAM – details of selected items

Implementation or Enhancement of BOSS in Region
When all prior elements of the Regional BOSS implementation process outlined in Exhibit 10 have been completed, bus on shoulder is ready for implementation. As implementation day approaches, a more detailed timeline and action steps for each partner should be established, with a particular focus on communications within agencies, among agencies, and with the public.

Operational, Maintenance, Enforcement, and Public Outreach Adjustments as Needed
Adjustments to operational, maintenance, enforcement, and public outreach strategies or policies will almost certainly be needed as the BOSS program moves from planning to implementation in a region. The BOSS Implementation and Operations Team (BOSS Team) in each region should continue to meet on a periodic basis to share information, identify potential improvements, and cooperatively implement those improvements.

Recommendations for Changes to BOSS Statewide IOP
This NC BOSS IOP seeks to cover a number of preparatory, operational, and maintenance areas associated with the deployment of bus on shoulder operation in North Carolina. However, nothing substitutes for actual experience, and the regional BOSS Team should compile a list of recommended changes, additions, or improvements to the BOSS (NC IOP) so as to improve information sharing across the state and with jurisdictions beyond North Carolina.

Ongoing Monitoring and Review of Regional BOSS Program
The pilot project in the Research Triangle region is in essence the initial field research project for the implementation of Bus on Shoulder Systems in North Carolina. The NCDOT Transportation Mobility and Safety Division shall develop a plan to effectively monitor the performance of the initial pilot project and any subsequent BOSS installations that may include:
- Start and end dates for the evaluation of the program
- Designation of “treatment” (i.e., pilot implementation) and “control” (no BOSS implementation) sections
- Data collection and evaluation criteria
- Timeline for reporting results
- Communication with BOSS Team partners about issues that may arise

The results of the research of the pilot BOSS implementation shall be compiled and shared with regional, state, and federal partners to inform the potential next steps for the implementation of BOSS in the region and elsewhere in North Carolina.

REFERENCES AND ACKNOWLEDGEMENTS

Minnesota DOT / "Team Transit"
Many elements of this implementation and operations plan for the development of BOSS in North Carolina rely on extensive experience of Minnesota with bus on shoulder operations in terms of both duration of program (more than two decades) and extent of system (nearly 300 shoulder miles). NCDOT and other partners gratefully acknowledge the assistance and support of "Team Transit"– a partnership of regional transit agencies and the Minnesota Department of Transportation that provides overall coordination for bus on shoulder operations in Minneapolis-St. Paul and vicinity. Representatives from the I-40/Research Triangle Regional Partnership visited the Twin Cities region in October and November, 2011 to observe first-hand the operation of the bus shoulder system there.

For more information on Team Transit in Minnesota, visit the following links:

http://www.dot.state.mn.us/metro/teamtransit/docs/operating_rules_on_shoulder.pdf
http://www.dot.state.mn.us/metro/teamtransit/docs/bus_only_shoulder_guidelines.pdf
http://www.dot.state.mn.us/metro/teamtransit/docs/mn_statutes_2006.pdf
http://www.dot.state.mn.us/metro/teamtransit/visual/Training%20For%20Bus%20Drivers%202.wmv
http://www.dot.state.mn.us/metro/teamtransit/docs/bus_only_shoulder_guidelines.pdf

I-40 Regional Partnership The I-40 Regional Partnership in the Research Triangle region has served as the impetus for advancing BOSS in the area and provides an ongoing coordination mechanism through a regional BOSS Team. The members of the I-40 Regional Partnership in the Research Triangle region who have focused on the implementation of BOSS and other potential improvements to the I-40 corridor include those listed on page 12 of this document.

RTA Volunteers
The RTA would like to acknowledge the assistance of several FAST member firms that have provided past or ongoing assistance with the implementation of BOSS in our region, including CDM Smith, PB Americas, Martin/Alexiou/Bryson, PC, AECOM, and WSP SELLS, as well as all members of the I-40 Regional Partnership in the Research Triangle region.

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APPENDICES

Appendix – NCDOT Design Criteria for Bus on Shoulder Systems Implementation

Bus on Shoulder Systems (BOSS): Geometric Design Criteria

Type of Highway: Urban Multi-Lane Freeway and Expressway; Buses on right shoulders only

CONTROLLING GEOMETRIC DESIGN CRITERIA	STANDARD	NOTES
Design Speed, mph	35	Maximum speed for busses traveling on shoulder, as per operational policy
Shoulder Width, ft	10.0 12.0	10.0 ft minimum, 12.0 ft desirable 12.0 ft in areas of new construction or reconstruction
Bridge Width, ft	10.0 12.0	10.0 ft minimum width, 12.0 ft desirable 12.0 ft in areas of new construction or reconstruction
Grades, max. %	nc	No change (nc) match existing roadway
Front Slopes	6:1	If front slopes are not steeper than 6:1, they may be steepened to 6:1. If front slopes are steeper than 6:1, match existing, except in the following cases: • If fill slope is steeper than 3:1 and higher than 2 ft, provide guardrail. • If fill slope is steeper than 3.5:1 and higher than 5 ft, provide guardrail, unless there is 18 ft between the edge of shoulder and the point where the fill slope becomes steeper than 3.5:1.
Structural Capacity	HS25	For new bridges. For existing bridges to allow shoulder use the shoulder must be structurally adequate (capable of carrying legal loads and does not appear on the inventory of inadequate bridges).
Horizontal Alignment, radius, ft	nc	No change (nc) match existing roadway
Vertical Alignment, Minimum K value	nc	No change (nc) match existing roadway
Stopping Sight Distance, ft	250	Stopping Sight Distance based on 35 mph design speed
Cross Slope, ft/ft	0.02 – 0.04	NCDOT Roadway Standard Drawing 560.02
Superelevation max, ft/ft	nc	No change (nc) match existing roadway
Vertical Clearance, ft	14	AASHTO's A Policy on Geometric Design of Highway & Streets 2011: Chapter 8, pg. 8-4 Tallest Design Vehicle 10'-9"
Horizontal Clearance to Obstructions, ft	0	AASHTO's A Policy on Geometric Design of Highway & Streets 2011: Chapter 8, pg. 8-5 2 ft beyond edge of shoulder is preferable, as a minimum, place at the edge of shoulder.

Appendix – Selected Operational Policy Documents
BOSS Pilot: Reporting & Relaying Incident Details

Purpose:
The following are guidelines to assist communication between the NCDOT's Statewide Transportation Operations Center (STOC), the Triangle Transit Authority (TTA) as well as the North Carolina State Highway Patrol (NCSHP) and Durham Police Department (DPD) in regards to the detection of traffic incidents and how they are relayed to various partners within the Pilot Program of the Bus on Shoulders System (BOSS).

Emergency and Urgent Incidents:
Traffic incidents vary widely in terms of response as well as the level of impact that they have on the mobility and safety of the roadway. For the purpose of the BOSS pilot, the following two categories are proposed in order to assist BOSS partners in distinguishing one incident type from another and determining who the report needs to be delivered to:

- **Emergency Incidents:**
  - Vehicle Accidents
  - Disabled Vehicles involving a medical emergency
  - Toxic or Hazardous Materials
  - Fire-related Incidents
  - Any incident impacting a travel lane
- **Urgent Incidents:**
  - Disabled or Abandoned Vehicles
  - Large or potentially hazardous debris
  - Damage to shoulder or structures

TTA Bus Drivers & Dispatchers:
In the course of traveling on the shoulder for BOSS, TTA Bus Drivers will frequently come across traffic incidents that not only impede their use of the shoulder but also have an impact on regular commuter traffic as well. As trained transportation personnel, TTA drivers possess the knowledge and experience to recognize traffic incidents and to accurately report their location and possible impact to traffic. Just like NCDOT and Law Enforcement personnel, this information can be received and acted upon with confidence.

- Emergency Incidents: Upon detection of any of the emergency incidents listed above, TTA drivers may report the incident to their Dispatchers who, upon receipt of this information, should contact the appropriate Law Enforcement telecommunications centers for DPD or NCSHP.
- Urgent Incidents: Upon detection of any of the urgent incidents listed above, TTA drivers should report this information to their Dispatchers who, upon receipt of this info, should notify the STOC of the incident. STOC 24/7 phone number: 877-627-7862

Law Enforcement Personnel:
As incidents occur on the roadway, they are often relayed to Law Enforcement personnel very shortly after they have occurred. Law Enforcement personnel (including DPD and NCSHP) have a primary responsibility to respond to many of these incidents in order to assure public safety and proper adjudication.

- Emergency Incidents: Upon receipt of a report of any of the previously listed emergency incidents, personnel at the appropriate law enforcement telecommunications center should contact the STOC to relay the incident details such that appropriate response measures can be implemented including
  - Dispatching IMAP to the scene
  - Activating Dynamic Message Signs (DMS) to warn or redirect motorists
- Urgent Incidents: As law enforcement units in the field detect or receive reports of any of the previously listed urgent incidents, they should relay this information to their Dispatchers who should notify the STOC such that the appropriate response measures can be implemented including
  - Activation of Signal 4 (rapid recovery/removal) procedures

STOC Operators:
As incidents are received from any of the BOSS partners previously discussed, STOC Operators should assure that all appropriate response measures are implemented and should keep in regular contact with the reporting agency as well as responders in order to provide updates including:

- Possible ETAs for DOT responders
- Progress of response efforts
- Cancellation or suspension of response measures

Appendix – Selected Maintenance Policy Documents
(to be added)

Appendix – Selected Enforcement Policy Documents
(to be added)

Appendix – Selected Public Outreach Policy Documents
(to be added; see also subsequent pages)

Appendix – Sample BOSS One-Pager

Bus on Shoulder System (BOSS) Pilot in North Carolina's Research Triangle Region

Bus on shoulder operation is a low-cost, fast-implementation treatment that can provide immediate benefits to transit whenever mainline travel is experiencing moderate to heavy degrees of congestion. Bus on shoulder operation will allow transit buses with trained drivers to operate on the shoulders of selected freeways and expressways in order to bypass congestion and maintain transit schedules.

Bus on shoulder operations were first implemented in Minnesota more than 20 years ago, with nearly 300 shoulder-miles in use today. More than 10 states now use bus on shoulder, and no state has discontinued an operating bus on shoulder program for operational or safety reasons once commenced.

In North Carolina, transit buses will only be able to use shoulders when travel speeds are below 35 MPH in the main lanes in the direction of travel, and buses will only travel up to 15 MPH faster than other vehicles in addition to the 35 MPH limiting speed. However, the shoulders will retain their primary use as a breakdown or emergency area, and buses will have to yield to all other vehicles when using the shoulder.

Expected benefits of the program for North Carolina are similar to those identified by Minnesota and other states, and are expected to include some or all of the following:

- Shorter transit travel times
- More predictable and reliable transit schedules
- Fewer missed transfer connections
- Increased transit ridership
- Reduced driver overtime
- Decreased operational costs

The first BOSS pilot implementation in North Carolina will occur on I-40 in the Research Triangle area during 2012. If successful, the program could be expanded to other routes, with the goal of creating a regional Bus on Shoulder System.

Bus on Shoulder Guidelines for North Carolina

If travel speeds in main lanes in direction of travel are:	**Then transit buses on adjacent right shoulder:**
65 MPH, 55 MPH, even 35-40 MPH	N/A: Cannot use shoulder
20, 25, 30, 35 MPH	Can go up to 35 MPH
15 MPH	Can go up to 30 MPH
10 MPH	Can go up to 25 MPH
5 MPH	Can go up to 20 MPH
Stopped (0 MPH)	Can go up to 15 MPH

Appendix – Sample FAQs for Bus on Shoulder Systems in North Carolina

Sample FAQs for Bus on Shoulder Systems in North Carolina

Note: The FAQs that follow were initially developed for the pilot implementation of BOSS in Durham County in 2012.

Q. What is bus on shoulder operation?

A. Bus on shoulder operation allows authorized transit buses with trained drivers to operate on the shoulders of selected freeways at low speeds during periods of congestion in order to bypass congested traffic and maintain transit schedules. Bus on shoulder operation is a low-cost treatment that can provide immediate benefits to transit whenever mainline travel is experiencing moderate to heavy degrees of congestion.

Q. What is a Bus on Shoulder System (BOSS)?

A. A regional Bus on Shoulder System (BOSS) is a network of freeway shoulders available for travel by authorized transit buses under congested conditions. North Carolina is seeking to develop such a system in the Research Triangle region and potentially other regions of the state, commencing with a pilot installation on I-40 beginning in 2012.

Q. Where will the Bus on Shoulder System initial pilot segment be located?

A. The pilot section will be located on Interstate 40 in southern Durham County in the Research Triangle region of North Carolina.
- On westbound I-40, the pilot will begin just west of the NC 147 interchange (exit 279) and continue to the US 15-501 interchange (exit 270).
- On eastbound I-40, the pilot will begin at the US 15-501 interchange (exit 270) and continue to the Page Road interchange (exit 282).
- The total length of the pilot is approximately 20 shoulder-miles.

Q. When will buses be able to travel on the shoulder?

A. When traffic in the main lanes in the direction of travel is traveling no faster than 35 MPH, authorized transit buses will be able to travel in the adjacent right shoulder at speeds up to 35 MPH, as long the bus stays within 15 MPH of general purpose travel speeds. This means that buses can travel up to 35 MPH as long as speeds in the main lanes are between 20 MPH and 35 MPH.

Q. Will there be time-of-day restrictions for bus on shoulder operation, for example, only during "rush hours"?

A. No. Approximately 50% of all congestion is "non-recurring", that is, outside of predictable travel periods. Congestion can arise due to either heavy traffic volumes or capacity reductions associated with weather, incidents, and the like. Authorized transit buses will be permitted to travel on bus shoulders in the pilot area during any period of congestion as long as maximum speed thresholds are met.

Q. If I have an emergency, will I still be able to use the shoulder? What if I can't get out of the way of a bus?

A. Shoulder use for emergencies will continue to take precedence over bus on shoulder operation. BOSS operation on the shoulder during peak periods is a subservient use of the shoulder, which means that authorized transit buses traveling in the shoulder will have to yield to all other vehicles. That having been said, unattended vehicles will be rapidly towed away from shoulders in the pilot area.

Appendix – Sample FAQs for Bus on Shoulder Systems in North Carolina *(continued)*

Q. Will all transit buses travel on the shoulders in the pilot section when speed thresholds are met?
A. No. Only authorized transit buses with trained drivers will be permitted to travel on the shoulders during periods of congestion. These drivers will have the option, but not the requirement, of operating on the shoulders in congested conditions. Even when speeds in the main lanes permit shoulder travel, trained bus drivers may always elect to use only portions of the shoulder mileage, or none at all, depending on their professional judgment of the conditions at that time.

Q. Will any signs be installed on I-40 or on the on-ramps to I-40 in the pilot area to alert motorists to the Bus on Shoulder System?
A. Yes. "Shoulder: Authorized Buses Only" and "No parking -- tow away zone" signs will be installed on I-40 in the pilot area. "Watch for buses on shoulder" signs will be installed at I-40 on-ramps in the pilot area. All sign installations will occur in March 2012, prior to the commencement of pilot BOSS operations on I-40 in 2012. In addition, other public outreach will be conducted, including the use of selected overhead dynamic electronic message signs on I-40.

Q. If buses are limited to 15 MPH faster than other vehicles, does that mean that when traffic is stopped on I-40, buses will only be able to travel up to 15 MPH on the shoulder?
A. Yes. While 35 MPH is the maximum shoulder operating speed, buses must also keep within 15 MPH of general purpose travel speeds, and that limitation controls when traffic speed in the main lanes drops below 20 MPH. Therefore, if traffic is stopped, 15 MPH is the limiting speed for bus travel on the shoulder. See the table below for specific speed thresholds under bus on shoulder operation.

Travel Speed examples associated with maximum BOSS operating speeds

If travel speeds in main lanes in direction of travel are:	**Then transit buses on adjacent right shoulder:**
65 MPH, 55 MPH, even 35-40 MPH	N/A: Cannot travel on shoulder
20, 25, 30, 35 MPH	Can go up to 35 MPH
15 MPH	Can go up to 30 MPH
10 MPH	Can go up to 25 MPH
5 MPH	Can go up to 20 MPH
Stopped (0 MPH)	Can go up to 15 MPH

Q. Will urban Interstate speed limits need to be lowered below 65 MPH, 60 MPH, or 55 MPH in order to implement the BOSS program?
A. No. Since bus on shoulder usage only applies during congested conditions when travel in the main lanes is below 35 MPH, no speed limit changes will be needed to implement bus-on-shoulder operation in North Carolina.

Q. If traffic is moving at say 40-45 MPH, my understanding is that the buses cannot travel on the shoulder. How will buses stay on schedule?
A. The goal of the bus on shoulder program is to provide a low-cost way of improving schedule certainty for transit under congested conditions while maintaining a high degree of safety on our freeway system. Bus travel on the shoulder is indeed limited to 35 MPH speeds and below. Once buses can travel above 35 MPH they must stay on the main lanes and can largely stay on schedule.

Appendix – Sample FAQs for Bus on Shoulder Systems in North Carolina *(continued)*

Q. How much will it cost to get Interstate 40 ready for bus-on-shoulder operation in the Research Triangle region?

A. The direct costs of implementing a pilot Bus on Shoulder System (BOSS) along approximately 20 shoulder-miles of I-40 is approximately $2,000/shoulder-mile, with those costs primarily for signage. This is an incredibly cost-effective improvement to enhance transit reliability. In addition, it may also save area transit agencies money in terms of reduced operating costs.

Q. Allowing buses to travel on the shoulder during peak periods seems like a good idea. Why is this limited to a small section of freeway in one area of the state?

A. More than ten states have implemented bus on shoulder usage during peak periods, and this is North Carolina's first pilot project. The pilot will begin in 2012, and an end date has not been determined, although it is planned to last at least one year. However, if the pilot is successful in terms of both operational and safety performance over time, expansion of bus shoulder operation to other portions of I-40, Wade Avenue Extension, and other freeways in Durham, Orange, and Wake counties will be considered. In addition, other areas in North Carolina may pursue the creation of a Bus on Shoulder System on freeways in their area.

Q. While bus on shoulder may be new to North Carolina, I understand that it has been used elsewhere with success. Which other states are using bus on shoulder operation?

A. More than ten states currently use bus on shoulder operation on one or more roadways, including the following:

- South region: FL, GA
- Northeast/Mid-Atlantic region: NJ, DE, MD, VA
- Midwest region: OH, MN, IL, KS
- West region: CA, WA

The Minneapolis-St. Paul region alone has nearly 300 shoulder-miles of bus shoulder in operation. The Minnesota program began approximately 20 years ago. The North Carolina BOSS program is modeled after the successful bus shoulders program in Minnesota.

Q. Virginia allows all vehicles to travel on the shoulder during peak periods in both Northern Virginia (e.g., I-66) and Hampton Roads (e.g., I-64). What is the reason that North Carolina will restrict shoulder travel during congested periods to just transit buses rather than allowing all vehicles to travel on the shoulder to avoid congestion?

A. North Carolina is pursuing a pilot Bus on Shoulder System (BOSS) program for the Research Triangle region that will improve transit operations during congested periods and enhance the viability of transit as a travel option. BOSS is a low implementation cost program with a number of unique travel, safety, and cost benefits. Some of the benefits associated with BOSS include:

- Small number of vehicles, operated by trained, professional bus drivers
- Slow travel speeds (35 MPH or less)
- High visibility of buses by motoring public and higher vantage point for drivers
- Increased transit schedule reliability and improved attractiveness of transit as a travel option
- Reduced travel time impact of congestion which lowers transit operating costs
- Low implementation cost

NCDOT has previously explored the potential of allowing all vehicles to travel on freeway shoulders such as on I-485 in south Charlotte and may consider doing so again in the future. Any consideration of all allowing all vehicles to travel on freeway shoulders in the future will examine the impact on freeway operations, travel safety, transit schedule reliability, and overall cost.

Appendix – Sample FAQs for Bus on Shoulder Systems in North Carolina *(continued)*

Q. What are the reasons that the Research Triangle region is examining bus-on-shoulder operation for I-40, as opposed to adding an HOV (high-occupancy vehicle), express toll, or other premium lane on the Interstate?
A. Bus on shoulder operation can be implemented much more quickly and less expensively than the creation of a new travel lane since a BOSS uses the existing the freeway shoulder. In addition, the implementation of BOSS now will not preclude the future addition of express lanes on I-40 or other freeways. In fact, successful implementation of BOSS can create a larger base of transit ridership that could use a future express lane.

Q. I don't plan on using transit. How will I benefit from the creation of a regional Bus on Shoulder System?
A. Bus on Shoulder Systems (BOSS) are a very cost-effective way to make bus travel more attractive as well as more efficient, which can increase transit ridership while saving public transit operators money and/or allowing them to provide more transit service options. If more people use transit as a viable and reliable travel option that will improve the performance of our overall transportation system.

Q. Is this initiative primarily being led by NCDOT or are other agencies involved?
The two primary implementation partners for the BOSS initiative are NCDOT and Triangle Transit, which provides regional public transportation services for the Research Triangle area in cooperation with local transit providers.

The Bus on Shoulder System program in the Research Triangle region is an initiative of the I-40 Regional Partnership. The Partnership is a cooperative initiative of the NC Department of Transportation (NCDOT), the Capital Area Metropolitan Planning Organization (MPO), the Durham-Chapel Hill-Carrboro MPO, cities and towns along the corridor, Triangle Transit, RDU Airport, the Research Triangle Park (RTP), the North Carolina State Highway Patrol (SHP), local law enforcement, the Federal Highway Administration (FHWA), the Regional Transportation Alliance (RTA), and other partners. The Partnership is designed to provide an ongoing focus on the Triangle's most critical freeway in order to maintain its long-term viability. Meredith McDiarmid, PE, NCDOT State Systems Operations Engineer, serves as the corridor executive for I-40 in the Research Triangle area (between I-85 and I-95).

Appendix – Sample BOSS Team Documents

Sample Boss Team Invitation

Dear Regional Transit Partner,

The NC Department of Transportation, Triangle Transit, and other members of the I-40 Regional Partnership are focusing on an expected pilot implementation of a Bus on Shoulder Systems (BOSS) project on I-40 in the Research Triangle region later this year. The I-40 Regional Partnership is initiating a regional BOSS Implementation/Operations Team (BOSS Team) which will exhibit primary coordinating responsibility for several elements of the BOSS program including corridor selection, implementation guidelines, and driver training.

The Team's initial focus will be the successful development and execution of a pilot BOSS implementation on the corridor. However, the Team will continue to meet periodically even after the conclusion of a successful pilot in order to maintain the effectiveness of the program and to consider expansion of BOSS to other locations in the region.
We would like to invite you and/or a designee from your organization to become a member of the regional BOSS Team. We will have an optional orientation meeting to what Bus on Shoulder Systems are on Thursday, March 24th, and then our first BOSS Team meeting on Thursday, April 14th. Each meeting will be at 2:30pm at Triangle Transit headquarters in southeast Durham - 901 Slater Road. An expected future meeting schedule can be found below.

Please reply by Monday, March 7 as to whether you and/or a designee would be willing to participate in these Team meetings, and your availability (and/or the availability of your representative/designee) for both the optional orientation meeting in March and the first Team meeting in April.
Thank you for your commitment to regional transportation!

Meredith McDiarmid, PE
NCDOT State Systems Operations Engineer
Corridor Executive, I-40/Research Triangle

John Tallmadge
Director of Commuter Resources
Triangle Transit

Joe Milazzo II, PE
Executive Director
Regional Transportation Alliance

Expected schedule of initial meeting dates (all meetings at Triangle Transit, 901 Slater Rd at 2:30pm)
- Th Mar 24 -- Optional orientation
- Th Apr 14 -- First BOSS I/O Team meeting
- Th May 12 -- Second meeting
- Th June 9 -- Third meeting
- Th July 14 -- Fourth meeting
- Th August 11 -- Fifth meeting
- Th August 25 -- Sixth meeting
- Th September 8 -- Seventh meeting

Appendix – Sample BOSS Team Documents *(continued)*

Sample Boss Team Meeting Agenda

I-40 Regional Partnership
Bus on Shoulder Systems (BOSS) Team Meeting
Meeting 6 -- Friday, December 9, 2011
9:00 - 11:30 am, Triangle Transit

AGENDA

1. **Welcome, introductions, and thank yous** -- *Meredith McDiarmid, PE, NCDOT*

2. **BOSS status update** -- *Meredith McDiarmid, PE, NCDOT*
   -- **Progress to date, critical path items, pending tasks**

3. **Revisions to Implementation and Operations Plan**

4. **Field visit via bus of pilot corridor** – *Tammy Romain, Triangle Transit & Battle Whitley, NCDOT*

5. **Driver training** -- *Tammy Romain, Triangle Transit*

6. **Signage plan preparations** -- *Ron King, PE, NCDOT*

7. **Update on similar initiatives in other states:**
   -- Metro Chicago, IL: I-55
   -- Metro Kansas City, KS: I-35

8. **Public outreach and education** -- *Steve Abbott, NCDOT and Brad Schulz, Triangle Transit*
   -- Media coverage this week: R*aleigh News & Observer 'Road Worrier' column* and editorial

9. **Operations, Communications, and Enforcement Protocols** -- *NCDOT Transportation Mobility and Safety staff*

10. **Other outstanding items**
    -- Review of drainage structures -- *NCDOT*
    -- Other corridor preparation items -- *NCDOT*
    -- Potential pilot corridor extensions -- *NCDOT*
    -- Pilot evaluation framework -- *Triangle Transit and NCDOT*
    -- Other items as identified by BOSS Team

11. **Key milestone dates**

12. **Confirm next two meeting dates:**
    -- Friday, January 6, 2012
    -- Friday, February 3, 2012

Adjourn
