2 Alternatives

2.1 Introduction

This chapter provides a summary of the various alternatives identified as potentially satisfying the stated purpose and need of the project. The screening process used to select a reasonable range of alternatives is described along with a detailed explanation of each alternative including No-Action (or No-Build Alternative). A summary of the environmental consequences of each alternative from Chapter 4 is also provided and the Selected Alternative identified.

2.2 Project Scoping

Scoping is the identification of the issues and range of alternatives to be considered in the EIS. This was accomplished for the present project through correspondence, telephone calls and formal and informal meetings with federal, state and local agencies and officials. Formal Scoping meetings for which notices were published in the Federal Register and local papers, were held on May 19, 1992, and December 6, 2000. At the first meeting, a number of questions were raised relative to traffic projections and how traffic on I-93 might influence traffic volumes on other state highways. Ultimately, it was decided the study would be put on hold until after the Statewide Transportation Model could be created to address the traffic issues.

The second Scoping Meeting was held after the study had been re-initiated and the *Scoping Report (VHB, May 2000)* published. The second meeting was held to provide an opportunity to formally take comment on the purpose and need of the project, the study area under consideration, the alternatives considered and the key issues involved. Key issues focused primarily on how secondary impacts would be evaluated and addressed and the need to fully evaluate rail as an option to highway widening. In addition, a number of Advisory Task Force, Public Informational, and Resource Agency meetings were held prior to, and since the second Scoping Meeting, to foster public participation in the process.

2.3 Alternatives Considered

Conceptual alternatives were identified and discussed in the *Scoping Report (VHB, May 2000)* and the subsequent *Rationale Report (VHB, January 2001)*. These alternatives provided a range of potential solutions or actions to address the purpose and need of the I-93 Salem-Manchester project. The six basic types of alternatives were:

- No-Build,
- Implementation of Transportation System Management (TSM) actions, see Section 2.3.2,
- Providing additional lanes to the existing highway (highway widening),
- Implementation of Transportation Demand Management (TDM) strategies, see Section 2.3.4,
- Providing alternative modes of transportation (a form of TDM),
- A combination of these.

Alternative highway corridors involving the relocation of I-93 (or sections thereof) to bypass existing I-93 were not considered viable options because of the magnitude of investment required, presumed environmental impacts, and current traffic patterns associated with the existing facility.

The following sections describe each of the basic types of alternatives.

2.3.1 No-Build

The No-Build Alternative is essentially the continuation and perpetuation of the existing situation and the shortcomings inherent on the present highway corridor. Given the base year 1997 Average Daily Traffic (ADT) volumes, which range from 61,800 vehicles per day (vpd) between Exits 3 and 4 to 104,400 vpd south of Exit 1, and the projected 2020 No-Build ADT volumes, which range from 73,000 vpd to 137,000 vpd at the same locations, this alternative would not meet the project purpose and need, and in fact would result in a worsening situation relative to transportation safety and mobility. As such, the No-Build Alternative is not considered a viable alternative, but does serve as a baseline condition for comparison with other alternatives.

■

2.3.2 Transportation Systems Management

Transportation Systems Management (TSM) refers to short range, moderate cost measures aimed at reducing congestion and enhancing safety on the existing transportation system or roadway network. Generally, these measures involve little or no right-of-way impacts. Such measures might include adding traffic signals, modifying traffic signal timing or phasing, adding or extending turn lanes within the existing right-of-way, improving acceleration and deceleration lanes, restriping of existing pavement markings, and the incorporation of turn restrictions. In addition, Intelligent Transportation System (ITS) technology, such as variable message boards and emergency communications, can be considered.

In general, TSM improvements cannot address the long-term safety and capacity needs of a highway, but can provide some short-term relief in advance of the ultimate solution.

This section describes the specific TSM improvements that were investigated for the I-93 project including an analysis of ramp metering and shoulder lane use as possible TSM measures.

2.3.2.1 Interchange Geometry Improvements

A number of TSM improvements associated with the interchanges along the study corridor were evaluated (**Figure 2.3-1**).

Exit 2

The relatively short length and steep grade of the northbound on-ramp at Exit 2 can be problematic. The ramp grade (approximately 4 percent) combined with the relatively high percentage of truck activity (11 percent in the morning peak hour) can result in congestion and create potentially hazardous conditions as motorists caught behind slow moving trucks attempt to pass trucks at the gore area in an effort to enter the highway. In addition, the signalized northbound and southbound Exit 2 ramp intersections with Pelham Road (NH 97), as well as the nearby intersections of Pelham Road with Keewaydin Drive and North and South Policy Street, currently operate at or close to capacity.

To address the deficiency at the Exit 2 northbound on-ramp (**Figure 2.3-2**) a TSM option would be to extend the northbound on-ramp to provide greater distance and time for truck traffic to get up to speed before entering the highway. Note that this action would not address the LOS F operation of the merge movement during the evening peak hour, but would enhance the safe and efficient operation of the ramp merge.

In addition to extending the northbound ramp, the Town of Salem with participation from the State proposes to upgrade Pelham Road at the Exit 2 Interchange (**Figure 2.3-3**) in 2002. These modifications include widening Pelham Road to a 4-lane section and upgrading the Pelham Road/ Keewaydin Drive/Southbound ramp intersection, the Pelham Road/Stiles Road/Manor Parkway intersection, and the Pelham Road/ northbound ramps intersection. These modifications would provide one additional lane (resulting in a four-lane section) along Pelham Road through these intersections to provide for more traffic throughput at the intersections. Pelham Road, between the ramp intersections, would consist of two through lanes in the westbound direction, and a single through lane and an exclusive left-turn lane in the eastbound direction. A 2- to 4-foot shoulder would be provided on each side with a 5-foot sidewalk along the south side of the roadway. These modifications would substantially improve the operating conditions along Pelham Road over the near term.

Exit 3

At Exit 3, the intersections of NH 111 with the northbound and southbound ramps currently operate at capacity (LOS E) during the evening peak hour. The proximity of the NH 111/NH 111A intersection to the NH 111/northbound ramp intersection combined with the capacity constraints of the NH 111/northbound ramp intersection results in substantial delay and long vehicle queues along NH 111 and along the northbound off-ramp. In addition, unsignalized left-turn exiting movements from the southbound off-ramp onto NH 111 westbound operate at LOS F with long delays. However, the relatively low left-turn volume (75 vehicles during the morning peak hour and 70 vehicles during the evening peak hour) does not justify the installation of a traffic signal.

To address the deficiency at the Exit 3 northbound off-ramp (**Figure 2.3-4**), a TSM option would be to widen the off-ramp to provide double left-turn lanes. This concept is currently under design as part of the NH 111 Windham-Salem (10075) project. In addition, improved traffic signal coordination could be provided between the northbound off-ramp signal and the signal at the NH 111A/NH 111 intersection, located 500 ft to the east. With these modifications, the northbound off-ramp intersection would operate at LOS C in the evening peak hour.

At the southbound ramps (**Figure 2.3-5**) a recommended TSM option would be to extend the right-turn lane on the NH 111 eastbound approach to the intersection to better delineate and channelize the right-turn movement onto I-93 southbound. This action would allow motorists who are turning left onto NH 111 westbound from the I-93 southbound off-ramp to better distinguish the eastbound right-turn movements from the eastbound through movements. This improvement would enhance the safe and efficient operation of the intersection. In addition, the acceleration lane where the southbound on-ramp meets I-93 could be extended (**Figure 2.3-6**) to improve the merge between the ramp and the mainline. Installation of a traffic signal at the Southbound off-ramp/NH 111 intersection is not proposed as a TSM option because traffic volumes on the ramp are relatively low and the westbound approach on

NH 111 does not have enough room to provide two through lanes and an exclusive left-turn lane required to keep the intersection operation acceptable.

Exit 4

At the Exit 4 Interchange, the signalized northbound and southbound ramp intersections with NH 102 operate at acceptable levels of service. However, during the evening peak hour the NH 102 eastbound left-turn movement at the intersection with the northbound on-ramp can experience queues that exceed the available storage. A TSM option would be to extend the storage for the left-turn lane by approximately 300 feet (**Figure 2.3-7**). This could be accomplished by modifying the existing raised median.

Exit 5

The signalized northbound and southbound ramp intersections at Exit 5 operate at capacity (LOS E) during the peak hours of the day. Motorists experience delay on all approaches. However, from a safety perspective, the immediate need would be to address the existing problem of vehicles queuing back onto the I-93 southbound mainline from the southbound off-ramp. During the weekday evening peak hour, vehicles often queue back onto the shoulder area along the I-93 southbound approach to the off-ramp.

To address the queuing problem at the southbound off-ramp (**Figure 2.3-8**) a TSM option would be to lengthen the ramp and widen the shoulder area approaching the off-ramp to provide additional storage for these vehicles. This location would require a more substantial interim modification awaiting the long-term interchange reconstruction. The interim solution would likely require some widening of the existing railroad bridge just north of the southbound off-ramp to accommodate a longer ramp. The southbound off-ramp would also be widened to allow for proper separation of exiting and through vehicles. Retaining walls and special slope treatments would also be required to minimize impacts to surrounding wetlands.

Signal timing at the interchange intersections (**Figure 2.3-9**) could also be modified to provide additional green time to the off-ramp movements. Loop detection could be placed at the beginning of the off-ramp to detect the presence of queued vehicles and enhance the operation of the ramp intersections. The solution would in all likelihood increase the queuing along NH 28. However, because speeds are slower on NH 28 than along I-93, this would improve safety.

As an interim improvement to reduce the tendency of the southbound off-ramp queue to back up into the highway, NHDOT will be replacing the traffic signal controller that currently controls the traffic signal phasing and timing at the interchange. The new traffic signal controller will allow for the implementation of more efficient signal-phasing. Specifically, NHDOT will be implementing a phasing scheme that would allow the Route 28 eastbound left-turn movement onto the northbound on-ramp to occur under the same phase as the left-turn from the southbound off-ramp. Similarly, the Route 28 westbound left-turn movement onto the southbound on-ramp would occur under the same phase as the left-turn from the northbound off-ramp. This signal phasing modification is expected to reduce overall delay at the interchange by reducing the potential of excessive queuing and blockage between the ramps on Route 28.

2.3.2.2 Ramp Metering

The primary objective of any freeway control technique is to improve the safety and efficiency of mainline freeway operations by reducing the factors that increase freeway congestion. One method in freeway traffic control is freeway entrance ramp metering, commonly known as ramp metering. Ramp metering controls the access of vehicles into the mainline flows so that the vehicles entering upstream of the area of traffic flow to be managed are approximately proportional to the vehicles exiting downstream of the area. The purpose is to regulate freeway demand so that demand does not exceed highway capacity.

Control is provided via signalized entrance ramps which delay drivers entering the highway so that flow on the highway can be maintained at an acceptable level of operation. Ramp metering balances the overall traffic flow by regulating ramp demand in proportion to freeway capacity. Drivers trying to enter the highway must wait in the resulting queue and may be encouraged to find either another:

- point of entry,
- route,
- time to enter the freeway, or
- transportation choice.

Entrance ramp control operations can be subdivided into two main types, known as 'pre-timed metering' and 'traffic-responsive metering'[4]. Pre-timed metering, the most common form, is when the ramp meter rate is set as the difference in vehicles per hour (vph) between downstream capacity and upstream demand, based on historical volume data[5].

Traffic-responsive metering differs from pre-timed ramp metering in that the ramp meter rate is reflective of the current available capacity, which is based on 'real-time' monitoring of upstream and downstream traffic flows. Additional vehicle detectors placed either before the ramp meter for queue detection or after the meter for monitoring merge conditions can increase the efficiency of the meter operations. When several meters are linked together, the ramps respond to the entire freeway condition rather than the local condition, this is known as an 'integrated system

4 Transportation and Traffic Engineering Handbook, ITE, Chapter 25, pages 786-798, 1982.
5 Same as above.

control'. Institute of Transportation Engineers (ITE)[6] studies have shown that responsive metering connected to a central control station can result in lower travel times, fewer crashes and higher total travel.

Ramp metering can also be used to encourage alternative transportation choices such as high occupancy vehicle (HOV) lanes. HOVs can be allowed to bypass the ramp queue. This is known as priority access control and it encourages carpools, vanpools, and transit use. Encouraging these travel modes has the net effect of lowering overall vehicular demand on the freeway while still serving the same number of people.

Advantages/Disadvantages

There are several advantages offered by ramp metering. The regulation of vehicles entering the main line flows presents drivers with a set of consistent operation parameters that they can easily adapt to and provide the following benefits:

- More consistent freeway flow speeds, which result in less air pollution.
- Utilizing freeway corridor capacity more efficiently by eliminating bottlenecks at ramp entrances, where heavy entering traffic disrupts mainline flow.
- Reducing the number of congestion related collisions that occur when drivers are forced to compete for gaps in the traffic flow.
- In the case of traffic response metering, there is an added benefit of being able to respond to variable conditions such as a weather or traffic incidents.
- An integrated system optimizes the traffic flow over an entire corridor thereby increasing efficiencies at the local level as well as over the entire system. If traffic response metering is utilized, traffic flow through the entire system could be optimized for the given capacity.
- Vehicle queue sensors would increase meter rates and balance ramp demand with queue storage thereby reducing spillover to local roads.

Disadvantages of ramp metering include:

- Limited freeway entrances could cause substantial queues at metered entrance ramps because of lack of alternative routes. If there is inadequate storage area, such queuing may extend onto local roadways and interfere with non-freeway traffic.

6 Same as above.

- Increased delay at metered ramps may divert traffic to other ramps and roadways, shifting congestion to other locations.

- Increased delay at metered ramps may divert traffic to travel at a different time of day, extending the hours of congestion and inconveniencing drivers.

- Existing interchanges with insufficient geometric capacity may require costly upgrades to provide sufficient storage capacity to prevent queuing onto local roadways.

- The need to provide enforcement of ramp meters to prevent cheating that will reduce the effectiveness of the meters.

According to the *Manual on Uniform Traffic Control Devices*[7], there has been insufficient experience with ramp metering to permit development of numerical warrants applicable to the wide variety of conditions found in actual practice. However, guidelines have been suggested for successful application of controls. Installation of freeway entrance ramp controls may be warranted when:

- The reduction in freeway delay exceeds the delay to ramp users and drivers on alternative routes.

- There is adequate storage space for queued vehicles.

- There are suitable alternative routes.

- There is recurring freeway congestion due to demand exceeding capacity or there is recurring congestion or accident hazard at the freeway entrance because of an inadequate merge area.

2.3.2.3 Shoulder Lane Use

The use of shoulders, or breakdown lanes, as travel lanes has been in existence in the United States since the late 1960s. More than 24 states have implemented projects involving the use of shoulders as a means of providing additional travel lanes and capacity since that time. Typically, opening shoulder lanes for travel during peak hours is primarily viewed as a temporary solution to peak period congestion until the permanent solutions are constructed.

Using the existing shoulders along I-93 in New Hampshire as a travel lane was considered as a possible short-term TSM option to help relieve congestion during the

[7] The Manual on Uniform Traffic Control Devices (MUTCD) is approved by the Federal Highway Administrator as the National Standard in accordance with Title 23 U.S. Code, Sections 109(d), 114(a), 217, 315, and 402(a), 23 CFR 655, and 49 CFR 1.48(b)(8), 1.48(b)(33), and 1.48(c)(2).

peak travel period of the day. Based on a review of the existing traffic operations for I-93, the area that was of particular interest to evaluate the use of a shoulder lane treatment was the northbound section of I-93 between Exit 1 (Rockingham Park Boulevard) in Salem and Exit 3 (NH 111) in Windham, a distance of 3.9 miles. This section regularly experiences congestion in the evening peak period. Between the state line and Exit 3 the I-93 northbound barrel consists of four lanes south of Exit 1 and two lanes immediately north of Exit 1. This narrowing of the highway in conjunction with the short distance between interchanges makes this section of I-93 particularly susceptible to congestion. There are three interchanges in this segment and the posted speed limit is 65 miles per hour (mph) north of Exit 1 and 55 mph south of Exit 1.

Accommodating the use of the shoulder along I-93 northbound between Exits 1 and 3 for peak period travel would require widening the entire 3.9-mile corridor to provide a minimum 12-foot shoulder. Additional widening in specific locations would also be necessary to provide sufficient clear distance from obstacles along the edge of roadway and to provide for emergency vehicle pulloffs.

In addition to the mainline treatment, there are four bridges that would need to be widened, and three where modifications to elements (stone slope protection, guardrail or concrete barrier) beneath the bridges would need to be modified to provide the necessary highway width to allow traffic to use the shoulder as a through lane during peak periods of congestion. In total, the highway width would be a minimum of 42 feet to accommodate a 4-foot median shoulder, two 12-foot travel lanes, a 12-foot shoulder lane, and a minimum 2-foot offset to a guardrail or concrete barrier.

Advantages/Disadvantages

A review of the shoulder use issue and existing conditions along I-93 north from the Massachusetts/New Hampshire border to Exit 3 include the following:

- Safety statistics associated with other locations, where the shoulder is used as a means of increasing capacity, indicate that there is a general statistical increase in traffic accidents associated with the usage of the shoulders as travel lanes. However, as drivers become more familiar with the use of the shoulder as a travel lane, accident rates decline over time (although accident rates remain higher than pre-usage periods).[8]

- Incident response is an important issue to consider in determining if a shoulder lane should be implemented. In the event of an incident along I-93 which requires emergency response, it is likely that the traffic flow through the shoulder portion of the roadway will also be affected by the incident. Under these situations, it will be difficult for emergency personnel to respond quickly.

[8] Report 369 - Use of Shoulders and Narrow Lanes to Increase Freeway Capacity; National Cooperative Highway Research Project, Transportation Research Board; Washington DC 1995 Safety Implications of Using Highway Shoulders as Travel Lanes; Alicia Powell Wilson, Central Transportation Planning Staff; Boston, Massachusetts; April 1997.

- Since the existing traffic volumes and operations indicate that I-93 within the study area is currently over capacity, the corridor could benefit from peak period use of a shoulder lane as a temporary traffic management solution. However, as described below, given existing physical constraints along the corridor, this is not a quick or low-cost alternative.

- Maintenance is another issue that arises with the implementation of a shoulder lane, the maintenance of the northbound lanes will be limited to off-peak periods.

- Based on the recommended minimum cross-section, there is inadequate width to accommodate the proposed use of the shoulder over the 3.9 miles between Exits 1 and 3, without widening the entire roadway corridor by an average of two to four feet.

- If a shoulder lane were to be opened to traffic, the friction between motorists entering and exiting the highway will increase due to the reduction in the acceleration and deceleration areas.

- The availability of an effective clear zone along the outside shoulder of I-93 will be affected by shoulder lane use. The clear zone is defined as an area free of obstructions adjacent to the travel lanes and by definition includes the shoulder. Clear zones provide a driver the opportunity to either recover control of a vehicle that has left the paved roadway or to stop in case of emergency. The use of a shoulder lane as a temporary travel lane will reduce the available clear zone between the travel way and the roadside obstructions where they exist.

Much of the widening for the shoulder lane between Exits 1 and 2 would also require additional widening beyond the shoulder lane pavement to accommodate guardrail due to the steep fill slopes. This widening would result in impacts to wetlands, including designated prime wetlands, adjacent to I-93. The section of I-93 between the Pelham Road bridge and the Brookdale Road bridge (approximately 3,000 feet) would require additional widening due to the narrowness as the Exit 2 NB on-ramp merges with the mainline. The northbound on-ramp at Exit 2 would also require reconstruction to accommodate the additional width for the shoulder lane.

Based on the AASHTO recommended minimum pavement cross-section, the I-93 northbound bridges over Porcupine Brook, NH 38, Pelham Road, and NH 111A between Exit 1 and Exit 3 would require widening of approximately four feet to accommodate the 42-foot width needed.

At the Brookdale Road bridge over I-93 NB, the existing 10-foot shoulder under the bridge would require widening and modifications to accommodate the installation of guardrail or barrier protection to allow for the use of the shoulder lane.

In the area of the two Rockingham Park Boulevard bridges over I-93 NB, the existing easterly travel lane shoulder field measures 11 feet wide with a 2-foot offset to existing guardrail. This shoulder would need to be widened one foot and the existing guardrail replaced with a concrete barrier offset at two feet from the easterly travel lane shoulder.

Pull-off locations for emergency situations when shoulders lanes are in use would be required. By using the shoulder as a through lane, the ability for vehicles to exit the travel way under emergency conditions is limited. Space for disabled vehicles is limited to emergency pulloff areas. Disabled vehicles that cannot access the emergency pulloff may be forced to stop in the shoulder lane creating an unsafe situation for the driver of the disabled vehicle as well as the shoulder lane vehicle who is forced to maneuver around the disabled vehicle. At a minimum, emergency pulloff areas would need to be provided every 2,500 feet. The pulloffs would require additional highway widening potentially creating additional resource and property impacts.

Problems created with shoulder use lanes include general confusion by motorists, lack of a recovery area, lack of a place for disabled vehicles other than at the areas spaced 2500 ft apart, and lack of space for maintenance vehicles to work safely along the highway.

Additional clearance to fixed objects on the side of the roadway would also need to be provided. Guardrails and barriers must have a 2-foot minimum clearance from the edge of pavement, while breakaway signs require 6-feet of clearance.

- The proximity of the interchange spacing between Exits 1 and 2 would reduce the effectiveness of shoulder lane operating conditions and increase safety concerns associated with traffic exiting and entering I-93 in this area.

- I-93 between Exits 2 and 3 is not desirable for shoulder lane use. The 4-5 percent grades in combination with near maximum roadway design curvatures further compromise safety relative to shoulder lane use.

The implementation of shoulder lanes north of Exit 3 and along the southbound barrel of I-93 between Exits 1 and Exit 5, although not fully evaluated, would face similar difficulties as discussed in the preceding text. The need to widen bridges, improve clear zone offsets, and provide for emergency pulloffs would be similarly problematic.

2.3.2.4 Intelligent Transportation Systems (ITS)

Intelligent Transportation Systems (ITS) are potential TMS strategies that could contribute to reducing congestion and improving the safety of the I-93 corridor. Such contributions could help the current situation, the situation during the reconstruction and widening process, and over the long term following the completion of the widening. ITS are typically considered to be Transportation System Management

(TSM) improvements, but they can also serve Transportation Demand Management (TDM) (Sec. 2.3.4) strategies to address the needs of the corridor.

Intelligent Transportation Systems are applications of information processing, communications, control, and electronics to improve the efficiency and/or safety of a surface transportation system. While ITS technology may not eliminate the need to expand the physical infrastructure, it can make an important contribution on how efficiently the infrastructure is utilized.

Examples of how ITS technologies can contribute to efficient utilization of the infrastructure are as follows:

- Collect and transmit information on traffic conditions and transit schedules for travelers before and during their trips. Alerted to hazards and delays, travelers can change their plans to minimize inconvenience and additional strain on the system.
- Decrease congestion by reducing the number of traffic incidents, clearing them more quickly when they do occur, rerouting traffic around them.
- Collect turnpike tolls automatically, helping reduce delays at toll plazas.
- Improve the productivity of commercial, transit, and public safety fleets using automated tracking, dispatch and weigh-in-motion systems that speed vehicles through administrative checks and efficiently manage vehicle fleets.

Most ITS deployments have been in major metropolitan areas such as Minneapolis, New York, Los Angeles, etc. New Hampshire on its own and in concert with other states is developing and utilizing Intelligent Transportation Systems technologies that are appropriate to its less urbanized needs. The I-93 corridor presents an opportunity to make further use of ITS technologies before, during and after the highway reconstruction takes place.

2.3.2.4.1 ITS Initiatives in New Hampshire

Among the initiatives currently underway in New Hampshire are the following:

Tri-State ITS Program

The Tri-State Rural Advanced Traveler Information System (Trio) is a cooperative program being undertaken by New Hampshire, Maine and Vermont to develop a regional traveler and tourism information system based on ITS technologies.

Trio's vision is to help provide an improved quality of life for residents and visitors promoting enhanced access to appropriate economic and social activities through the judicious application of Intelligent Transportation Systems (ITS).

Trio's goals include the promotion of economic development through more efficient operation of the highway network, improving access to activities and services, and helping facilitate a safe transportation experience for visitors and residents. Trio also seeks to enhance the region's special environment, preserve community values and reduce energy consumption.

In 2001, Trio held stakeholder meetings across the Tri-State region to identify transportation and tourism needs that can be addressed by ITS. Now, a "Statewide Base System" of real-time traveler and tourism information is being deployed across Northern New England. Trio's approved Implementation Plan envisions that infrastructure deployments, such as I-93, will quickly follow. Various statewide enhancements may then be added over the remainder of the initial five-year period.

The "Statewide Base System" comprises three regional information subsystems that can work directly to assist travelers in the I-93 corridor. The first, Condition Acquisition Reporting System (CARS), includes construction, incident, accident, delay and tourism event information. The second, Foretell, covers road and weather conditions across the Tri-State Region, including road condition prediction out to 30 hours ahead. The third system will provide for public access to these information databases on the Internet. These three ITS systems will allow I-93 travel reports to be viewed within a wider, multi-state traveler information framework.

Electronic Toll Collection

The NHDOT is proposing to convert its toll collection systems to allow the option of electronic toll collection on turnpikes using Intelligent Transportation Systems technology. Electronic toll collection allows drivers to attach a toll tag to the windshield of their vehicle that is recognized automatically in specially-equipped toll lanes. Each driver has an account with the NHDOT which must be kept in credit. Users are able to replenish their accounts automatically through the use of a credit card.

Although electronic toll collection will not directly impact I-93 between Salem and Manchester, it should enhance the overall efficiency of the corridor, encouraging motorists to utilize the corridor as opposed to alternative routes. Toll tags can also serve as a traffic management tool if, by agreement with users, additional toll readers are used to track traffic routing through congested sections, as is currently happening around New York City. Many New Hampshire motorists will become familiar with Intelligent Transportation Systems as a result of electronic toll collection, which can serve as an introduction to further ITS opportunities.

Incident Management Initiative for the I-93 Corridor

The worsening congestion along the I-93 corridor between Salem and Manchester is routinely compounded by major and minor incidents (crashes and breakdowns). In response NHDOT in cooperation with FHWA began discussions in 2000 with State

Police and local safety (police, fire, ambulance, towing) officials to improve upon Incident Management Procedures. The management of incidents was largely a set of individual protocols based on the local practices of those responding to specific circumstances. Response activities focused on the incidences themselves, with the motoring public a secondary consideration. Long delays, secondary incidents, and traffic diversions on secondary highways were becoming more problematic.

The Incident Management Initiative for the I-93 corridor has involved training seminars for state and local safety, environmental, and highway staff; monthly meetings with all stakeholders to develop incident management procedures; and the development of near term and long term goals and objectives for continued improvement in incident management relative to response time, minimizing traffic delays, and addressing traffic diversion issues. Among the near term results are the following:

- Recognition that communication procedures and equipment need to be improved.
- State and local officials are re-evaluating response procedures and sectional responsibility.
- Emergency Reference Markers have been installed to improve a driver's ability to accurately locate incidents along the corridor and to more accurately convey the location of an incident to emergency personnel and improve emergency response time to the scene.
- Quick clearance of a scene is being re-evaluated to reduce future delays.
- The towing industry support function is being re-evaluated.
- Improved coordination with the NHDOT has occurred.
- There is increased understanding and awareness of each agency's functions and capabilities and a greater emphasis on cooperation.
- Local agencies have identified areas that would improve their ability to provide emergency services, such as additional access points and dry hydrants at bridges.

The long-term solutions for the I-93 corridor are being pursued within the framework of a Statewide Incident Management Protocol for which the I-93 corridor serves to some degree as a test case. Among the ideas being pursued are the following:

- Formalize and continue the monthly meetings to further the improvements in coordination and cooperation among the State and local agencies, departments, and service providers.

- Evaluate and deploy ITS technologies to effectively monitor and control traffic movements along the corridor.

- Utilize the Tri-State Rural Advanced Traveler Information System (Trio) being developed to provide real time information to travelers.

- Establish a Traffic Control Center to monitor traffic movement along this and other major corridors in the State. This is moving forward as a component of a Statewide Emergency Operations Center being developed in conjunction with the Department of Safety.

- Coordinate ITS implementation with local ITS initiatives that are being proposed by the Town of Salem involving signal coordination and a centralized command center.

More specific to the I-93 corridor, and with consideration of existing needs, incident management during construction, and incident management over the long term following construction, the following recommendations will be considered:

Pre-Construction

- Expand the current level of community involvement.

- Address communication issues and needs.

- Finalize additional points of emergency access to the corridor.

- Implement a program to install dry hydrants at appropriate locations.

- Upgrade guide signing along alternative detour routes.

- Develop a detailed detour plan that would include implementation criteria and variable message signs.

- Evaluate existing intersections/roadway sections and develop plans to improve capacity where appropriate.

- Formalize response procedures to incidents, evaluate their effectiveness and modify as required.

- Continued evaluation of the effectiveness of Emergency Reference Markers, previously installed on the I-93 corridor from the Massachusetts state line to Manchester.

Construction

- Include Incident Management Procedures as part of the construction documents and specifications for the widening project. These could involve service patrols of the construction zones, pre-positioned tow trucks along the highway to facilitate rapid incident removal and other protocols.

- Utilize ITS Technologies as appropriate and evaluate their effectiveness.

- Include Incident Management infrastructure in the overall layout for widening improvements, such as additional emergency access points, dry wells, conduit, sensors, etc.

Post-Construction

- Continue the coordinated Incident Management Practices implemented in the pre-construction and construction phases.

- Expand ITS Technologies as appropriate.

- Continue to use this corridor as a "test case" for new technologies and other Incident Management Practices.

2.3.2.4.2 ITS Opportunities for I-93 in Southern New Hampshire

Planning for ITS deployments specific to I-93 in southern New Hampshire is continuing as part of the second stage of the Trio Implementation Plan, addressing infrastructure deployments. The current planning is a continuing refinement of the broader, top-level ITS plan for the State to a more detailed and specific level of implementation and deployment. Deployments will be done before, during, and after construction. Potentially appropriate ITS technologies cover two main functions, information collection and information dissemination. Information collection tools typically involve traffic flow counters, road-weather information systems, real-time vehicle location systems to track bus or construction / maintenance vehicle progress, video cameras, and cellular phone reports from commuter volunteers. Information dissemination tools could include changeable message signs, highway advisory radio, internet, cable TV, and telephone information systems. Details of these technologies are presented under Transportation System Management (TSM) options below.

Information Collection Options

Information technology offers a variety of data collection tools that can be used as part of TSM deployments.

Automatic Traffic Recorders

Automatic traffic flow counters are already used at many locations in New Hampshire, including points along I-93. Traffic counters provide background information on traffic flows for uses such as transportation planning, accident analysis and validation of toll receipts. Traffic count data can be used in real time to help monitor roadway usage and predict congestion in advance. Automatic counters can be supplemented by truck classification or weigh-in-motion devices where heavy traffic has important effects on roadway capacity.

There are two existing traffic counting sites on I-93 close to the New Hampshire/ Massachusetts state line, one in Salem (south of Exit 1) and one in Windham (between Exits 3 and 4) with additional sites north of Manchester (**Figure 2.3-10**). To provide for automated incident and congestion detection, additional monitoring sites could be installed at more frequent intervals along the corridor. Providing detectors every one-half mile would require 32 additional mainline locations. Optionally, sites could also be located on exit ramps. These traffic monitoring sites would allow early detection of incidents and other traffic delays along the I-93 corridor.

Cameras

Video cameras often have a role in strategic corridors. Video images can be used to assess incidents once the initial detection has occurred using traveler reports or automated systems. Providing video images to travelers via the Internet or kiosks has also proved to be extremely popular with system users and substantially increases the users' confidence in related traveler information. Finally, after the events of September 11, 2001, it should be noted that such camera systems can offer security benefits. They are accepted and utilized in European countries that have suffered from intermittent terrorist attacks over the last three decades.

The proposed video camera sites will be determined by conducting a field survey considering a full coverage of I-93 to the extent possible. Overall, approximately 59 video camera sites are being considered along the I-93 corridor in order to achieve this goal (**Figure 2.3-11**). If cameras are linked to traffic flow counters, they can be used to identify the problem when an automatic congestion alarm is raised. This allows a response team to be swiftly dispatched to deal with an incident before delays become severe.

Road Weather Information Systems (RWIS)

Road-weather information systems can monitor roadway temperatures, wind speeds and rain or snowfall in real time. This information can help motorists be informed about driving conditions before they use the I-93 corridor. The information will also help NHDOT operations staff make timely decisions on required winter maintenance actions, so that operating capacities can be maintained even in adverse weather situations. Finally, the information provides an important input to regional road weather prediction systems such as Foretell, being deployed as part of the regional ITS Statewide Base System.

Two road weather stations are proposed along the I-93 Corridor in southern New Hampshire, one north of Manchester between Exits 11 and 12, and the other near the Massachusetts state line, between Exits 1 and 2 (**Figure 2.3-12**). These two sites will form part of a regional network of stations giving early warning of adverse weather as it begins to cross the region.

Automatic Vehicle Location (AVL)

Vehicle location systems can track buses, construction vehicles or maintenance vehicles to help achieve increases in safety and efficiency. Bus locations can support real-time transit arrival information systems. Maintenance and construction vehicle tracking can offer safety benefits and management efficiency returns as part of integrated information systems for use by contractors and winter maintenance supervisors.

The NHDOT will work with transit operators and construction contractors to identify the vehicle fleets that should be equipped with location systems. Rather than equipping only the specific buses operating in the I-93 corridor, the transit location equipment may form part of a wider, regional transit management and information system. This would give greater flexibility to operators in redeploying equipment as needs arise, as well as serving the public with real-time transit information throughout the region.

Condition Acquisition Reporting System (CARS)

The Condition Acquisition and Reporting System (CARS) uses the World Wide Web to allow authorized users to input construction, accident, delay, and other roadway, weather and tourism event information into statewide databases **(Figure 2.3-13)**. The NHDOT is working with State and local police to track major roadway events as they happen. Data may also be entered by authorized town and city agencies, transit dispatchers, and freight companies.

The CARS statewide traffic event database provides a central source of up to the minute information on current roadway conditions. The database will support each of the various information dissemination systems described in the next section, without the need for manual re-entry of data into each separate system.

Finally, volunteer commuter traffic reporters can provide valuable early reporting of incidents and congestion, often before police or NHDOT staff can reach the incident scene. These volunteers, or designated motorist observers, can be recruited and trained using an approach similar to that of New Hampshire tourism’s 'Granite State Ambassadors' scheme, through which volunteers staff help desks and visitor centers. Regular commuters will make their routine journeys, but can call in any unusual incidents by cellular phone. In the future, it may even be possible for voice recognition software to take messages from trained observers and enter confirmed reports straight into the regional CARS incident database, without further manual intervention.

Information Dissemination Options

Real time traffic data can be disseminated via technologies such as changeable message signs, highway advisory radio, television and telephone information systems. Conventional radio, TV, Internet and Cable channels can also have a part to play.

CARS-511

The Condition Acquisition and Reporting System (CARS) described in the previous section is operable as of May 2003 and supports information sharing between the various agencies that need to coordinate their responses to major incidents. State police, local police, cities, towns, and NHDOT staff pool their incident and response information using this Internet software program. Local officials are able to further utilize real time information to deploy resources to address more localized situations that are the result of delays on the highway (for example, traffic detouring to local roadways to avoid delays). Specialist users, such as transit operators and tow truck companies, can also be allowed access to the information, to help them operate more efficiently. The result of this improved coordination will be more effective incident management, allowing problems to be cleared more quickly and safely.

Internet road reports are automatically updated from CARS to get the information out to the public in homes and workplaces. These reports will include maps showing the location of roadwork or incidents, plus further descriptions of current traffic conditions as necessary. Optionally, video images can also be included with these web pages so that users can see current road conditions directly for themselves.

Public/Private Partnership

Radio and TV stations provide an important public service in disseminating information to travelers, both before and during a journey **(Figures 2.3-14 and 2.3-15)**. The broadcast media can be given real time access to CARS, or can use the public internet road reports and web camera images described above. Cable TV systems can also be encouraged to use public access channels to offer real-time information on regional traffic conditions

Dynamic Message Signs

Dynamic message signs can display traffic incident warnings directly to passing motorists as soon as they are entered into the regional CARS traffic event database. Congestion, weather, driving conditions and other urgent messages can also be displayed. A two-tier system is proposed to deal with regional and local traffic needs. The proposed locations represent an aggressive deployment strategy that aims to include all the possible decision-point sign locations. However, this approach could be phased due to the high cost of locating dynamic message signs to cover every single decision point on a roadway network.

At the regional level, dynamic message signs will be deployed in advance of strategic intersections on major routes. Major decision points north of the reconstruction corridor are shown in **Figure 2.3-16**. Dynamic message signs in advance of these points will allow drivers to make strategic route choices well before they reach a particular traffic delay. The signs are typically located between a half and one mile ahead of the exit ramp, to allow drivers time to make a decision.

Similar decision points south of the reconstruction corridor are located in Massachusetts. New Hampshire will aim to share regional traffic information with Massachusetts so that any changeable message signs at those locations can be integrated into the wider regional system.

At the local level, dynamic message signs can also be located ahead of other major intersections. In this corridor, signs can be placed on I-93 in advance of Exits 1 to 5, in both directions, so that drivers can make local detours where necessary **(Figure 2.3-17)**. Portable signs can also be used during construction activities or for special events. Each NHDOT Maintenance District has a number of such signs available, that can be integrated into the wider regional system using two-way wireless links.

Finally, dynamic message signs can also be used to provide real-time transit information. Smaller, more detailed signs will be located at the park-and-ride sites along the corridor. These signs can provide real-time bus arrival and departure information to passengers.

Highway Advisory Radio (HAR)\Low Power FM (LPFM)

Highway advisory radio (530 or 1610 kHz AM) is already used at some locations in New Hampshire. Enhanced traveler information services may also soon be possible using longer range, low-power FM stations newly-authorized by the FCC (Federal Communications Commission). CARS can update radio bulletins automatically, minute by minute, so the timeliness and detail of the information will be greatly improved over existing highway advisory radio. Warned in advance, drivers can slow ahead of an incident, maintain lane positions or take other actions to improve safety or avoid delays. Potential low power FM locations are illustrated in **Figure 2.3-18**. In the event of difficulties in obtaining the low power FM radio licenses, AM stations may be used instead.

511 - Travel Information Number

Traveler information phone services using a new, national "511" phone number have also been recently approved by the FCC. The 511 Travel Information number is available statewide in New Hampshire and travelers are able to call from an office or home phone, or while on the move using hands-free cellular phone technology. Voice recognition allows drivers to request information on particular routes without pressing any touch-tone keys. The I-93 corridor has generally good cellular coverage (**Figure 2.3-19**).

2.3.2.5 Summary and Conclusions

The Transportation Systems Management (TSM) actions will not address all the long-term safety and capacity needs of the highway, however some actions can provide short-term relief in advance of the more comprehensive solution. Specifically many of the interchange TSM actions would, in the short-term, enhance the safe and efficient flow of traffic in the vicinity of the interchanges. In addition, Intelligent Transportation Systems (ITS) technology will be incorporated into the overall improvements to I-93. Such systems will supplement and complement regional and statewide efforts currently underway in New Hampshire, and will serve in the long term to enhance the safety and capacity of the I-93 corridor. Ramp metering is not proposed to be carried forward for further study as its effectiveness relative to improving I-93 would be limited to the southbound barrel in the morning peak period, and the resulting backups on secondary roads within the interchange area would be excessive. The evaluation of shoulder lane use did not support its continued consideration because of safety, cost and construction scheduling issues.

The specific interchange modifications that are to be carried forward and the reasons why the ramp metering and the shoulder lane use will not be carried forward are summarized in the following paragraphs.

Interchange Modifications

Extending the northbound on-ramp at Exit 2 would enhance the safe and efficient operation of the ramp merge. In addition, upgrading Pelham Road, including the widening of Pelham Road to a four-lane section and upgrading the Pelham Road/ Keewaydin Drive/southbound ramps intersection, the Pelham Road/Stiles Road/ Manor Parkway intersection, and the Pelham Road/northbound ramps intersection would substantially improve the operating conditions along Pelham Road.

At Exit 3, the widening of the northbound off-ramp to provide a double left-turn lane is currently under design as part of the NH 111 Windham-Salem project and will improve operations at the intersection. Extending the eastbound right-turn lane on NH 111 at the southbound on-ramp and extending the acceleration lane where the southbound on-ramp meets I-93 would enhance the safe and efficient operation at the intersection and improve the merge operation on I-93.

Extending the length of the left-turn lane on the NH 102 eastbound approach to the northbound ramp at Exit 4 would address an existing queuing deficiency at this location.

Extending the southbound off-ramp at Exit 5 and widening the shoulder area on I-93 approaching the off-ramp would address the existing safety problem of vehicles queuing back onto the I-93 mainline. In addition, the signal timing at the intersection can be coordinated with loop detection on the ramp to detect the presence of queued vehicles.

Ramp Metering

Ramp metering along the I-93 corridor between Manchester and Salem would not provide an effective method of improving traffic operations throughout the corridor. In general, it would only be potentially effective in addressing morning peak period congestion when more traffic generally enters the highway than exits at each interchange.

Ramp metering is generally used in urban areas where alternative travel routes are available. The principal drawback to ramp metering on I-93 in New Hampshire is that there is a limited number of access points to I-93, and thus alternatives are limited for drivers facing long queues at metered ramps. Any diversions would only serve to move congestion to new locations. To the extent that there is no diversion, many ramps would have inadequate storage space to accommodate queued vehicles. This would result in queues extending to local roadways and interfering with non-interstate related traffic.

For these reasons ramp metering as a TSM measure is not proposed.

Shoulder Lane Use

The existing cross-section along the entire 3.9-mile section of the I-93 northbound barrel between Exits 1 and 3 would require some amount of geometric improvements prior to using the shoulder as a means of providing additional capacity. The construction associated with the widening of the corridor and the widening and/or modification of seven bridges would require a substantial capital investment and have potential environmental impacts. While using the shoulder lane as a means of increasing the capacity of the corridor would help in the near-term, it would be a temporary solution only. The use of a shoulder lane is a tradeoff of capacity needs for safety.

Statistically, adding a shoulder lane will lead to an increase in vehicle accidents. The potential increase in accidents will further exacerbate the ability of emergency personnel to respond to an incident in a timely fashion. The construction activities, including traffic control, necessary to complete the construction of the shoulder lane would further disrupt the existing traffic flow and further increase congestion for, in all likelihood, a two-year construction period. The actual use of the shoulder lane, once completed, may have only a one or two year life with the more permanent (albeit phased) solution being contemplated to begin construction in 2004. The capital investment needed to meet the current AASHTO standards for shoulder lane use would be better spent on a more permanent transportation solution, with the completion of the section of I-93 between Exits 1 and 3 given a priority.

For the above reasons, the use of the shoulder as a means of increasing capacity along I-93 northbound between Exit 1 and Exit 3 or elsewhere on this project, was not considered further.

2.3.3 Highway Widening and Interchange Improvements

Given the major capital investment of the existing I-93 corridor, all highway design alternatives considered have focused on widening the existing roadway rather than constructing a new facility off-line. Interchange modifications have also focused on reconstructing and modernizing the existing layouts and no new interchanges were considered. It should be noted that a local initiative by the Towns of Derry and Londonderry to construct a new interchange (known as Exit 4A) between Exits 4 and 5 is ongoing. While there is and has been coordination between the NHDOT and the Towns to evaluate issues of commonality and concern, the interchange project has independent utility and is being considered on its own merits within the context of a separate Environmental Impact Statement and the NEPA process. Also note that as part of the Environmental Impact Statement for the Manchester Airport Access Road project, an easterly extension from the Airport to I-93 Exit 5 was considered. The Easterly connection was eliminated from further consideration during the DEIS due to the Londonderry Town Council's opposition to any of the five easterly alternatives.

The alternatives presented in this section are a combination of initial concepts identified in the *Rationale Report* and additional concepts received from the stakeholders during the public participation process. During the development of these alternatives, environmental, socio-economic and engineering constraints were taken into account in an attempt to minimize impacts to resources whenever practicable. As mentioned, these concepts and options were presented, through an on-going series of Advisory Task Force Meetings (ATF), Public Official's Workshops and Public Informational Meetings in each of the corridor communities and at local, State and Federal agency and Resource Agency meetings beginning in the summer of 2000 (see Chapter 8). These meetings were held to explain how and why the various concepts were developed and to receive comments and direction to better understand the needs, issues, and concerns of each of the communities and stakeholders.

2.3.3.1 Description of Highway Build Alternatives

Concepts for addressing existing and future travel demands for the I-93 corridor include adding travel lanes to the existing highway. Alternatives considered involved widening the existing highway from two lanes in each direction to either three or four lanes in each direction. Relative to the widening alternative, incorporation of high occupancy vehicle (HOV) lanes to serve immediate or future needs was also considered.

Widening the highway to a total of either 3 or 4 lanes in each direction will require consideration of future plans for I-93 in Massachusetts. Today I-93 in Massachusetts, as it approaches the New Hampshire border, is a 6-lane highway (3 lanes in each direction). Recent construction south of Massachusetts Exit 47 (1.3 miles south of the New Hampshire state line) currently allows the highway shoulder to be used as a fourth travel lane during commuter hours. In addition, Massachusetts is in the process of completing a planning study, the *I-93 Corridor Traffic Study, Andover and Methuen, Massachusetts,* which is investigating transportation improvement alternatives along the I-93 corridor between Andover, MA and the New Hampshire state line in Methuen. The Massachusetts study recognizes the travel demand and safety issues along the corridor and acknowledges the need for widening the highway from three lanes in each direction to four lanes in each direction and eliminating the use of the shoulder lane in Massachusetts.

At the northern terminus of the project study limits in Manchester, I-93 is a 6-lane highway (3 lanes in each direction) with additional lanes to accommodate the weaves and ramps necessary for the I-93/I-293/NH 101 Interchange and highway splits and merges in the Manchester area. West of I-93, as part of another project approximately 2.3 miles of I-293 is currently being reconstructed and widened from 2 lanes in each direction to 3 lanes in each direction. Adding additional lanes south of the I-93/I-293/NH 101 Interchange will require some additional pavement in the interchange area to provide efficient and safe transitions.

Current interchange configurations and connecting roads within the study area were evaluated for potential design improvements to accommodate the widening and existing and projected traffic demand, based on current AASHTO and NHDOT design standards. They were also evaluated independently for possible improvement as Transportation Systems Management (TSM) measures (see Section 2.3.2.).

The widening concepts that were considered included three Build Alternatives: a Four-Lane Alternative (four northbound and four southbound lanes) from Salem to Manchester; a Three-Lane Alternative (three northbound and three southbound lanes) from Salem to Manchester; and a Combination Alternative. The Combination Alternative is comprised of elements from both the Four-Lane and the Three-Lane Alternatives. The Combination Alternative begins at the MA/NH border with four lanes extending northerly approximately 4.3 miles (to north of Salem/Windham Town Line) for the southbound barrel and 7.3 miles for the northbound barrel (to just north of the Exit 3 Interchange). It then continues with three lanes northerly to the end of the project (approximately 15.5 miles and 12.5 miles for the southbound and northbound barrels, respectively).

Future Accommodations

For each of the Build Alternatives, space for a potential future light rail line is also being proposed as part of this project. This I-93 corridor rail line would extend into Massachusetts, either connected to the existing Manchester to Lawrence rail line or perhaps connected to a new line that would follow I-93 in MA to the Anderson Transportation Center in Woburn, MA. Space for a rail line would be reserved in NH for either option. In NH, the footprint being preserved for a potential rail line begins along the west side of I-93 at the MA/NH state line and continues northerly until just north of Exit 1 where the rail line would cross over the I-93 southbound barrel into the median and continue northerly inside the median, through Exit 5. North of Exit 5, the line would then be connected to the existing abandoned Manchester to Lawrence Branch to the west of I-93. This would provide the potential for a future connection to the Manchester Airport and/or downtown Manchester.

In addition, each of the Build Alternatives make allowances for the potential reactivation of rail service along the former Manchester-Lawrence Rail Corridor. Grade-separated crossings of the rail corridors are maintained so as to not preclude the opportunity for future rail service, either along the Manchester-Lawrence line or in the highway median, at some point in the future.

The I-93 typical cross section for the Build Alternatives includes provisions for three or four 12-foot wide general-use travel lanes, a 12-foot wide inside shoulder and a 12-foot wide outside shoulder in each direction. An additional 6-foot wide inside graded panel in each direction allows for flexibility during final design and an opportunity to accommodate the development of a potential future High Occupancy Vehicle (HOV) Lane with the Four-Lane Alternative. The minimum median width is approximately thirty-eight feet (south of Exit 1). In areas where space for a future rail line is preserved within the median, the median width varies between approximately 60 feet to 90 feet (**Figure 2.3-20**).

Three Lanes vs. Four Lanes

South of the Exit 1 Interchange in Salem, only a Four-Lane Alternative is proposed, and as such becomes a fundamental design component for the Three-Lane, the Four-Lane, or the Combination Alternative. It should be noted that, although the projected 2020 traffic volumes show a need to provide for five general-use lanes south of Exit 1, to meet the future year traffic demand (see Section 4.2.3 discussion), NHDOT's direction is to not construct more than four general-use travel lanes in one direction in New Hampshire. Constructing a four-lane section would provide a safer roadway section and immediate operational relief when completed. Improving and retaining the existing three-lane section south of Exit 1 was not considered practicable because the existing section is failing under today's traffic demand.

It should also be noted that until the timing and the implementation strategy for the widening of I-93 in Methuen and Andover from three-lanes to four-lanes in each direction is determined, the proposed eight-lanes in New Hampshire will transition, using appropriate lanes tapers and informational signing, to match the existing six lanes at the MA/NH border. All of proposed widening for the proposed eight-lane section in New Hampshire would be constructed to accommodate the future connection to the eight lanes being considered in Massachusetts.

As part of the three Build Alternatives, optional design layouts were developed for the five interchange areas, local crossroads, and several sections of the mainline. At Exit 1 and Exit 2, two interchange options were developed for each location. At Exit 3 nine options were developed reflecting two mainline and two connecting road improvement options, configured with various interchange ramp layouts. In the Exit 4 area, two I-93 mainline alignment options were developed and at Exit 5, three interchange options were developed.

As a general rule, these options can be configured with any of the three Build Alternatives, which allows for an array of improvement choices, each having its own range of socio-economic and environmental impacts. During the development of the alternatives and options for this project, it was decided that the interchange and connecting road modifications would be constructed to be generally compatible with, and accommodate, both the Three-Lane and the Four-Lane Alternatives.

2.3.3.2 Description of Highway Segments

To allow a straightforward comparison of the various Build Alternatives and options, the 19.8-mile corridor was divided into six Segments (A through F; **Figure 2.3-23**).

Segment A is 1.0 mile in length and involves the area beginning at the MA/NH border and ending near the northbound rest area in Salem. Segment B is 0.9 miles long and includes the Cross Street overpass and the Exit 1 Interchange at Rockingham Park Boulevard in Salem. Segment C is 2.2 miles in length and includes the NH 38 (Lowell Road) underpass, the Exit 2 Interchange at NH 97 (Pelham Road), and the Brookdale Road overpass in Salem. Segment D is a 4.9-mile section located entirely in the Town of Windham and includes the NH 111A underpass, the Exit 3 Interchange with NH 111, and the North Lowell Road underpass. Segment E is 5.2 miles in length and involves a 2.0-mile section of I-93 in the Town of Derry and a 3.2-mile section of I-93 in the Town of Londonderry. The Derry section includes both the Fordway Extension and Kendall Pond Road underpasses while the Londonderry section includes the Exit 4 Interchange with NH 102, the Ash Street/Pillsbury Road overpass, and the Stonehenge Road underpass. The last section, Segment F, is 5.6 miles in length and includes a 2.7-mile section in the Town of Londonderry and a 2.9-mile section in the City of Manchester. In Segment F, the Londonderry section includes the Exit 5 Interchange with NH 28, and the Manchester section includes the I-93 bridges over Bodwell Road and Cohas Brook, and the southerly portion of the I-93/I-293/NH 101 Interchange.

2.3.3.3 Build Alternatives with Interchange Options

Segments A and B

Again, for each of the three primary Build Alternatives (the Four-Lane Alternative, the Three-Lane Alternative, and the Combination Alternative), the mainline for Segments A and B are the same, and include four general-use lanes along the northbound and southbound mainline sections.

Segment A

Beginning at the MA/NH border, Segment A is approximately 1.0 mile in length and ends approximately 0.3 mile south of the Cross Street overpass. This Segment also includes the existing northbound rest area (**Figure 2.3-24**). The proposed widening for the Segment is primarily controlled by the need to reduce impacts to Policy Brook and the Spicket River (primarily flood related issues for both) located immediately adjacent to the northbound barrel. To minimize these impacts, the northbound barrel generally holds the eastern edge and grade of the existing pavement such that the widening and associated re-grading does not encroach into the Spicket River floodway or the Policy Brook watercourse. The widening of the northbound barrel would primarily take place to the west, into the existing median. This Segment of I-93 is a transition area where, in addition to the highway widening for the proposed four northbound and southbound lanes, traffic management lanes are proposed to control and manage traffic entering and exiting I-93 at Exit 1 and the northbound rest area.

For the northbound barrel the existing three-lane section is widened to four-lanes beginning approximately 400 feet north of the Massachusetts/New Hampshire border. An auxiliary travel lane would be added adjacent to the mainline traffic approximately 0.2 mile north of the MA/NH border for approximately 0.3 mile to introduce a two-lane off-ramp to a two-lane collector-distributor (C/D) road. The C/D road functions as a separate parallel roadway (approx. 20-foot median separation from the mainline) that will improve overall traffic flow by isolating the through traffic on I-93 from the traffic entering and exiting the rest area, traffic exiting to the Exit 1 northbound off-ramp, and the weaving motion between the two. The existing rest area ramps will be connected to the C/D road and require some minor realignment and reconstruction (i.e., the northbound off-ramp involves approximately 200 feet, and the northbound on-ramp involves approximately 700 ft).

For the southbound traffic, Segment A primarily consists of four travel lanes and generally parallels the northbound barrel. Because the existing highway section in Massachusetts is currently three lanes, the proposed four-lane widening in New Hampshire would transition to the three southbound lanes in Massachusetts beginning approximately 1000 feet north of the Massachusetts/New Hampshire border. The southbound barrel is separated from the northbound barrel by a proposed concrete barrier and narrow median (approximately 38 feet in width) with all southbound widening occurring to the west.

MA / NH Four-Lane / Three-Lane Transition Option. An option to transition the proposed four-lane northbound and southbound highway section to the existing three-lane northbound and southbound sections in Massachusetts would be to extend the proposed four-lane section southerly to the I-93/MA 213 Interchange (**Figure 2.3-24**), where the additional highway travel lanes could be added as traffic from MA 213 enters onto I-93 northbound or eliminated as traffic exits from I-93 southbound to MA 213. The work would involve the reconstruction and widening of approximately 0.6 mile of I-93 in Massachusetts, primarily north of the MA 213 Interchange, and include the addition of a northbound and southbound lane, modifications to the MA 213 southbound off and northbound on-ramps, and the widening of the I-93 bridges over Hampshire Road and Harris Brook. The widening would take place predominantly to the west of the existing highway and likely impact floodplains and wetland. Extraordinary means such as retaining walls would be considered to minimize their impacts. These conceptual modifications and associated environmental impacts have been discussed separately with Massachusetts Officials.

Segment B

Segment B begins just north of the northbound rest area in Salem and extends approximately 0.9 mile generally following the existing grade of I-93 and ending 0.1 mile south of the NH 38/I-93 overpass in Salem (**Figure 2.3-24**). This Segment includes the Exit 1 Interchange with Rockingham Park Boulevard and the continuation of the northbound C/D road described in Segment A. The C/D road would allow traffic departing the rest area, that desires to access I-93 NB, to weave with traffic exiting I-93 northbound to the Exit 1 northbound off-ramp (clear of any of the I-93 through traffic) before merging onto I-93 NB. The C/D road would provide a connection to the existing (and proposed) two-lane Exit 1 northbound off-ramp and transition back to I-93 northbound to allow rest area traffic to access I-93 northbound.

Exit 1 (Rockingham Park Boulevard). The Exit 1 northbound on-ramp would retain a similar configuration to the existing ramp, however the ramp would be reconstructed and lengthened because of the necessary grade raise due to the longer southbound ramp-bridges over I-93. The acceleration lane for the northbound on-ramp is proposed to be lengthened, requiring the widening (by approximately 12 feet) of the existing bridge over South Policy Street. A retaining wall, approximately 10-feet high and 900 feet long, will also be required along the east side of the ramp to minimize impacts to Porcupine Brook and adjacent wetlands. For the southbound on- and off-ramps at Exit 1, there are two options. Both options generally preserve the same interchange (trumpet type) configuration with a one-lane ramp for southbound traffic exiting to Rockingham Park Boulevard and a two-lane ramp for traffic entering I-93 southbound from Rockingham Park Boulevard.

Exit 1 Southbound Ramps, On-line Option. The first option retains the existing substandard ramp geometry (existing off-ramp radius is only 180 feet/25 mph design) to minimize impacts to the adjacent wetlands (**Figure 2.3-24**). The southbound ramps would be reconstructed along the existing alignment and new longer span bridges would be constructed over I-93 as necessary to gain the required horizontal and vertical clearances. The grades for the new ramp bridges would be raised approximately two feet because of the increased structure depth of the longer span bridges. With this option, substantial temporary widening of the southbound on-ramp and off-ramp would be required to maintain traffic during the bridge and ramp construction. In addition, the proposed southbound off-ramp bridge and approaches would be widened to accommodate two-lanes and to allow for one-lane of traffic in each direction during construction. The On-line option would reconstruct approximately 0.5 mile of the southbound off-ramp and 0.8 mile of the southbound on-ramp. The southbound on-ramp modifications include two 12-foot travel lanes, a 10-foot outside shoulder and a 4-foot inside shoulder. The southbound off-ramp modifications include one 12-foot travel lane, a 10-foot outside shoulder and a 4-foot inside shoulder.

Exit 1 Southbound Ramps, Off-line Option. A second option for the southbound ramps at Exit 1 would provide for an improvement to the existing geometry by reconstructing the ramps to minimum, but modern, highway standards (radius 260 feet/30 mph design) (**Figure 2.3-24**). The improved geometry would require shifting the ramps approximately 70 to 200 feet to the west. The wetland system adjacent to the existing ramps will be impacted by the off-line ramp shift. Similar to the On-line Option, new bridges over I-93 would be constructed as necessary to gain the required horizontal and vertical clearances. The grades for the new ramp bridges would be raised approximately two feet because of the increased structure depth of the longer span bridges. The new off-line ramps would not require any substantial temporary widening to maintain traffic during construction. However, the proposed southbound off-ramp bridge would be widened (similar to the On-line Option) to accommodate two-lanes, and to allow for one lane of traffic in each direction during construction. The Off-line Option would reconstruct approximately 0.9 mile of the southbound off-ramp and 0.6 mile of the southbound on-ramp. The southbound on-ramp modifications include two 12-foot travel lanes, a 10-foot outside shoulder and a 4-foot inside shoulder. The southbound off-ramp modification includes one 12-foot travel lane, a 10-foot outside shoulder, and a 4-foot inside shoulder.

Cross Street. The Cross Street bridge and its approaches will require reconstruction to accommodate the widening of I-93. Two options are being considered and they include an On-line Option and an Off-line Option. For both options, the new bridge would be constructed over I-93 as necessary to achieve the required horizontal and vertical clearances. The bridge grade would be raised approximately two feet to accommodate the longer span. The bridge span and abutment layout would provide the span length and clearance necessary to accommodate space for a potential light rail line passing under Cross Street on the west side of the southbound barrel.

Cross Street Bridge, On-line Option. The On-line Option replaces the existing bridge generally on its existing alignment and uses a temporary detour bridge, north of the existing bridge to maintain traffic during construction (**Figure 2.3-24**). The On-line

Option would reconstruct approximately 0.4 mile of Cross Street and its approaches and provide for two 12-foot travel lanes with 4-foot shoulders and a 5-foot sidewalk.

Cross Street Bridge, Off-line Option. The Off-line Option replaces the existing bridge with a new curved girder bridge approximately 75 feet to the north, and uses the existing bridge to maintain traffic during construction (**Figure 2.3-24**). The Off-line Option would reconstruct approximately 0.4 mile of Cross Street and its approaches and provide for two 12-foot lanes with 4-foot shoulders and a 5-foot sidewalk.

Segments C, D, E and F

General: Three vs. Four Lanes

For the remaining Segments C, D, E, and F north of Exit 1, the highway widening for the Three-Lane and the Four-Lane Alternatives are very similar except for the number of proposed general-use travel lanes associated with either the Three-Lane or the Four-Lane Alternative. The chief difference between these two alternatives is that the Three-Lane Alternative would have 24 feet less paved travel way (i.e., one 12-foot lane in each direction) than the Four-Lane Alternative. On the surface, the difference between the two roadway footprints would result in fewer impacts to the natural environment and the adjacent properties with the implementation of the Three-Lane Alternative. However, while this is true to a degree, one additional design element that requires consideration when evaluating the Alternatives is the overall constructability and the ability to safely maintain traffic during construction.

Because the Build Alternatives would involve widening and reconstructing the existing two-lane highway and bridges to either three or four lanes in each direction, and because the traffic currently experiences severe congestion with the existing two lanes, there is a need to provide sufficient highway width during construction to safely maintain a minimum two lanes of traffic in each direction. With the Four-Lane Alternative, traffic would be maintained on the existing two-lane highway while the roadway and/or bridges are widened to accommodate the two additional lanes. Once the new widening is complete, traffic would shift onto the two new lanes and the two existing highway lanes and bridges would then be reconstructed (**Figure 2.3-22**). The over-widening of the three-lane section required to maintain traffic during construction approximates the total width and impacts of the 4-lane section.

For the Three-Lane Alternative, which is being considered for the 17.9-mile section (Segments C, D, E, and F) north of Exit 1, traffic would remain on the existing two-lane section while the new third lane is constructed. However, to reconstruct the two existing highway lanes and bridges, additional widening on a temporary basis would be necessary to safely maintain two lanes of traffic during construction. The additional widening would include the width necessary to accommodate two travel lanes, shoulders and a space for traffic control barriers to safely maintain traffic during construction. Where the I-93 grades are raised to accommodate an increase in bridge structure-depth due to the longer bridge spans, the width of the additional widening would increase proportionately to accommodate construction activities while maintaining two lanes of traffic (**Figure 2.3-22**).

Segment C

Segment C begins just north of the Exit 1 Interchange with Rockingham Park Boulevard, extends approximately 2.2 miles northerly through the Exit 2 Interchange with Pelham Road, and terminates at the Salem/Windham Town Line. This Segment includes the northbound and southbound I-93 bridges over NH 38 (Lowell Road), the Exit 2 Interchange at NH 97 (Pelham Road), and the Brookdale Road overpass.

The southerly layout for Segment C begins near the Exit 1 Interchange and extends approximately 1.1-miles to the Exit 2 Interchange. In this southerly section three preliminary highway mainline/rail accommodation concepts were developed and compared against each other to understand the relative engineering issues, and environmental and property impacts **(Figure 2.3-25.1)**. The primary issues of concern include potential impacts to Porcupine Brook, adjacent prime wetlands and the residential and industrial buildings in close proximity to the northbound (Trolley Lane) and southbound barrels (Fern Road). Concept 1 would construct a new widened northbound barrel to the east of the existing northbound barrel, the existing northbound barrel would then be available for a future rail line and the southbound barrel would be widened to the west. Concept 2 would widen the existing northbound barrel to the east and widen the existing southbound barrel to the west, providing for a future rail line within the existing median. Concept 3 would widen the existing northbound barrel to the east and widen the existing southbound barrel to the west, providing for a future rail line west of the widened southbound barrel. As identified in the *Rationale Report,* Concept 2, by observation, has the least impacts and would be carried forward and evaluated in more detail.

Concept 2 holds both the existing northbound and southbound median edges of pavement as a control and all of the highway widening for either the Three-Lane or the Four-Lane Alternative occurs to the east for the northbound barrel and to the west for the southbound barrel. Maintaining the existing median width as a control in this area serves two functions. First, it substantially reduces any highway widening impacts to Porcupine Brook and adjoining wetlands in the median. Second, it preserves an opportunity to provide space for a future rail line in the median.

The northerly section of Segment C begins just south of the Exit 2 Interchange and extends approximately 1.1 miles to the Salem/Windham Town line. This section involves the Exit 2 Interchange and the Brookdale Road bridge overpass in addition to the widening of the mainline section. The mainline alignment continues to hold the existing northbound and southbound median edges of pavement as a control through the Exit 2-Interchange area. The grade for the northbound and southbound barrels would be raised approximately five feet to accommodate the new longer span bridges over the widened Pelham Road.

Just south of Brookdale Road, and extending to the Salem/Windham Town line, the existing easterly edge of pavement for the northbound barrel is widened approximately 4 feet to the east to accommodate a truck climbing lane while the rest of the widening is to the west. Widening to the west minimizes impacts to the South Shore Road residences adjacent to the northbound barrel and maintains the existing buffer (approximately 300 feet) between the northbound barrel and Canobie Lake.

NH 38 (Lowell Road). In the area of Lowell Road, the northbound and southbound barrels will be raised approximately two feet to gain the required vertical clearances for the new wider and longer bridges. The new bridges will be long enough to accommodate a future five-lane section for Lowell Road (**Figure 2.3-25.2**) (Lowell Road is not proposed to be widened as part of the proposed I-93 modifications). A temporary detour bridge and approaches would be built west of and immediately adjacent to the southbound barrel to maintain traffic while the new bridges are constructed. A retaining wall approximately 5 feet high and 330 feet long is proposed to minimize impacts to the proposed development driveway to Furniture World along the west side of the southbound barrel immediately north of NH 38.

Upon completion, the southerly detour embankment would be retained and serve as part of a sound wall which would extend parallel to the southbound barrel and reduce noise impacts for the Fern Road area homes. Adjacent to Lowell Road along the Exit 1 northbound on-ramp, a retaining wall approximately 20-feet high and 300 feet long is proposed to minimize impacts to Porcupine Brook along the east side of the northbound barrel.

Exit 2 Interchange (NH 97/Pelham Road). Three options were considered for the Exit 2 Interchange (**Figure 2.3-25.2**). The first or Diamond Interchange Option uses a standard type diamond interchange configuration with signals at both the northbound and southbound ramp intersections with Pelham Road. The second or Loop Option is similar to the first in that the northbound ramp layout is configured as a diamond interchange with signals at the intersection with Pelham Road while the southbound ramps are both configured as free-flow ramps with the Pelham Road. Vehicles traveling eastbound on Pelham Road utilize a slip-ramp whereas the westbound traffic uses a loop-ramp design to access I-93 southbound. The third or Roundabout Option (suggested in the Comment Letters received as part of the Pubic Hearing held in November 2002) involves a diamond interchange ramp configuration as with the first option, but differs by incorporating roundabout layouts at each of the ramp intersections with Pelham Road instead of signalized intersections. For all three options, the northbound ramps generally preserve the diamond-type configuration that exists today. The northbound ramps intersect Pelham Road opposite each other at either a signalized intersection or unsignalized roundabout intersection. The northbound on-ramp transitions into a truck-climbing lane (12-foot lane with 4-foot shoulder, 0.8 mile long) for the long uphill grade (3 percent) of the northbound barrel as it extends north from the Exit 2 Interchange.

At the southbound ramps all three options eliminate the existing difficult weave area between the southbound on and off ramps. The Diamond Interchange Option would construct a new diamond configuration with signals at the southbound on and off-ramp intersection with Pelham Road, similar to the northbound ramps. The Loop Option would provide a loop ramp configuration for traffic traveling westbound on Pelham Road to I-93 southbound. The loop ramp would pass over Pelham Road on a separate structure adjacent to the southbound mainline and then merge into one lane with the eastbound Pelham Road on-ramp traffic before merging with the I-93 southbound mainline. Because of the free-flow operation the loop configuration, the need for a signalized intersection (required with the southbound diamond configuration) with the southbound on-ramps along Pelham Road is eliminated. However, with the loop options the southbound of-ramp is shifted opposite Keewaydin Drive to form a 4-way signalized intersection, and approximately 900 feet of Keewaydin Drive would be reconstructed and widened. This widening requires additional property impacts. The loop ramps in the NW quadrant of the interchange would also traverse across the existing wetland areas in the infield of the existing loop configuration. The Roundabout Option would construct a roundabout at the southbound on and off-ramp intersection with Pelham Road, similar to the northbound ramps for this option. For all three interchange options, a retaining wall approximately 15 feet high and 1000 feet long is proposed along the southbound off-ramp to reduce slope impacts to existing buildings and properties. To the south, for the loop configuration option only, a retaining wall approximately 13 feet high and 350 feet long is proposed along the southbound on-ramp to reduce slope impacts to the Holiday Inn parking lot.

Pelham Road. For all three of the Exit 2 Interchange options, Pelham Road would be reconstructed and widened. The work begins near the North Policy Street/ South Policy Street intersection, extends westerly approximately 0.6 miles, and ends at the Stiles Road/Manor Parkway intersection. The Pelham Road modifications would include two twelve-foot travel lanes in each direction with five-foot shoulders and a raised median, which becomes a left-turn lane at intersections where appropriate. A five-foot sidewalk on one or both sides of the road, depending on section of Pelham Road, is also proposed. Retaining walls for both options are proposed along Pelham Road to the west of the interchange area to minimize impacts to the adjacent businesses. The first, located on the north side of Pelham Road opposite Park West Village, is approximately 300 feet long and 5 feet high. The second is approximately 50 feet long and 3 feet high and is situated in front of the Butler Realty property on the south side of Pelham Road.

Pelham Road with the Diamond Interchange Option. The existing five-lane Pelham Road section (two through-lanes in each direction and a single left-turn lane in the median) at the South and North Policy Road intersection is proposed to be extended westerly to just east of the Exit 2 northbound ramps where the widening transitions to a seven-lane section. Pelham Road would be widened to seven-lanes to accommodate two eastbound to northbound left-turn lanes and a single westbound to southbound left-turn lane, in addition to the two through-lanes in each direction. The seven-lane section transitions to five-lanes at the Keewaydin Drive intersection and then extends to the Stiles Road/Manor Road intersection. For the Diamond Option, five traffic signals will be required located at the following intersections with Pelham Road: Manor Parkway/Stiles Road, Keewaydin Drive, southbound ramps, northbound ramps, and North/South Policy Street (**Figure 2.3-25.2**).

Pelham Road with the Loop Interchange Option. As with the Diamond Option, the existing five-lane Pelham Road section is extended westerly to the Exit 2 Interchange. For this option, the widening for the westbound double left-turn lanes are extended to Keewaydin Drive before transitioning back to five-lanes and ending at the Stiles Road/Manor Road intersection. Four traffic signals for the Loop Option will be required at the following intersections with Pelham Road: Manor Parkway/Stiles Road, Keewaydin Drive/southbound ramps, northbound ramps, and North/South Policy Street. The Loop Option layout, when compared to the Diamond Option, will eliminate one signal by combining the southbound off-ramp intersection with Keewaydin Drive creating a four-way intersection (**Figure 2.3-25.2).**

Pelham Road with the Roundabout Interchange Option. The existing five-lane Pelham Road section (two through-lanes in each direction and a single left-turn lane in the median) at the South and North Policy Road intersection is proposed to be extended westerly to just east of the Exit 2 northbound ramps where the widening transitions to a two-lane roundabout at the northbound ramps. The widening continues westerly as a four-lane section with raised median to a two-lane roundabout with the southbound ramps. West of the southbound ramps roundabout, Pelham Road transitions to five-lanes at the Keewaydin Drive intersection and then extends to the Stiles Road/Manor Road intersection. For the Roundabout Option, two roundabouts at the ramp terminals and three traffic signals will be required located at the following intersections with Pelham Road: Manor Parkway/Stiles Road, Keewaydin Drive, and North/South Policy Street **(Figure 2.3-25.2)**.

Brookdale Road. Brookdale Road in Salem passes over I-93 approximately 0.7 miles north of the Exit 2 Interchange. Two options were developed, an Off-line option where a new bridge is constructed to the south of the existing bridge and an On-line option where the new bridge would be constructed along the alignment of the existing bridge with a temporary detour bridge to the south. For both options, the new bridge would be constructed over I-93 as necessary to achieve the required horizontal and vertical clearances and provide for two 4-foot lanes with 4-foot shoulders and a 5-foot sidewalk on the north side (**Figure 2.3-25.2**).

On-line Option. The On-line Brookdale Road option would reconstruct approximately 0.3 mile of Brookdale Road and its approaches and replace the existing bridge generally on its existing alignment. A temporary detour bridge to the south would be necessary to maintain traffic during construction.

Off-line Option. The Off-line option would construct approximately 0.3 mile of Brookdale Road and approaches on new alignment. The new bridge would be located approximately 60 feet to the south of the existing. The existing bridge would be used to maintain traffic during construction of the new bridge.

Segment D

Segment D is located in the Town of Windham and begins at the Salem/Windham Town line, extends approximately 4.9 miles northerly through the Exit 3 Interchange with NH 111, and terminates at the Windham/Derry Town line (**Figures 2.3-26 through 2.3-31**). It should be noted that the Combination Alternative under consideration transitions from a Four-Lane Alternative to the Three-Lane Alternative in this segment. For the Combination Alternative in the northbound direction, the four-lane section extending from the MA/NH line to the south would transition to a three-lane section near the Windham Weigh Stations. For the Combination Alternative in the southbound direction, the three-lane section extends southerly from Manchester through the Exit 3 Interchange before merging with the proposed two-lane Exit 3 southbound on-ramp where the five-lane section merges to four lanes and extends southerly to the NH/MA border.

The major elements of this segment include the widening and/or realignment of the I-93 northbound and southbound mainline, the Exit 3 Interchange at NH 111 (Indian Rock Road), the northbound and southbound I-93 bridge replacements over NH 111A (Range Road), the northbound and southbound I-93 bridge widenings at North Lowell Road and minor modifications to the Windham Weigh Stations. In addition, there are nine Exit 3 Interchange options, which include two alignment options involving the I-93 mainline, two alignment options for NH 111 west of the Exit 3 Interchange, two options for the re-configuration of the southbound ramp, three options for the re-configuration of the northbound ramps, and an option to relocate a section of NH 111A.

I-93 Mainline. Within this segment, the portion of the mainline between the Salem/Windham Town Line through Exit 3 to just south of the weigh stations would be realigned to create one of two layout options for either the Three-Lane or the Four-Lane Alternative. The two options include the I-93 Northbound Shift Option and the I-93 Tight Shift Option and both relocate the northbound and southbound barrels into the median to varying degrees in the vicinity of the Exit 3 Interchange in order to address existing geometric deficiencies and increase separation between the successive northbound ramp terminal and NH 111A intersections. Another option was suggested following the November 2002 public hearing by private interests. This option would hold the existing alignment and widen each barrel of I-93 while maintaining as much of the existing median as possible to allow for private development. Elsewhere the widening generally involves holding the outside edges of the existing pavement for both the northbound and southbound barrels with one exception. The exception involves a 1.4-mile section of the mainline, just north of the weigh stations, where the highway widening shifts from the median to the outside. In doing so, the widening matches into the existing bridges (southbound constructed in 1994, northbound constructed in 1998) over North Lowell Road (**Figures 2.3-26 through 2.3-31**).

I-93 Northbound Shift Option. The I-93 Northbound Shift Option begins just south of NH 111A and involves relocating a 0.9-mile section of the northbound barrel approximately 500 feet to the west into the existing median area (**Figures 2.3-26 and 2.3-27**). The relocation of the northbound barrel allows the proposed NH 111/Northbound ramp intersection to shift further away from the existing NH 111/NH 111A intersection. Currently the existing NH 111/Northbound ramps and the existing NH 111/ NH 111A intersections are close together (approximately 500 feet) creating operational problems for both intersections. The proposed layout provides for more separation (either 1,100 feet or 1,800 feet depending upon the northbound ramp option chosen) between the intersections. The relocated northbound barrel will generally follow the same three-percent maximum grade as the existing northbound barrel. A new longer span and higher bridge would carry the northbound barrel over the widened NH 111. The northbound bridge over NH 111A (re-constructed in 1994) would be replaced.

For this option, the modifications to the southbound barrel involve widening the existing highway toward the median including a 0.5-mile section centered over NH 111 where the southbound barrel is realigned easterly approximately 100 feet. The easterly shift of the southbound barrel allows for construction of a new I-93 southbound bridge over NH 111 while addressing the need to provide for two-lanes of traffic during construction. The existing southbound grade (five-percent) is retained. The southbound bridge over NH 111A would be replaced.

For the Northbound Shift Option, a park-and-ride lot is proposed to be constructed in the remaining median area between the northbound and southbound barrels south of NH 111. Access to the park-and-ride from NH 111 would be provided at a signalized intersection between the northbound and southbound ramp intersections with NH 111. (See Park-and-Ride discussion, Section 2.3.5.4)

I-93 Tight Shift Option. A second mainline option for the Exit 3 Interchange was developed in response to the Town of Windham's request to look at reducing the I-93 Exit 3-Interchange area footprint. This option, called the Tight Shift Option, realigns both the northbound and southbound barrels into the existing wide median (**Figures 2.3-28 through 2.3-30**). The southbound barrel is realigned approximately 150 feet east of the existing NH 111A overpass and approximately 300 feet to the east of the existing southbound barrel over NH 111 before transitioning back to the existing southbound barrel north and south of the interchange area. The grade for the southbound barrel is proposed to be raised nearly 25 feet above NH 111 in the Exit 3-Interchange area to flatten the existing downgrade from five-percent to approximately three-percent. The grade raise would improve the current undesirable geometric combination of a steep downgrade with relatively sharp horizontal curvature along the southbound barrel.

The northbound barrel is proposed to be relocated adjacent to the new southbound barrel (approximately 90 feet is held in the median between the proposed northbound and southbound barrels to preserve space for a potential future rail line) beginning just north of the Brookdale Road bridge and extending northerly for approximately 2.2 miles. Similar to the Northbound Shift Option described previously, the Tight Shift Option allows the northbound ramps to be relocated away from the existing NH 111/ NH 111A signalized intersection to improve intersection operations. (The existing distance between the existing northbound off-ramp and the NH 111A signals is 500 feet while the distance between proposed signalized intersections for the relocated NH 111A and the northbound off-ramp is 1,200 feet). With the Tight Shift Option, approximately 1.9 miles of the existing northbound barrel is bypassed. Approximately 0.4 mile is reused for the development of a proposed park-and-ride access road and for the modification of the northbound on-ramps. The remaining 1.5 miles of the existing northbound barrel is proposed to be removed and re-graded, including a 0.2 mile section that is proposed to be part of a wetland mitigation package.

NH 111A (Range Road). As a result of input from the Town of Windham, the proposed park-and-ride access option shown in the DEIS was modified. The original access option was to construct an access road connecting at the unsignalized intersection between NH 111 and NH 111A. The revised design (**Figure 2.7-7**) relocates NH 111A away from its current intersection with NH 111 to separate local traffic from through and commercial traffic and give better access to remaining adjacent land for future development. The proposed layout involves constructing a 0.5 mile section of NH 111A on new alignment approximately 500 feet west of existing NH 111A. This new section of NH 111A connects to NH 111 at a signalized intersection approximately 600 feet west of the existing NH 111/NH 111A intersection. The 0.5 mile bypassed portion of existing NH 111A would remain as a local service road for the existing businesses and properties and access to West Shore Road. The existing NH 111/NH 111A signalized intersection would be reconfigured as an unsignalized intersection allowing for right-turn vehicles to enter and exit this local service road and left turn vehicles to only enter the local service road (left turn vehicles exiting the local service road would be prohibited). The westerly end of the local service road would connect to the relocated section of NH 111A at an unsignalized intersection.

For the Tight Shift Option, a park-and-ride lot is proposed to be constructed just east of the new realigned northbound barrel. Access to the park-and-ride lot would be from the relocated section of NH 111A (see Park-and-Ride discussion, Section 2.3.5.5).

NH 111 (Indian Rock Road). The modifications considered for NH 111 include two options involving the location of NH 111 west of I-93. East of I-93 northbound, modifications to NH 111 involve reconstructing and widening NH 111 to five lanes (two 12-foot travel lanes in each direction with 10-foot shoulders and a raised median which becomes a left-turn lane at intersections where appropriate) beginning at the NH 111/NH 111A intersection and extending approximately 0.6 mile to near the I-93 southbound bridge over NH 111. The proposed NH 111 improvements for this project also include space to accommodate utilities and a sidewalk. The easterly modifications would connect to the NHDOT's five-lane Windham–Salem 10075 project (currently in design, with construction scheduled to start in 2003). The Windham-Salem project begins just east of the NH 111/NH 111A intersection in Windham and extends easterly approximately 3.0 miles into Salem.

West of the I-93 southbound bridge over NH 111, two options (the Relocation Option and the On-Line Option) were studied for NH 111.

NH 111 Relocation Option. The NH 111 Relocation Option involves modifications to a 1.2-mile section of NH 111 beginning near the I-93 southbound barrel and extending westerly and matching to existing NH 111 just before the Village Green shopping plaza signals (**Figures 2.3-27, 2.3-29 and 2.3-30**). Approximately 1.0 mile of this section would be constructed on a new NH 111 alignment approximately 450 feet to the north of existing NH 111. The relocation would minimize impacts to a number of businesses and properties adjacent to existing NH 111, although other businesses at each end of the relocation would require complete acquisition. The 0.5-mile bypassed portion of existing NH 111 would serve as a frontage road for the existing businesses and properties and connect to the relocated NH 111 at a signalized intersection opposite Wall Street. A turnaround, just east of the Castleton driveway would allow vehicles to reverse direction on the dead-ended portion of the bypassed section of NH 111. The layout for NH 111 west of I-93 could include extending the same five-lane section (six-lane section for the southbound diamond interchange configuration ramp before transitioning to five-lanes) as proposed for the easterly NH 111 modifications through the new Wall Street/Old NH 111 Connector intersection. The five-lanes would then transition to the existing 3-lane section (one travel-lane in each direction and a single painted median center turning lane) at the signalized intersection for the Village Green stores. An alternative width for relocated NH 111 would be to transition the 5-lane section required at the southbound ramp intersection down to a 3-lane section just west of the intersection. This section would then match into the 3-lane section that exists at the Wall Street intersection. The right-of-way width would be sufficient to widen this section of NH 111 in the future, when the additional lanes are required.

NH 111 On-Line Option. The NH 111 On-line Option involves modifications to a 1.2-mile section of NH 111 beginning near the I-93 southbound barrel and extending westerly through the Wall Street intersection and ending just before the Village Green shopping plaza signals (**Figures 2.3-26 and 2.3-28**). The On-line option would involve extending the five-lane section (six-lane section in the case of the southbound diamond interchange configuration before transitioning to five-lanes) proposed for NH 111 east of the southbound barrel. The five lanes would transition to three lanes west of the Castleton Drive. A raised median island proposed through the interchange area and the southbound ramps would extend to Waters Edge Road precluding left turns to and from existing drives adjacent to the signalized intersection with the southbound ramps. The three-lane (one travel-lane in each direction and a single painted median center turning lane) section would then extend west through the Wall Street intersection to the existing three-lane section at the signalized intersection at the Village Green stores. The five-lane to three-lane layout would present operational problems due to congestion from NH 111 westbound traffic backing up into the interchange area prior to the design year of 2020. A five-lane layout from the southbound ramps to Wall Street was considered but not pursued as the widening would severely encroach upon every property along this section of NH 111 and adversely affect access to many of the properties (because the grades of the driveways would be made substantially steeper).

The three-lane layout would widen the existing pavement closer to the properties along both sides of NH 111. Retaining walls of varying heights and lengths would be required along the north side of the roadway to limit property impacts, and access to properties along the south side of NH 111 would be further compromised as the driveways and side roads would necessarily become steeper. Access to properties in general would be further compromised over time as traffic volumes continue to increase along NH 111.

Exit 3 Southbound Ramp Layouts. The existing southbound ramp configuration at Exit 3 involves a loop-ramp in the southwest quadrant for all southbound traffic getting off I-93 and an adjacent slip ramp for all southbound traffic getting onto I-93 from NH 111.

The proposed interchange modifications involve reconstructing and realigning the southbound ramps to reflect more modern highway standards. The southbound off-ramp is proposed to be reconfigured to a standard (albeit long) diamond type ramp layout. In all cases, the reconfigured southbound off-ramp begins approximately 0.7-mile north of Exit 3 to provide desirable ramp geometry, safe sight distance and a reasonable ramp-downgrade (six-percent maximum) for traffic exiting I-93 to NH 111 at a signalized intersection. For the proposed southbound on-ramp, the ramp layout would be developed out of the influence of the proposed NH 111 signals with the southbound off-ramp allowing the on-ramp to operate in a free-flow condition. To the west of the proposed southbound on-ramp modifications, the eastbound traffic is provided a separate right turn lane along NH 111 before entering the southbound on-ramp.

For the NH 111 westbound traffic that desires to travel south on I-93, there are two layouts under consideration.

The first layout provides free-flow movements, which can only be implemented with the NH 111 Relocation Option. The free-flow layout involves a single lane free-flow loop ramp located in the NW quadrant of the Exit 3 Interchange. The NH 111 westbound traffic would exit NH 111 in a separate right turn lane, loop around and cross over NH 111 on a new structure adjacent to the new I-93 southbound mainline bridge over NH 111. This ramp traffic would merge with the NH 111 eastbound ramp traffic onto a two-lane on-ramp prior to merging with the I-93 southbound mainline through traffic (**Figures 2.3-27 and 2.3-30**).

The second layout for NH 111 westbound to I-93 southbound traffic uses a signalized double-left turn lane. This interchange configuration can be used for both the NH 111 Relocation Option and the NH 111 On-line Option. The layout involves providing a signalized intersection along NH 111 where both the southbound off and the southbound on-ramps are located opposite each other. To access the southbound ramp, the NH 111 westbound traffic would turn left from double-left turn lanes at a signalized intersection and merge to a single-lane ramp. This southbound on-ramp, and the southbound on-ramp for the NH 111 eastbound traffic, would then merge together onto a two-lane on-ramp and proceed southerly before merging with the I-93 southbound mainline through traffic (**Figures 2.3-26, 2.3-28 and 2.3-29**).

Exit 3 Northbound Ramp Layouts. The existing northbound ramp configuration involves a diamond ramp for northbound traffic getting off from I-93 and an adjacent loop-ramp for NH 111 traffic getting onto I-93 NB.

For both the Northbound Shift Option and the Tight Shift Option, the I-93 northbound traffic exiting to NH 111 eastbound or westbound would use a diamond type two-lane off-ramp configuration connecting with NH 111 at a signalized intersection. As described earlier, the relocation of the northbound barrel allows the proposed northbound off-ramp to shift further away from the existing NH 111/ NH 111A intersection creating a more desirable intersection separation and improved operations. Relative to the northbound on-ramp layouts, in all cases the northbound on-ramp transitions into a truck-climbing lane (12-foot lane w/4-foot shoulder, 0.8 mile long) for the long grade (3 percent) of the northbound barrel as it extends north from the Exit 3 Interchange.

For the Tight Shift Option, the NH 111 eastbound and westbound traffic would use a diamond type ramp configuration to access I-93 northbound. The layout involves providing a signalized intersection along NH 111 where both the northbound off and the northbound on-ramps are located opposite each other. For the NH 111 eastbound traffic, vehicles would turn left from a left-turn lane at the signalized intersection and access the northbound on-ramp. For the NH 111 westbound traffic, a separate right-turn lane and free-flow slip ramp is provided just east of the proposed signalized intersection, in the NE quadrant of the interchange. Both northbound on-ramps for the NH 111 eastbound and the westbound traffic merge together and proceed northerly in one lane (as noted above, a truck climbing lane) before merging with the I-93 northbound traffic (**Figures 2.3-28 through 2.3-30**).

With the Northbound Shift Option, there are two eastbound to northbound layouts for NH 111 traffic to travel northbound on I-93. The first layout is the same configuration as the Tight Shift diamond layout described above (**Figure 2.3-26**). The second layout involves an on-ramp configured as a single lane free-flow loop ramp in the southeast quadrant of the interchange. The NH 111 eastbound traffic would exit NH 111 in a separate right turn lane, loop around and cross over NH 111 on a new structure adjacent to the new northbound I-93 mainline bridge over NH 111. With this layout, the NH 111 westbound traffic accessing the northbound on-ramp would use a free-flow slip ramp in the northeast quadrant of the interchange. Both of the northbound on-ramps are merged into one lane (as noted above, a truck climbing lane) just north of NH 111 before merging with the I-93 northbound mainline through traffic (**Figure 2.3-27**).

A third layout for the northbound ramps, which was developed as part of the Windham-Salem study completed in 1995, included a northbound to westbound flyover ramp as part of a similar Northbound Shift Option. As part of this I-93 study this layout was considered early-on, but dismissed. As identified in the *Rationale Report,* the other layouts evaluated provide satisfactory levels of service with fewer impacts.

Windham Northbound and Southbound Weigh Stations. The northbound and southbound Windham weigh stations are located approximately 1.4 miles north of the Exit 3 Interchange and were recently reconstructed in 1999. The proposed highway widening in all cases would occur away from the weigh stations and into the median area. Only minor modifications to the acceleration and deceleration lane transitions will be required to maintain access to the stations (**Figure 2.3-31**).

North Lowell Road. The northbound and southbound bridges over North Lowell Road were replaced with new structures in 1998 and 1994, respectively. The bridges were constructed as two-lane bridges and designed to accommodate additional widening for one or two future lanes on either side of the bridges while maintaining the necessary clearances. The proposed modifications for any alternative would be to widen the existing bridges to the outside (**Figure 2.3-31**).

Segment E

Segment E is located in the Towns of Derry and Londonderry and begins at the Windham/Derry town line to the south, extends approximately 5.2 miles northerly through the Exit 4 Interchange with NH 102, and terminates at the I-93 overpass at Stonehenge Road in Londonderry (**Figures 2.3-32 through 2.3-34**).

The major elements of this Segment include the widening and/or realignment of the I-93 northbound and southbound mainline, the re-alignment of the Exit 4 Interchange at NH 102 (Nashua Road), the northbound and southbound I-93 bridge widenings over Kendall Pond Road and Fordway Extension in Derry and Stonehenge Road in Londonderry, and the replacement and lengthening of the Ash Street/Pillsbury Road bridge over I-93.

I–93 Mainline. Beginning near the Windham/Derry Town line and extending north through Kendall Pond Road, the I-93 northbound and southbound widening transitions from a widening to the outside for both barrels to a westerly widening to avoid impacts to a Prime Wetland located along the east side of the northbound barrel approximately 0.3 miles south of Kendall Pond Road. Between Fordway Extension and Kendall Pond Road two options were considered for the southbound barrel. The first would hold the median edge of the southbound barrel and widen westerly. This option would require a retaining wall (20 to 30 feet high) approximately 2000 feet long in the median area because of the 20-25 ft. grade difference between the two barrels. The second option would shift the southbound barrel further westerly, on new alignment, approximately 90 feet. This shift would reduce the need for a retaining wall in the median, but would result in a larger ledge cut along the west side of I-93. This option would appear to be easier to construct with respect to maintenance of traffic (**Figure 2.3-32**). From Kendall Pond Road northerly approximately 3.4 miles to Stonehenge Road, the northerly end of Segment E, easterly and westerly widening options were developed for the northbound and southbound barrels.

Easterly Widening Option. The Easterly Widening Option was developed to retain the existing Exit 4 southbound interchange ramps in the NW quadrant in an effort to limit difficult and expensive construction that would otherwise be encountered due to the high rock and the inherent difficulty in reconstructing the ramps while maintaining traffic during construction. The Easterly Widening Option would retain the existing southbound ramps by holding the westerly edge of the existing I-93 southbound barrel with all widening of the southbound barrel and the construction of the northbound barrel occurring to the east. The easterly widening would eliminate impacts to the existing Exit 4 Park-and-Ride facility located immediately adjacent to the southbound off-ramp. North of the southbound off ramp, the widening continues to hold the westerly edge of the southbound barrel and eliminates highway impacts to the historic apple orchard property, that is eligible for the National Register. The northbound ramps shift to the east and are reconstructed and lengthened to accommodate the mainline shift and widening. The existing diamond configuration would be retained. This option shifts the I-93 northbound barrel closer to Wheeler Pond, however, no construction would be required in the pond. A retaining wall approximately ten-feet high and 950 feet long would be constructed along the easterly side of the northbound barrel to reduce impacts to the parking areas for the Londonderry Commerce Center and Stom Commercial Park. Near Stonehenge Road, the widening of I-93 transitions from an easterly widening to an outside widening for both the northbound and the southbound barrels (**Figure 2.3-33**).

Westerly Widening Option. The second option involves widening I-93 to the west. This alternative was developed to shift the widening away from Wheeler Pond area. This alternative would hold the easterly edge of the existing I-93 northbound barrel and maintain the widening of I-93 to the west. No construction would be required in the pond. The westerly shift will require the realignment and reconstruction of the existing southbound on and off-ramps in the NW quadrant of the interchange. The layout would require substantial rock removal for the reconstruction of the southbound ramps. The realignment of the southbound ramps would impact the existing park-and-ride access road and parking area for approximately 900 feet of the access road and require reconstruction and development of replacement parking (20 spaces). Reconstruction and realignment of the southbound ramps will also create substantial traffic control issues while trying to maintain traffic during the removal of the high rock adjacent to traffic. The diamond configuration of the northbound ramps would be retained, but the ramps would be reconstructed and lengthened to accommodate the highway widening. North of the Exit 4-Interchange area, the westerly shift continues to hold the easterly edge of the northbound barrel north from the Exit 4-Interchange area. The historic Woodmont apple orchard property would also be impacted. Near Stonehenge Road, the widening of the I-93 mainline transitions from a westerly widening to an outside widening for both the northbound and the southbound barrels (**Figure 2.3-34**).

Exit 4 - NH 102 (Nashua Road). At Exit 4, the modifications include maintaining the same basic interchange configuration that exists today while widening NH 102, replacing the existing NH 102 bridge over I-93 and reconstructing and lengthening the ramps. The proposed revisions involve realigning approximately 0.6 mile of NH 102 and constructing a new bridge over I-93 approximately 120 feet south of the existing bridge. The proposed grade of NH 102 would be raised approximately 3 feet to accommodate the longer span bridge over the widened I-93 northbound and southbound barrels. The realignment would allow the use of the existing bridge to maintain traffic while the new bridge is completed. The new bridge would provide for a seven-lane section (two 12-foot travel lanes in the eastbound direction with 5-foot shoulders, 5-foot sidewalks and a raised median which becomes a double left-turn lane as appropriate). To the east of I-93, the seven-lane section along NH 102 is carried to the signalized intersection with the southbound ramps, transitions to five-lanes at the Burger King Drive, and matches to the existing three-lane section at Londonderry Road. To the west of I-93, the seven-lane section transitions to five-lanes near the signalized intersection with the southbound off-ramps and continues westerly matching the existing roadway section near the NH 102 eastbound on-ramp.

Fordway Extension. The northbound and southbound bridges over Fordway Extension were replaced with new structures in 1998. The bridges were constructed as three-lane bridges and designed to accommodate additional widening for one future lane on either side of the bridges while maintaining the necessary clearances. The proposed modifications for any of the Alternatives under consideration would be to widen each of the existing bridges to the west. No roadway modifications are anticipated for Fordway Extension (**Figure 2.3-32**).

Kendall Pond Road. The northbound and southbound bridges over Kendall Pond Road were replaced with new structures in 1998. These bridges were also constructed as three-lane bridges and designed to accommodate additional widening for one future lane on either side of the bridges while maintaining the necessary clearances. The proposed modifications for any of the Alternatives under consideration would be to widen the existing bridges to the west. No roadway modifications are anticipated for Kendall Pond Road (**Figure 2.3-32**).

Ash Street/Pillsbury Road Bridge over I-93. The Ash Street/Pillsbury Road Bridge over I-93 is proposed to be replaced to accommodate the I-93 widening for four lanes and preserve a space in the median for future rail. Two options are under consideration.

On-line Option. The On-line option would reconstruct approximately 0.2 mile of Ash Street/Pillsbury Road and its approaches and replace the existing bridge generally on its existing alignment. The new bridge would have two 12-foot lanes, 5-foot shoulders and a 5-foot sidewalk. A temporary detour bridge to the south would be necessary to maintain traffic during construction (**Figure 2.3-33**).

Off-line Option. The Off-line option would construct approximately 0.5 mile of Ash Street/Pillsbury Road and approaches on new alignment to the south. The new bridge would be located approximately 50 feet to the south of the existing. The existing bridge would be used to maintain traffic during construction and removed after the traffic is shifted to the new structure. The new bridge would have two 12-foot lanes, 5-foot shoulders and a 5-foot sidewalk (**Figure 2.3-34**).

Stonehenge Road. The northbound and southbound bridges over Stonehenge Road were replaced with new structures in 1998. The bridges were constructed as two-lane bridges and designed to accommodate additional widening for one or two future lanes on either side of the bridges while maintaining the necessary clearances. The proposed modifications at Stonehenge Road for any of the Alternatives under consideration would be to widen the existing bridges to the outside. No roadway modifications are anticipated for Stonehenge Road (**Figures 2.3-33 and 2.3-34**).

Segment F

Segment F is located in the Town of Londonderry and the City of Manchester and begins at the Stonehenge Road overpass in Londonderry, extends approximately 5.6 miles northerly through the Exit 5 Interchange with NH 28, and terminates at the I-93/I-293/NH 101 Interchange in Manchester (**Figures 2.3-35 and 2.3-36**).

The major elements of this Segment include the widening and/or realignment of the I-93 northbound and southbound mainline, the Exit 5 Interchange at NH 28 (Rockingham Road), the northbound and southbound I-93 bridge replacements over the Manchester to Lawrence rail line (abandoned), the northbound and southbound I-93 bridge widenings at Bodwell Road and northbound bridge widening over Cohas Brook (southerly crossing). Also included are the proposed widenings for the northbound bridge over Cohas Brook (northerly crossing) and the I-293 northbound to westbound bridge over Cohas Brook.

I–93 Mainline. The mainline modifications for this section begin at Stonehenge Road, and extend northerly. Over the first mile, the I-93 northbound and southbound lanes are widened to the outside to a point just south of the Exit 5 Interchange where all widening then shifts to the west to avoid impacts to a locally sensitive wetland and pond in the NE quadrant of the Exit 5 Interchange. The space reserved for the future rail line ends just north of the Exit 5 Interchange where the I-93 rail line would tie back into the existing abandoned Manchester to Lawrence rail line to the west. The grade for the northbound and southbound barrels would be raised approximately six feet to accommodate the new longer span bridges over the widened NH 28 (**Figure 2.3-35**).

For the northbound barrel extending from the Exit 5 Interchange northerly for approximately 2.4 miles, the widening would continue to hold the outside edge of the highway with all widening occurring into the median before transitioning into the Department's recently constructed Bodwell Road project. The I-93 northbound widening would match into the Bodwell Road project by adding width to the outside edge of the northbound barrel. In doing so, impacts to Cohas Brook and associated wetlands in the median area can be minimized. The Three-Lane or the Four-Lane Alternative northbound travel lanes transition to five northbound lanes south of the Bodwell Road bridge crossing. The five-lane section would be carried north to the I-93 NB/I-293 NB/NH 101 westbound split where two northbound lanes would diverge to the west and match into the existing two lanes for the I-293 NB/NH 101 westbound connection and three northbound lanes would continue northerly and match into the existing three I-93 northbound travel lanes (**Figure 2.3-36**).

The widening of the southbound barrel continues to remain toward the outside before transitioning into the current Bodwell Road project.

Similar to the northbound barrel, the I-93 southbound widening would transition into the recently constructed I-93/Bodwell Road by widening to the outside of the highway. Two southbound travel lanes from I-293 SB/NH 101 eastbound would merge with three travel lanes from I-93 southbound north of the Bodwell Road bridge crossing, and the five lanes would then be carried south over Bodwell Road before transitioning to four travel lanes. For the Three-Lane Alternative, the five-lanes would transition to a four-lane section and continue southerly for approximately 0.3 mile before transitioning to the Three-Lane Alternative (**Figure 2.3-36**).

Exit 5 Interchange (NH 28/Rockingham Road). There are four options proposed for the Exit 5 Interchange (**Figure 2.3-35**). Two options represent the same general diamond-type northbound/southbound signalized ramp configuration that exists today. A third option retains a diamond configuration for the southbound ramps and relocates the northbound ramps further to the south. The fourth option involves using roundabout layouts at the northbound and southbound ramp intersections with NH 28. All four of the interchange options reflect the same design elements for NH 28 west of the southbound ramps. The reconstructed southbound ramps would have the same general diamond layout as exists today, however they would be lengthened and widened with additional turn lanes. The southbound ramps would intersect NH 28 opposite each other at either a signalized intersection or an unsignalized roundabout. To the west of the southbound ramps, NH 28 would be reconstructed and widened. The westerly modifications to NH 28 begin at the southbound ramps and extend westerly through the unsignalized intersection with Perkins Road and through the signalized intersection of NH 28 /Vista Ridge Drive and Symmes Drive. The improvements include two 12-foot travel lanes in each direction with five-foot shoulders with a combination of raised and painted median treatments, which allow for left-turns where appropriate. The five-lane section transitions to a three-lane section just west of the Symmes Drive intersection before transitioning to the existing two-lane section of NH 28. A 5-foot sidewalk on the north side of NH 28 is also proposed between Liberty Drive, east of the interchange, and Symmes Drive. The Symmes Drive approach to NH 28 would be modified and connect to a proposed park-and-ride lot on the north. The existing access into the Waste Management transfer station from NH 28 would be modified to right turn in only. A new full access connecting Waste Management to NH 28 will be provided via the proposed park-and-ride lot access road connecting to Symmes Drive.

During the course of the evaluation process for park-and-ride lots at Exit 5, five concepts were developed: two with access from Symmes Drive and one lot with access from Perkins Road; one lot with access from NH 28 in the southeast quadrant of the interchange; and one with access from Auburn Road (see Park-and-Ride Section 2.3.5.4 and **Figure 2.3-41**). With the Perkins Road conceptual park-and-ride lot (Option 3), approximately 0.4 mile of Perkins Road would be reconstructed and a section relocated westerly opposite Symmes Drive with a signalized intersection at NH 28 (**Figure 2.3-41)**.

To the east of I-93, three options were developed for NH 28 and the northbound ramps. The Options include:

NH 28 On-line and NH 28 Relocation Options. The widening modifications for both the On-line and Relocation Options for NH 28 are similar to the widening of NH 28 west of I-93 described above. The modifications to NH 28 for these options begin at the southbound ramps and extend easterly approximately 0.5 mile. The NH 28 widening with signalization at the ramp intersections includes two 12-foot travel lanes in each direction with 5-foot shoulders and a combination of raised and painted median treatments which allow for left-turns where appropriate (between the northbound and southbound diamond interchange ramps, NH 28 includes two through lanes and a single left-turn lane in each direction, a total of six lanes). The NH 28 widening with the roundabout layout at the ramp intersections includes two 12-foot travel lanes in each direction with 5-foot shoulders and a raised median island between the ramp intersections and a combination of painted or raised median treatments for left turns to the east of the northbound ramps, where appropriate. The five-lane section along NH 28 transitions to the existing two-lane section just east of Liberty Drive. A 5-foot sidewalk on the north side of NH 28 is also proposed between Liberty Drive and Symmes Drive. The Liberty Drive approach to NH 28 would be signalized. Access at the NH 28/Auburn Road intersection would accommodate right turns entering and exiting Auburn Road as well as left turns entering Auburn Road. Approximately 1,400 feet of Independence Drive would be reconstructed and its westerly intersection with Auburn Road realigned opposite a driveway into a newly constructed office development. Approximately 500 feet of Auburn Road would also be reconstructed and widened. The northbound diamond ramps would be lengthened and widened to provide for turning lanes at a signalized intersection with NH 28. For the On-line Option, the eastern edge and the existing curvature for NH 28 are held as controls with widening occurring primarily toward the west. Full drive access to the Sunoco Gas Station is relocated opposite the Liberty Drive intersection.

For the NH 28 Relocation Option, a section of NH 28 between the northbound Ramps and Liberty Drive is relocated to the west requiring acquisition of the Sunoco Gas Station property. A section of existing NH 28, remaining from the relocation, would be retained and dead-ended with access provided via a connection to Auburn Road. The primary difference between the On-line and the Relocation Option is somewhat improved geometry of this section of NH 28 and the required property acquisition for the Relocation Option. All other design elements are similar.

NH 28, Northbound Ramp Relocation Option. The third option evaluated for the northbound ramps is the northbound Ramp Relocation Option. This option shifts the existing northbound ramp intersections with NH 28 approximately 1000 ft. further to the south and opposite the Liberty Drive intersection. By combining the NH 28 northbound ramps and proposed Liberty Drive signal, one signal would be eliminated near the Exit 5-Interchange area. The layout would extend the NH 28 five-lane section easterly from the Symmes Drive intersection to the Liberty Drive intersection where a six-lane section (two 12-foot travel lanes in each direction and a double left-turn lane for the northbound on-ramp) is developed to accommodate the traffic operations. This option also reduces the pavement width directly under the I-93 overpass bridges from a six-lane section necessary with the On-line and the Relocation Options (two-travel lanes in each direction and one left-turn lane in each direction) to a five-lane section. The intersection of Auburn Road and Independence Drive would be modified to accommodate the change in travel patterns resulting from the Auburn Road/NH 28 intersection.

I-93 NB/SB Bridges over the Manchester to Lawrence Rail Line. The I-93 northbound and southbound bridges over the former Manchester to Lawrence line are proposed to be replaced. The northbound and southbound barrels will be raised approximately five feet to gain the required vertical clearances for the new wider and longer bridges to accommodate space for a future rail line (**Figure 2.3-35**).

Bodwell Road Bridges. The northbound and southbound bridges over Bodwell Road were recently reconstructed to accommodate four lanes (two through lanes and two auxiliary lanes for the I-293 ramps). For the widening of I-93, the proposed modifications to the Bodwell Road bridges would widen the existing bridges to the outside to accommodate five lanes. No roadway modifications are anticipated for Bodwell Road (**Figure 2.3-36**).

Northbound Bridge over Cohas Brook (Southerly Crossing). The northbound bridge over Cohas Brook (southerly crossing) was reconstructed to accommodate four lanes (two through lanes and two auxiliary lanes for the I-293 ramps). The proposed modifications to the bridge would be to widen the existing bridge to the outside (**Figure 2.3-36**).

Northbound Bridge over Cohas Brook (Northerly Crossing). The I-93 northbound to I-293 westbound ramps over Cohas Brook will be retained. The I-93 northbound mainline box culvert at Cohas Brook will be lengthened toward the west to accommodate three travel lanes and 10-foot shoulders. The I-93 southbound mainline box culvert at Cohas Brook will be lengthened towards the west to accommodate three travel lanes and 10-foot shoulders. I-293 eastbound to I-93 southbound box culvert will be retained (**Figure 2.3-36**).

2.3.3.4 Corridor Bike Path

Facilities for bicycles originally included in the layout presented in the Draft EIS have been eliminated from further study. NHDOT recently completed a separate Bikeway Feasibility Study in March 2003 to identify alternative transportation corridors for pedestrian and bicycle travel between Salem and Concord, NH. The study included consideration of on-road shared shoulder alternatives along local roads, the I-93 corridor bike path presented in the DEIS (described below), and a rail trail alternative. The study recommended the development of a rail trail facility located along the abandoned Manchester-Lawrence railroad corridor. The Feasibility Study recommended that the I-93 bicycle path layout not be pursued. The NHDOT is continuing to work with regional and local officials to implement the Bikeway Feasibility Study recommendations.

For the I-93 Corridor Bike Path, a single off-road bike path option was developed for the corridor between Exit 2 and Exit 5. In doing so constructability and cost implications were considered, and the magnitude of property and resource impacts were assessed. The path as considered would be constructed adjacent to the I-93 corridor, within the proposed highway right-of-way and as part of widening I-93 from the existing two-lane highway in each direction to three- or four-lane highway in each direction.

The location of a bike path is controlled by the need to minimize property and resource impacts, the need to provide linkage to the existing local roads and regional bike system, and the ease of traveling through the highway interchange areas. Wherever practicable, the bike path was developed to follow along the edge of the improved I-93 highway in the area disturbed by the highway widening. The proposed bike path connects each of the corridor park-and-ride lots beginning with the proposed Exit 2 lot in Salem, extending to the proposed Exit 3 lot in Windham and the existing Exit 4 lot in Londonderry, ending at the proposed Exit 5 Park-and-Ride lot in Londonderry, a distance in total of approximately 12 miles. The bike path parallels the northbound barrel, except between Fordway Extension and Pillsbury Road (Exit 4-Interchange area), and between Stonehenge Road and Rockingham Road (Exit 5-Interchange area), where it parallels the southbound barrel. Crossovers are proposed at existing side roads.

The path as proposed would be a 10-foot paved path with 2-foot gravel shoulders. Grades were kept to a minimum (<5 percent) wherever possible in an effort to maintain compliance with the Americans with Disabilities Act (ADA). The bike path would intersect at grade all side roads crossing over or under I-93, which would allow greater access to the path.

2.3.3.5 Summary and Conclusions

The evaluation of the Build Alternatives included consideration of a Three-Lane Alternative, the Four-Lane Alternative, and the Combination Alternative. All focused on widening the existing two-lane roadway to either three or four lanes in each direction. Existing interchange layouts were evaluated for possible modernization and reconstruction. No consideration was given to constructing new interchanges on new location, as part of this study to widen I-93. However, under separate study, Derry and Londonderry are doing an independent study for a potential Exit 4A just north of Exit 4. Environmental, socio-economic and engineering constraints were taken into account during the development of these alternatives with impacts to resources minimized as practicable. Within the I-93 mainline highway corridor, additional width was included to accommodate a potential future rail line and the potential for future HOV lanes. Accommodations were made to not preclude either future median mass transit alternatives or restoration of rail service along the abandoned Manchester-Lawrence rail corridor. In addition, the layout includes provisions for sound walls, where appropriate and drainage facilities as required for water quality control purposes.

The 19.8-mile corridor was split up into six segments (A through F) for evaluation purposes relative to the various options within each segment. A total of 19 options were developed along the length of the corridor. Each option was evaluated for both the Three- and Four-lane Alternatives. Though the Four-Lane Alternative has one additional lane in each direction, compared to the Three-Lane Alternative, additional temporary width would be required to construct the Three-Lane Alternative while maintaining two lanes of traffic in each direction, and will likely approximate, in some cases only temporarily, the impacts resulting from the Four-Lane Alternative.

All three of the highway widening alternatives considered (the Three-Lane, Four-Lane, and Combination Alternatives) were carried forward for further evaluation. There are only two segments (Segment C and Segment D) with options considered early in the design process that have not been carried forward. For Segment C, three mainline alignments in the area immediately north of the Lowell Road (NH38) crossing were evaluated. The three options were developed given the constraints involving wetlands east and west of the highway and Porcupine Brook meandering through the median between the north and southbound barrels of I-93. By observation, and based on input from the natural resource agencies, the concept developed has all widening take place outside the median, and in effect results in minimal impact to Porcupine Brook in the median. For Segment D, the 1995 Exit 3 Interchange concept developed as part of the Windham-Salem NH 111 project (10075), which included a northbound to westbound flyover off-ramp, has not been carried forward. The options evaluated in Segment D provide satisfactory levels of service with fewer impacts. The highway widening and interchange options carried forward, which were developed to accommodate all three of the mainline alternatives, are summarized, by segment, in the following paragraphs.

- In **Segment A**, the proposed mainline and collector distributor highway layouts are the same for all three alternatives. The layouts were developed with an understanding of highway needs and environmental constraints and reflect the least damaging practicable approach. For the Cross Street overpass, two options were carried forward. An On-Line Option, which would require building a separate detour bridge to maintain traffic during construction, and an Off-Line Option, which would be constructed adjacent to the existing bridge.

- In **Segment B**, Exit 1 northbound ramps are the same for all three alternatives. Two options were considered for the Exit 1 southbound ramps. The On-Line option rehabilitates and retains the existing substandard geometry constructed in the 1960's, and the Off-Line option improves the existing geometry by reconstructing the ramps to current minimum highway standards. Retaining the existing substandard geometry was considered due to the presence of wetlands within and adjacent to the interchange and the designation of those wetlands as prime wetlands, although the designation has since changed.

- **In Segment C**, Exit 2 northbound ramp configurations remain the same through this Segment for all three alternatives. Both of the proposed Exit 2 southbound ramp options would eliminate the existing difficult weave. The Diamond Option mirrors the diamond layout for the northbound ramps and requires a smaller footprint than the Loop Option. The Loop Option provides more of a free-flow operation for traffic accessing the mainline. Both options require widening Pelham Road to a maximum of either six-lanes and four signals with the Loop Option, or seven-lanes and five signals with the Diamond Option. The loop ramp layout requires one additional bridge over Pelham Road. The roundabout concept (developed in response to comments received at the Public Hearing held in November, 2002) for the northbound and southbound ramp intersections at

Pelham Road, has not been carried forward. The direct physical impact of the roundabout option is not appreciably different from the signalized intersection option. Although the operational review found that an acceptable level-of-service can be achieved using a two-lane roundabout design, NHDOT feels that at this time a roundabout layout is not consistent with the NHDOT's practice for design of freeway type interchanges.

In recent years there has been an emergence of interest in modern roundabouts in New Hampshire as well as other part of the United States. NHDOT has recently evaluated use of roundabouts in Keene, Plymouth, and Ossipee. Currently only two roundabouts (Nashua and Keene) have been constructed in New Hampshire. Although there are many benefits to roundabouts, their function varies depending on their size. Modern roundabouts can range in size from an inscribed circular diameter as small as 50 feet for mini-roundabouts to as much as 500 feet for large multi-lane roundabouts. Smaller roundabouts are best for traffic calming, while larger roundabouts serve to provide high vehicular capacity. Roundabouts operate most safely when their geometry forces traffic to enter and circulate at slow speeds. Horizontal curvature and narrow pavement widths are used to produce this reduced-speed environment. However, the capacity of roundabouts is negatively affected by these low-speed design elements. As the widths and radii of the entry and circulatory roadways are reduced, the capacity of the roundabout is also reduced.[9] As widths and radii increase, the throughput capacity and vehicle speeds increase. In other words, the type of roundabout must be consistent with the functional need and desire (traffic calming or capacity).

To be successful, the installation of a roundabout must meet the need (traffic calming or capacity), must meet the acceptance of the community and must be consistent with the long-term vision of the transportation system. At this important juncture between the Interstate system and the local road network a high capacity multilane roundabout is required to provide sufficient capacity at these intersections. The NHDOT held numerous Public Informational meetings on this project and did not receive any input from the communities reflecting a desire to consider roundabouts at the interchanges along I-93.

NHDOT feels that, in general introducing smaller-diameter, single-lane traffic calming type roundabouts first makes the most sense for New Hampshire to acclimate the public before moving ahead with the larger, high capacity roundabouts. While analysis shows the roundabout option could work from a traffic standpoint, NHDOT has concerns with public acceptance and public unfamiliarity, particularly along the Interstate system. For these reasons, the NHDOT does not believe that interchange roundabouts are the appropriate traffic control device for this location.

[9] A Policy on Geometric Design of Highway and Streets, AASHTO, 2001, 4th Edition.

Two options were developed for the Brookdale Road overpass. An On-Line Option, which would require building a separate detour bridge to maintain traffic during construction, and an Off-Line Option, which would construct a new bridge adjacent to the existing bridge.

- In **Segment D**, nine options were developed to evaluate and assess the merits and effectiveness of layouts based on variations of the I-93 mainline, NH 111, and the interchange ramp configurations connecting with NH 111.

I-93 Mainline. Two mainline options were developed for the Exit 3 Interchange area. The Northbound Shift option relocates the northbound barrel westerly into the median area with only minor alignment adjustments to the southbound barrel to facilitate construction. The Tight Shift Option, developed in response to the Town of Windham's desire to reduce the overall footprint of the Exit 3 Interchange area, relocates both the southbound and the northbound barrels into the median area. Both of the mainline options improve intersection operations by providing greater distance between the northbound ramps and the existing NH 111/NH 111A intersection. The alignment for the Tight Shift Option also improves the geometry and shifts the mainline highway away from both Canobie Lake and Cobbetts Pond and also aids in reducing the overall Exit 3 Interchange footprint. The Town of Windham also requested that consideration should be given to relocating NH111A westerly away from its current intersection with NH 111 and that this option should provide for access to the proposed park-and-ride facility, as well as access to existing and future development on adjoining land.

For the Northbound Shift Option, six optional Exit 3 Interchange layouts were developed in concert with the NH 111 reconstruction, while three interchange and NH 111 configuration layouts were developed for the Tight Shift Option.

An option suggested by private interests following the November 2002 Public Hearing, involved holding the existing alignment of each barrel and widening the highway to maintain the existing median for private development. This option has not been carried forward as it does not address the continued intersection operational concerns due to the proximity to the NH 111A intersection; promotes development and associated traffic concerns within the interchange; does not address existing geometric deficiencies; and provides no comparative environmental benefit.

Exit 3 Interchange Ramps. The choices for the Exit 3 Interchange ramps for either of the two mainline options include diamond type layouts utilizing signalized intersections with NH 111 or loop-ramp type layouts providing for free-flow movements between I-93 and NH 111 in some locations.

All I-93 southbound off-ramp layouts were configured as a diamond type ramps due to the difficulty in developing a practicable loop-ramp configuration considering the relatively steep grades and the close proximity of Cobbetts Pond. For NH 111 eastbound traffic, all southbound on-ramp layouts utilize a diamond type free-flow slip ramp. For westbound traffic on NH 111, two ramp configurations were developed. A signalized diamond layout and a free-flow loop layout. The loop ramp layout requires an additional bridge over NH 111.

The northbound ramp layouts are similar to the southbound options. All northbound off-ramp layouts utilize a diamond type ramp layout similar to what currently exists. All northbound on-ramp layouts for NH 111 westbound traffic traveling north onto I-93 utilize a diamond type free-flow slip ramp. For eastbound NH 111 traffic traveling onto I-93 northerly, two ramp configurations were developed. A signalized diamond ramp layout and a free-flow loop ramp layout. The loop ramp layout requires an additional bridge over NH 111.

NH 111. For NH 111 east of the southbound ramps, there is one alignment layout that essentially utilizes and widens NH 111 in the area of the existing highway. West of the Exit 3 Interchange, two NH 111 alignments were developed which involve either reconstructing NH 111 on-line or relocating NH 111 slightly to the north and bypassing the segment of NH 111 just west of I-93.

The On-Line maintains the alignment of the existing NH 111. The existing highway would be widened to five lanes in the vicinity of the Exit 3 ramps and then transition to a three-lane segment tying into the existing three-lane segment east of the Village Green Plaza. The On-Line Option, as proposed, would impact the frontage of a number of properties and accentuate problems relative to accessing adjacent properties due to the width of the highway, the effects of the geometry of intersecting driveways, and the heavy traffic volumes. Overtime such a layout would experience severe operational difficulties given the magnitude of the traffic volumes and the presence of numerous driveways along this segment of NH 111. Widening and extending the five-lane section westerly to meet future traffic demands was considered, but given the severity of the property impacts and the Town of Windham's concerns, this option was not pursued.

The Relocation Option relocates NH 111 approximately 450 feet to the north and allows existing NH 111 from Wall Street to the SB ramps to be bypassed. In doing so, the through traffic is moved away from the many intersecting local roads (6) and residential and commercial drives (13) that exist along NH 111 between Wall Street and the southbound ramps. In addition, the heavy traffic would be removed further away from Cobbetts Pond. Existing NH 111 would act as a frontage road under the Relocated Option, with access to relocated NH 111 via a signalized intersection with Wall Street.

- In **Segment E**, two options for the southbound barrel were considered in the area just south of Kendall Pond Road. The one option would hold the median edge of the existing southbound barrel and widen to the west. This option would require extensive retaining walls. The second option shifts the whole I-93 southbound barrel to the west, thereby eliminating the need for extensive retaining walls and at the same time be more conducive to construction relative to maintenance of traffic. For the mainline through Exit 4, two options were considered, that would widen I-93 either easterly or westerly. Both options maintain the same basic interchange configuration that exists at Exit 4 today. The configuration of the northbound ramps is the same for both options, while the level of construction required for the southbound ramps would differ depending on the option.

  The Easterly Widening Option holds the westerly edge of the southbound barrel with all widening accommodated towards the east. This option retains the existing southbound ramps and avoids impacts to the adjacent park-and-ride facility and the historic Woodmont apple orchard to the north. The Westerly Widening Option holds the easterly edge of the northbound barrel with all widening accommodated towards the west. This option reduces the widening adjacent to the Wheeler Pond area, but would require complete reconstruction of the southbound ramps, which would be both costly and difficult for traffic management during construction because of the substantial rock removal required. The Westerly Widening Option would impact the existing park-and-ride facility and the historic apple orchard. With either option the NH 102 bridge over I-93 would be replaced with a new bridge, to the south of existing bridge.

  Two options are considered for the Ash Street/Pillsbury Road bridge over I-93. An On-Line Option, which would require a detour bridge to maintain traffic during construction, and an Off-Line Option, which would construct a new bridge adjacent to the existing bridge.

- In **Segment F**, the proposed alignments for the mainline, NH 28 west of I-93, and for the Exit 5 southbound ramp configurations would remain the same for all three Build Alternatives. East of the Exit 5 Interchange, three options were developed for the northbound ramps and NH 28. Two options, the NH 28 On-Line and the NH 28 Relocation Options, essentially retain the existing northbound ramp diamond configuration and involve reconstructing NH 28 to the south, either on existing alignment or as part of a short westerly realignment of NH 28 to improve its curvature. [Both of these options included variations of the northbound and southbound ramp intersections with NH 28 to include either a signalized ramp layout or a roundabout configuration. The roundabout layout for Exit 5 as with the Exit 2 roundabout concept has not been carried forward. (See previous roundabout discussion for Segment C.)] The third option, the Northbound Ramp Relocation Option, involves relocating the northbound ramps to the south, opposite the Liberty Drive intersection. This option eliminates one traffic signal located along NH 28 in the interchange area.

In summary, all three of the highway widening alternatives considered, the Three-Lane, Four-Lane, and Combination Alternatives, were carried forward for more detailed evaluation along with the options listed above. Analysis and comparison of impacts to the natural and built environments, including consideration of cost, constructability, and applicability to meeting the project purpose and need, are required to evaluate the Three-Lane, Four-Lane or Combination Alternatives.

2.3.4 Transportation Demand Management

Transportation Demand Management (TDM) encompasses a variety of strategies that are designed to change personal travel behavior to reduce the demand for automobile use and the need for highway capacity expansion. This is accomplished through measures that reduce the number or length of drive-alone trips or that move trips out of times of peak roadway congestion.

TDM measures focus on providing incentives (or disincentives) to drivers who drive alone to encourage them to change their travel behavior to ride-share or use another mode of travel. TDM measures include consideration of major infrastructure investments to provide and expand alternative modes of transportation such as HOV lanes, park-and-ride facilities, bus services, and rail service. (Bus and rail services are discussed separately below under Mode Alternatives.)

Another measure designed to reduce peak hour traffic flow on highways is ramp metering. Ramp metering discussed in Section 2.3.2.2 is actually a Transportation System Management (TSM) measure because its primary purpose is to maximize the efficient utilization of the existing highway system. It can also have the effect of encouraging ride-sharing and transit use, but it can cause traffic to divert to other routes and shift the locations of roadway congestion and delay.

2.3.4.1 Employer-Based Measures

TDM strategies are most effective in changing commuting behavior if they are implemented through employers. As a result, employers are frequently responsible for funding TDM programs, at least in part. This reliance on private funding differentiates TDM programs from more traditional transportation services and creates opportunities for public/private partnerships to address transportation issues.

Nationally, a large variety of TDM strategies have been adopted. The most commonly implemented strategies include:

- Programs that encourage the use of transit, such as on-site sale of transit passes, employer shuttles to transit stations, employer subsidies for transit use (including employer provided passes), and adequate parking at transit stations.

- Ride-matching programs and preferential parking at the work site for carpools and vanpools.
- Bicycle and pedestrian amenities such as bicycle storage, showers and lockers, and improved pathways and access.
- Commuter choice programs which equalize tax treatment of parking and transit benefits. Employers can provide parking "cash-out" to encourage use of alternative modes.
- Support programs for those who commute via alternate modes, such as on-site services (shopping, banking, and day care) and guaranteed ride home programs.
- Variable work arrangements and work hours such as telecommuting, flextime, and compressed work weeks.

Implementation of TDM programs may occur voluntarily or may be required through government regulations. The government also encourages TDM programs through financial incentive programs.

Implementation of voluntary TDM programs is frequently facilitated through ride-share brokerages or transportation management associations (TMAs). Both are public/private partnerships that design, market, and implement programs that support commuting alternatives and administer incentives to employees who use the alternatives. These organizations also collaborate with state and local governments, public agencies, and transit operators to increase the availability of transportation alternatives.

Although these organizations exist in a variety of sizes and operational structures, they generally use government support in combination with private funding, which is obtained through cash grants, member dues, fees for services, or in-kind contributions. Ride-share brokerages offer area-wide services, but also work with individual employers to implement TDM programs at individual work sites. TMAs are groups of employers that band together to address specific transportation issues in their area by implementing TDM measures for member employers.

Typically, both types of organizations work with employers to provide a variety of TDM programs including ride-matching, on-site transit pass sales, employer shuttles to transit, guaranteed ride home programs, parking management, flexible work hours, and telecommuting. In addition, these organizations offer technical assistance to employers, provide marketing materials, and sponsor promotional events to educate employees about their commuting options.

The majority of work-related travel along the I-93 corridor is to workplaces in Massachusetts. These include employers in downtown Boston, employers along the I-95 (Route 128) and I-495 circumferential highways around Boston, and employers along I-93 between I-95 and the New Hampshire state line. Employer-based TDM measures that would impact the I-93 corridor in New Hampshire would need to be implemented largely in Massachusetts.

Massachusetts has a number of TMAs that provide a range of services to many New Hampshire residents who work along the I-93 corridor and in Boston. The Massachusetts TMAs that have the greatest likelihood of influencing travel on the I-93 corridor in the study area are:

- The River Road TMA in Andover
- Junction TMO (Transportation Management Organization) in the Ballardvale Street/Lowell Junction area of Andover and Wilmington
- The Artery Business Committee TMA in Boston
- Commuter Works/MASCO in Boston (Longwood Medical and Academic Area)
- The Inter-institutional TMA in Boston (Boston Medical Center)
- The Logan TMA at Logan Airport
- The Seaport TMA in South Boston
- The Charles River TMA in Cambridge
- The 128 Business Council TMA

2.3.4.2 Congestion Pricing

Congestion pricing is essentially a TDM strategy that provides a financial disincentive to driving alone during peak periods of travel.[10] Congestion pricing is based on the market–based concept that those who demand use of a facility should pay for the capacity required to supply an adequate level of service on the facility. This suggests that drivers, during the highest demand periods, would change their travel behavior in order to maximize their individual needs.

Congestion pricing involves charging a premium price for use of a transportation facility during periods of congestion. This could involve imposing a charge during peak periods for a facility that is otherwise free of charge or it could involve charging a higher fee during peak periods on an existing toll facility.

Congestion pricing serves to reduce overall roadway delays on a facility by:

- Diverting drivers to alternative routes of travel;
- Causing drivers to share a ride to reduce individual expenses:
- Changing time of travel to times of reduced or no congestion; and
- Increasing the cost of travel and eliminating some trips altogether.

[10] Implementing Effective Traffic Demand Management Measures: Inventory of Measures and Synthesis of Experience, prepared by Comsis Corporation and the Institute of Transportation Engineers, for the U.S. Department of Transportation, DOT-T-94-02, September, 1993, p. 1-1.

In addition to reduced delays, congestion pricing provides benefits by:

- Raising revenues to provide improved transit service and/or other alternatives to single occupant vehicles (SOVs);
- Raising revenues needed to maintain and improve the roadway system; and
- Reducing vehicle miles traveled (VMT) thereby reducing vehicular emissions.

The main disadvantages of congestion pricing include:

- Adverse impacts on low income and disadvantaged groups -- congestion pricing could be viewed as a regressive tax, in that it is not tied to a person's ability to pay the fee. It is widely believed that congestion pricing will have a greater impact on low income and disadvantaged persons.[11]

- Impacts of traffic diversions on local streets and other roadways that serve as alternative routes -- congestion pricing may adversely affect communities adjacent to priced corridors because drivers will divert to nearby routes to avoid the tolls.[12] In fact, route diversion, rather than time or mode diversion, will be the most likely effect of congestion pricing.

- Actual and perceived lack of convenient transportation options to tolled roadways -- congestion pricing and alternative modes go together. The Federal Transit Administration's (FTA) experience points out that a charge for the use of roadway space will not be publicly accepted unless a viable, visible, and well-publicized alternative mode of transportation is provided for the affected area and for affected users.[13] Again, if alternative modes are not available, many drivers have little choice but to take an alternate route, or pay the toll.

- Opposition by some commercial interests — congestion pricing represents an increased cost of doing business, which could adversely affect local businesses sending or receiving deliveries. In many cases, business and delivery schedules have already been adjusted as much as possible and further shifting away from peak periods would not be possible.

- Concern that revenues will not be used for the transportation purpose for which they were collected, or in the areas where they were collected — revenues hold one of the keys to the political and public success of congestion pricing.[14, 15] There are a number of options for the use of revenues and there may be concerns that over time, revenues would not be used as proposed. Particular concern focuses

[11] Lari, Adeel Z. and Kenneth R. Buckeye, "Measuring Public Acceptability of Congestion Pricing Options in Minnesota," ITE 1996 Compendium of Technical Papers, p. 476.
[12] *Ibid.*, p. 476.
[13] Arrillaga, Bert, "U.S. Experience with Congestion Pricing," ITE Journal, December 1993, p. 42.
[14] Van Hattum, David, "Political and Institutional Issues in Congestion Relief Tolls--Report on a National Study," ITE Journal, October 1996, p. 47.
[15] Small, Kenneth, "Using the Revenues from Congestion Pricing," Transportation, Vol 19, p. 359-381.

on revenues being diverted to other facilities or areas where congestion pricing is not in place.

There are four general types of congestion pricing projects:

1. **Variable Toll Facilities for New Highways.** The easiest form of providing congestion pricing is by making it a part of a brand new highway facility that will serve as another corridor to an existing transportation system. In doing so, the facility can be completely modern, other routes will exist, and the toll charges can be easily justified as necessary to support the construction cost, as well as the maintenance cost of the new facility.

2. **Variable Toll Facilities on Existing Toll Highways.** The second easiest form of providing congestion pricing is to convert an existing toll facility from charging uniform tolls to charging variable tolls. If drivers are already accustomed to paying a toll, then the practice of varying the toll by time of day or by vehicle occupancy can be a logical next step. In doing so, the facility should be outfitted with electric toll collection equipment to ease congestion and delay at the tolls and provide additional incentive to participate in the automated program.

3. **Variable Toll Facilities on Existing Non-Toll Highways.** A third way of providing congestion pricing is to convert a non-toll facility to a variable toll facility. Such a conversion is difficult to accomplish. Toll facilities need to be constructed, not only at the terminal of the highway facility, but also at the interchange locations where traffic is entering or exiting the highway. To address the capacity needs through the toll access, additional highway widening is required with further impact to the environment and surrounding properties. Electronic toll collection should be incorporated to minimize delays as much as possible. It should also be noted that the ability to place tolls on interstate highways that currently do not have tolls is limited by federal law. Such toll initiatives must be carried out under the auspices of specific available FHWA programs, following approval of application.

4. **High Occupancy Free/Others Tolled (HOT) Lanes.**[16] A fourth means of congestion pricing involves constructing a barrier-separated high occupancy vehicle (HOV) system (physically separated HOV lanes with individual on and off-ramps independent of general purpose lanes and interchange ramps) and making available, for a price, the use of the HOV facility by single occupancy vehicles. High occupancy vehicles (HOVs) would travel in the HOV lane for free, but the single occupancy vehicles (SOVs) would pay a toll, with the cost depending on the congestion in the general purpose lanes. Such HOV facilities are known as HOT lanes. The benefit of such a facility is that the ridership in the facility can be maximized by varying the toll cost and thus the incentive/

[16] "HOT Lane" is a recent term devised by economists at the University of California-Irvine and the Reason Foundation.

disincentive to SOV motorists to use the HOT lanes. The drawback of such a facility is that the HOT system is expensive as it is separate from, and essentially independent of, the general purpose lane system; the facility requires a toll collection component which introduces additional costs and results in some delay that would otherwise not exist for HOVs; and the facility is perceived to cater to the wealthy who can more readily afford to pay this toll.

A variation of this fourth type of congestion pricing was implemented by the NHDOT along the F.E. Everett Turnpike in Bedford, NH in the mid-1990s. The initiative involved allowing vehicles with three or more people to not have to pay a toll, and as such, encourage HOV ridership. After two years, the project was discontinued due to limited success in reducing the volume of single occupancy vehicles (SOV).

The potential success of congestion pricing depends on the extent of congestion, the capacity and availability of alternative routes and modes, and the type of project employed. If congestion is already spread over several hours of the day, rather than concentrated in discrete, short time periods, then congestion pricing may not be very effective. Motorists may not see the benefit from shifting to another time period if congestion is still present. If reasonable alternative modes of travel are not available, then motorists are most likely to divert to an alternative, and possibly inappropriate, route near the priced facility.

If the system to be fitted with congestion pricing is a toll facility, public acceptance is likely to be more forthcoming. Infrastructure costs would be less and thus more palatable as well. If the system is a non-toll facility, then necessary infrastructure for congestion pricing will be substantially more expensive both in terms of construction as well as environmental and property costs, and public acceptance is likely to be more difficult to obtain. To incorporate congestion pricing through the use of a HOV system, infrastructure costs (as well as environmental and property impacts) are substantial, and public perception that the system benefits the wealthy calls into question the merits of such an arrangement.

2.3.4.3 Intelligent Transportation Systems (ITS)

Intelligent Transportation Systems are often used in support of Transportation Demand Management (TDM). In essence ITS enhance communication between the user and the infrastructure providing the TDM measure. Such ITS technologies or strategies were previously discussed in Section 2.3.2.4 and can be used to manage traffic/travel demand on the I-93 corridor before, during, and after construction. NHDOT is proceeding, through a Statewide ITS consultant, to develop the detailed tactical implementation of these ITS technologies within the corridor based on the strategic regional and statewide ITS architecture. NHDOT will be considering in more detail the following elements at the appropriate stages:

Pre-Construction

Develop and implement appropriate communication technologies along I-93 corridor to collect and analyze data from the sensors, and disseminate information.

Install pole mounted non-intrusive traffic detectors along I-93 (one between each interchange) from Massachusetts State Line to I-93/I-293 split to monitor traffic and provide real-time update on traffic delays to motorists along the corridors. These traffic detectors can also be used to detect incidents. These non-intrusive detectors can easily be moved during construction.

Install Portable Dynamic Message Signs at key locations as discussed in Section 2.3.2.4.2 to provide travelers real time information on traffic delays, detours, and incidents along the I-93 corridor.

Install cameras at key locations along I-93 (from Massachusetts State line to Exit 5) to monitor traffic and detect incidents. These cameras can be mounted on the same pole as the traffic detectors and relocated during construction. Also, images from these cameras can be displayed on the internet so that motorists, TV stations, and radio stations can access the information via web sites.

Install Road Weather Information System (RWIS) at two key locations as discussed in Section 2.3.2.4.2 along the I-93 corridor. These two sites will form part of a regional network of stations giving early warning of adverse weather. Install only atmospheric sensors prior to construction at these sites. Pavement sensors can be installed once construction is complete.

Install AM or Low Power FM (LPFM) sites along I-93 corridor to provide information to motorists as discussed in Section 2.3.2.4.2. These Highway Advisory Radios can be used to provide enhanced traveler information as well as promote tourism.

Promote public/private partnerships with NHDOT, State Police, TV stations, and radio stations to share information on traffic situations along I-93 corridor and provide information to the public in a timely manner.

Promote use of the 511 Travel Information Number, which is available statewide in New Hampshire to provide travelers with the information they need to make better-informed travel decisions. When travelers become aware of current or forecast weather and road conditions, traffic incidents or delays, they may choose to travel at other times, by other means, or not at all.

Promote use of alternate modes of transportation, such as ride-share and transit. Multi-Modal Traveler Information Systems take an extra step beyond the highway-based systems described above. The 511 Travel Information Number can be enhanced to provide real-time transit schedules and schedule adherence, availability of parking spaces in the park-and-ride lots, as well as highway congestion information. This will be important as the new proposed park-and-ride facilities and expanded corridor bus service become operational at the outset of the mainline reconstruction. Alternative mode choices can be properly evaluated by travelers before they become tied up in traffic delays. Trio's proposed statewide enhancements (Section 2.3.2.4.1) envision regional, multi-modal additions to the advanced traveler information systems currently being deployed. Substantial benefits can be expected in support of TDM strategies along I-93 once these multi-modal enhancements become operational.

Construction

Maintain ITS systems deployed pre-construction to manage traffic and provide timely information to travelers. Relocate the non-intrusive traffic detectors, cameras, and portable dynamic message signs as appropriate to accommodate construction.

Implement Smart Work Zone technologies to monitor traffic through construction zones and also provide information to travelers, TV, and radio stations.

Provide travel information through 511, AM, LPFM, and dynamic message signs.

Install infrastructure for future, permanent post-construction ITS applications.

Promote use of alternate modes of transportation, such as ride-share, and transit.

Post-Construction

Expand ITS Technologies as appropriate.

Install permanent non-intrusive traffic detectors, cameras, and dynamic message signs.

Install pavement sensors at the RWIS sites to detect pavement temperatures and conditions.

Provide travel information through 511, AM, LPFM, and dynamic message signs. Expand travel information services by providing information to motorists using in-vehicle technologies, such as pagers and cell phones.

Expand use of alternative modes. Online Scheduling and Reservations make it easier for travelers to use alternative modes of transportation by providing online tools or other electronic means for making reservations, obtaining schedules, paying fares, etc. This helps support mode switching at congested periods by reducing barriers to transit use, such as exact change requirements or general unfamiliarity with transit payment systems.

Electronic Fare Payment and Smart Cards offer similar advantages to travelers during the actual journey. New Hampshire is already investing in electronic payment system technologies at its highway toll plazas, due to come on line within the next two years. ITS can also provide broader electronic fare payment systems for transit and parking which can help support park-and-ride or public transit incentives.

2.3.4.4 Summary and Conclusions

In terms of I-93, the TDM measures with the greatest probability of success are those sponsored by employers. Congestion pricing is not reasonable because I-93 currently experiences peak periods of congestion of approximately three hours in length in both the morning and the evening. This extension of peak hour volumes to additional hours before or after the real hour, commonly referred to as "peak period spreading," has already occurred to a great extent, and disincentives to shift demand from the peak hour into adjacent hours will likely be unacceptable. Instead congestion pricing is likely to be perceived as a solution that does not address congestion, but simply levies a tax on those who must use the facility. Lastly, as a non-toll facility, public acceptance of making I-93 a toll facility would be difficult at best. Where toll facilities exist in New Hampshire, there is considerable public sentiment to eliminate their toll status. Additional impacts associated with toll facilities would be problematic. Similarly, HOT lanes are considered to be questionable in this instance particularly in light of the findings relative to the lack of HOV lane usage. ITS technologies will be incorporated into the overall improvements to I-93 to better manage traffic/travel demand before, during, and after construction.

■

2.3.5 Mode Alternatives

For the analysis of potential improvements for I-93 between Salem and Manchester, an evaluation of transportation modes other than personal passenger vehicles in general-purpose highway travel lanes was conducted. These alternative modes included rail services, bus services, and HOV lanes. The objective for analyzing these other modes was to understand how they may complement and minimize the need for highway improvements.

This section describes the individual HOV, rail, and bus modes considered. It also reviews the methodology used to project rail, bus and HOV ridership, and presents the results of the analysis of potential ridership for the various modes.

The mode options that were analyzed include four rail options, two HOV lane options, and two bus options. Following establishment of parameters describing capabilities and limits of each option, the mode options were tested with varying assumptions about the capacity of I-93, including no-widening (i.e., no increase in existing capacity), widening to three lanes in each direction, and widening to four lanes in each direction. All analyses included the assumption that the extension of commuter rail service from Lowell to Nashua is operational.

The mode options analyzed were chosen based on technology, financing, and infrastructure that are available today or are plausibly feasible. The intent was to test the ridership potential of alternative modes under favorable, but realistic conditions. The parameters used to define the options did not necessarily limit the capacity of the various options. For example, sufficient parking was assumed at each bus or rail station to accommodate all potential demand at the station. Similarly, a sufficient number of cars per train or buses were assumed to be available to satisfy projected demand.

Based on the preliminary analysis results, those mode options deemed feasible and practicable were combined with each other and various highway lane configurations (i.e., two, three, or four general use lanes in each direction). Fourteen mode combinations were identified to test the potential interaction between rail, bus, HOV and highway options and to determine how the ridership generated by these different combinations of mode options might influence the need for highway improvements. Section 2.3.5.5 presents projections of ridership for these combinations of other modes and highway widening options.

2.3.5.1 High Occupancy Vehicle (HOV) Lanes

HOV facilities provide lanes dedicated to vehicles carrying more than one person. The number of people required per vehicle and the time periods the lanes are so dedicated are dependent on the demand for the lanes. To be successful, HOV lanes must not be congested or there will be little incentive for drivers of single occupancy vehicles (SOV) to consider ride-sharing or bus services. In addition, the HOV lane must not be under-utilized, or motorists in general use lanes will question the merit of having HOV lanes. Possible HOV lane configurations include concurrent flow lanes and a single exclusive reversible (contra-flow) lane.

Two I-93 HOV lane options were preliminarily developed. The parameters and assumptions defining these options were:

1. One HOV lane in each direction on I-93 in New Hampshire from north of Exit 5 to the New Hampshire/Massachusetts state line. Access/egress would not be provided at either Exit 1 or 2 due to the proximity of the interchanges to each other and to the state line. Vehicles would be allowed to access/egress at all other exits.

   The geometric configuration of the lane was not a factor in the projection of ridership, but for the purposes of analyzing engineering and environmental impacts, a concurrent flow lane adjacent to the general purpose lanes was assumed. The cross section included a 14-foot inside enforcement shoulder, a 12-foot HOV lane, a four-foot painted buffer, two or three 12-foot general purpose lanes, and an outside shoulder lane.

2. One HOV lane in each direction on I-93 from north of Exit 5 in New Hampshire to I-95 (Route 128) or the Woburn Interchange in Massachusetts. This scenario assumed that vehicles can access/egress the HOV lane at each New Hampshire interchange. The roadway cross section would be the same as for the first alternative and include a concurrent flow lane adjacent to two or three general purpose lanes.

2.3.5.2 Passenger Rail Service

Mode Options developed for the I-93 Salem – Manchester corridor included four rail alternatives along three basic rail alignments (see *Rail Alternatives Evaluation Report*, VHB, November 13, 2000). These rail alternatives were primarily focused on providing commuter service to Boston, MA thereby relieving auto congestion along the I-93 highway corridor during peak periods **(Figure 2.3-37)**. The alternatives developed included commuter rail service along the New Hampshire Main Line (West Rail Corridor from Manchester to Lowell, MA via Bedford, Merrimack and Nashua); commuter rail service along the Manchester and Lawrence Branch (East Rail Corridor from Manchester to Lawrence, MA) with two optional alignments near the Manchester Airport (i.e., tunnel and relocation); and two light rail services along the I-93 highway right-of-way beginning near Exit 5 or the Manchester Airport, and continuing along I-93 south of Exit 1, where it would connect either to Lawrence, MA (I-93 Basic Rail Corridor) or to the Anderson Transportation Center in Woburn, MA (I-93 Enhanced Rail Corridor). The *Rail Alternatives Evaluation Report* examined a number of different parameters associated with the implementation of rail service alternatives and Table 2.3-1 summarizes these parameters.

Each of the rail alternatives is described below.

East Rail Corridor (Manchester–Lawrence Line)

The East Rail Corridor principally follows the Manchester and Lawrence Branch (M&L), which is for the most part, an abandoned 28-mile rail line **(Figure 2.3-37)** that runs north-south from Manchester, NH to Lawrence, MA. The M&L branches from the New Hampshire Main Line (West Rail Corridor) in the Manchester Freight Yard, which is just south of the site of the former Manchester Station (near Commercial Street). From there, the line runs south toward Manchester Airport. In the area of the airport, two options were considered for this corridor, due to the recent extension of Runway 6-24 across the railroad right-of-way. One option (Option 1) would be to construct a tunnel (with the tunnel assumed to be able to accommodate double tracks, clearance for double stack freight cars, very flat grades, approximately 15 feet of cover and poor foundation materials) underneath the runway within the former railroad right-of-way. With this option, service to the airport could be provided by constructing a rail station near the airport; however, some type of shuttle service would be needed to link rail and airport users. The other option (Option 2) would be to relocate the rail line around the airport creating a new railroad right-of-way. Service to the airport with this option could be provided with a shuttle bus

Table 2.3-1
Summary of Rail Alternatives

Evaluation Parameter	West Rail Corridor (Nashua to Manchester)	East Rail Corridor w/Tunnel Option	East Rail Corridor w/Relocation Option	I-93 Rail Corridor (Basic)
Service Characteristics				
Route Length (Miles)	18.8	27.8	27.8	22.9
New Stations	3	4	3	4
Average Peak Direction Travel Time (Minutes)	83	94[1]	94[1]	83[1]
Type of Service	Through	Shuttle	Shuttle	Shuttle
Annual Trips	294,270	462,570	462,570	453,390
Locomotives/Coaches (Moderate)	6/42	3/9	3/9	0/9[3]
Annual Train Miles (Moderate)	96,900	129,900	129,900	98,300
Infrastructure				
Grade Crossings	20	42	49	11
Undergrade Structures	18	16	16	21
Moderate Scenario Costs				
Infrastructure ($m)[2]	$51.7	$172.9[4]	$97.1	$176.6
Equipment ($m)	$79.9	$24.1	$24.1	$36.7
Annual Operating ($m)	$4.5	$3.6	$3.6	$2.7
Total Annual Cost ($m)	$15.8	$19.1	$13.4	$19.6
Annual Revenues ($m)	$0.9	$0.3	$0.3	$0.6
Net Annual ($m)	$14.9	$18.8	$13.1	$19.0
Cost per Trip ($)	$51	$41	$28	$42
Cost per New Transit Trip ($)	$96	$83	$58	$80

1 Includes 5 minute average transfer time during peak period in predominant direction of travel. Off-peak and reverse peak transfer times higher.
2 Costs do not include real estate requirements
3 I-93 Rail Corridor utilizes a light rail system with self-propelled vehicles.
4 Note change, see Response #11 to letter P-1 (Volume 3).

connection to the airport. For both options, after passing by the Airport the rail line would continue south through Londonderry, Derry, Windham and Salem, east of I-93, to Lawrence, Massachusetts where it would connect to the Massachusetts Bay Transportation Authority's (MBTA) Haverhill Line.

A majority of the M&L rail corridor in New Hampshire is owned by the State. Some portions have been sold to towns or private land owners. A short portion of the line in Salem is owned by Guilford Transportation Industries (GTI) through the Boston & Maine Corporation. GTI has fled for abandonment of freight service north of Lawrence. In Massachusetts, the line is owned by the MBTA and GTI has freight rights.

The East Rail Corridor service would be a commuter rail shuttle service between Manchester and Lawrence with intermediate stations located near I-93 Exit 5 in Londonderry, and I-93 Exit 1 in Salem. Standard commuter rail equipment would be used for the service between Manchester and Lawrence. At the existing MBTA Lawrence Station, passengers would transfer to commuter rail trains on the Haverhill Line and continue south through Andover and on to Boston. Total travel time between Manchester and Boston would average 94 minutes. The service assumes that the MBTA trains would have sufficient capacity to accommodate the New Hampshire riders.

The rail service alternative has been developed as a shuttle instead of through service primarily due to the lack of capacity on the MBTA's Haverhill Line. There is currently a 12-mile segment of single-track railroad between Andover and Reading, which limits the number of trains the MBTA can operate north of Reading to Lawrence and Haverhill. Approximately half of the existing weekday Haverhill Line service terminates at Reading because of the capacity constraint. Therefore, it was assumed that any new service on the M&L would terminate at Lawrence requiring the transfer.

To institute rail shuttle service along the East Rail Corridor between Manchester and Lawrence would require capital improvements through the reconstruction of most of the existing track structure (rail, ties, ballast, sub-grade), bridges, grade crossings, and signal and communications system. Additionally, depending upon the specific rail alignment taken near Manchester Airport, a 820-foot rail tunnel under the runway or a 5-mile relocation of the rail corridor around the runway on a new alignment would be required. The East Rail Corridor infrastructure cost estimates associated with tunnel option or the relocation option are $172.9 M ($6.3 million per mile) and $97.1 M ($3.6 million per mile), respectively. These cost estimates do not include real estate or environmental mitigation.

Equipment required for the service would vary depending on the amount of service provided. For both options using this corridor, three service levels were considered. The high level of service includes 12 weekday and 4 weekend roundtrips. The moderate level of service includes 8 weekday and 3 weekend roundtrips. The low level of service includes 6 weekday and 3 Saturday roundtrips. Since the rail service along the M&L Branch would be a shuttle from Lawrence to Manchester, integration with MBTA's north side commuter rail fleet would not be necessary. The train sets, comprised of one locomotive and three coaches, would be dedicated to the New Hampshire service. Three sets of equipment would likely be required to operate either the Moderate or High Levels of Service with the Low Level of Service likely requiring only two sets of equipment. The capital equipment costs range from $16.1M for the low level of service to $24.1M for the high level of service.

West Rail Corridor (Manchester-Lowell Line)

The New Hampshire Main Line (West Rail Corridor) runs in a north-south direction west of the I-93 highway corridor. From the site of the Manchester Station, the rail line crosses the Merrimack River to Bedford and follows the river through Merrimack and Nashua to Lowell, Massachusetts. From Lowell, the line continues south into Boston's North Station **(Figure 2.3-37)**.

Daily freight traffic operated by Springfield Terminal Railway presently uses the line. Service from Lowell to the Nashua Yard consists of main line and local freight trains, as well as "unit coal" trains that head north to a power plant in Bow, NH. Train service north of Nashua consists primarily of trains serving local industries and the unit coal trains serving Bow. Mainline through freight trains also operate between Nashua and Boston in the late evening or very early morning hours. In March 1999, GTI was operating the unit coal train to Bow three days a week. Local freight service was operated daily from the Nashua Yard south to service customers located along the line to Lowell. Similarly, local freight service was offered daily from Nashua to the north.

Restoration of commuter rail service along this line is being approached in a two-phase program. Phase 1, which is presently progressing through preliminary design, includes an extension of service from the existing MBTA commuter rail terminus in Lowell to a new park-and-ride station located adjacent to F.E. Everett Turnpike off of Spit Brook Road in Nashua. The Phase 1 effort would extend service approximately 11 miles for the Exit 1 Station. Phase 2, which has been considered as a mode alternative for the I-93 corridor, would further extend service from Nashua to Manchester, a distance of 19 miles. A downtown Nashua Station is expected to be incorporated along this line as part of Phase 2, and in doing so increase the use of the rail line. In addition, within this Phase 2 19-mile segment, three potential station sites were considered: Star Drive in Merrimack, the proposed Airport Access Road in Bedford, and Granite Street in Manchester.

The West Rail Corridor service would be typical commuter rail service operating with locomotive-hauled coaches between Manchester and North Station in Boston. This service would be an extension of the current MBTA Lowell Line service, providing service to all stations along the line. The travel time between Manchester and Boston would average 83 minutes.

Commuter rail service along the West Rail Corridor between Manchester and Lowell would require a capital improvements through rehabilitation of the existing track structure (rail, ties, ballast, sub-grade), bridges, the signal and communications system, grade crossings, stations and support facilities, as well as construction of some new infrastructure. The West Rail Corridor infrastructure cost estimate totals $73.2 M which includes $21.5 M for the section from Lowell to Nashua and $51.7 M for the segment from Nashua to Manchester. These cost estimates do not include real estate or environmental mitigation.

Equipment needs for the West Rail Corridor service would vary depending on the amount of rail service provided. Three levels of service were considered. The high level of service would include 12 weekday and 4 weekend roundtrips. The moderate level of service would include 8 weekday and 3 weekend roundtrips. The low level of service would include 6 weekday and 3 Saturday roundtrips. The service would likely require between four and eight additional sets of equipment. The train sets, comprised of one locomotive and seven coaches, would be part of the MBTA north side commuter rail fleet. This equipment would not be dedicated solely to the NH rail service, but would be rotated among the various north side rail services. The capital equipment costs range from $53.3 M for the low level of service to $106.6 M for the high level of service. The high cost for equipment reflects the fact that the equipment will service a line extending from Manchester all the way to Boston. Such costs for other rail services assume that this equipment will be used along a shorter segment of rail line.

I-93 Basic and Enhanced Rail Corridors

The third and fourth rail alternatives considered as part of the I-93 Salem–Manchester improvements involve constructing a new light rail line within the existing I-93 highway corridor **(Figure 2.3-37)**. As such, both alternatives would result in a rail line within the I-93 highway corridor for 16.5 miles between Exit 5 in Londonderry and the Massachusetts state line. At the state line, for the I-93 Basic Rail Corridor, the rail alignment would leave the I-93 highway corridor and connect into the M&L Branch right-of-way continuing to Lawrence, MA. For the I-93 Enhanced Rail Corridor, the rail alignment would continue within the I-93 highway corridor through Massachusetts down to the Anderson Transportation Center. At the northern end for both rail corridors, near Exit 5, a connection would be made to the M&L Branch right-of-way along which a maintenance/layover facility would be sited. The Enhanced Option includes an extension of service to the Manchester Airport.

Due to the geometry of the I-93 corridor (i.e., the grades and curves) standard commuter rail would not be a viable option. However, Light Rail vehicles can operate on grades up to 4 percent and on curve radii as tight as 83 feet, and consequently can negotiate curves and grades encountered within the I-93 highway corridor. The most likely light rail system to be used in this corridor would be diesel light rail. This type of system, which is gaining favor in North America, does not require the construction of the electrified power system necessary to propel traditional light rail vehicles. The vehicles are propelled by diesel engines that are in each car. For the I-93 rail service these vehicles would operate in three-car consists.[17] A typical articulated light rail

[17] The term consist refers to the number of rail locomotives and coaches or vehicles that comprise a single train.

vehicle (double ended) in a three-car consist could seat 180 to 210 passengers with space for approximately 210 to 270 additional passengers standing. Assuming a shuttle type schedule of service similar to the east corridor, three sets of equipment would be required to operate a moderate or high level of service.

Due to safety considerations, the equipment planned for this corridor cannot be used on the commuter rail line between Lawrence and Boston. Therefore, passengers would be required to transfer to the MBTA Haverhill Line in Lawrence or to the MBTA line in Woburn for service to Boston. Total travel time between Exit 5 in Londonderry and Boston would average 83 minutes for the I-93 Basic Rail Corridor and a similar travel time (depending on the number of stops in Massachusetts) for the I-93 Enhanced Rail Corridor. In New Hampshire, stations would be located near the Manchester Airport, at Exit 5 in Londonderry, Exit 4 in Derry, Exit 3 in Windham, and Exit 2 in Salem. In New Hampshire, the alignment would be primarily located in the highway median, veering outside the median south of Exit 1 due to physical constraints.

The development of a light rail system along the I-93 corridor between Lawrence, MA and Londonderry would require substantial capital infrastructure improvements. The capital infrastructure program would include the construction of new track (rail, ties, ballast, sub-grade), bridges, grade crossings, and a signal and communications system along the entire corridor. The I-93 Basic Rail Corridor infrastructure cost estimate is $176.6 M ($7.7 million per mile). This cost estimate does not include real estate or environmental mitigation.

The additional cost to extend the I-93 rail corridor from Londonderry to Manchester, for comparison with the east rail corridors, would be $20 million for the option that relocates the rail line around the airport to $96.4 million for the option that constructs a tunnel under the runway at Manchester Airport.

The levels of service considered for this corridor were similar to those of the other rail corridor alternatives developed for the study. This included a high, moderate and low service level ranging from 12 to 6 daily weekday roundtrips between Exit 5 and Lawrence. These levels of service would require 6 vehicles for the low level of service and 9 vehicles for the moderate and high level of service. The capital equipment costs range from $24.5 M for the low level of service to $36.7 M for the high level of service.

2.3.5.3 Bus Service

For this project, two transit services were evaluated as mode options. They included: an expansion of existing commuter bus service to Boston; and an Enhanced Bus Service which was modified to a Ridesharing and Commuter Incentive Program to serve employment centers along the I-93 corridor in northern Massachusetts. Both services included the provision of a transit subsidy. NHDOT has further evaluated and developed additional details in preparation for implementing Expanded Bus service and Enhanced Ride-sharing opportunities within the corridor. The following sections describe the 1) parameters and assumptions defining the two transit services; 2) transit fare subsidy and funding strategy; 3) operating and capital cost estimates; and 4) the proposed implementation schedule for these services.

Expanded Bus Service

The proposed Expanded Bus Service will expand on the current Concord Trailways commuter bus services, which provide service from Manchester and Londonderry (I-93, Exit 4) to Boston, MA. The proposed service is expected to operate on 30-minute headways from each park-and-ride facility in the peak direction during weekday peak periods, and on 60-minute headways during off-peak periods and on weekends. Service will be added initially from park-and-ride facilities at Exits 5 and 2. It is intended that service from the Exit 3 park-and-ride facility, which is programmed for construction later in the I-93 improvement project, will be added once the facility has been completed and as demand is warranted. Additionally, the NHDOT intends to maintain commuter service from the downtown Manchester bus station and from the existing Exit 4 park-and-ride facility. Each park-and-ride facility will include sufficient parking to accommodate demand, and basic passenger terminal facilities to be managed by the bus operator(s).

The Expanded Bus Service plan assumes that Exit 5 and Exit 2 services will operate independently during peak periods, with each bus only stopping at one park-and-ride facility. During off-peak periods and on weekends, the service may be combined to serve both the Exit 5 and Exit 2 facilities in one route.

The following is a proposed weekday service schedule developed for the purposes of this study. Modifications and opportunities for cost saving improvements may be made to the service schedule as the NHDOT works with the contracted bus service provider. Service frequency, departure times, stops and stopping patterns may also be changed based on the needs of the service.

Table 2.3–2
Proposed I-93 Commuter Bus Schedule: Weekday Service

Exit 5				Exit 2			
Southbound		Northbound		Southbound		Northbound	
Depart Exit 5	Arrive Boston	Depart Boston	Arrive Exit 5	Depart Exit 2	Arrive Boston	Depart Boston	Arrive Exit 2
5:00 AM	5:55 AM	6:30 AM	7:25 AM	5:00 AM	5:40 AM	6:30 AM	7:10 AM
5:30 AM	6:25 AM	7:30 AM	8:25 AM	5:30 AM	6:10 AM	7:30 AM	8:10 AM
6:00 AM	7:05 AM	8:00 AM	8:55 AM	6:00 AM	6:50 AM	8:00 AM	8:40 AM
6:30 AM	7:35 AM	8:30 AM	9:25 AM	6:30 AM	7:20 AM	8:30 AM	9:10 AM
7:00 AM	8:15 AM	9:30 AM	10:25 AM	7:00 AM	8:00 AM	9:30 AM	10:10 AM
7:30 AM	8:50 AM	10:30 AM	11:25 AM	7:30 AM	8:35 AM	10:30 AM	11:10 AM
8:00 AM	9:15 AM	11:30 AM	12:25 PM	8:00 AM	9:00 AM	11:30 AM	12:10 PM
9:00 AM	10:15 AM	12:30 PM	1:25 PM	9:00 AM	10:00 AM	12:30 PM	1:10 PM
10:00 AM	11:00 AM	1:30 PM	2:25 PM	10:00 AM	10:50 AM	1:30 PM	2:10 PM
11:00 AM	12:00 PM	2:30 PM	3:25 PM	11:00 AM	11:50 AM	2:30 PM	3:10 PM
12:00 PM	1:00 PM	3:30 PM	4:35 PM	12:00 PM	12:50 PM	3:30 PM	4:20 PM
1:00 PM	2:00 PM	4:00 PM	5:05 PM	1:00 PM	1:50 PM	4:00 PM	4:50 PM
2:00 PM	3:00 PM	4:30 PM	5:35 PM	2:00 PM	2:50 PM	4:30 PM	5:20 PM
3:00 PM	4:00 PM	5:00 PM	6:05 PM	3:00 PM	3:50 PM	5:00 PM	5:50 PM
4:00 PM	5:00 PM	5:30 PM	6:35 PM	4:00 PM	4:50 PM	5:30 PM	6:20 PM
4:30 PM	5:30 PM	6:00 PM	7:05 PM	4:30 PM	5:20 PM	6:00 PM	6:50 PM
5:00 PM	6:00 PM	6:30 PM	7:35 PM	5:00 PM	5:50 PM	6:30 PM	7:20 PM
6:00 PM	7:00 PM	7:30 PM	8:25 PM	6:00 PM	6:50 PM	7:30 PM	8:10 PM
7:00 PM	8:00 PM	8:30 PM	9:25 PM	7:00 PM	7:50 PM	8:30 PM	9:10 PM
8:00 PM	9:00 PM	9:30 PM	10:25 PM	8:00 PM	8:50 PM	9:30 PM	10:10 PM
9:00 PM	10:00 PM	10:30 PM	11:25 PM	9:00 PM	9:50 PM	10:30 PM	11:10 PM
10:00 PM	10:55 PM	11:30 PM	12:25 AM	10:00 PM	10:40 PM	11:30 PM	12:10 AM
11:00 PM	11:55 PM	12:30 AM	1:25 AM	11:00 PM	11:40 PM	12:30 AM	1:10 AM

Enhanced Bus/Ride-sharing and Commuter Incentive Program

The Enhanced Bus service defined in previous studies would provide access between New Hampshire and employment centers along the I-93 corridor in northern Massachusetts. The enhanced bus service would include two routes. The first route would originate at Exit 5 with a stop at Exit 4 while the second route would originate at Exit 4 with a stop at Exit 3. As with the Expanded Bus service, sufficient parking was assumed to be available at each bus station. It was assumed that both routes would stop at Exit 45 (River Road), Exit 42 (Dascomb Road), Exit 38 (Route 129) and Exit 37 (The Anderson Transportation Center) in Massachusetts.

A stop at Exit 2 was not included with this option because of the increase in travel time that would result. The riders who would use an Exit 2 stop could use the Exit 3 stop. The number of passengers that would be lost (from Exits 5, 4, and 3) by adding an additional stop is expected to be about the same magnitude as the number that would be added by including a stop at Exit 2. In addition, an Exit 2 bus stop for riders to employment centers along I-93 in northern Massachusetts would have less appeal given the relatively short distance between Exit 2 and the employment centers. Commuters would be more likely to drive directly to the employment centers in such a situation rather than drive to a bus stop, park, and take a bus.

While developing the implementation plan for the Enhanced Bus service, NHDOT investigated the feasibility of this type of program for the I-93 corridor. Working collaboratively with the local MPOs, TMOs and TMAs, it was learned that previous attempts to provide local bus service along the I-93 corridor have not been successful or cost-efficient. Existing programs along the I-93 corridor, despite a low-cost or free fare and heavy marketing to commuters, have not come close to projected ridership. Several area bus services of this type have been reduced, modified or not even initiated due to the inability to attract riders for this type of regularly scheduled bus service along the I-93 corridor to employment centers with ample free parking.

Based on these discussions, it was determined that the demand for this type of service is not sufficient to begin service at this time. It would be more beneficial to provide an Enhanced Ride-sharing program, such as vanpooling or carpooling, in conjunction with a commuter incentive program along the corridor. This type of service would be provided until such time that a sufficient ridership base is developed for scheduled bus service. NHDOT will continue to work with Massachusetts' statewide commuter service organization, CARAVAN for Commuters, Inc., to develop concepts for a ride-sharing program from southern New Hampshire that serves the entire I-93 corridor. The Commonwealth of Massachusetts contracts with a private, non-profit organization that provides assistance to commuters, companies, and TMAs in efforts to improve air quality, reduce traffic congestion, and maximize mobility. NHDOT proposes to subsidize a commuter incentive program in its early stages.

A commuter incentive program provides financial rewards for commuters who choose transit, carpool or vanpool, or other alternatives to driving alone. It is a cost-effective approach to provide alternatives in a market with limited transit demand.

It is NHDOT's intention to continue to work with the Commonwealth of Massachusetts and their contractor service organization to develop a plan for a ridesharing and commuter incentive program.

Transit Fare Subsidy

Under some situations, a transit fare subsidy was also considered in the analysis of ridership potential for the transit service options. The subsidized fare of $3.00 to $3.40 per one-way trip is comparable to the current MBTA commuter rail fare. The reduced fare was designed to make the cost of commuter bus service competitive with commuter rail service and was set at the same level at which commuter rail service is subsidized by the MBTA in Massachusetts. In this way, the transit services could be evaluated in terms that are comparable to rail service.

Transit Funding Strategy

NHDOT is developing a strategy to fund the proposed transit services during I-93 construction. All appropriate avenues of funding for this service are being pursued including CMAQ, FTA, etc. It is anticipated that CMAQ funds will be used to purchase vehicles for the Expanded Bus Service, to cover the anticipated operating deficit for the Expanded Bus Service for the first three years of operation. FTA capital fund allocations for bus purchase are anticipated to be used in conjunction with CMAQ funds to finance bus purchases. The long-term viability of these services will be dependent upon the ability to make these services self-sufficient after the initial three-year period. NHDOT has been working with the private bus operators to determine strategies, such as marketing programs, which will assist in making the service self-sufficient in the future. NHDOT anticipates that approximately $300,000 will be allocated for a marketing program during the first three years of service, a portion of which may be funded by CMAQ funds. In an effort to make the service financially sustainable, NHDOT is also considering the possibility of registering the new vehicles as state vehicles, which would allow the provider to reduce costs on fuel, registration and tolls.

Additionally, NHDOT has proposed to use $300,000 in CMAQ funds to subsidize the commuter incentive programs that would encourage use of both the Expanded Bus service and the Ride-sharing Program. NHDOT is currently working with the Commonwealth of Massachusetts and its contractor to create a Commuter Incentive Program and to identify any associated costs to the State.

Cost Estimates

Two types of costs have been identified for the transit services outlined: annual operating and capital costs. Order of magnitude cost estimates have been developed for each component and are summarized in the following sections.

Annual Operating Costs

These costs were derived based on an estimate of the number of vehicle revenue hours that would be operated in a year, and on an average operating cost per vehicle revenue hour. The number of annual vehicle revenue hours was estimated by multiplying the number of trips per day by the length of each trip, and then multiplying the resulting figure by the number of service days per year (251 weekdays and 114 weekend days). Additional operating costs may be created if buses must travel significant "deadhead" miles.

The estimated annual operating cost for the Expanded Bus Service was determined by multiplying the number of annual vehicle revenue hours by $96.60, the average operating cost for one bus in revenue service for one hour across U.S. transit agencies in 2001. (Source: 2001 National Transit Summaries and Trends).

The estimated annual operating costs for the Expanded Bus Service alternative are summarized in Table 2.3-3. [It is anticipated that there will be little to no new costs for the Commuter Incentive Program established as part of this project beyond proposed CMAQ funding. However, NHDOT is currently working with the Commonwealth of Massachusetts to finalize the program and to identify associated annual operating costs.]

Table 2.3-3
Estimated Annual Operating Cost for Expanded Bus Service

	Expanded Service Weekday	Expanded Service Weekend
Round Trips Per Day	46	19
Vehicle Revenue Hours Per Day	115	47.5
Days per year	251	114
Annual Vehicle Revenue Hours	28,865	5,415
Operating Cost per Vehicle Revenue Hour	$96.60	$96.60
Annual Operating Cost	$2,800,000	$525,000

The Total Annual Operating Cost for the Expanded Bus Service is estimated to be $3,325,000. The Expanded Bus Service operating plan assumes that the buses layover in Boston during the midday. There may be additional costs associated with the service for storing these buses in Boston for the day depending on the operator; however, midday layover costs are not included in this estimate. Operating costs may need to be adjusted if buses must lay over in outlying locations.

Annual Capital Costs

The estimated capital cost for the Expanded Bus Service includes the capital cost for vehicles required to provide the service. Also included for the Expanded Bus Service is the capital cost of constructing a bus maintenance/layover facility in the Exit 5 area. Construction of a bus maintenance/layover facility minimizes annual operating costs. The Expanded Bus Service may also require additional capital costs for the layover of buses in Boston. The costs of any required layover facility use would be included in the operator's costs as either capital costs (i.e., cost of facility) or operating cost (i.e., cost to deadhead to a layover site).

Total Annual Costs

The estimated total annual costs for the Expanded Bus Service combine the annual operating costs and the annual capital costs. A summary of costs is provided in Table 2.3-4. The estimated capital costs do not include construction of park-and-ride facilities, which are included elsewhere, or estimates for docking space at South Station in Boston that may be necessary for the Expanded Bus Service.

Table 2.3-4
Total Annual Costs — Expanded Bus Service

	Expanded Bus Service
Estimated Annual Operating Cost	$3,300,000
Estimated Annual Capital Cost	$1,050,000
Total Annual Cost	$4,350,000

Bus Procurement Costs

The operating plan developed for the Expanded Bus Service is based on the operation of highway coaches with seating capacity for 51 passengers. The capital cost for these buses has been estimated at $450,000 per bus including in-plant inspection. The Expanded Bus Service requires the procurement of 14 buses . The capital cost would be approximately $6,300,000.

Bus Layover and Maintenance Facility (Exit 5)

In addition to the park-and-ride terminal facilities, NHDOT plans to construct a bus layover and maintenance facility for the buses required to service the I-93 corridor. The facility will be located adjacent to the Exit 5 park-and-ride lot (**Figure 2.3-41**; Section 2.3.5.4). The site currently under consideration is located at the northwest quadrant of the Exit 5 Interchange immediately north of the abandoned Manchester-Lawrence railroad corridor. This location would also allow for the construction of additional parking should the Exit 5 park-and-ride require expansion in the future. Based on discussions with the current bus service operator, providing a facility at Exit 5 will reduce the costly deadheading of buses from Concord or another location (currently the Concord Trailways bus layover and storage is located in Concord).

The facility would include a maintenance building approximately 10,000 square feet in size for maintenance, washing, and fueling buses and a second, smaller building for overnight storage of buses. The maintenance building includes office space and parts storage, and two or three maintenance bays including a pit for maintaining the vehicles. Indoor storage in a building kept above freezing temperatures provides buses that are warm and thus ready to accept passengers, and also free of ice and snow that otherwise presents a hazard to other motorists. The bus layover and maintenance facility would be constructed as part of the overall infrastructure improvements along the corridor, as with the construction of the park-and-ride lot and bus terminals.

Implementation Schedule

NHDOT is committed to implementing the Expanded Bus service and Enhanced Ride-sharing and Commuter Incentive program as funding permits. It is NHDOT's intention to begin the process of procuring the new fleet in early 2004. By mid-2004, NHDOT plans to advertise a Request for Proposals to solicit operators for the Expanded Bus service. Implementation of the Expanded Bus service in the corridor will occur in late 2005 to correspond with the opening of the Exit 5 and Exit 2 park-and-ride facilities, and in advance and anticipation of the I-93 mainline construction.

NHDOT is currently working with the Commonwealth of Massachusetts to determine a schedule for initiating the Commuter Incentive program within the same timeframe.

2.3.5.4 I-93 Park-and-Ride Facilities

Park-and-ride facilities provide necessary support for HOV and transit services and ultimately help support TDM measures. Without adequate parking available, these services cannot be utilized to the fullest extent. Estimates for park-and-ride usage at each of the four existing and proposed park-and-ride lots were developed by analyzing origin and destination patterns for commuters from the towns in the vicinity of each park-and-ride lot traveling to Boston and other employment centers in Massachusetts.

To support transit and HOV options, new park-and-ride facilities were proposed along I-93 at Exits 2, 3, and 5. The proposed facility at Exit 3 would replace the existing facility west of Exit 3, which is underutilized because of its distance from the interchange and access problems. The existing park-and-ride facility at Exit 4 would continue to provide bus service. Given the construction of additional park-and-ride sites, demand at the Exit 4 site would, in the near term, likely decrease somewhat.

The following sections describe the location and size of each of the park-and-ride facilities, as envisioned. Each new park-and-ride site was located to support an expansion of bus service as well as commuter rail corridor service, if instituted within the I-93 highway corridor. Each park-and-ride facility was sized to accommodate projected rail, bus and HOV ridership.

The NHDOT is coordinating with bus service providers to consider opportunities to provide bus service at the proposed park-and-ride facilities.

Exit 2 Park-and-Ride

The proposed park-and-ride lot concept developed for Exit 2 is located in the southeast quadrant of the Exit 2 Interchange and is shown in **Figure 2.3-38**. The facility would be located between Fairmont Road and Raymond Avenue and extend along Boyer Lane, adjacent to the northbound off-ramp. Access for the facility would be provided via a signalized intersection at Raymond Avenue and South Policy Street, which is approximately 2,000 feet south of the Pelham Road/South Policy Street intersection. Approximately 800 feet of Raymond Avenue and 1,100 feet of South Policy Street would be reconstructed. The projected demand from potential carpooling and bus ridership for bus service to Boston from this location is estimated to be 300 spaces.

This layout would involve several parcels of land, including the acquisition of seven homes and one business. This preliminary concept would allow for the construction of approximately 430 spaces with potential for expansion to the south to accommodate a future rail station. The estimated construction cost (excluding right-of-way costs) for the park-and-ride lot, including buildings/shelters, and the access modifications to Raymond Avenue and South Policy Street is $2.3 million. A pedestrian bridge would be required to access the future rail station platform in the median. The NHDOT is coordinating with bus service providers to consider opportunities to provide bus services at this location.

Exit 3 Park-and-Ride

The existing park-and-ride lot in Windham is located on NH 111 approximately 0.8 miles west of I-93 with access provided via Wall Street. The lot was upgraded in 1998 to further encourage travelers to use the facility. This existing facility provides parking for approximately 150 vehicles and was previously served by bus transit to Boston; however, this service was ended due to the lack of riders and the delay buses experienced in getting to and from I-93. The projected demand from potential carpooling and bus ridership for bus service to Boston from this location is estimated to be 200 spaces.

Two new park-and-ride options (that complement the I-93 Northbound Shift option or the Tight Shift option) have been developed, one of which would serve as a replacement to the existing Exit 3 facility. Both options are conveniently located closer to I-93 at the Exit 3-Interchange area. Both of these options would allow for the construction of approximately 525 parking spaces with the potential for future expansion to accommodate a rail station. The NHDOT is coordinating with bus service providers to consider opportunities to provide bus services at this location.

For the I-93 Northbound Shift option (Section 2.3.3), the new park-and-ride facility is located in the median area between the two barrels of I-93. The median in the Exit 3 area is currently 1,000 feet wide and can accommodate this type of facility. Access would be provided via a new connector road intersecting with an improved NH 111 at a signalized intersection located between the NH 111/I-93 northbound and southbound ramp intersections. The facility would be situated parallel to the southbound barrel of I-93, with approximately 100-200 feet separating the facility from the highway. Access to a future rail line at Exit 3 would be via a direct connection. This layout would involve approximately 4 parcels of land. The estimated construction cost (excluding right-of-way costs) of the Northbound Shift option park-and-ride lot, including buildings/shelters, and the construction of a new access road from NH 111 to the park-and-ride lot is $3.8 million.

For the Tight Shift option (Section 2.3.3), the new park-and-ride facility would be located outside the median area east of the proposed relocation of the northbound barrel. Access would be located from a 0.5 mile relocated section of NH 111A connecting to NH 111 at a signalized intersection. The new section of NH 111A would be widened to provide a left-turn lane for vehicles entering the proposed park-and-ride. The Town of Windham requested that the bus terminal and associated building be located adjacent to the relocated section of NH 111A with the parking lot behind to be more compatible with the envisioned gateway/village zoning district. The Town also suggested that the parking lot be constructed in stages to meet the actual demand. This layout would involve two parcels of land. The estimated construction cost (excluding right-of-way costs) of the Tight Shift option park-and-ride lot, including buildings/shelters, the widening of NH 111A and the construction of access roads is $ 4.7 million. Access to a future rail line at Exit 3 would be via a pedestrian bridge over the northbound barrel, which would access a rail station platform in the median.

The proposed Exit 3 Park-and-Ride options are shown in **Figure 2.3-39**.

Exit 4 Park-and-Ride

Exit 4 has an existing park-and-ride facility located in the northwest quadrant of the Exit 4 Interchange. Access is provided via Hampton Drive, approximately 1100 feet west of the NH 102/southbound off-ramp intersection. This existing facility provides parking for approximately 470 vehicles and is currently served by Concord Trailways. The projected demand from potential carpooling and bus ridership for bus service to Boston from this location is estimated to be 450 spaces.

The existing park-and-ride facility would be retained and minor modifications would be made to the current parking layout to accommodate a new terminal building with either the easterly or the westerly I-93 widening alternatives (Section 2.3.3). However, the westerly widening option, which requires the relocation of the southbound off-ramp to the west, would impact the existing park-and-ride facility. The impact would require the relocation of 900 feet of the existing park-and-ride access road resulting in the elimination of approximately 20 parking spaces. The easterly I-93 widening option would have no impacts on the existing park-and-ride facility.

The existing park-and-ride facility will provide continued service to current and future ridership, however this facility would not allow for convenient access to a future rail line in the median. Conceptual evaluations to expand the park-and-ride lot in the Exit 4 area that would provide connectivity for future rail showed potentially substantial impacts to environmentally sensitive property (Woodmont apple orchard). Whether a new facility would eventually replace the existing facility will need to be determined as part of a future rail study to consider, in more detail, potential rail service needs. The estimated construction cost (no right-of-way costs anticipated) of the building/shelter and modifications to the existing park-and-ride lot is $0.6 million. The proposed park-and-ride modifications for the easterly and westerly widening options are shown in **Figure 2.3-40**.

Exit 5 Park-and-Ride

Five proposed park-and-ride concepts were developed for the Exit 5 area. The projected demand from potential carpooling and bus ridership for bus service to Boston from the Exit 5 area is estimated to be 500 spaces.

The first park-and-ride concept, Option 1, is located in the northwest quadrant of the interchange adjacent to the I-93 Exit 5 southbound off ramp and is shown in **Figure 2.3-41**. The Option 1 park-and-ride is located on property used by Waste Management, Inc., as a waste transfer facility. The land needed to develop this facility would include approximately 16 acres from this private business. Primary access would be provided from Symmes Drive, which connects to NH 28. Approximately 450 feet of Symmes Drive would be reconstructed and connected to a new signalized intersection with an improved NH 28. Secondary access would be provided by a right turn in (opposite Perkins Road) approximately 1000 feet east of the Symmes Drive/NH 28 intersection. This access would also provide an opportunity for NH 28 westbound traffic to reverse direction. Those vehicles trying to reverse direction could do so by turning right into the park-and-ride lot, then turning left onto Symmes Drive and then turning left onto NH 28 eastbound at the NH 28/Symmes Drive signalized intersection. The proposed facility would accommodate approximately 600 parking spaces. The estimated construction cost (excluding right-of-way costs) of the park-and-ride lot, including buildings/shelters, and the reconstruction of approximately 450 feet of Symmes Drive for access to the park-and-ride lot is $2.1 million. Future access to the rail line (assuming it is located on the old abandoned rail corridor) would be direct.

The second concept, Option 2, would also be located in the northwest quadrant of the interchange closer to Symmes Drive and on properties west of the transfer station. This option is shown in **Figure 2.7-18 and Figure 2.3-41** as part of the Selected Alternative. The Option 2 layout, as embodied in the Selected Alternative, was modified following the DEIS to lessen the property impacts, predominantly utilizing the Cycle World site (3 businesses) and two other vacant parcels with partial property impacts to the Exxon gas station, Waste Management Transfer Center, and a Senior Care Center. Primary access would be provided from Symmes Drive, which connects to NH 28. Approximately 500 feet of Symmes Drive would be reconstructed and connected to a new signalized intersection opposite Vista Ridge Drive. Secondary access to the park-and-ride would be provided by a right-turn in drive approximately 400 feet east of the Symmes Drive/NH 28 intersection. Because the proposed reconstruction and widening along NH 28 precludes the vehicles from the adjacent transfer station property from making left turns at its existing drive, a new drive from the transfer station would connect to the proposed park-and-ride access road, allowing the transfer station gain access to the proposed Symmes Drive signal at NH 28. The proposed facility would accommodate approximately 480 parking spaces. Future access to the rail line would be similar to Option 1 and would be direct. The estimated construction cost of Option 2 is $2.0 million.

A third park-and-ride concept, Option 3 would be located in the southwest quadrant of the I-93 Exit 5 Interchange approximately 0.25 mile south of NH 28 and parallel to the southbound barrel of I-93. This concept is shown in **Figure 2.3-41**. The land needed to develop this facility would include approximately twenty acres from four residential properties. Access to the park-and-ride would be provided via a 1000-foot connector road from Perkins Road, south of the hotel. In order to allow the users full access to the proposed park-and-ride, approximately 0.4 mile of Perkins Road would be relocated and reconstructed from the new park-and-ride connector road westerly to NH 28 opposite the Symmes Drive intersection. The NH 28/Symmes Drive intersection would be signalized. The proposed facility would accommodate approximately 700 parking spaces. A pedestrian bridge over I-93 southbound would be required to access the future rail station platform in the median, similar to what would be required at Exit 2 and possibly Exit 3. The estimated construction cost (excluding right-of-way costs) of the park-and-ride lot, including buildings/shelters, and the reconstruction of approximately 0.4 mile of Perkins Road and a 1,000 foot access road to the park-and-ride lot is $5.2 million.

Option 4, is located in the southeast quadrant of the Exit 5 Interchange between NH 28 and I-93, opposite Liberty Drive and on property currently occupied by a Sunoco Station. This option is shown in **Figure 2.3-41**. The proposed facility would accommodate approximately 525 parking spaces. Primary access would be provided directly to NH 28 at a proposed signalized intersection opposite Liberty Drive. The proposed improvements to NH 28 to accommodate this park-and-ride lot are generally similar to improvements under consideration to accommodate access to Liberty Drive and the Sunoco gas station as described in Section 2.3.3.3 **NH 28 On-line and NH 28 Relocation Options**. However, because of a greater volume of northbound NH 28 left-turn vehicles entering the park-and-ride (compared to the Sunoco Station left-turn volume), the left-turn lane and the widening of the NH 28 southerly approach to the proposed Liberty Drive/NH 28 signalized intersection would be extended southerly an additional 200 feet. Access to a future rail platform in the median would require the use of a pedestrian bridge that would span the northbound off-ramp and the northbound barrel. The estimated construction cost (excluding right-of-way costs) of the park-and-ride lot, including buildings/shelters, and the additional 200 feet reconstruction of NH 28 is $1.8 million.

Option 5 would impact three parcels of land located along the north side of Auburn Road approximately 0.25 mile from the NH 28. This concept is shown in **Figure 2.3-41**. Access to the park-and-ride lot would be directly from Auburn Road. The properties impacted include one undeveloped parcel designated as a Tree Farm and two residential properties. The proposed facility would accommodate approximately 500 parking spaces. Approximately 1000 feet of Auburn Road would be widened and reconstructed beginning at the proposed improvements to the intersection of Independence Drive/Auburn Road (as part of the proposed reconstruction of NH 28) and extending northerly. The widening would extend the proposed left- turn lane at Independence Drive/Auburn Road northerly to the proposed park-and-ride entrance. The proposed improvements to NH 28 to accommodate this park-and-ride lot are generally similar to improvements under consideration to accommodate access to Liberty Drive and the Sunoco gas station and as described in Section 2.3.3.3 **NH 28 On-line and NH 28 Relocation Options**. However, with the resultant increase in volume of traffic using the proposed Auburn Road park-and-ride, the left-turning traffic (570 vph in the design year 2020 PM) turning into Liberty Drive would extend the length of the left-turn vehicle queue to approximately 475 feet. This queue length can be accommodated within the proposed NH 28 widening and the overall NH 28/Liberty Drive intersection design year level of service is LOS D. The operational LOS for the left-turn movement into Liberty Drive would be at capacity (LOS E).

Future rail access to the park-and-ride lot could be provided to the abandoned Manchester and Lawrence rail line (if reactivated), but not the I-93 Rail Corridor. Currently, portions of the former rail corridor right of way for this section is owned privately and being developed into an office park development. The estimated construction cost (excluding right-of-way costs) of the park-and-ride lot, including a terminal building, and the reconstruction of approximately 900 feet of Auburn Road is $2.1 million.

2.3.5.5 Ridership Projections

This section summarizes the analysis of ridership projections for mode alternatives originally presented in Volume 1 of the *Rationale Report* (*January 2001)*. The development of ridership projections for rail, bus, and high occupancy vehicle (HOV) lane options were developed in two phases. In the first phase, preliminary analyses were conducted to evaluate individual rail, bus and HOV mode options. Based on the results of the preliminary analyses of individual mode options, 14 mode combinations were identified for further analysis.

Analysis of Individual Rail, Bus, and HOV Mode Options

The individual mode options that were analyzed include the four rail and two HOV lane options described above plus six bus options. The six bus options are all based on the Expanded Bus Service described above in combination with a fare subsidy option and the HOV lane options. The six bus options include service with and without a fare subsidy combined with no HOV facility, an HOV facility in New Hampshire only, and an HOV facility in New Hampshire and Massachusetts.

Methodology for Projecting Ridership for Rail, Bus, and HOV Mode Options

The method used for projecting rail and bus ridership is described in the *National Cooperative Highway Research Program (NCHRP) Report 187: Quick-Response Urban Travel Estimation Techniques and Transferable Parameters*. This or similar methods have been used for planning transit projects by public agencies nationwide. The main inputs used for the ridership forecasts were the 1990 Journey-to-Work (JTW) data, population and employment forecasts, existing and future travel times, transit travel time, and auto and transit costs. Projections were developed for each mode option assuming no other options were provided.

The process for projecting 2020 ridership for each rail and bus option entails projecting the 2020 commuter population for each market/service area associated with a proposed rail or bus station. To determine how much of the 2020 commuter population would take transit, the auto and rail impedances for each origin (home location) and destination (work location) pair, were compared. Transit and automobile travel impedances were measured in minutes and included total travel time associated with each trip plus out-of-pocket costs converted to time (minutes). The transit share was then calculated for each town by using the logit mode choice equation described in the NCHRP Report 187.

A similar process was followed for projecting HOV lane usage. The physical configuration of the HOV facility did not factor into the calculations of ridership. The analysis methodology assumed that there would be sufficient enforcement of restrictions on lane use that would keep the HOV lane free flowing until HOV volume reached the capacity of the HOV lane. All non-HOVs were restricted to using the available general purpose lanes and the travel time in the general purpose lanes was estimated based on projected levels of service. The analysis was conducted for southbound travel in the morning peak period and northbound travel in the evening peak period.

Since the mode choice equation from the NRPC Report had been calibrated for another geographical area, specific calibration for the I-93 corridor was undertaken. This was done by using the equation to estimate ridership for the existing bus service. The calculated ridership was then compared to actual boardings at the downtown Manchester Station and the park-and-ride counts at the Londonderry (Exit 4) stop. In order to match the actual boardings, adjustments were made to the various model parameters.

Preliminary Ridership Projections for Mode Options

The West Rail Corridor generated the smallest ridership of the four rail options with approximately 430 daily boardings. The East and I-93 Basic Rail Corridors generated more than twice as many daily boardings as the West Rail Corridor with approximately 960 and 900 daily boardings, respectively. These two corridors generated essentially the same ridership because they are parallel and close to each other, serve the same market areas, and provide similar service. As a result of the similarity in ridership between the two, it was decided to use only the East Rail Corridor in any subsequent analyses. The Enhanced Rail Corridor generated the largest Boston bound ridership with about 1,160 daily boardings. In addition, it included about 650 boardings for commuters destined to I-93 employment centers in Massachusetts.

The largest projected bus ridership was for the option that included a fare subsidy and an HOV lane in both New Hampshire and Massachusetts. It generated 2,200 boards daily. The provision of an HOV lane in New Hampshire-only resulted in virtually the same bus ridership as that with no HOV lane, and consequently was dropped from further consideration. The provision of a fare subsidy increased ridership by 14 to 19 percent.

The analysis of HOV options indicated there would not be sufficient travel time savings to induce the formation of new carpools or vanpools with an HOV lane in NH only. This reflects the conclusions of the bus analysis that an HOV lane in New Hampshire only would not increase bus ridership. Therefore, all further analyses of HOV lanes included lanes in both New Hampshire and Massachusetts.

Analysis of Rail, Bus, HOV, and Highway Widening Mode Combinations

Based on the preliminary analysis results, those individual mode options deemed feasible and practicable were combined with each other and various highway lane configurations (i.e., two, three, or four general use lanes in each direction). Fourteen mode combinations were identified to test the potential interaction between rail, bus, HOV and highway options, and to determine how the ridership generated by these different combinations of mode options might influence the need for highway improvements. In developing the mode combinations, an additional bus option, Enhanced Bus service, was added. As described earlier, it would provide access between New Hampshire and employment centers along the I-93 corridor in Northern Massachusetts similar to the service provided by the Enhanced Rail option.

The purpose of the analysis of mode combinations was to determine what combinations would attract the greatest ridership and divert the largest number of drivers from I-93. These diversions were then analyzed to determine their effect on the need for highway improvements. Specifically, the highway level of service with these mode combinations was calculated to determine if a desired level of service on the highway could be achieved with a more limited set of highway improvements (see Table 2.3-6).

Description of Combinations Analyzed

Table 2.3-5 defines how the mode options were combined. The table includes an identification number for each combination, the number of general purpose lanes provided on I-93, and a check mark to indicate which of the individual bus, rail, and HOV options are included.

The following provides an explanation of each of the mode combinations tested:

- Combinations 1-3 test the three rail options carried forward with two general purpose highway lanes (no highway expansion). Rail ridership is expected to be higher with two lanes because of increased highway congestion and increased highway travel time.

- Combinations 4-5 also include only two highway lanes and test Expanded and Enhanced bus services with an HOV lane. Mode combination 5 also includes a bus subsidy and the West Rail.

Table 2.3-5
Rail, Bus, HOV Lane Mode Combinations

Mode Combination ID Number	Number of General Purpose Lanes[1]	HOV Lane[2]	Expanded Bus	Enhanced Bus	Bus Subsidy	Enhanced I-93 Rail	West Rail	East Rail
1	2						✓	
2	2							✓
3	2					✓		
4	2	✓	✓	✓				
5	2	✓	✓	✓	✓		✓	
6	3		✓	✓				
7	3	✓	✓	✓				
8	3		✓	✓	✓		✓	
9	3	✓	✓	✓	✓		✓	
10	4		✓	✓				
11	2	✓		✓	✓			✓
12	3	✓		✓	✓			✓
13	2					✓		✓
14	3	✓	✓	✓	✓	✓		

1 Number of general purpose lanes in each direction north of Exit 1. Two lanes in each direction represents the highway no-build condition except for the segment of I-93 south of Exit 1 which currently has three general purpose lanes in each direction.
2 The HOV lane is a third lane in addition to the existing two general purpose lanes for Alternatives 4, 5 and 11, and a fourth lane for Alternatives 7, 9, 12 and 14. It extends from south of I-293 to I-95 (Route 128) in Massachusetts.

- Combination 6 includes 3 general use lanes and tests Expanded and Enhanced bus service without a subsidy.
- Combination 7 adds an HOV lane to Combination 6.
- Combination 8 includes 3 general use lanes and tests Expanded and Enhanced bus service with a subsidy and west rail service.
- Combination 9 adds an HOV lane to Combination 8.
- Combination 10 includes 4 general use lanes and tests Expanded and Enhanced bus service.
- Combinations 11 and 12 combine Enhanced Bus (service to northern Massachusetts), a bus subsidy, an HOV lane, and East Rail (service to Boston) with two and three general purpose lanes, respectively.
- Combination 13 tests Enhanced Rail with East Rail and two general purpose highway lanes.
- Combination 14 combines both bus services, an HOV lane, a bus subsidy, and Enhanced Rail with three general purpose highway lanes.

Methodology for Projecting Ridership for Mode Combinations

The general methodology for projecting ridership with individual modes was used for mode combinations. However, when the mode options were combined, the interaction between transit services serving similar markets was considered to avoid double counting and over estimating total transit ridership. In this stage of analysis, each service/market area was assigned to a specific station for a particular transit option based on the total impedance for each option that could serve a particular area. In general, a service or market area was assigned to the transit route with the least impedance.

For the analysis of mode combinations, a bus subsidy was included in each combination that included both a rail line and a bus option. This was done to make the bus options competitive with the rail options when they were combined together. In mode combinations without a rail option, no bus subsidy was included.

For the analysis of combinations with an HOV option, it was assumed that the HOV lane would continue to I-95 (Route 128) in Massachusetts. It was also assumed that the HOV lane was in addition to whatever number of general purpose lanes were included in the analysis. However, the total number of lanes, including the HOV lane, was never more than four in each direction.

Ridership Projections for Mode Combinations

In reviewing the results from analysis of ridership for the various modes in different combinations with each other, Mode Combinations 3 and 13 have the largest projected daily transit ridership with 3,365 southbound trips. Both combinations include Enhanced Rail with two general purpose lanes on I-93. Although Combination 13 also includes East Rail, the ridership projection is the same as for Combination 3 because the East Rail serves the same market as Enhanced Rail.

The next largest ridership projections are for Mode Combinations 5 and 14 with just under 3,000 daily southbound trips each. Both of these combinations include Enhanced and Expanded bus service, an HOV lane, and a bus subsidy. The most effective transit combinations involve Enhanced Rail or Enhanced and Expanded Bus service with an HOV lane and bus subsidy.

To determine the impact of the transit mode combinations on roadway conditions, the projected daily transit ridership was diverted from projected traffic volumes on I-93. The reduction in daily person trips was converted to a reduction in vehicle trips by dividing by the average auto occupancy rate for the area (1.11) from the 1990 journey-to-work (JTW) census data.

Diversions from single occupant vehicles to HOVs resulting from the provision of an HOV lane were also calculated. The number of HOVs created was subtracted from the number of SOVs eliminated to calculate the net reduction in vehicles. The largest reduction in vehicles resulting from the HOV lane is 480 daily southbound vehicles, and occurs when there are only two general purpose lanes on I-93. With three general purpose lanes, the number of vehicles diverted is reduced to about 290.

The largest total projected reduction in daily vehicles between Exit 1 and the Massachusetts state line is for Mode Combination 5 with a reduction of almost 2,400 daily southbound vehicles. This represents 3.3 percent of the total daily directional volume of 71,100. Mode Combinations 3 and 13 result in a reduction of almost 2,300 vehicles.

Existing congestion on I-93 extends over a three hour period in both the morning and evening. Vehicle reductions for these three-hour peak periods were estimated separately for transit and HOV modes from the daily reductions. Daily transit reductions were converted to three-hour peak period reductions assuming that 82 percent of daily one-way transit volume occurs in the peak period. The 82 percent was estimated from existing MBTA commuter rail ridership data. The daily HOV vehicle reduction was used directly for the three-hour peak period reduction because the HOV lane would probably be restricted to HOVs only in peak periods when there is congestion in the general purpose lanes. Peak period vehicle reductions range from about 100 vehicles for Mode Combination 1 to almost 2,050 vehicles for Mode Combination 5. The reduction for Combination 5 represents a 9 percent decrease in the directional design hour volume. Several other combinations produce reductions of 8 percent or so, including Combinations 3, 4, 13, and 14.

Highway Level of Service Analysis

Level of service analyses were conducted for each segment of the I-93 corridor for the 2020 design hour volumes assuming the traffic volume reductions associated with each of the Mode Combinations. The evaluation of the various alternative modes of transportation was designed to determine if use of rail, bus and HOV lanes by commuters could result in fewer trips and, consequently, reduce the number of lanes needed to maintain an acceptable level of service during the design hour. The evaluation of traffic operations, taking into account the possible reductions in vehicle trips, shows that the availability of alternative modes would not reduce the volume of traffic on I-93 to a level where an acceptable level of service could be maintained with fewer travel lanes. Specifically, the various alternative modes of travel would result in little or no reduction in travel on I-93 during the design hour.

These various alternative modes of travel result in little or no reduction in the volume of traffic during the design hour because the level of congestion along the corridor extends well beyond a one-hour period. Currently, commuters routinely experience substantial delays that extend beyond a one-hour period and this situation will worsen over time. Reductions in traffic that would result from the implementation of the various alternative modes of transportation would serve to reduce the period of time in which congestion occurs, but not the level of congestion within the design hour.

A summary of the level of service analyses for all segments of the corridor for each Mode Combination is presented in Table 2.3-6. As shown in the table, none of the mode combinations meet the established criteria of providing at least a LOS D operation over all segments for the 2020 design hour. However, Mode Combination 10, which is the only combination that provides four general purpose lanes, comes the closest to meeting the criteria providing LOS D or better along each segment of the corridor with the exception of the segment south of Exit 1. The four-lane section south of Exit 1 would operate at LOS E.

All other mode combinations show either a LOS E or a LOS F operation along the segments south of Exit 3. In fact, only Mode Combinations 7, 9, and 14, which each provide three general purpose lanes plus an HOV lane in various combinations with bus service, the west rail, and the enhanced rail, were able to obtain a LOS D operation between Exits 1 and 3 for the hour prior to and following the design hour.

Considerations and Implications

Impacts on Traffic Level of Service

The analysis of levels of service on I-93 with various combinations of rail, bus, and HOV options indicates that in 2020 I-93 would continue to operate at deficient levels of service and would require additional travel lanes to operate at acceptable levels of service. None of the alternative combinations of rail, bus, and HOV options reduces the number of additional travel lanes needed to provide acceptable operating levels of service.

The mode combinations tested were developed to maximize rail, bus, and HOV ridership and the resulting diversion of traffic from I-93. Some of the combinations included no widening of I-93 because ridership on rail, bus, and the HOV lane is maximized when travel times on the highway are greatest. Widening the roadway will decrease delay and reduce the number of drivers diverted to rail, bus, or HOV options. The combinations with the greatest diversion did not result in a reduction in the number of additional lanes needed for I-93 in 2020.

Rail Ridership

The Enhanced Rail Corridor provides service for Boston bound travelers as well as for travelers to major employment centers in northern Massachusetts along I-93. Based on the initial analysis of all the rail options (assuming four travel lanes in each direction on I-93), Enhanced Rail generates the largest number of daily boardings to Boston. It also generates additional daily boardings to northern Massachusetts. In the analysis of mode combinations, the Enhanced Rail generated almost 3,000 daily boardings with only two lanes in each direction on I-93. About 1,260 of these boardings are for trips to downtown Boston.

The major disadvantage of the Enhanced Rail corridor is that it depends on the continuation of the corridor in Massachusetts to the Anderson Regional Transportation Center in Woburn. The preliminary conclusions of the Study Advisory Committee for the I-93 corridor study in Methuen and Andover in northern Massachusetts recommend a joint study by New Hampshire and Massachusetts of rail service between Boston and Manchester.

When analyzed individually, the East and I-93 Basic rail corridors generated the second highest levels of increased daily boardings (half the level of the Enhanced Rail Corridor). Although these ridership levels are lower than the Boston bound riders on the Enhanced Rail Corridor, neither corridor is as dependent on an extensive infrastructure investment in Massachusetts as is the Enhanced Corridor. When analyzed individually, the West Rail Corridor generates the smallest increase in rail boardings of the four rail alternatives. Further, the portion of the West Corridor ridership generated by the Merrimack Station is not expected to divert traffic from I-93. In terms of its impact on I-93 traffic, the West Rail Corridor appears to be the least effective rail option.

Table 2.3-6
2020 Directional Design Hour Volumes (DDHV) and Shoulder Hour Level of Service Summary for I-93 Between I-293 and the Massachusetts State Line Resulting from Bus, Rail and HOV Lane Improvements

	South of Exit 1		Exit 1 to Exit 2		Exit 2 to Exit 3		Exit 3 to Exit 4		Exit 4 to Exit 5		North of Exit 5	
Mode Combination	DDHV[1] LOS[2]	Shoulder Hour[3] LOS	DDHV LOS	Shoulder Hour LOS	DDHV LOS	Shoulder Hour LOS	DDHV LOS	Shoulder Hour LOS	DDHV LOS	Shoulder Hour LOS	DDHV LOS	Shoulder Hour LOS
1 (No-Build w/West Rail)	F	F	F	F	F	F	F	E	F	F	F	F
2 (No-Build w/Enhanced Rail)	F	F	F	F	F	F	F	E	F	F	F	F
3 (No-Build w/Rail)	F	F	F	F	F	F	F	D	F	E	F	F
4 (No-Build w/HOV, Bus)	F	F	F	F	F	F	E	D	F	E	F	F
5 (No-Build w/HOV, Bus, West Rail)	F	F	F	F	F	F	E	D	F	E	F	F
6 (3 Lanes w/Bus)	F	F	F	E	F	E	D	C	D	D	D	D
7 (3 Lanes w/HOV, Bus)	F	F	E	D	E	D	C	C	D	C	D	D
8 (3 Lanes w/Bus, West Rail)	F	F	F	E	F	E	D	C	D	D	D	D
9 (3 Lanes w/HOV, Bus, West Rail)	F	F	E	D	E	D	C	C	D	C	D	D
10 (4 Lanes w/Bus)	E	E	D	D	D	D	C	C	C	C	C	C
11 (2 Lanes w/HOV, Bus, East Rail)	F	F	F	F	F	F	E	D	F	E	F	F
12 (3 Lanes w/HOV, Bus, East Rail)	F	F	E	E	E	E	C	C	D	C	D	D
13 (2 Lanes w/HOV, Bus, East Rail)	F	F	F	F	F	F	F	D	F	E	F	F
14 (3 Lanes w/HOV, Bus, Enhanced Rail)	F	F	E	D	E	D	C	C	D	C	D	D

1 DDHV – Directional Design Hour Volume
2 LOS – Level of Service (see attached sheet for definition)
3 Shoulder Hour – The Hour before and after the Design Hour

HOV Lanes

Recommendations relative to incorporating HOV lanes in the improvements for I-93 are influenced by three factors: projected volume in the HOV lane, provision of an HOV lane in Massachusetts, and impact on total traffic volume on I-93. *National Cooperative Highway Research Program (NCHRP) Report 414, HOV Systems Manual*, recommends a minimum operating threshold of 400 to 800 vehicles per hour per lane for freeway HOV lanes. The minimum operating thresholds are designed to ensure that the facility does not appear to be underutilized to users of the general purpose lanes.

Since all the HOV analyses for I-93 have been based on 2+ HOVs, the 800 vehicle minimum operating threshold appears to be appropriate for the I-93 corridor. Projected peak hour HOV lane volumes with three general purpose lanes in each direction the entire length of the corridor would exceed the 800 vehicle minimum operating threshold only on the segment south of Exit 1. With only two general purpose lanes throughout the corridor (except south of Exit 1 where there are currently three lanes), the segment south of Exit 2 is projected to have a peak hour volume just below the 800 vehicle threshold. With either 2 or 3 general purpose lanes, the smallest minimum operating threshold (400) would not be exceeded north of Exit 5 and would barely be met north of Exit 4. As a result, projected hourly HOV volumes do not meet a minimum operating threshold that would be appropriate for I-93 between Salem and Manchester.

The projected HOV volumes represent approximately 10 to 11 percent of the total peak hour peak direction volume for I-93 between Exit 1 and the Massachusetts State line. This represents an increase over existing conditions. As reported in Section 3.2.1.1, counts conducted in April 2002 on I-93 southbound, south of Exit 1 in the morning peak hour indicate that HOVs currently represent about 8 percent of the total traffic volume.

The volumes projected through the ridership study and mode combinations analysis are based on the assumption that the HOV facility is continued in Massachusetts between the state line and I-95 (Route 128). If there was no Massachusetts facility, the 800 vehicle minimum operating threshold would not be met on any segment of I-93 and the 400 vehicle threshold would be not be met for the segments north of Exit 4. The preliminary conclusions of the Study Advisory Committee for the I-93 corridor study in Methuen and Andover in northern Massachusetts includes a recommendation to widen the roadway with an additional general purpose lane in each direction. An HOV facility is not recommended.

The provision of an HOV lane is designed to encourage the formation of carpools and reduce the number of vehicles on the roadway. Based on the travel time savings expected with an HOV lane that continues into Massachusetts to I-95 and assuming there are three general purpose lanes in addition to the HOV lane, a reduction of approximately 125 vehicles in the peak hour is expected south of Exit 1. This represents about 1.6 percent of the projected peak hour volume of 7,650 vehicles. Similar or smaller percentage reductions are expected on segments north of Exit 1. These reductions are not large enough to have a discernible effect on traffic congestion in the general purpose lanes. Further, these reductions are based on the provision of an HOV lane in Massachusetts, which is not included in the preliminary recommendations of the Study Advisory Group for the study of I-93 in northern Massachusetts.

Bus Ridership

The analysis of the Expanded Bus service showed that an HOV lane in both Massachusetts and New Hampshire substantially increased bus ridership. An HOV lane in New Hampshire-only had little effect on ridership. The analysis of individual options also included consideration of a bus fare subsidy comparable to the fare subsidy that would be provided to rail users under the current MBTA fare structure. The subsidy increased daily bus boardings by 250 to 270.

The largest bus ridership projection is 2,840 daily boardings with Mode Combination 5. Mode Combination 5 includes an HOV lane, bus subsidy, Expanded and Enhanced bus service, and the West Rail Corridor. The projected ridership is somewhat less than the 3,000 daily boardings projected for the Enhanced Rail (Mode Combination 3). The inclusion of an HOV lane appears to have the most influence on bus ridership, increasing the ridership volume by 600 to 700 riders for mode combinations with HOV lanes versus those that do not have HOV lanes.

The projections of ridership for various bus options does not include an estimate of the number of buses needed to carry the projected ridership. Of particular concern is the capacity of existing bus docking space at the South Station bus terminal.

Related Issues

In addition to the conclusions presented above, several related issues need to be considered:

- The ridership projections for the most part are based on traffic expected during peak commuter hours. The various modes analyzed in the ridership projections would not generally serve tourist or recreational traffic which is an important factor in travel on I-93.

- The ridership projections do not address or account for safety deficiencies associated with the existing highway.

2.3.5.6 Summary and Conclusions

The preliminary analysis of the eight mode options presented above provided an understanding of the potential of each and a focus for further development of individual mode options as well as development of combinations of mode options. The analysis indicated that ridership volumes for the I-93 Basic Rail option would be similar to that for the East Rail option, and consequently subsequent analyses did not test the Basic Rail option. Similarly, the New Hampshire-only HOV lane does not produce sufficient ridership on buses or in carpools to warrant further testing of this option.

Subsequent studies were conducted to evaluate the mode options in combination with each other and with various highway widening alternatives, to both test the ridership that might be generated, as well as to project the resulting level of service of the highway given the ridership generated. In this way alternative modes were evaluated on their merits, and the need for widening I-93, and to what degree, was also tested.

2.4 Initial Screening of Alternatives

This section summarizes the process to screen the conceptual alternatives. The process involved evaluating conditions along the corridor, considering resources potentially subject to impact, considering issues of concern to communities and the public, and evaluating existing and potential alternatives. The rationale for eliminating certain alternatives from further study is explained, followed by the identification of a "reasonable range of alternatives" (Section 2.5).

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2.4.1 Resource Agency Meetings

In order to facilitate the development and later initial screening of alternatives, a number of meetings were held by the NHDOT with the various Federal, State and local project stakeholders. Information which progressed from conceptual ideas through eventual plans, analysis and reports was presented or distributed to the various agencies or to the general public in attendance.

The NHDOT and the FHWA are the state and federal agencies responsible for technical oversight and development of the EIS for the I-93 project. Together, these agencies provide for the technical review for this project, particularly in the case of transportation issues. In addition, technical review and input is sought from the Federal Transit Administration, Regional Planning Commissions, and technical staff that reside with the local communities. Technical review activities served as a preliminary forum to consider all project related materials, ideas and design concepts developed. These technical review meetings were held as required, throughout the life of the project, to review project related information and solicit input. In turn, revisions were made or additional studies were conducted, as appropriate, to supplement the study process.

Another level of review includes both federal and state environmental Resource Agencies. These agencies are responsible for making or influencing permitting decisions based on state and federal laws and regulations, and ultimately serve to

protect natural, cultural, and socio-economic resources potentially affected by the project. The agencies are focused on assuring the least impacts, while providing a practicable solution that meets the project purpose and need.
State resource agencies involved in this project include:

State Agency	State Level Responsibility
NH Department of Environmental Services	Wetlands, Air Quality, Water Quality
NH Natural Heritage Inventory	Threatened or Endangered Plant Species
NH Division of Historical Resources	Historical and Archeological Resources
NH Office of State Planning	Floodplains, Land Use Planning
NH Office of Emergency Management	Floodplains
NH Fish & Game Department	Fisheries, Wildlife, Threatened or Endangered Wildlife Species

Federal resource agencies involved in this project include:

Federal Agency	Federal Level Responsibility
US Environmental Protection Agency—Region 1	Wetlands, Air Quality, Water Quality
US Army Corps of Engineers – N.E. District	Wetlands, Water Quality, Historic and Archeological Resources, Floodplains
US Fish & Wildlife Service	Fisheries, Wildlife, Threatened or Endangered Species
Federal Emergency Management Agency	Floodplains

The I-93 project has been identified as a high priority project by the NH State Legislature via HB1106 because of the importance of this highway corridor to the region and the State. In addition, the tenets of environmental streamlining, as outlined in TEA-21 federal legislation, were followed in an effort to streamline the environmental permitting process, so that improvements could be constructed and implemented as soon as possible.

As an outgrowth of the streamlining process and in conjunction with the public participation program, the Resource Agency meetings for this project, normally held at NHDOT headquarters in Concord, were held in the communities along the project corridor. Information related to the study was presented and distributed at these meetings. The meetings were open to the general public and public participation is encouraged through public notice. Additional meetings have also been held with the Resource Agencies as part of the streamlining process. These meetings also resulted in revisions or additional studies, as appropriate, to address comments solicited from these agencies.

A total of twenty-one Resource Agency meetings have been held to date with seven additional meetings held to establish and coordinate the Environmental Streamlining process. Actual dates and locations of these meetings are listed in Chapter 8 of this report along with the topics of discussion.

An Advisory Task Force (ATF) was established early in the project process. The I-93 ATF is made up of thirteen people consisting of two people, representing each of the five communities through which I-93 passes, and one person appointed by each of the three Regional Planning Commissions, whose regions are affected by the project.

ATF meetings were held on a regular basis early in the public participation process to present and distribute project related information. The meetings were held in the evenings, and were open to the general public, with public participation encouraged. Over time, the meetings evolved into public informational meetings with discussions principally focused on issues of concern to the community in which the meeting was being held.

In total, 12 ATF meetings were held within the five communities along the corridor. Actual dates and locations of these meetings are listed in Chapter 8 of this report along with the topics of discussion.

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2.4.2 Public Officials and Public Informational Meetings

Meetings with local and regional, appointed and elected public officials of the five communities directly affected as well as the general public were held periodically to review project findings, status, and schedule. The meetings are held in the evenings. In general, Public Officials Meetings are held to review project-related information and solicit input. Revisions and additional studies, as appropriate, are conducted to address comments received.

Two rounds of public officials meetings have taken place for this project. A first series of meetings with each of the five communities were held in March, 2000 to initiate the public participation process and present the study area for the corridor and discuss the issues of concern and alternatives to be studied.

During the months of November and December, 2000, a second round of meetings were held in the communities to discuss study findings relative to alternative modes of transportation and present the concept plans for widening the highway and improving the interchanges.

In all, eleven Public Officials Meetings have been held to date within the five communities along the corridor. Actual dates and locations of these meetings are listed in Chapter 8 of this report along with topics of discussion.

Public Informational Meetings are similar in format, agenda and intent as the Public Officials Meetings, although the emphasis for the latter is to obtain feedback from community officials, while for the former is to disseminate information and obtain feedback from all interested parties. Typically the Public Informational Meetings have been held in series of five (one meeting per corridor community) and in total, 15 Public Informational Meetings have been held.

The first round of Public Informational Meetings was held between July and September, 2001 to discuss the various options developed and present more detailed concept plans. A second round of Public Informational Meetings was held in November and December, 2001 to review updated plans and critical issues. A third round of Public Informational Meetings was conducted in June/July 2002 to discuss the NHDOT's Preferred Alternative and other outstanding issues.

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2.4.3 Environmental Constraints

In developing the conceptual alternatives, environmental (natural, cultural, and socio-economic resources) and engineering constraints were considered. Environmental data based on available mapping, project research, agency contacts, and field investigations as outlined in the *Scoping Report* (VHB 2000) were used to identify resource constraints. The conceptual layouts of the I-93 mainline and interchange alternatives attempted to first avoid environmental resources within the engineering constraints of widening the existing I-93 corridor. That is, the mainline alignments were shifted to the east or west, within interstate geometric design and constructability parameters, to avoid or at least minimize impacts to important resources and properties. Areas that exhibited substantial or unmitigatable impacts were noted.

Concepts were viewed at a macro level and the designs were essentially two-dimensional in nature, except at certain locations where critical cross sections were developed to better understand the potential impacts and engineering issues. Resource impacts were not quantified but instead were visually compared to see whether one concept would probably have greater impacts than another. Resources that were considered important environmental constraints influencing the conceptual design and selection of alternatives included the following:

Surface Water Resources

The Canobie Lake Watershed was a particular concern, in part because the Lake serves as Salem's water supply. In addition, the Cobbetts Pond watershed was of concern as an important recreational resource in the Town of Windham. Other lakes, ponds, and streams were a concern relative to water quality, with many of the area waterbodies and watercourses having recreational and other values to the communities in the region.

The potential for stormwater delivery of pollutants to surface waters is a general concern throughout the I-93 corridor. In particular, Canobie Lake, a Class A waterbody serving as the water supply to the Town of Salem, and Cobbetts Pond are potential receptors of non-point inputs of road runoff due to their proximity to the corridor. In addition to the potential for non-point inputs to these lakes, there are tributaries to these waterbodies that serve as potential pathways for delivery of drainage derived from an extensive section of I-93.

Floodplains

Conceptual alternatives were screened for their effect on the floodplain areas that exist within the five communities through which I-93 passes.

The Spicket River and its tributaries (particularly Porcupine Brook and Policy Brook with their proximity to I-93) in the Town of Salem was of special concern relative to flooding because of a history of flooding problems both within the study area (in New Hampshire) and in downstream communities in Massachusetts. Flood impacts along this river system extend from Salem to Methuen and Lawrence, Massachusetts. What is referred to as "primary valley storage" is provided along the section of this river that parallels I-93 near the Massachusetts border. This storage could be affected by widening the highway.

Beaver Brook in the Derry/Londonderry area and Cohas Brook, in Manchester also have floodplains and floodways that may be directly affected by improvements to the existing highway.

Groundwater

Most public and community water supplies fall outside the immediate corridor of the existing highway. However, the potential for road salt contamination of nearby wells was a general concern throughout the I-93 corridor. Additionally, there are a number of specific locations where protection of groundwater was an issue. These included the following locations:

- Windham community water supply well between Canobie Lake and I-93
- Proximity to Canobie Lake (Class A water body serving as water supply for the Town of Salem) and surrounding watershed
- The joint Wellhead and Watershed Protection Areas established by the Towns of Salem and Windham.
- The Groundwater Resources Conservation District established by the Town of Derry.

Air Quality

Air quality remains a primary consideration. The alternatives carried forward should not exacerbate the existing violation of carbon monoxide (CO) standards and ought to improve upon it. Similarly for ozone, the alternatives must be compatible with other regional projects and trends so as to not increase, and preferably decrease, regional emission of ozone precursors.

Noise

Changes in traffic noise levels were a concern for a number of neighborhoods in close proximity to I-93. To the extent practicable, widening layouts were developed to maintain offsets to neighborhood areas and, if this were not possible, the practicality of erecting sound walls was considered.

Wetlands

Wetlands were recognized to be an important resource for which impacts had to be avoided to the extent practicable. Those wetland impacts that could not be avoided had to be minimized and mitigation provided. Wetlands that were considered particularly important were those associated with Porcupine Brook in Salem, a heron rookery near the southbound weigh station in Windham, an extensive wetland system just north of Lowell Road on the west side of the highway also in Windham, Wheeler Pond in Londonderry, a large unnamed pond and associated emergent marsh just north of Exit 5 in Londonderry, and the wetland system along Cohas Brook in Manchester.

Avoidance of substantial impacts to NH designated "Prime Wetlands" at the local level as well as vernal pools was also a goal. Wetlands designated as prime carry special consideration relative to impacts and mitigation. Prime wetlands potentially impacted by the I-93 improvements are located in Salem and Derry.

Vegetation and Wildlife Habitat

Concerns relative to wildlife along the I-93 corridor principally involved consideration of minimizing impacts to wildlife habitat to the extent practicable. Specific areas of interest included the marsh at the junction of I-293 and I-93 (an important habitat for waterfowl, wading birds, and aquatic mammals); the riparian wetland system along Cohas Brook, and the great blue heron rookery near the southbound weigh station in Windham.

Socio-economic Impacts

Socio-economic impacts include direct impacts to people's homes, businesses, and work places, and indirect impacts affecting access, land use, setting, travel patterns, safety, and local and regional economies. For the most part, direct impacts create hardships and need to be avoided or minimized to the extent practicable. Indirect impacts are more difficult to estimate and evaluate, and can result in benefits or problems that are long-term in nature. Socio-economic issues of primary concern involved minimizing impacts to private property, while incorporating into the proposed layout enough planning to assure the I-93 corridor can continue to service the transportation needs of the region long into the future. Interchange areas generally contain relatively dense commercial/industrial development that typically constrains designs. Neighborhoods elsewhere on both sides of the mainline also pose a serious challenge relative to avoiding or minimizing impacts.

Cultural Resources

Archaeological Sites and Historic Architectural Properties

Archaeological sites and historic properties are scattered along and within the highway corridor the length of the project. Areas of both prehistoric and historic archaeological sensitivity occur in many locations along the corridor and were viewed as constraints in developing alternative concepts for highway improvements. Typically such areas should be avoided where possible. If impacted, additional research and recovery are required. Similarly extant historic properties and buildings that are potential constraints are located in Salem along the easterly Cross Street approach to I-93; in Windham along NH 111 immediately west of I-93, along NH 111A in the median area of I-93 south of Exit 3 and east of I-93 just north of Exit 3; in Londonderry , the Ash Street/Pillsbury Road Bridge, the Woodmont Orchards north and west of Exit 4, and along Stonehenge, Rockingham and Perkins Roads; and the Pumping Station east of I-93 along Cohas Avenue in Manchester. Again, such areas needed to be avoided if possible, and, if not, measures to mitigate the impacts developed.

Public Lands

Public lands of particular concern would be those that fall under the Section 4(f) and Section 6(f) purview. Section 4(f) of the Department of Transportation Act of 1966 states "… special effort should be made to preserve the natural beauty of the countryside and public park and recreation lands, wildlife and waterfowl refuges and historic sites." There are several Section 4(f) land parcels within, and surrounding the I-93 study area.

Section 6(f) lands are defined as lands that have been acquired or improved with funds provided by the federal Land and Water Conservation Act. Two properties located in the I-93 study area qualify as Section 6(f) properties: Hedgehog Park in Salem and Crystal Lake Park in Manchester. Based on preliminary review of the proposed conceptual highway improvements, it was concluded that these properties could be avoided.

Secondary and Cumulative Impacts

Secondary growth was a major issue of concern among some resource agencies given the potential for stimulating further development in New Hampshire as a result of improving the I-93 corridor to accommodate more traffic. Some secondary development within New Hampshire and Massachusetts resulting from improvements to I-93 are anticipated.

Cumulative impacts may involve improvements to NH 111 through Windham and Salem, the Exit 4A Interchange in Londonderry and Derry, the Airport Access highway in Merrimack, Bedford, Manchester, and Londonderry and the continuing expansion of the Manchester Airport. Cumulative impacts could also involve improvements to I-93 in Massachusetts that are currently being considered as part of the Traffic Corridor Study of I-93 from Andover north to the New Hampshire line initiated by the Merrimack Valley Regional Planning Commission (MVPC) in Massachusetts.

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2.4.4 Initial Screening Traffic and Highway Operational Considerations

From an operational perspective, a first step in considering alternatives is to determine the number of basic lanes that would accommodate future travel demand along I-93. The basic lanes of a highway are the travel lanes that are needed solely to accommodate the movement of through traffic. Basic travel lanes do not include traffic management lanes such as climbing lanes, acceleration/deceleration, weaving, and merging type lanes, which may be needed in the vicinity of an interchange to accommodate vehicles entering and exiting the highway. These basic lanes serve to provide a consistent number of lanes over a substantial length of highway.

The results of this analyses of strictly operational needs indicate that to provide at least a LOS D operation in 2020 would require the following number of basic lanes along the corridor.

- 10 lanes (5 lanes in each direction) south of Exit 1,
- 8 lanes (4 lanes in each direction) between Exit 1 and Exit 3, and
- 6 lanes (3 lanes in each direction) between Exit 3 and I-293.

Again, these basic lane requirements are the number of basic lanes, exclusive of traffic management lanes, that are needed to accommodate through traffic along the each segment of the I-93 corridor. Note that to provide a LOS D operation along the segment south of Exit 1 would require a ten-lane section. This exceeds the NHDOT's general guideline of not constructing highways with more than eight basic lanes (four lanes in each direction).

In addition to determining the number of basic travel lanes, the evaluations of alternatives included a traffic operations analysis for each of the modes that might address the corridor needs. In general the capacity of a freeway type lane is reached when the volume of traffic approaches approximately 2,200 vph. Volumes above 2,200 vph cause the time of congestion to lengthen into the hour before and after the peak hour congestion. The level of service analyses have been conducted for each segment of the I-93 corridor for the 2020 design hour volumes.

The evaluation of the various alternative modes of transportation, as presented in the previous section, provides ridership estimates for alternative modes such as rail and bus, and usage estimates for an HOV lane. Use of rail, bus and HOV lanes by commuters would result in fewer vehicle trips on the I-93 corridor and, consequently could reduce the number of lanes needed to maintain an acceptable level of service during the design hour.

The subsequent evaluation of traffic operations, taking into account the possible reductions in vehicle trips due to the availability of alternative modes of travel, shows that the availability of alternative modes would not reduce the volume of traffic on I-93 to a level where an acceptable level of service could be maintained with fewer travel lanes than the basic requirements proposed above. Specifically, the various alternative modes of travel would result in little or no reduction in travel on I-93 during the design hour.

These various alternative modes of travel result in little or no reduction in the volume of traffic during the Design Hour because the level of congestion along the corridor currently extends beyond a one hour period and this situation will worsen over time through the 2020 design year. Currently, commuters routinely experience substantial delays that extend over a three-hour period. Therefore, the reductions in traffic that result from the various alternative modes of transportation actually occur at the outside of the commuter period rather than during the design hour. In other words, the use of other modes of transportation would serve to reduce the number of hours of congestion, but not the level of congestion within the design hour.

A summary of the level of service analyses for each segment of I-93 between the Massachusetts state line and I-293 is presented in Table 2.3-6. The table includes the levels of service for both the directional design hour and the hour immediately before or after the directional design hour (i.e., shoulder hour). In doing so, the merits of any particular mode combination for a particular segment can be better evaluated. For example, if the level of service remains the same both in the directional design hour and the shoulder hour, then the mode combination has a more marginal effect on addressing the needs of the highway. If the shoulder hour has a better level of service, then the mode combination shows more potential for addressing the highway needs of the particular segment.

As shown in the table, none of the mode combinations meet the established criteria of providing at least a LOS D operation over all segments for the 2020 design hour. However, Mode Combination 10, which is the only combination that provides four general purpose lanes, comes the closest to meeting the criteria as LOS D or better is provided along each segment of the corridor with the exception of the segment south of Exit 1. The four-lane section south of Exit 1 would operate at LOS E. This result is consistent with the previously stated finding that 5 lanes in each direction would be needed south of Exit 1 to maintain a LOS D.

All other mode combinations show either a LOS E or a LOS F operation for the 2020 Design Hour along the segments south of Exit 3. In fact, only Mode Combinations 7, 9, and 14, which each provide three general purpose lanes plus an HOV lane in various combinations with bus service, the west rail, and the enhanced rail, were able to obtain a LOS D operation between Exits 1 and 3 for the hour prior to and following the design hour.

The following conclusions were drawn from the results of the alternative mode of transportation evaluation.

- The various transit and HOV options, either alone or in combination, do not reduce the number of additional travel lanes required to provide acceptable levels of service on I-93

- The most effective transit options in terms of the net diversion of vehicles from I-93 are the Enhanced Rail Corridor or the provision of an HOV lane with Expanded and Enhanced bus service. The Enhanced Rail Corridor generates the highest level of ridership of all the transit options. The combination of Enhanced and Expanded bus service with an HOV lane generates almost as much ridership as the Enhanced Rail Corridor. The net diversion for each of these alternatives is approximately the same.

- The Enhanced Rail Corridor requires extensive infrastructure improvements in Massachusetts along the I-93 corridor to provide service to major employment centers and the Anderson Transportation Center in Woburn. The MVPC study of the I-93 corridor in Methuen and Andover Massachusetts considered several options for rail service in Massachusetts. Although the study report is not finalized, the preliminary recommendations of the Study Advisory Committee call for improvements to the Haverhill commuter rail line to allow increased service and a cooperative study by New Hampshire and Massachusetts of potential options for rail service between Manchester and Boston.

- To be effective, an HOV lane in New Hampshire must be extended into Massachusetts and would require an extensive infrastructure investment along the I-93 corridor in northern Massachusetts. The MVPC study of the I-93 corridor in Methuen and Andover Massachusetts considered an HOV lane option. Although the study report is not finalized, the preliminary recommendations of the Study Advisory Committee call for widening the roadway to four general purpose lanes in each direction and do not include the provision of an HOV facility.

- The East and I-93 Basic Rail corridors generate between one-third and one-half the ridership of the Enhanced Rail Corridor depending on the number of travel lanes on I-93. However, these alternatives require much less infrastructure investment in Massachusetts than does the Enhanced Rail Corridor.

- The West Rail Corridor would have a less effective influence in addressing traffic issues along I-93.

- An HOV lane in New Hampshire-only does not generate HOV volumes that meet the recommended minimum operating threshold.

- An HOV lane in Massachusetts and New Hampshire generates HOV volumes that meet the recommended minimum operating threshold only south of Exit 1.

- Providing an HOV lane in Massachusetts and New Hampshire increases bus ridership substantially over having no HOV lane or an HOV lane only in New Hampshire.

- As noted above, a rail alternative does not reduce the number of lanes required to address existing and future traffic needs. With that said, the widening of I-93 to more than four lanes in each direction will not be acceptable, and future capacity needs will have to be served by other facilities or modes of transportation. Therefore, it would appear to be important to reserve space within the highway corridor that can be utilized in the future as required.

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2.4.5 Conclusions from Initial Screening

Conclusions from the above described screening can be summarized as follows:

No-Build

The No-Build Alternative is not considered a viable alternative relative to the project purpose and need, but will serve as a baseline condition for comparison with other alternatives. The No-Build Alternative involves accepting the deteriorated condition of the infrastructure, increased congestion, and decreased safety, a seemingly untenable situation.

Highway Widening

The initial highway widening concepts incorporated a typical roadway cross section, which included four 12-foot travel lanes, a 10-foot outside shoulder, a 14-foot inside (HOV enforcement) shoulder and a 4-foot painted buffer area between the two inner most travel lanes, in each direction. The inner most travel lane could be utilized as an HOV lane. This typical cross section was mirrored in the opposite direction for a total of 8 lanes or 4 lanes in each direction. The minimum median width between the two northbound and southbound barrels varied between approximately 60 feet to 90 feet, so as not to preclude the potential for a future rail line down the median.

As previously noted, an HOV facility would not produce the minimum recommended ridership to make these lanes a feasible option. It was therefore recommended that the HOV lane option be dropped from further consideration. This would result in a reduction in width of 6 feet in each direction, or a total of 12 feet in the overall corridor width. With that said, the extra 6 feet in each direction was carried forward with all widening layouts to provide sufficient flexibility to finalize the selected design, address constructability issues, and so as to not preclude the possibility of instituting HOV lanes in the future should Massachusetts incorporate them or the practicality of such lanes become apparent in the future.

Mainline Improvements

The I-93 mainline improvements were carried forward for additional evaluation. Three different widening concepts were developed between Exits 1 and 2 to minimize or avoid impacts to Porcupine Brook:

- Concept 1 – constructing a new northbound barrel to the east, widening the southbound barrel to the west and providing for a future rail line on the existing northbound barrel,
- Concept 2 – widening the existing northbound barrel to the east, widening the southbound barrel to the west and providing for a future rail line within the median, and
- Concept 3 – widening the existing northbound barrel to the east, widening the southbound barrel to the west and providing for a future rail line to the west,

Of these only Concept 2 was selected to be carried forward for more detailed evaluation. By observation, this concept had the least impacts assuming the rail line would be supported on a trestle system.

The remaining I-93 mainline concepts carried forward and evaluated in more detail minimize or avoid impacts to important resources, while at the same time providing practicable alignments both in terms of construction and long term operation.

Interchange Improvements

In addition, the following I-93 interchange improvements were selected for further evaluation:

- Exit 1 Options- **(Figure 2.3-24)** Both concepts were carried forward and evaluated further.
- Exit 2 Options – **(Figure 2.3-25)** Both concepts were carried forward and evaluated further.
- Exit 3 Options-(**Figures 2.3-26 through 2.3-30)** All nine concepts were carried forward and evaluated further except for the design concept developed for Exit 3 in 1995, as part of the Windham-Salem NH 111 (10075) project, which included a flyover ramp. This concept was not carried forward, as other options evaluated provide satisfactory levels of service with fewer impacts.
- Exit 4 Options – **(Figures 2.3-33 and 2.3-34)** Both concepts were carried forward and evaluated further.

- Exit 5 Options- **(Figure 2.3-35)** All three concepts were carried forward and evaluated further.

TDM Measures

TDM measures, with the exception of Congestion Pricing, were carried forward for more detailed evaluation. Congestion pricing was not proposed for further study as it would do little to address current congestion levels, there is a lack of alternative routes or modes, and it would likely be viewed as a regressive tax and incompatible with New Hampshire's quality of life.

Proposed construction of park-and-ride lots at Exits 2, 3 and 5, along with continued use of the existing lot at Exit 4, were also carried forward. A number of concepts were developed and refined, as appropriate, to minimize impacts and maximize use, and to evaluate alternative sites for a particular interchange.

Mode Options – Rail, Transit

Based on the study of potential ridership and its affect on highway level of service, bus service, rail service and the use of HOV lanes, either alone or in combination with each other, do not eliminate the need to widen the highway, if acceptable levels of service are to be achieved over the next 20 years, or even over the intermediate time frame of 2010. The mode options will help alleviate the length of time over which congestion occurs, but the peak hour of congestion will remain, and under many of the mode combinations tested, the 3+ hour period of congestion will remain. With this in mind, it was concluded that further consideration of HOV lanes and rail service be discontinued as part of this project. These measures do not result in enough diversion to influence the need to widen the highway and would result in major additional expenditures for construction and long term operation. They also require substantial investment by the State of Massachusetts.

Improvements in bus service in the form of expanded bus service, and enhanced ride-sharing opportunities were proposed for further evaluation. In addition, given the likelihood that rail service will be required to meet the long-range needs of transportation in the area served by I-93, it was proposed that space be reserved within the I-93 highway corridor for a possible future passenger rail line. By reserving such space, future opportunities for rail service, and possibly as an interim measure for bus service, will remain available. In addition, NHDOT has committed to conducting a study with the Commonwealth of Massachusetts to evaluate long-term transit alternatives between Boston, MA and Manchester, NH. NHDOT is currently working with MEOTC to develop a scope of work and process by which the study will be conducted. Funding has been secured at the federal level, a scope of work has been determined and the consultant selection process has been initiated. The study is scheduled to begin in 2004, and will be the first step in implementing a plan to substantially improve transit options for the area currently served by I-93 from Manchester, NH to Boston, MA.

2.5 Identification of a Reasonable Range of Alternatives

Based on the collective consideration and analysis described in Section 2.4, the following seven alternatives or combination thereof were selected as a "reasonable range of alternatives" for more detailed evaluation in this DEIS (see Chapter 4.0):

1. The No-Build Alternative, which essentially serves as the baseline condition for comparison with the Build Alternatives.

2. Transportation Systems Management (TSM) measures; specifically minor improvements such as ramp lengthening and lane widenings that can be accomplished within the existing ROW at minimal expense. Such measures generally do not address the long-term project purpose and need, but can help to alleviate problems in the near term. Two other TSM measures, ramp metering and shoulder lane use, were determined to be impractical and were not proposed for further consideration.

3. Widening I-93 to 4-lanes in each direction the entire length of the corridor including interchange improvements, in addition to constructing or expanding park-and-ride lots at Exits 2, 3, 4, and 5, and providing room and, as practical, constructing sub-grade for future rail transit service within the highway corridor.

4. Widening I-93 to 3-lanes in each direction for the entire length of the corridor including interchange improvements, in addition to the same park-and-ride lot construction and provision for future rail transit service as noted with the 4-lane widening alternative.

5. Widening I-93 to 4-lanes in each direction south of Exit 3 and 3-lanes in each direction north of Exit 3 including interchange improvements, along with the provisions proposed with either the 3 or 4-lane widening schemes. This is the so-called "Combination Alternative".

6. Transportation Demand Management (TDM) measures; specifically Intelligent Transportation Systems (ITS) techniques as well as employer based measures utilizing incentives and disincentives to encourage people to not drive alone. It was concluded that congestion pricing, another TDM measure, would be impracticable.

7. Improvements in bus service to include expanding existing service and providing enhanced ride-sharing opportunities to employment centers in northern Massachusetts. After ridership studies, it was concluded that neither rail service nor HOV lanes would be effective alone or in combination with other mode options in satisfying the need for the project.

2.6 Comparison of Alternatives

2.6.1 Environmental Consequences

Detailed descriptions of the impacts associated with the various project alternatives are presented in Chapter 4. A brief summary is presented below and in **Figures 2.6-1 and 2.6-2**.

The No-Build Alternative serves as the baseline condition for comparing impacts of the three- and four-lane widening alternatives. In general, future impacts would be avoided (e.g., losses of wetlands or impacts on historical resources) or at least not further exacerbated (e.g., noise impacts) with selection of the No-Build Alternative. In some cases, the quality of an environmental resource may improve , e.g., pollutant loading to streams is expected to decrease with the Build Alternatives due to more-advanced treatment measures for highway runoff which would be incorporated into the highway's design.

There will be no exceedance of State or Federal carbon monoxide (CO) standards with either the Three- or Four-Lane Alternatives. At the mesoscale level, both alternatives would be in compliance with the 1990 Clean Air Act Amendment and the New Hampshire State Implementation Plan.

From a surface water quality standpoint, the Three-Lane Alternative with the proposed treatment measures will result in 19 of the 21 streams having lower or no net increase in pollutant loading with two streams showing a slight increase as compared to today's conditions. In comparison, with the Four-Lane Alternative, 17 streams will show lower or no net increase in pollutant loading with four streams showing a slight increase. The new park-and-ride facilities at Exits 2, 3 and 5 and the construction of a new terminal building at the existing park-and-ride lot at Exit 4 would have only minor effects on surface water quality.

Relative to groundwater resources, the Three Lane Alternative, including new park-and-ride lots, the new roadway will overlay an additional 58 to 70 acres of stratified-drift aquifer as compared to the existing condition or No Build, while the Four-Lane Alternative overlays an additional 72 to 83 acres. Impacts (included in these totals) associated with the alternative new park-and-ride lots at Exit 5 vary from 0 (Perkins Road) to 13 acres (Auburn Road). With regard to potential well impacts, both the Three-Lane and Four-Lane Alternatives put the new roadway slightly closer to five community wells in the Exit 3 area, although one option, i.e., Tight Shift, moves the highway further away from a large community well (adding to its protection) near the west end of Canobie Lake. At Exit 4, both widening alternatives, are (as is the existing highway), within the wellhead protection area of a community well.

The Three-Lane and Four-Lane Alternatives, including the park-and-ride lots, affect 41 to 44 acre-feet of the 100-year floodplain. Approximately 5 to 6 acre-feet of floodway (i.e., stream or river channel) are affected by both alternatives.

Active farmland is affected only in the Exit 1 and Exit 4 areas. Less than one-half acre is affected by either widening option at Exit 1, while at Exit 4 the westerly widening option could impact up to 9 acres of the Woodmont Orchard. Impacts to important farmland soils vary from 9 to 11 acres for the Three-Lane Alternative and 10 to 12 for the Four-Lane Alternative, including park-and-ride lots.

Wetland impacts for the Three-Lane Alternative vary between 53 and 71 acres depending on the options and park-and-ride lots selected, while the Four-Lane Alternative affects 62 to 82 acres. The impacts of the new park-and-ride lots contribute between 0.4 to 3.2 acres to these totals depending on the options selected. Both alternatives also affect 1 to 3 vernal pools, which are essential breeding habitat for certain types of salamanders and wood frogs, depending on the particular options selected. Total upland and wetland habitat impacts are expected to range from 190 to 240 acres for the Three-Lane Alternative and 210 to 260 acres for the Four-Lane Alternative. Some restoration of this habitat will occur with re-landscaping of the highway edges after construction. The proposed mitigation involving both wetland creation and land preservation is intended to offset these habitat impacts.

Only one known location of a state-threatened plant species, a lupine wildflower, is affected by either widening alternative. The New England cottontail, a possible candidate for Federal threatened or endangered status, was not located in the project corridor during a winter 2002-2003 field study.

For either the Three or Four-Lane Alternatives, noise analysis indicates that 316 sensitive receptors will experience noise levels approaching or exceeding FHWA Noise Abatement Criteria after the project is built. This compares to 265 under the future No-Build condition. Sound walls have been proposed where practicable based on effectiveness and cost.

From a cultural resources standpoint, the Three-Lane Alternative depending on options selected will affect 4 to 8 historic properties eligible for the National Register, while the Four-Lane Alternative will affect 4 to 9 historic properties. Potential mitigation measures for these resources are suggested in Section 4.10.2.4. In addition, 20 to 23 archaeological sites may be affected by either alternative.

Both widening alternatives are expected to reduce local tax bases by $8.3 to $15.4 million. The resultant effect on each community's tax revenue varies with the actual tax rate in each. The total number of business acquisitions is the same for both the Three-Lane and Four-Lane Alternatives (including the park-and-ride lots), and varies from 9 to 18. The number of residential acquisitions is also the same for both alternatives and ranges from 18 to 23 depending upon the design options selected. Stimulation of growth, i.e., secondary growth, may result in an additional 41,000 people and 22,000 jobs within the region influenced by this segment of I-93 by the year 2020. No community facilities including schools, parks, or other structures, are impacted by any of the proposed highway improvements.

With either the Three-Lane or Four-Lane Alternative, some 10 to 13 properties impacted will require further investigation relative to the possibility of encountering contamination from hazardous materials.

Since the project's major purpose is to provide a more efficient flow of traffic, with less congestion during peak commuting hours in particular, the proposed improvements will result in future fuel conservation, as compared with the expected future use under the no-build condition. Offsetting some of this future energy conservation will be the increased energy demands associated with the greater maintenance requirements for the widened highway.

2.7 Selected Action

2.7.1 Description of Selected Alternative

Based on an evaluation of the Reasonable Range of Alternatives for the project and with input from the State and Federal Resource Agencies and corridor communities, with more than 50 meetings (see Section 8.0) having been held, NHDOT and FHWA identified a Selected Alternative. Feedback from the local communities suggested that NHDOT should 1) construct four lanes in each direction, and not three, the entire length of the corridor from Salem to Manchester; 2) minimize impacts to private properties; 3) construct sound walls; and 4) begin construction as soon as possible.

The Resource Agencies have recognized the need to address I-93 and have concurred with the project purpose to improve the efficiency and safety of the corridor. They have also agreed that the Build Alternatives identified in Section 2.5 were a reasonable range of alternatives, from which, based on additional study, a preferred alternative could be selected. They have noted that the direct impacts to the natural resources should be avoided and/or minimized to the extent practicable, and mitigation provided to offset impacts. Several of the Resource Agencies also requested that NHDOT go forward with an in-depth, two-state study of future transit service. They requested the study take place as soon as possible given the long lead-time involved in instituting such a service.

In response to this input and in order to address the Purpose and Need of the project, the NHDOT's Selected Alternative involves a combination of transportation infrastructure improvements and strategies for the 19.8-mile study corridor. The main element of the improvement involves widening I-93 from the existing limited access two-lane highway in each direction to a limited access four-lane highway in each direction. The Four-Lane Selected Alternative begins in the Town of Salem, NH at the Massachusetts/New Hampshire State line and extends northerly through Salem, Windham, Derry and Londonderry, and into Manchester, ending at the I-93/I-293 interchange **(Figures 2.7-1 through 2.7-22)**. In addition, the NHDOT has also selected the following design modifications and infrastructure improvements for the five interchanges and local roads within the project corridor:

- In the Exit 1 Interchange area, the existing Cross Street bridge will be replaced with a new bridge located just to the north. The existing interchange at Exit 1 will be reconstructed to improve the substandard ramp geometry. **(Figure 2.7-2)**

- At Exit 2, the existing interchange is reconstructed to a diamond-type interchange configuration. Pelham Road will be widened and reconstructed from Policy Road to Stiles Road **(Figure 2.7-4)**. Just north of Exit 2, the Brookdale Road bridge will be replaced on-line, utilizing a temporary bridge for maintenance of traffic during construction. **(Figure 2.7-5)**

- In the Exit 3 Interchange area, both the northbound and southbound barrels of I-93 are relocated (referred to as the Tight Shift Option) into the median area **(Figures 2.7-6 through 2.7-7)**. The interchange ramps will be reconfigured with a diamond interchange design **(Figure 2.7-7)**. NH 111 will be reconstructed and widened with the work beginning just west of the NH 111/NH 111A intersection. As NH 111 proceeds to the west, NH 111 is relocated (off-line option) north of its existing location before tying into existing NH 111 near the NH 111/Wall Street intersection. **(Figures 2.7-7 through 2.7-9)** NH 111A will be relocated on new alignment west of existing NH 111A **(Figure 2.7-7).**

- In the Exit 4 Interchange area, I-93 will be widened to the east, retaining the existing layout for the southbound ramps. The existing northbound ramps diamond configuration at the northbound ramps will be reconstructed, with longer ramps. NH 102 will be reconstructed and widened from Londonderry Road to the southbound ramps. The NH 102 bridge over I-93 will be replaced with a new bridge built directly south of the existing bridge. The Ash Street/ Pillsbury Road Bridge will be reconstructed on-line, utilizing a temporary bridge for maintenance of traffic during construction. **(Figures 2.7-14 through 2.7-16)**

- At Exit 5, NH 28 will be widened and reconstructed on-line from Symmes Drive to Liberty Drive including the reconstruction of the Perkins Road, Vista Ridge and Symmes Drive approaches, as well as the reconstruction of a portion of both Liberty and Independence Drives. The existing diamond interchange will be reconstructed and modernized. **(Figures 2.7-17 through 2.7-18)**

In addition to the overall corridor highway improvements, three new park-and-ride lots will be constructed with bus service facilities planned at Exits 2, 3 and 5, and improved at the existing park-and-ride facility at Exit 4.

- At Exit 2, the park-and-ride lot will be located adjacent to the interchange in the SE quadrant with access via Pelham Road to South Policy Street to Raymond Avenue. **(Figure 2.7-4)**

- At Exit 3, the park-and-ride lot will be located adjacent to the relocated northbound barrel in the SE quadrant of the reconstructed interchange. Access will be from NH 111 east of the Exit 3 Interchange and from a relocated NH 111A. **(Figure 2.7-7)**

- At Exit 4, the existing parking lots will be retained and a new terminal building constructed. **(Figure 2.7-14)**

- At Exit 5, the park-and-ride lot will be located in the NW quadrant of the interchange just west of the southbound off-ramp. The park-and-ride lot access will be from NH 28 and Symmes Drive connecting to NH 28. **(Figure 2.7-18)** Along with the park-and-ride facilities at Exit 5, a bus maintenance facility will be located adjacent to the park-and-ride lot, at the end of Symmes Drive, north of the former Manchester-Lawrence railroad corridor. This maintenance facility will support the implementation of the Expanded Bus Services.

Early construction of the park-and-ride facilities at Exit 2 and Exit 5 and the implementation of additional bus services are proposed in advance of the mainline highway widening work to provide options for commuters seeking alternatives during construction. The current bus service to Boston will be expanded with service from the new park-and-ride/bus station facilities along with the existing Exit 4 park-and-ride lot, and a ride-sharing program, such as vanpooling or carpooling, in conjunction with a commuter incentive program along the corridor will be implemented, as practicable, to employment centers in northern Massachusetts.

Intelligent Transportation System technologies and Incident Management strategies are an integral part of the overall transportation improvement strategy for the I-93 corridor. The Department proposes to implement some of these measures such as variable message boards, highway advisory radio broadcasts, web site information, emergency reference markers, and coordination strategies among safety agencies before the highway widening. Additional measures will be added when the highway widening is completed.

To further expand multimodal opportunities in the corridor, NHDOT recently completed a separate Bikeway Feasibility Study to identify alternative transportation corridors for pedestrian and bicycle travel between Salem and Concord, NH. The study recommended the development of a rail trail facility located along the abandoned Manchester-Lawrence railroad corridor. The Feasibility Study recommended that the I-

93 bicycle path layout, as presented in the DEIS, not be pursued. The NHDOT is continuing to work with regional and local officials to implement the Bikeway Feasibility Study recommendations.

The Selected Four-Lane Alternative will accommodate space for a potential future rail corridor or other mass transit opportunity between the MA/NH state line northerly to the Exit 5 Interchange. The potential light rail line within the highway corridor could be a link in a future rail system providing rail service between Lawrence, MA or Woburn, MA (and ultimately Boston, MA) to the south and the Manchester Airport and/or the City of Manchester, NH to the north. In addition, the proposed layout provides provisions, such as bridge replacements and continued grade separated crossings, to facilitate, and not preclude, possible future rail service on the Manchester-Lawrence line.

In 2004, the NHDOT will embark on a Transit Investment Study in conjunction with the State of Massachusetts to consider in more detail the long-term rail and transit needs for the I-93 corridor between Manchester and Boston. The study is expected to help guide future pubic and private investment decisions involving alternative corridors and various modes of public and freight transportation. The study is expected to commence in 2004 and be completed in spring of 2006.

Construction of the proposed modifications to the I-93 corridor and the implementation of the above described transportation strategies will improve overall transportation efficiency within the 19.8-mile corridor. By modernizing the highway and increasing its capacity, the flow of traffic will be improved and congestion minimized resulting in a more efficient transportation corridor and improved safety.

The project also includes the establishment of a Community Technical Assistance Program. This proposed initiative will supplement local land use planning by making available technical planning assistance to help communities in the area influenced by this section of I-93 better deal with and manage growth and development pressures.

NHDES and NHF&GD recognize the need and importance of the project and have indicated satisfaction with the project mitigation and enhancements. USEPA has indicated they would not veto the project based on the proposed mitigation. USACOE confirmed the Selected Alternative as the Least Environmentally Damaging Practical Alternative and that the project mitigation and enhancement meet requirements of the 404(b)(1) Guidelines.

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2.7.2 Impacts of Selected Alternative

Impacts of the Selected Alternative including transportation improvements and costs are summarized in **Figure 2.7-23**. Relative to air quality, construction of the Selected Alternative will not lead to any exceedance of state or federal Carbon Monoxide (CO) standards. From a mesoscale level, the project will be in compliance with both the 1990 Clean Air Act Amendment and the New Hampshire State Implementation Plan.

From a water quality standpoint, pollutant loading will increase slightly in four streams, but be lower or show no net increase in 17 of 21 streams crossed by the Selected Alternative, because of the proposed stormwater-treatment measures. These measures include grassed swales and detention basins throughout the length of the project corridor. The Tight Shift Option at Exit 3 is expected to improve the quality of stormwater runoff eventually reaching Canobie Lake (Salem's municipal water supply). Water quality will be improved by moving the highway away from Canobie Lake and by moving the northbound on and off-ramps out of the watershed. Potential impacts to surface waters due to road salt application continues to be a regional issue and NHDOT will continue to monitor chloride levels in selected streams in cooperation with NHDES and USEPA. From a groundwater recharge standpoint, about 82 acres of stratified drift aquifer will be unavoidably covered with new, impervious roadway surface (including the Exit 5 park-and-ride lot). In addition, widening the highway will require that culverts be lengthened at many of the 23 stream crossings, resulting in some loss of aquatic habitat, including one additional perennial stream affected by the park-and-ride facility at Exit 5.

The Selected Alternative will impact an estimated 6 acre-feet of floodway and 43 acre-feet of 100-year floodplain. The largest impacts occur to the floodplains lying along Policy Brook, Porcupine Brook, Harris Brook, and Beaver Brook. Mitigation has included steepening highway embankments and utilizing retaining walls where appropriate. Additional mitigation will include providing flood storage in the form of stormwater detention basins and newly created wetlands in locations adjacent to or upstream of flood-prone areas.

Because the majority of the highway widening and other improvements will take place within the existing right-of-way, only about 10 acres of important farmland soils will be converted under the Selected Alternative. Approximately 40 percent of this conversion involves prime farmland soil, while the remainder is statewide or locally important farmland soils. About one acre of currently active farmland will be affected by the Selected Alternative, primarily at Exit 1.

The Selected Alternative will impact approximately 77[18] acres of wetlands . The majority (64 percent) of this impact occurs to forested wetland, the most common type along the highway corridor. In addition, three vernal pools, which function as essential breeding habitat for mole salamanders and wood frogs, will be impacted by the filling associated with the highway widening. The sum total of all habitat loss, i.e., both wetlands and uplands, is estimated to be about 260 acres with the Selected Alternative, which includes the three proposed park-and-ride lots. The proposed wetland mitigation package consisting of about 26 - 34 acres of wetland/floodplain creation and approximately 1000 acres of land preservation will offset this loss. Only one known location of a state-threatened or -endangered plant species, the wild lupine (*Lupinus perennis*), will be affected. Attempts will be made to relocate colonies of this species as mitigation. Although the state threatened and endangered hognose snake (*Heterodon platyrhinos*) has been reported within the vicinity of the corridor, no known locations will be affected by the project. A field study conducted within the project corridor and at the proposed mitigation sites found no evidence of the New England cottontail (*Sylvilagus transitionalis*), a candidate species for federal protection. The Selected Alternative is not expected to have any effect on this species.

The Selected Alternative will result in elevated noise levels at certain receptor locations along the project corridor. In the year 2020, 51 more receptors will experience noise levels that approach or exceed the FHWA's Noise Abatement Criteria as compared to current conditions (i.e., 316 versus 265 receptors, mostly homes). Sound walls have been proposed to mitigate these sound impacts wherever practicable from a cost and effectiveness standpoint. Visual impacts of the Selected Alternative will be largely limited to highway profile elevation changes, especially at Exit 3. The reduction of the median width and reduction of the natural vegetation buffer between the highway and adjacent development will also have some negative effect on aesthetics.

From a cultural resources standpoint, the Selected Alternative affects 23 sensitive archaeological sites; 11 of which are Native American sites and 12 are historic archaeological resources. The Selected Alternative will also affect six extant historic structures and properties, which have been determined to be eligible for the National Register of Historic Places (i.e., Kinzler House, Robert Armstrong House, George Armstrong House, Robert J. Prowse Memorial Bridge, Reed Paige Clark Homestead, and Gearty House). There will be adverse effects to the Robert Armstrong House, George Armstrong House, Robert J. Prowse Memorial Bridge, and the Gearty House.

Widening and interchange improvements associated with the Selected Alternative will require the acquisition of 21 residential and 14 business structures, including 8 residential and 3 business structures associated with the new park-and-ride lots. NHDOT conceptual relocation studies indicate that alternative housing and business sites are available for residential and business relocations. The effect on the tax bases of the acquisitions is not substantial and amounts to a loss of approximately $11.0

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[18] See Appendix B for a detailed listing of wetland impacts for the Selected Alternative, which has been revised since publication of the DEIS.

million out of a total of $7.1 billion in assessed value for the five communities. This results in a total reduction of about $.20 million in local tax revenues or less than 0.1 percent for the five communities. There will be no environmental justice impacts as no minority or low-income populations are differentially affected by the project. In addition, no community facilities (e.g., schools, fire stations, town buildings, public parks, etc.) will be affected. Secondary growth impacts in the I-93 region may involve an increase in population of nearly 41,000 people and an increase in employment opportunities amounting to almost 22,000 additional jobs by the Year 2020.[19] These increases are in addition to what might be expected if the highway were not built.

An estimated 13 sites with potential hazardous materials involvement will be affected by the project. These sites will require further study, although none is expected to pose a substantial problem.

From an energy standpoint, the Selected Alternative will create a more efficient flow of traffic resulting in future fuel conservation as compared to the No Build. The widening and other improvements will require a higher expenditure of energy for various maintenance activities like plowing, sanding, roadway surface and bridge repairs, as compared to current conditions.

2.8 Project Costs

A detailed breakdown of the estimated project costs in 2002 dollars for the Three-Lane and the Four-Lane Alternatives are shown in **Figures 2.8.-1 and 2.8.-2**. The tables depict transportation infrastructure improvement costs related to I-93 mainline and interchange ramp configurations, the costs associated with reconstructing the local connecting roadways, the costs connected with bridge widening and replacement and costs associated with Intelligent Transportation System (ITS) measures to further enhance vehicle operations and incident management. The tables also identify costs related to the implementation of the additional park-and-ride facilities. Right-of-way, design and construction engineering costs as well as costs associated with mitigating the project impacts to the environment are also identified.

The costs are broken out for the various project Segments (A-F) and for the various options evaluated.

South of Exit 1, in Salem, the designs for the Build Alternatives are the same and include four lanes. North of Exit 1, the primary differences in costs when comparing the Three-Lane Alternative with the Four-Lane Alternative is essentially the cost associated with constructing an additional 12-foot travel lane in each direction along the I-93 mainline. The difference in these costs however, are actually closer than one

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[19] The numbers cited in the DEIS were for New Hampshire only and were identified as such. For consistency with the rest of the document and to avoid confusion, the combined totals for Massachusetts and New Hampshire have been substituted here for the FEIS.

would expect due to a need to provide sufficient highway width during construction to safely maintain a minimum of two lanes for both northbound and southbound traffic. With the Four-Lane Alternative, traffic would be maintained on the existing two-lane highway while the highway is widened to accommodate the additional two lanes. However, to safely maintain traffic for the Three-Lane Alternative, the highway would require over-widening to a width nearly that of the Four-Lane Alternative to provide the minimum two lanes of traffic in each direction.

Each of the five interchange layouts are the same except for where and how the ramps are merged for the Three or the Four-Lane Alternative. The park-and-ride lots and bike path layouts were developed to accommodate either the Three-Lane or the Four-Lane layout, and are therefore are essentially the same cost.

The right-of-way impacts and associated costs are based on a proposed right-of-way for a Four-Lane Alternative. This allows the proposed sound walls to be constructed in a final location and allows for construction of either the Four-Lane Alternative or Three-Lane Alternative.

For the Combination Alternative which begins at the MA/NH border in Salem with four lanes extending northerly to Windham in the vicinity of the Exit 3 Interchange and then transitioning to three lanes and extending northerly to Manchester at the I-93/I-293 split, the costs can be extracted directly from the tables. A range in costs for the Combination Alternative can be determined by adding the costs from the Four-Lane Alternative, Segments A, B, C, and D, to the costs for the Three-Lane Alternative, Segments E, F. The estimated Combination Alternative Total Costs range from $392.7 to $439.7 million.

For the Three-Lane Alternative, the range for the low and the high cost is estimated to be from $381.4 to $420.3 million. For the Four-Lane Alternative, the range for the low and the high cost is estimated to be from $400.9 to $440.4 million.

The estimated cost of the Selected Alternative which includes the mainline widening and reconstruction (4 lanes in each direction), interchange reconfigurations, bridges, modifications to local roadways as well as engineering, right-of-way and environmental mitigation is $421.4 million (see **Figure 2.8-2**).