Final Environmental Impact Statement

Spaulding Turnpike Improvements

NHS-027-1(37), 11238

Newington to Dover

New Hampshire

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Newington to Dover, New Hampshire

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NEWINGTON-DOVER
SPAULDING TURNPIKE IMPROVEMENTS
STRAFFORD AND ROCKINGHAM COUNTIES, NEW HAMPSHIRE

FINAL ENVIRONMENTAL IMPACT STATEMENT

Submittal Pursuant to 42 USC 4332 (2)(c) and
49 USC 303, 16 USC 470 (f), 33 USC 1344
by the
US Department of Transportation
Federal Highway Administration
And
New Hampshire Department of Transportation

Cooperating Agencies

US Army Corps of Engineers
US Environmental Protection Agency
US Coast Guard
US Fish and Wildlife Service
National Marine Fisheries Service

Federal Aviation Administration
NH Division of Historical Resources
NH Department of Environmental Services
NH Fish and Game Department
NH Office of Energy and Planning

December 20, 2007
Date of Approval

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For NH Department of Transportation

December 20, 2007
Date of Approval

For Federal Highway Administration

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The proposed project involves reconstruction and widening of a 3.5-mile section of an existing highway facility (Spaulding Turnpike/NH 16, extending north from the Gosling Road/Pease Boulevard Interchange (Exit 1) in the Town of Newington, across the Little Bay Bridges, to a point just south of the existing toll facility in the City of Dover) that serves as a major north-south transportation link for the State of New Hampshire. The Selected Alternative[1] would improve safety and increase transportation efficiency by relieving traffic congestion and reducing travel time, and accommodate projected increases in traffic demand. Alternatives considered in this EIS include (1) taking no action; (2) upgrading the existing route to add capacity; (3) applying Travel Demand Management (TDM) measures, such as transit system expansion, additional park-and-ride lots, high occupancy vehicle lanes, *etc.*; (4) applying Transportation System Management (TSM) improvements to selected interchange locations and existing roads; and (5) combinations of these alternatives. Various options for bridge rehabilitation, widening, and/or replacement of the Little Bay Bridges, final disposition of the historic General Sullivan Bridge, consolidation of the interchanges, and various designs of grade, alignment, and geometry were evaluated. Impacts to the natural, cultural, and socio-economic environment were analyzed, including the indirect and cumulative impacts associated with the project. Mitigation is proposed to offset or reduce unavoidable direct impacts associated with the project.

Agencies listed above have been invited to be Cooperating Agencies for the EIS process and representatives have participated in appropriate project coordination meetings.

1 Gray shading throughout the FEIS indicates changes since the DEIS was issued in July 2006.

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Executive Summary

A. Project Description/Purpose and Need

A.1 Study Area Description

The section of Spaulding Turnpike (NH 16) under study is approximately 3.5 miles long, extending from just north of Exit 1 in Newington to just south of the Dover Toll Plaza, including the Little Bay Bridges. Most of this section of the Turnpike is a limited access (fully controlled) facility and consists of two (2) through lanes in each direction separated by a median of varying width. The study area includes five interchange areas (Exits 2, 3, 4, 5 and 6) to accommodate access and turning movements in a relatively short section of the Turnpike. The Turnpike is part of the National Highway System and is functionally classified as a principal arterial connecting the Seacoast Region with Concord, the Lakes Region and the White Mountains.

Poor traffic flow conditions can be attributed to two separate factors: physical infrastructure deficiencies and high traffic volumes. Physical deficiencies along the Turnpike include substandard curvature along interchange ramps, inadequate acceleration and deceleration lanes at interchanges, inadequate weave distances between the interchange ramps, and substandard shoulder widths on the Little Bay Bridges. These factors, combined with high traffic volumes, often result in reduced travel speeds, constrained maneuverability, and congestion during the peak hour conditions, as well as the increased potential for crashes and its negative effect on safety.

Crash data supports the diminishing level of safety along this section of the Turnpike. Over a seven-year period, from January 1997 through December 2003, a total of 1,263 crashes were recorded in the study area, with an overall crash growth rate of 14 percent per year. This yearly growth rate is approximately six times higher than the rate of traffic growth (2.3 percent) along the Turnpike during the same time period and a strong indicator of the deteriorating level of safety.

In addition to the physical deficiencies of the Spaulding Turnpike, the traffic volume demands on the corridor also contribute toward the poor traffic flow. During the commuter weekday peak hours (7:00-8:00 AM, 5:00-6:00 PM), study area motorists traveling along the Spaulding Turnpike currently experience traffic congestion and substantial delay. With the Little Bay Bridges currently carrying in excess of 70,000 vehicles per day, many of the freeway segments and interchanges along the highway experience volume demands that exceed the available capacity of the roadway system. Traffic forecasts for the year 2025 project traffic to increase from its current level to approximately 94,600 vehicles per day.

A.2 Purpose and Need

The project Purpose and Need statement is fundamental to the analysis of the project under the National Environmental Policy Act (NEPA), the Clean Water Act (Section 404), and other environmental regulations. The following Purpose and Need was developed in conjunction with a public Advisory Task Force (ATF), reviewed by other State and Federal agencies with no objections, and unanimously adopted by the ATF on October 29, 2003.

Purpose

The purpose of this project is to improve transportation efficiency and reduce safety problems, while minimizing social, economic, and environmental impacts, for an approximate 3.5-mile section of the Spaulding Turnpike extending north from the Gosling Road/Pease Boulevard Interchange (Exit 1) in the Town of Newington, across the Little Bay Bridges, to a point just south of the existing Toll Plaza in the City of Dover. Options that include implementing Transportation System Management (TSM) improvements, reusing the General Sullivan Bridge for local motorized and non-motorized traffic, enhancing rail service, improving bus transit service and instituting other Transportation Demand Management (TDM) strategies that may reduce vehicle trips along the Spaulding Turnpike have been considered, in addition to widening the mainline, widening and/or replacing the Little Bay Bridges, and reconstructing the interchanges.

Need

The Spaulding Turnpike is eastern New Hampshire's major limited access north-south highway, serving as a gateway linking the Seacoast Region with Concord, the eastern portion of the Lakes Region, and the White Mountains. The Turnpike is also part of the National Highway System reflecting its significance as an important transportation link in the state and regional system. Functionally classified as a principal arterial, it is a major commuter route which ties the growing residential areas of Dover-Somersworth-Rochester with the industrial and regional commercial centers in Newington, Portsmouth, and northern Massachusetts. It serves as the major artery for freight into and out of the areas north of the Little Bay Bridges, and is the economic lifeline of the region. It also serves as a major tourist route, providing access to the northern reaches of the state from the seacoast and points south of New Hampshire.

Traffic volumes on the Little Bay Bridges have steadily increased from approximately 30,000 vehicles per day in 1980 to greater than 70,000 vehicles per day in 2003 resulting in high levels of congestion on the bridges and along the Turnpike near and within the interchange areas.

Over the next 20 years this average daily volume is expected to increase to approximately 94,600 (2025) vehicles per day. These projections support the conclusion that the existing facility will be increasingly less able to operate at the levels of service and safety for which it was originally designed. During weekday and weekend peak hours of the day, the Turnpike currently operates at unacceptable levels of service (LOS E and/or F) with motorists experiencing severe congestion and long delays within this segment of the corridor.

The Turnpike has a number of existing geometric deficiencies including substandard shoulder width on the Little Bay Bridges and substandard merge, diverge, and weave areas at the interchanges. Many of the traffic maneuvers required to enter, exit or change lanes along this section of the Turnpike are capacity-constrained under current traffic conditions and contribute to driver discomfort and crashes. Existing acceleration, deceleration and weaving sections along the Turnpike are inadequate by current design standards. Historic crash data indicates that the frequency of vehicle crashes continues to increase raising concerns relative to motorist safety. Due to the nature of the existing facilities, these crashes, as well as vehicle breakdowns, create long delays in an area for which there are no viable alternate routes.

In addition to the capacity deficiencies and safety issues, this section of the Turnpike bisects residential and recreational areas in Dover and the residential and commercial/industrial areas in Newington resulting in an inefficient and circuitous use of the Turnpike by people desiring to travel east-west and vice versa. Local connectivity for motorists, pedestrians, and bicyclists from one side of the Turnpike to the other is also deficient.

This section of the Turnpike is located in a moderate seismic region, identified as Seismic Performance Category B. The Little Bay Bridges and General Sullivan Bridge, which are classified as major structures, were not designed to meet the current seismic design criteria for this region.

The project is included in the State's Ten-Year Transportation Improvement Program and is the top long-term transportation priority of the Seacoast Metropolitan Planning Organization (MPO). As residential and commercial development and traffic growth along the corridor and within the region continue to increase, traffic operations and safety conditions will deteriorate further, resulting in increased vehicle delays, increased crash frequency, and the potential loss of commerce.

B. Description of Selected Alternative

Based on the evaluation of the reasonable range of project alternatives, and on public comments, input from resource agencies, the Advisory Task Force, Rockingham Regional Planning Commission, and Strafford Regional Planning Commission, and considering safety, transportation efficiency, cost, impacts to the environment, impacts to private property, permitting issues, and community support, the following combination of transportation elements has been determined to represent the Selected Alternative. It best balances the impacts and issues in addressing the project's Purpose and Need:

- Rehabilitate/Widen the Little Bay Bridges (LBB) to eight lanes (three general purpose lanes plus an auxiliary lane in each direction) maintaining the existing easterly edge of the bridge and widening entirely to the west.
  - Eight lanes on the bridges would provide an adequate level of service (LOS D) for the projected travel demand in 2025 and would offer satisfactory levels of service for an additional 10 to 12 years beyond the design year (based on extrapolating the projected traffic growth).
  - The three general purpose lanes plus an auxiliary lane in each direction (*i.e.,* eight lanes in total) on the Turnpike would extend between Exits 3 and 6. Six lanes in total would extend south of Exit 3 to match into the exiting cross-section of the Turnpike at Exit 1, and would extend north through Exit 6 to the Dover toll plaza.
  - The existing profile of the Little Bay Bridges (suitable for 60 mph design criteria) would be maintained, as would the existing vertical clearance over the channel.
  - The bridge rehabilitation would involve replacing the existing bridge decks, modifying the steel girders to upgrade the pin and hanger connections, repainting the steel girders, and seismically retrofitting the existing pier columns.
  - Bridge construction would be completed in two phases with traffic maintained on the existing bridges while the proposed bridge widening is constructed and traffic shifted onto the widened section of the bridge while the existing bridges are rehabilitated.
  - Widening westerly (towards the General Sullivan Bridge) would minimize the impacts to Little Bay and Hilton Park.
  - Cost of the Little Bay Bridge Rehabilitation and widening is estimated to be approximately $63.0 million.
  - The cost of the Turnpike approaches leading to and from the LBB (Bridge Segment) are estimated to be an additional approximately $15.6 million.

- Rehabilitate the General Sullivan Bridge (GSB) to a six-ton loading capacity to continue to function as a pedestrian/bicycle/recreational facility and to accommodate emergency response and maintenance vehicles from Newington
  - The GSB is a historic landmark structure. It is the second highest rated historic bridge in the state (as recognized by NHDHR and FHWA), eligible for the National Register of Historic Places, and identified as a highly valued Section 4(f) resource.
  - The GSB is currently an important bike/pedestrian connection across Little Bay and is used for fishing and other recreational activity. These transportation connections and recreational activities will be more pleasurable on the GSB in comparison to the use of a multi-use path attached to the widened Little Bay Bridges, which will carry a large volume of vehicles at highway speed.
  - Retaining the GSB as part of the Selected Alternative requires the removal of the GSB's northerly approach embankment and wingwalls to facilitate the proposed reconstruction of a local access connector under the LBB. The existing concrete wingwall along the approach embankment would be removed essentially exposing the back of the GSB abutment. With the removal of the northerly approach embankment, a new 280-foot long pedestrian/bike path including a 155-foot pedestrian/bicycle structure is proposed that would connect the northerly end of the GSB with the local access road sidewalk and with Hilton Park.
  - The estimated cost to rehabilitate the GSB to a six-ton capacity is approximately $26.0 million. The rehabilitation would involve the complete replacement of the deck and supporting structural system (*i.e.* floor beams and stringers), other miscellaneous repairs to the structural steel to arrest future corrosion, cleaning and painting the entire structure, and repairing the substructure (patching spalls and repointing the masonry). A seismic retrofit to primarily prevent the potential collapse of the structure will include at a minimum, a bearing retrofit. The net additional cost to the project of rehabilitating the GSB is estimated to be approximately $10.9 million, or approximately 4.8 percent of total project costs taking into account $5.7 million for the structure's removal and $9.4 million to replace the recreational connection across the Bay with a 16-foot wide multi-use path attached to the Little Bay Bridges. This does not take into account the cost of the necessary mitigation should the GSB be removed, which would further reduce the net cost difference.

- Alternative 3 in Dover
  - This Alternative provides a full service interchange at Exit 6 and improves both system and local connectivity for the neighborhoods on

both sides of the Turnpike and US 4, and for travelers heading easterly on US 4 towards Dover and northerly on the Turnpike.

- The proximity of the signalized diamond-type interchange at Exit 6 necessitates the closing of the Cote Drive on-ramp to the Turnpike.
- A two-lane northbound off-ramp widening to provide dual left and right turn lanes at its intersection with US 4 is proposed to handle the heavy volume of traffic exiting the northbound Turnpike at Exit 6.
- A new two-way bridge (replacing the existing westbound only bridge) would be constructed to carry US 4 over the Turnpike.
- Signals would be installed at the northbound ramps and at the southbound on-ramp. A third signal could potentially be required at the Dover Point Road intersection to provide safe egress for the neighborhood.
- A bridge would be constructed to carry US 4 over a new local connector roadway between Spur Road and Boston Harbor Road. This grade-separated facility provides a local connection for the neighborhoods north and south of US 4 and eliminates the need for a traffic signal at the Boston Harbor Road/ US 4 intersection, where turns would be restricted to right turns in and out only. A short on-ramp from this local connector to the southbound on-ramp from US 4 would maintain convenient access from the Dover Point neighborhoods and Hilton Park, while reducing some of the traffic demand at the Boston Harbor Road/ US 4 intersection.
- The Exit 5 off and on-ramps would be discontinued. The proximity of these ramps to the reconfigured Exit 6 would create traffic operational and safety problems. In addition, upgrading the geometry of the Exit 5 interchange to current standards would impact Hilton Park and the Wentworth Terrace neighborhood. Access to the park and Wentworth Terrace will be provided *via* a new two-way local connector road traversing under the Little Bay Bridges adjacent to the channel. A section of Hilton Drive extending north from the existing ramps to the existing pump station will be retained to create a loop road for trucks and other vehicles to move easily exiting the Wentworth Terrace neighborhood.
- An underpass utilizing the existing traveled way beneath the Little Bay Bridges is proposed to connect the east and west sides of Hilton Park and the residential neighborhoods. The existing roadway would be widened to accommodate two-way travel at a design speed of 20 mph. This underpass location provides the benefit of utilizing an existing grade-separated crossing as opposed to locating a grade-separated crossing further north, which would necessitate elevating the Turnpike and increasing noise and aesthetic concerns for the surrounding

properties. The existing east-west pedestrian and bicycle connection at this location will be maintained.

- New sidewalks are proposed along the west side of Dover Point Road between Hilton Park and the existing sidewalk opposite the Division of Motor Vehicles (DMV) property; along the north side of Spur Road between the Bayview Park parking area and the Scammell Bridge; along the west side of the connector road between Spur Road and Boston Harbor Road; along the new two-way connector beneath the Little Bay Bridge; and along the east side of Hilton Drive connecting to the reconstructed walkway along Pomeroy Cove.
- Sound barriers are proposed on both the east and west sides of the Turnpike between the LBB and Exit 6 which will mitigate for the elevated noise levels. Sound barriers are also proposed on both the east and west sides of the Turnpike north of Exit 6.
- The construction cost of Alternative 3 is estimated to be approximately $43.7 million.

- Alternative 13 in Newington
  - This alternative provides a reconfigured full service interchange at Exit 3 (Woodbury Avenue), a northern access into the Tradeport, and maintains on and off-ramps to provide full access at Nimble Hill Road and Shattuck Way at Exit 4.
  - This alternative also eliminates the ramps at Exit 2 (rerouting traffic to Exit 3), and includes provisions for a future Railroad Spur over the Turnpike into the Pease Tradeport should the need arise. Right-of-way and easements will be procured as part of the project and a portion of the railroad bridge's pier foundation will be constructed within the median of the Turnpike. An agreement between the NHDOT and the Pease Development Authority (PDA) with concurrence from FHWA will also be secured as part of the project to outline a shared cost arrangement should the rail spur be constructed in the future.
  - Sidewalks are proposed on both sides of Woodbury Avenue between Fox Run Road and Exit 3. Sidewalk on the north side of the roadway will be extended through the interchange, across the Turnpike and into the Tradeport on Arboretum Drive.
  - The ExxonMobil gas station/convenience store will continue to operate at its current location. However, access to the station from the Nimble Hill Road ramps will be limited to right-turns into and right-turns exiting the existing driveway. A local roadway, which would provide access to the gas station, Thermo Electron, and one other parcel (with existing direct access to the Turnpike) is proposed. This local roadway could also provide access to the former drive-in property *via* the roadbed

of the existing southbound Turnpike (once discontinued) should that property be developed in the future.

- Woodbury Avenue would be reconstructed to extend the two existing lanes in each direction with a center-raised median from the Fox Run Road intersection through the Exit 3 interchange area. A reduced cross-section is proposed in front of the Isaac Dow house and Beane Farm property to minimize impacts to these two historic resources.
- In conjunction with the Interim Safety Improvement project, this alternative improves local connectivity by providing a direct connection (via Shattuck Way) between the east and west sides of the Turnpike, and provides a local connection between Woodbury Avenue and the Tradeport.
- Bridge work will include the construction of a 3-span structure to carry Woodbury Avenue over the Turnpike, and widening and rehabilitation of the structure carrying the Turnpike over Shattuck Way.
- Two signals are proposed, one each at the intersection of the northbound and southbound Exit 3 ramps with Woodbury Avenue.
- The construction cost of Alternative 13 is estimated to be approximately $47.9 million.

- Of the various Transportation System Management elements that were identified for the project:
  - Improving the deceleration condition and signing at northbound Exit 6W have been completed.
  - Improving the signing on the LBB to emphasize the "no lane change zone" on the bridge has been completed.
  - The Interim Safety Improvement Project at Exit 4 in Newington was completed in 2006. As part of the project, an auxiliary lane between Exits 3 and 4 northbound was constructed to improve traffic merging from Woodbury Avenue onto the Turnpike.
  - One other TSM element that is recommended will provide short-term relief at Exit 6 by re-striping the Exit 6 southbound on-ramp area to create two through lanes on the Turnpike and a one-lane on-ramp from US 4. Temporary closure of the southbound on-ramp from Boston Harbor Road would be required. This would cost approximately $100,000 and is scheduled for implementation in 2008

- A number of Travel Demand Management actions are proposed to complement the bridge and roadway infrastructure improvements. Early implementation of these actions will also provide greater options to study area commuters during construction.

- A new park-and-ride facility consisting of 416 spaces is under construction at the Exit 9 area in Dover. The facility is being constructed as a separate project under the FHWA's Congestion Mitigation and Air Quality (CMAQ) program. Construction is scheduled for completion in 2008 to coincide with the planned Cooperative Alliance for Seacoast Transportation (COAST) express bus service and Dover's downtown transit loop service.
- A park-and-ride facility consisting of approximately 200 spaces is proposed for the Exit 13 area in Rochester. The NHDOT recommends that this project be addressed either under the CMAQ program or as part of the Rochester 10620H project (currently planned to advertise in 2008).
- A park-and-ride facility consisting of approximately 30 to 50 spaces is recommended for the US 4/NH 125 intersection area in Lee to accommodate travelers using US 4 eastbound. The NHDOT also recommends advancement of this project under the CMAQ program.
- To improve bus service in the seacoast area and reduce peak hour headways to provide a more attractive and reliable mass transit mode of travel, three bus alternatives will be advanced with capital investments and consideration of operating subsidies up to a maximum of five years. These items could be accomplished through the CMAQ program or with project-related funds.
  - Bus Alternative 1 involves expanded intercity service for Rochester, Dover, Portsmouth and Boston to serve the commuter market.
  - Bus Alternative 2 involves expanding the 2008 planned COAST express bus service among Rochester, Dover, and Portsmouth to reduce headways during the peak period for the planned express commuter bus service.
  - Bus Alternative 3 involves improving connectivity and headways for three existing bus routes: COAST Route 2 service between Rochester and Portsmouth, Wildcat Transit Route 4 service between Durham and Portsmouth, and COAST Tradeport Trolley services which connects these two routes with the Tradeport.
- Expansion of the *Downeaster* service was also proposed. A joint-sponsored CMAQ project (total cost $6.0 million) by the Maine DOT, NHDOT and Northern New England Passenger Rail Authority (NNEPRA) (Rail Alternative 1C) funded track and siding improvements in Maine and New Hampshire which allows NNEPRA to operate a fifth weekday roundtrip (current service is four roundtrips per weekday) between Portland and Boston. In addition, commuter peak period service improves with the arrival of the weekday AM commuter train in Boston at 8:00 AM, as opposed to 9:00 AM, which was the former schedule. The NHDOT has advanced this effort through a CMAQ

application with approximately $2.0 million of improvements in New Hampshire. Service was initiated in August 2007.

- To support the promotion of employer-based measures to encourage travel other than by SOV, it is proposed that funding for the seacoast area TMA, Seacoast Commuter Options, be provided to help extend the service for a maximum period of five years. The TMA is aggressively promoting its ride-share and guaranteed-ride-home programs and meeting with seacoast employers to offer cost-effective commuting alternatives. This extension of funding could be accomplished through the CMAQ program or with project-related funds.

C. Project History

This section of the Turnpike evolved from a two-lane facility when the General Sullivan Bridge was constructed in 1935 to the current median divided four-lane highway with five interchanges in a very compact and constrained area. The first Little Bay Bridge (currently carrying southbound traffic) was constructed in 1966 with the second bridge carrying northbound traffic constructed in 1984. When the northbound Little Bay Bridge was constructed in 1984, the General Sullivan Bridge was closed to motor vehicles and the Turnpike approaches were realigned with the Little Bay Bridges. Much of the current Spaulding Turnpike mainline roadway section still predates the Little Bay Bridges. The most recent substantial roadway modifications were related to the reconstruction of the Scammell Bridge over the Bellamy River (completed in 1999). That project included improvements to the ramp system from US 4, Boston Harbor Road and Dover Point Road to the Spaulding Turnpike southbound.

Recognizing a need to study potential improvements to address safety concerns and increased congestion, State Senate Bill 152-FN-A (1990) authorized the NHDOT to conduct a study of the approximately 3.5-mile section of the Spaulding Turnpike extending north from Exit 1 (Gosling Road) in Newington and traversing the Little Bay Bridges to (but not including) the Dover Toll Plaza just north of Exit 6. The study was initiated in 1990, but suspended in 1992 to allow completion of the Pease Surface Transportation Master Plan. In 1997, the Newington-Dover Feasibility Study was initiated to conceptually develop both a short-range plan to address existing safety deficiencies, and a range of long-term improvement alternatives to be carried forward for detailed engineering and environmental studies. The feasibility study was completed in 2000.

In 1998, the Route 16 Corridor Protection Study articulated a vision for the corridor (Portsmouth to Errol) to guide future growth and identified a number of planning principles and techniques to address the following major areas of concern: transportation, community design, travel and tourism, and land use and access management. The vision for the corridor and study findings and recommendations resulted from a cooperative effort of working groups of people, who reside and work in the corridor with support from State and regional planners. As part of the study, which underscores the linkage among transportation, economy and land use, 1997 and future (2017) year travel conditions along the corridor – including the Spaulding Turnpike – were evaluated taking into account future changes in land use and transportation improvement projects that were programmed for project development.

The Corridor Protection Study's traffic analysis indicated that while the section of Turnpike north of the Dover Toll Plaza would operate at a satisfactory level of service under future (2017) conditions, the 3.5-mile study area section of Turnpike between the Dover Toll Plaza and Exit 1 (Gosling Road) in Newington is capacity-constrained under both 1997 and 2017 future traffic conditions.

Within the framework of an EIS, this current study identifies, evaluates and recommends a long-term transportation and safety solution for this study area that is supported by community stakeholders and addresses the project's purpose and need.

D. Alternatives Considered

Based upon the results of the initial development, refinement, review and screening of alternatives, the following alternatives were endorsed by the ATF (June 23, 2004) and were carried forward into the development of this EIS for further detailed evaluation:

- The No-Build Alternative, which essentially serves as a basis for purposes of comparison with the Build Alternatives.

- Transportation Systems Management (TSM) measures, as described previously, that address current traffic operational and safety problem areas.

- Travel Demand Management (TDM) measures, which will provide alternatives to single occupancy vehicular travel. Specifically, the following measures were carried forward:
  - Rail Alternative 1A – Expanded *Downeaster* Service to Dover
  - Rail Alternative 1B – Expanded *Downeaster* Service to Rochester
  - Rail Alternative 1C – Expanded *Downeaster* Service to Dover (NNEPRA/MaineDOT proposal)
  - Restoration or preservation of the Pease Spur railroad corridor.
  - Bus Alternative 1 – Expanded Intercity Bus Service (Rochester-Boston).
  - Bus Alternative 2 – Expanded Express Bus Service (Rochester-Portsmouth).

- Bus Alternative 3 – Expanded Local Bus Service.
- Promotion of employer-based measures utilizing incentives to encourage employees not to commute alone.
- New park-and-ride facilities in Rochester, Dover, and Durham or Lee.

- Bridge Alternatives – Both located to the west side of the existing Little Bay Bridges:
  - Rehabilitation and widening of the Little Bay Bridges to either six or eight lanes with the General Sullivan Bridge Rehabilitation.
  - Rehabilitation and widening of the Little Bay Bridges to either six or eight lanes with the General Sullivan Bridge Removed.

- Highway Alternatives – Either six or eight lanes along the Turnpike and Little Bay Bridges for the following Alternatives:
  - Alternative 2 in Dover
  - Alternative 3 in Dover
  - Alternative 10A in Newington
  - Alternative 12A in Newington
  - Alternative 13 in Newington

These alternatives were evaluated in more detail and subject to additional agency and public input to determine associated impacts, costs, and permitting issues which are documented in Chapter 4 of the FEIS.

E. Summary of Beneficial and Adverse Effects of Selected Alternative

E.1 Adverse Effects

The No-Build Alternative serves as the baseline condition for comparing impacts of the Six- and Eight-lane widening alternatives. In general, future impacts would be avoided (*e.g.*, losses of wetlands or impacts on historical resources) with selection of the No-Build Alternative. In the case of some resources, the quality of an environmental resource may actually decline under the No-Build Alternative. For example, microscale (local) air quality problems would be expected to increase with the No-Build Alternatives due to higher levels of congestion and concomitant mobile source air pollution. And, noise generated by the highway will continue to increase even if the No-Build Alternative is implemented. In the case of noise impacts, the Build Alternative includes provisions for the construction of noise barriers in Dover which would not otherwise be constructed to mitigate this problem.

Socio-economics

The Selected Alternative would require full acquisition of one commercial property and a portion of a second commercial property including a barn, both in Dover. Local tax bases would be reduced by approximately $2.2 million. The resultant effect on Newington's tax revenue would be less than $9,000, while the effect in Dover would be approximately $22,000. Indirect economic effects, *i.e.*, "secondary" or "induced" growth, may result in an additional 1,865 people and 1,897 jobs within the region influenced by this improved segment of the Spaulding Turnpike by the year 2025. This additional growth is a very small fraction of the amount of overall growth predicted for the region even if the Turnpike is not improved (*i.e.*, a total of approximately 92,841 new residents by 2025 under the No-Build Alternative).

Farmlands

There will be no active farmlands affected by the project, although 2.7 acres of prime farmland soils would be lost in Newington. These areas are not and have not been used for agriculture for decades or longer. The mitigation for the wetland impacts resulting from the project does involve the permanent conservation of the Tuttle Farm on Dover Point, the oldest continuously-operated farm in the country.

Wetlands

Wetland impacts resulting from the Selected Alternative are estimated to be 20.4 acres, including impacts from the Turnpike improvements, construction of barriers to mitigate noise impacts, and estuarine impacts resulting from expansion of the bridge piers. None of the project alternatives would affect vernal pools, which are essential breeding habitat for certain types of salamanders and wood frogs. Most of this wetland impact will occur in areas directly adjacent to the existing Turnpike corridor and are therefore already impacted to some degree. Some wetlands, in fact, appear to have formed as a result of the original Turnpike construction. However, the construction of a new interchange in Newington will impact a substantial forested and riparian system associated with Pickering and Railway Brooks.

Restoration of Railway Brook is proposed as mitigation (approximately 3,100 linear feet of perennial stream), and approximately 150 to 250 acres of land preservation in Dover and Newington will help to offset these wetland impacts.

Wildlife

Given that the project area is relatively urbanized, impacts to wildlife habitat will be minor. No travel corridors were identified in the study area, and the vast majority of the area is already fragmented to the point that only relatively common, urban species would be affected. Certain portions of the study area do contain early successional habitat, which is relatively uncommon when compared to the amount of forested cover in the northeastern US. However, there could be some adverse effect resulting from the construction of the proposed Newington (Exit 3) interchange due to increased habitat fragmentation.

Threatened and Endangered Species

Only one known location of a state-threatened plant species, the prolific knotweed (*Polygonum prolificum*) was mapped within the limits of the Selected Alternative. Field searches for this population were unsuccessful, and the population is thought to be extirpated. Habitat for the New England cottontail, a possible candidate for Federal threatened or endangered status, was located by field study, but impacts to the species are expected to be minimal since the habitat quality is marginal.

Surface Waters

The study area is essentially defined by major surface waters including the Bellamy River, the Piscataqua River and the Little Bay. Additionally, six smaller watercourses were identified, all in Newington (Paul Brook, Railway Brook, Pickering Brook, Flagstone Brook and two unnamed streams).

A comparison of the estimated existing and proposed increases in impervious area associated with the Selected Alternative shows that for most streams, including Railway Brook, Flagstone Brook, Paul Brook and the two unnamed tributaries, there would be a minimal increase in impervious area (*i.e.*, < 1.0 percent of drainage area). Much of the new impervious area in the Newington area would occur in the lower Pickering Brook watershed. The additional impervious area associated with Alternatives 13 (the Selected Alternative), would represent 4.2 percent of this watershed area. Currently, about 19.0 percent of the lower Pickering Brook watershed (*i.e.*, east of Railway Brook) is estimated to be comprised of impervious area. Based on estimated impervious area changes, Alternative 13 would generate the least amount of impact to the surface waters in the study area.

The various streams on the Newington side of the project area primarily support the more tolerant warm-water fish species and other aquatic organisms. The benthic communities were determined to have low diversity and comprised of the more tolerant species that typically prevail in poor stream habitat conditions or where water quality conditions are diminished due to upstream pollution sources. Given the proposed water quality treatment measures for highway runoff, minimal impacts are anticipated to the aquatic resources in this stream.

Marine Resources

An extensive hydrodynamic model was developed for this EIS to investigate the potential effects of the project on the Little Bay/Great Bay Estuary. The model predicted only minimal changes in tidal conditions as a result of the Selected Alternative (*i.e.*, the extension of the existing Little Bay Bridge piers). While the model predicts that the pier extension may change tidal maxima, the predicted changes are on the order of 0.1 to 0.2 inches, depending on the tidal condition and the location in the estuary. Similarly, current velocities and directions are expected to change only minimally.

Considering the relatively small magnitude of change that the hydrodynamic model predicts, it is expected that biotic changes will also be minimal. Relative to the total tidal range (approximately 9 feet), this is a negligible change. Additionally, the model demonstrates that this magnitude of change is less than the total change experienced in the estuary prior to the General Sullivan Bridge construction. However, the expansion of the bridge piers will directly impact approximately 17,000 square feet of benthic habitat.

Navigation

Hydrodynamic modeling results indicate that current velocity maxima will increase by no more than 0.5 feet per second, with changes typically only 0.3 feet per second. These potential changes represent only a slight change from the estimated 10 feet per second maximum tidal current under existing conditions. The model predicts that current speeds will increase in some areas near the piers, while the speeds will decrease in other areas. Additionally, the model predicts that current directions will not change substantially, at least at the scale that can be resolved by the model.

Vertical and lateral clearances in the main navigation channel through the bridge area will be maintained so as not to impact navigation. Taken together with the results of the hydrodynamic modeling, it can be concluded that the project will have only minimal effects on navigation, and should not create situations that are more hazardous than the conditions already present.

Floodplain

The Selected Alternative would affect a total of 1.2 acres of 100-year floodplain (3.9 acre-feet). The majority of this impact is associated with the expansion of the bridge piers. The floodplain impacts are considered minor in the context of the tremendous volume of Little Bay and will have a negligible effect on the base flood elevations in the area. Any effect on flooding would be influenced by changes to the hydraulic characteristics in the channel (accounted for in the hydrodynamic model), rather than by displacing floodplain volumes.

Groundwater Resources

There are no impacts to public water supply wells associated with the Selected Alternative. However, the majority of Dover Point and a portion of the study area in Newington are mapped as a stratified-drift aquifer, a landform generally capable of producing substantial yields of groundwater. The Selected Alternative would result in approximately 14.1 acres of new impervious surface area over these deposits, which might affect the recharge of the aquifer. To help reduce this potential impact, NHDOT will examine the use of infiltration technology during final design of the reconstructed drainage system.

Air Quality

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

The proposed project satisfies regional transportation conformity requirements. The proposed project's air quality emissions were evaluated as an improvement in the NHDOT's State Transportation Improvement Program (STIP) for fiscal years 2007-2010, which was reviewed by USEPA and found to be in conformance by the US Department of Transportation.

Noise

During public meetings leading up to the publication of the Draft EIS, and during the Public Hearing in September 2006, noise impacts generated from the Turnpike were frequently raised by residents of the study area as one of their main concerns. A noise model developed for this EIS indicated that several portions of the study area are already adversely affected by noise levels. Predicted noise levels under the 2025 Build Alternative would not create any new impacts, but would perpetuate the problem. Noise barriers have therefore been proposed where practicable based on effectiveness and cost. Four such barriers are planned in Dover to mitigate noise impacts.

Community Resources

Two important recreational resources are located within the study area – Hilton Park and Bayview Park – both in Dover. The Selected Alternative would avoid acquisition of new right-of-way from Hilton Park, although temporary impacts to the park would be unavoidable during construction. New right-of-way and grading would be required on the Bayview Park property (a.k.a., the Bellamy River Wildlife Management Area, owned by the NHF&GD), totaling less than ½ acre. Sidewalks to the park and a new driveway are proposed to improve accessibility to the park, and the existing paved parking lot would be expanded to benefit park users.

Cultural Resources

The Selected Alternative manages to avoid direct impacts to all but a few historic properties (*i.e.*, properties determined eligible for listing on the National Register of Historic Places). Most notably, the Selected Alternative proposes to rehabilitate the historic General Sullivan Bridge as a bicycle and pedestrian facility, preserving a valued and highly significant historic resource . Other affected properties include the Beane Farm, Isaac Dow House and the Portsmouth Water Booster Station in Newington and the Ira Pinkham House in Dover. While incidental property impacts occur in all of these cases, only one structure, a barn associated with the Ira Pinkham House, will be directly impacted by the project.

In addition to the historic structures, much of the study area has been determined sensitive or probably sensitive for archaeological resources, both historic and Native American. The Selected Alternative would affect up to 18 such areas (approximately 44 acres of disturbance). Further information on these potential resources will be compiled following FHWA's Record of Decision (ROD) as more detailed design is developed and the potentially impacted areas solidified.

Hazardous Materials

Given the long history of land use in the area, particularly the commercial/industrial and military use in Newington, there is potential for the project to affect properties with a history of petroleum and other hazardous materials contamination. For the most part, the Selected Alternative avoids direct impacts to such properties, and no impact to human or ecological health is anticipated. Up to 20 properties potentially impacted by the Selected Alternative may be further studied during final design in order to accurately define the risk relative to the possibility of encountering contamination from hazardous materials.

E.2 Beneficial Effects

The Selected Alternative would result in a number of beneficial effects.

Safety and Traffic Operations

The Selected Alternative will result in safer and more efficient traffic operations in comparison to the No-Build Alternative.

- Substandard shoulder areas on the Little Bay Bridges and bridge approaches will be eliminated.
- Interchanges will be consolidated (Exits 2 and 3; Exits 5 and 6), improving spacing between interchanges, eliminating substandard geometry and providing the necessary traffic management lanes between Exits 3 and 6 to enable safe lane changes required by traffic entering and exiting the Turnpike. Traffic congestion and delays will be reduced and air quality will be improved.
- Connections to the Turnpike system will be improved at Exit 3 (Woodbury Avenue/Tradeport) and Exit 6 (US 4/Dover Point Road) improving system efficiency and eliminating circuitous travel.
- Local roadway connections will be improved:
  - Woodbury Avenue connection to Arboretum Drive (Tradeport).
  - Extension of Shattuck Way (Newington) and conversion to two-way traffic. (Construction was completed in 2006)
  - Two-way Hilton Park connector adjacent to channel.
  - Two-way connector between Spur Road and Boston Harbor Road (Dover).
- Improved pedestrian connections will be provided:
  - Connecting the east and west sides of Hilton Park.
  - Connecting Boston Harbor Road and Dover Point Road with Hilton Park.
  - Rehabilitation of the General Sullivan Bridge will maintain the important connection across the Bay.
  - Connecting the Spur Road and Boston Harbor Road neighborhoods with Bayview Park
  - Connecting Woodbury Avenue with Arboretum Drive (Tradeport).
- Future planning and accommodation for a rail connection traversing above the Turnpike between the Newington Branch line and the Pease Tradeport.
- Reduced travel demand and improved air quality from employer-based travel demand management (TDM) programs during construction, as well as, expanded bus service.
- Travel time during the peak hours of the day will be improved from the current approximately 10 minutes required to travel the 3.5-mile section of the Turnpike to approximately 4 minutes. In the future (2025), travel time is expected to be reduced from approximately 21 minutes (No-Build) to approximately 4 minutes with the Selected Alternative.

Environmental Benefits

In addition to the safety and traffic operational benefits summarized above, certain beneficial environmental effects will result from the improved traffic operations of the Turnpike. For example, the reduced congestion will help to reduce transportation-related air emissions, which, at the local scale, are directly related to traffic congestion. Similarly, transportation-related energy consumption is reduced in areas of decreased congestion.

Project-related environmental mitigation will help to offset impacts to natural resources. For example, as discussed previously, approximately 150 to 250 acres of land will be permanently protected as a result of the project's proposed mitigation. Railway Brook, a former branch of Pickering Brook, will be restored to replace lost stream and wetland habitat. Also, protection of the Tuttle Farm will help preserve an historic part of New Hampshire's agricultural heritage.

Other substantial beneficial elements include:

- Noise barriers in Dover to alleviate highway-related noise impacts to residential areas;
- Rehabilitation of the historic General Sullivan Bridge; and
- Eleven extended detention basins to treat stormwater runoff and improve water quality.

F. Issues and Areas of Controversy

Through the course of numerous public meetings (17 Advisory Task Force meetings, seven Public Informational meetings, a Dover City Council meeting and Public Hearing), input has been received that favored various aspects of the improvement alternatives. Major issues have been contemplated concerning access, the configuration of the interchanges, environmental impacts, right-of-way requirements, the elevation of the Turnpike (opposition expressed towards elevating the Turnpike due to associated noise and visual impacts), the fate of the General Sullivan Bridge (whether to remove or rehabilitate), six lanes versus eight lanes on the Little Bay Bridges, and a multi-modal approach to meeting transportation needs.

General Sullivan Bridge

One of the primary issues throughout the EIS process has been the fate of the General Sullivan Bridge. The Bridge has not been used to carry vehicular traffic since the expansion of the Little Bay Bridge in 1984, and has been in a state of increasing deterioration for some time. The US Coast Guard required demolition of the General Sullivan Bridge (once it no longer was used for transportation purposes) as a condition of its approval of the expansion of the Little Bay Bridge. However, the bridge is considered one of the most historic in New Hampshire, and perhaps even the northeast. It therefore is protected under state and federal law. After consideration of the costs and benefits of rehabilitation and reuse of the bridge as compared to its demolition, the NHDOT identified reuse of the bridge, although more costly, as the Preferred Alternative. Although widely supported by the FHWA, NHDHR, the City of Dover, Strafford Regional Planning Commission, Advisory Task Force, and members of the public, this decision has been questioned by some who feel that the extra funding should go to other important projects in the state. This sentiment is reinforced by the fact that the state's Ten-Year Transportation Improvement Plan is substantially under funded.

Dover Toll Plaza

During the scoping phase of the EIS, it was determined that toll operations at the Dover plaza, and potential impacts of these operations on traffic operations within the study area, should not be part of the scope of study. This decision raised questions from some members of the public, who felt that the Toll Plaza should be part of the study area. However, evaluation of toll operations and revenue require a systematic review and approach.

The Dover Tolls, therefore, cannot be considered without examination of the entire toll system, which was determined to be unreasonable for this project. Changes in toll plaza location, pricing and operations require state legislative and executive action. Recent implementation of the E-Z Pass system, which is a statewide and systemwide project, has reduced delay and congestion at all toll plazas, including the Dover facility. Additionally, previous and current traffic data indicate that congestion problems are limited to areas south of the Toll Plaza.

Access at Nimble Hill Road

At the local level, a number of concerns were expressed regarding access to the Turnpike from the existing gasoline station/convenience store adjacent to the southbound Turnpike roadway near Nimble Hill Road. Although the Turnpike is a limited access highway, this facility (an ExxonMobil station) does have direct access to the Exit 4 ramps. In order to improve safety in this area, all of the Newington alternatives either eliminated or restricted this direct access, which raised concerns about how this change might affect the business. The Selected Alternative will allow restricted access (right turns in/right turns out) to Nimble Hill Road and additional access to this property via a local access road south of the property.

Noise

Another local issue was the impact of the Turnpike on noise levels in the two communities. Both Newington and Dover residents repeatedly expressed concerns about these noise levels. The noise modeling showed that a number of residences in Dover currently exceed impact thresholds established in FHWA policy on noise. Only one impacted sensitive receptor was identified in Newington, even though some residents quite far from the Turnpike had complained about noise levels. As a result of the analysis and consistent with the

NHDOT noise policy, four permanent noise barriers in Dover (none in Newington as no areas met the economic criteria) are proposed as mitigation, and the grade of the new Turnpike mainline is proposed to be generally maintained at the same level as the existing.

Aesthetics

Viewsheds from the widened Little Bay Bridges and Turnpike, and from nearby Dover residences will be affected to varying degrees. Southbound riverscape views to the east will be impacted by the increased cross-section width of the Turnpike, as well as northbound views of Little Bay. Proposed noise barriers in Dover will create a widened tunnel-like view to the motorist and affect the view of Pomeroy Cove. In addition, these barriers, while offering noise abatement to residents, will restrict views of the highway.

Hilton Park

Hilton Park was identified by the public as a valuable recreational resource and its protection emphasized during early public meetings. Planning and preliminary design endeavored to avoid impacts to Hilton Park, and to enhance the park where possible. By widening the Little Bay Bridges to the west side of the existing bridges, impacts to Hilton Park from the bridge and Turnpike widening were avoided. The current northbound access to Hilton Park will be modified, however. Exit 5 will be eliminated under the Selected Alternative due to its proximity to Exit 6 which currently creates unacceptable traffic operations and safety conditions. These conditions notwithstanding, the upgrade of Exit 5 geometry to meet minimum standards would have impacted both Hilton Park and the Wentworth Terrace neighborhood, which was determined to be an unacceptable solution. Rather, the existing pedestrian and one-way vehicular connection traversing under the Turnpike adjacent to the channel, which links both sides of the Park, will be upgraded to provide a two-way vehicular connection to Dover Point Road and Exit 6. In addition, the pedestrian connection linking the pedestrian/path system in the park on both sides of the Turnpike will be improved and incorporated into the new and expanded pedestrian path system along Dover Point Road, the local connector road between Boston Harbor Road and Spur Road, and Spur Road on the west side of Bayview Park, and connected to Hilton Drive, Wentworth Terrace and the multi-use path adjacent to Pomeroy Cove on the east side of the Park.

Secondary Growth

NHDES and the USEPA have expressed concerns that suburban development in the region would accelerate as a result of improved highway capacity. This concern is based on the perception that the Spaulding Turnpike within the study area acts as a transportation bottleneck and therefore serves to constrain economic development north of the Little Bay Bridges. To assess this concern, the

Final EIS assesses potential "indirect" economic effects, including a discussion of potential land use impacts.

An economic forecasting and policy analysis model was used to evaluate indirect social and economic impacts on 33 communities located in the socio-economic study area region. A No-Build analysis revealed that the present rate of fairly brisk growth (in terms of population, employment and income) experienced by these communities since the 1970s would likely continue, but at a slightly slower rate. However, an evaluation of possible indirect effects due to improvements on the Spaulding Turnpike indicated a small impact on population and employment growth rates, and the corresponding indirect land development and environmental impacts.

G. Other Governmental Actions

The NHDOT and FHWA are not aware of any additional federal actions or any state or local government actions within the project study area that would conflict with the proposed action.

H. Major Unresolved Issues

Following the extensive public participation process leading up to the publication of this Final EIS, there are no major unresolved issues associated with the project.

I. Federal and State Actions Required for the Implementation of Proposed Action

- An Individual Wetland Permit application has been submitted jointly to the US Army Corps of Engineers (USACOE) and New Hampshire Department of Environmental Services (NHDES) for their approval. This project's development has followed the USACOE's Highway Methodology, which is designed to integrate their Section 404 permitting process with the requirements of the National Environmental Policy Act (NEPA).

- A Joint Public Hearing with the NHDES and USACOE was held on September 21, 2006 to accommodate the issuance of the Section 404 wetland permit and NHDES dredge and fill permit.

- A Section 401 Water Quality Certificate is required from NHDES before the Section 404 permit can be issued. This review will determine whether the proposed action meets all state water quality standards.

- The project will require a permit from the US Coast Guard (USCG) under its permitting authority pursuant to Section 9 of the Rivers and Harbors Act of 1899 and the General Bridge Act of 1946. Under the General Bridge Act of 1946, the USCG is responsible to preserve the public right of navigation and to prevent interference with interstate or foreign commerce. Their review will require that the bridges provide for the reasonable needs of navigation, as well as the reasonable needs of land traffic (*i.e.*, highway users).

- Pursuant to the National Pollutant Discharge Elimination System (NPDES), a Notice of Intent (NOI) application to the US Environmental Protection Agency (USEPA) for a General Permit for Construction Activity is required before construction can begin. A Stormwater Pollution Prevention Plan consistent with NHDOT Standard Specifications, which incorporate Best Management Practices (BMPs) for minimizing soil erosion and sediment movement, will be developed and submitted with this application.

- Concurrence by the National Marine Fisheries Service (NMFS) that the Selected Alternative will not have a substantial adverse effect on Essential Fish Habitat (EFH) has been received (see Volume 4, F-3).

- Under Section 4(f) of the US Department of Transportation Act as amended by the Federal-Aid Highway Act of 1968 (Public Law 90-495, 49 USC 1653), FHWA will need to make a determination that there is no feasible and prudent alternative to the use of land from Hilton Park, Bayview Park, and the affected historic resources before the project can advance. (See Chapter 5.)

- A Record of Decision (ROD) issued by FHWA is required before this project can proceed to final design. The ROD is issued no sooner than 30 days after release of the Final EIS.

1

Introduction

1.1 General Overview

The New Hampshire Department of Transportation (NHDOT) and the Federal Highway Administration (FHWA) have prepared this Final Environmental Impact Statement (FEIS) to evaluate and recommend improvements to a 3.5-mile segment of the Spaulding Turnpike (US 4/NH 16) extending north from the Exit 1 (Gosling Road) Interchange in Newington, across the Little Bay Bridges, and through the Exit 6 (US 4/Dover Point Road) Interchange to just south of the Dover Toll Plaza in Dover, New Hampshire. The basic goal of the Newington-Dover Spaulding Turnpike improvement project is to reduce safety problems and improve transportation efficiency, while minimizing social, economic and environmental impacts. A Scoping Report, documenting the first phase of the EIS study process, was completed in March 2004, a Rationale Report was issued in January 2005, and a Draft EIS was issued in July 2006.

Phases of the study are in accordance with the National Environmental Policy Act (NEPA) requirements and with a format established by the NHDOT [1] that include:

- Phase I: Establishing the Scope of the Project and Defining Existing Resources resulting in a Scoping Report.
- Phase II: Screening of Conceptual Alternatives resulting in a Rationale Report
- Phase III: Preparation of a DEIS.
- Phase IV: Public Hearing
- Phase V: Preparation of a Final Environmental Impact Statement (FEIS)

1 See Chapter 10 for a list of acronyms used in this DEIS.

The NHDOT process includes these key decision points:

- Concurrence with Purpose and Need (US Army Corps of Engineers [USACOE])[2]
- Reasonable Range of Alternatives Sign-Off (USACOE)[2]
- Approval of Draft EIS (FHWA)
- Least Environmentally Damaging Practicable Alternative Sign-Off (USACOE)[2]
- Sign-off on Appropriate Wetland Mitigation (USACOE)
- Report of the Special Committee[3] (State of New Hampshire)
- Approval of Final EIS (FHWA)
- Record of Decision (FHWA)
- Section 401 Water Quality Certification (NH Department of Environmental Services [NHDES])
- State Wetland Permit (NHDES, Wetlands Bureau)
- State Coastal Zone Management Consistency Determination (NHDES)
- Section 404 Permit (USACOE)
- US Coast Guard (USCG) Bridge Permit

During the course of the study process, public participation has been a key element relative to evaluating resources, impacts, and alternatives. An Advisory Task Force (ATF) was established at the outset of the project. The ATF is comprised of two representatives of each of the municipalities of Dover and Newington; single representatives of the municipalities of Durham and Portsmouth; and single representatives of the Rockingham Planning Commission (RPC), the Strafford Regional Planning Commission (SRPC), the Pease Development Authority (PDA), Cooperative Alliance for Seacoast Transportation (COAST), the Greater Dover Chamber of Commerce, the Portsmouth Chamber of Commerce, the Great Bay Estuarine Research Reserve, the FHWA and the NHDOT. The ATF has met approximately every two to three months in the evenings, with meeting locations rotated between Dover and Newington. The public has been encouraged to attend. In addition, a project website, www.newington-dover.com, has also served as a forum to provide project-related information to the public, and to solicit their feedback and comment.

2 Copies of correspondence from the Army Corps of Engineers are contained in Appendix A.
3 The Special Committee consists of three Executive Councilors appointed by the Governor to oversee the Public Hearing process. See Volume 4 for a copy of the Report of the Special Committee.

Additionally, Public Officials Meetings and Public Informational Meetings have been held periodically in both Newington and Dover.

A project Scoping Meeting[4] conducted at the Newington Town Hall (June 25, 2003) and an initial Public Information Meeting[5] conducted at Dover City Hall (November 12, 2003) provided opportunity to brief local officials and the public on the background, purpose and need of the project. Study area, affected environment, potential impacts that may warrant study and identification of a reasonable range of alternatives were discussed and confirmed. The project schedule and study process were outlined. These meetings also afforded local officials and the public an opportunity to raise issues of concern and suggest ideas to address the project purpose and need.

Subsequent Public Information Meetings were held in both Dover (June 30, 2004 and May 18, 2005) and Newington (July 1, 2004 and May 19, 2005). During these meetings, the project team outlined the specific alternatives developed during the conceptual design phase of the project, including bus and rail systems, high-occupancy vehicle lanes, bridge widening vs. replacement, and a number of other issues. The team presented plans showing alternative roadway layouts and solicited feedback from the public on proposed traffic circulation changes. Environmental issues such as noise effects and wetland impacts were discussed, and preliminary cost estimates for each alternative were presented.

Public Information Meetings were also held on November 7 (Dover) and November 9, 2005 (Newington) to present the Preferred Alternative, including several refinements made since the release of the Rationale Report in January 2005 and the Public Informational meetings in May 2005. These November 2005 meetings were the culmination of almost 20 months of work on the development of the project, during which numerous alternatives were examined, including bus and rail transportation as well as more than 30 different highway and bridge layout options. The details of proposed mitigation for noise and wetland impacts were also presented.

This Final Environmental Impact Statement (FEIS) documents Phase V of the EIS study process and includes four volumes. Volume 1 contains all text and tables, while Volume 2 contains all figures. Appendices are contained in Volume 3. All of the comments received at the Public Hearing and on the Draft EIS (DEIS), published in July 2006, as well as all NHDOT and FHWA responses, are contained in Volume 4. The first chapter of the FEIS describes the project study area and project history, and provides a description of the overall purpose and need for the project. Chapter 2 describes the transportation improvement strategies and other alternatives that were

4 See Scoping Meeting notes in Appendix B.
5 See Public Informational Meeting notes in Appendix B.

originally considered and that led to the identification of a reasonable range of alternatives for detailed study, as well as the Selected Alternative. Chapter 3 describes the existing baseline conditions in the study area, while Chapter 4 identifies the environmental consequences of alternatives studied in detail. Chapter 5 describes the Section 4(f) evaluation process and potential FHWA actions that require review under Section 4(f) of the USDOT Act of 1966, and discusses potential alternatives, avoidance and mitigation measures. Chapters 6 and 7 provide a list of EIS preparers and a document distribution list, respectively. Chapter 8 describes the agency coordination and public participation that has taken place to date, while references cited can be found in Chapter 9. Chapter 10 gives the reader a subject index and an acronyms list. In the Final Environmental Impact Statement (FEIS), Chapter 11 identifies project commitments made by NHDOT and FHWA to mitigate effects of the Selected Alternative.

This FEIS has been prepared in conformance with the requirements of the Council on Environmental Quality (CEQ), National Environmental Policy Act regulations and associated guidance documents of the FHWA. The purpose of the EIS is to provide full disclosure of potentially substantial environmental impacts, and to inform decision-makers and the public of the reasonable alternatives, which would avoid or minimize adverse impacts. The EIS describes existing transportation, social, economic, cultural and environmental resources in the study area and discusses the potential effects of the various project alternatives on these resources. The FEIS represents a cooperative effort among the FHWA, the NHDOT and the project consultants. The consulting team consists of:

Bridge, Roadway and Traffic Engineering:	Vanasse Hangen Brustlin, Inc.
Bridge Engineering:	Hardesty and Hanover, LLP
Environmental Analysis:	Vanasse Hangen Brustlin, Inc.
Socio-Economic Impacts:	RKG Associates, Inc.
Marine Habitat/Resources and Hydrodynamic Analysis:	University of New Hampshire
Historical Resources:	The Preservation Company
Archaeological Resources:	Victoria Bunker and Associates
Travel Demand Modeling:	Resource Systems Group

1.2 Project Setting and Overview

The Spaulding Turnpike is eastern New Hampshire's major limited access North-South highway extending approximately 33.2 miles from Portsmouth to Milton, NH (**Figure 1.2-1**). The 3.5-mile Newington-Dover section of the Turnpike also functions as an extension of the US 4 and NH 16 transportation corridors linking the Seacoast area and I-95 with Concord to the west and the White Mountains to the north, respectively. Locally, this section of the Turnpike also connects with Dover Point Road (Dover) to the north and Nimble Hill Road, Shattuck Way and Woodbury Avenue (Newington) to the south. South of Exit 2 (Fox Run Road), the Turnpike is a six-lane divided facility, and between Exit 2 and Exit 12 (NH 125), the Turnpike is a median-divided four-lane facility. North of Exit 12, the Turnpike narrows to a two-lane undivided facility. (Widening of the Turnpike from two lanes to a four-lane, median-divided facility between Exits 12 and 16 is currently under design as part of a separate project.)

Dover Point (Looking South)

Recognizing a need to study potential improvements to address safety concerns and increased congestion, Senate Bill 152-FN-A (1990) authorized the NHDOT to conduct a study of the approximately 3.5-mile section of the Spaulding Turnpike extending north from Exit 1 (Gosling Road) in Newington and traversing the Little Bay Bridges to (but not including) the Dover Toll Plaza just north of Exit 6 (**Figure 1.2-2**). The study was initiated in 1990, but suspended in 1992 to allow completion of the Pease Surface Transportation Master Plan. In 1997, the

Newington-Dover Feasibility Study was initiated to conceptually develop both a short-range plan to address existing safety deficiencies, and a range of long-term improvement alternatives to be carried forward for detailed engineering and environmental studies. The feasibility study was completed in 2000.[6]

In 1998, the Route 16 Corridor Protection Study[7] articulated a vision for the corridor (Portsmouth to Errol) to guide future growth and identified a number of planning principles and techniques to address the following major areas of concern: transportation, community design, travel and tourism, and land use and access management. The vision for the corridor and study findings and recommendations resulted from a cooperative effort of working groups of people who reside and work in the corridor with support from State and regional planners. As part of the study, which underscores the linkage among transportation, economy and land use, 1997 and future (2017) year travel conditions along the corridor – including the Spaulding Turnpike – were evaluated taking into account future changes in land use and transportation improvement projects that were programmed for project development.

Exit 4, Nimble Hill Road/Shattuck Way (Looking North)

6 VHB, Spaulding Turnpike Improvements, Feasibility Study, Newington-Dover (11238), February 2000.
7 NHDOT, Route 16 Corridor Protection Study, December 1998.

The Corridor Protection Study's traffic analysis indicated that while the section of Turnpike north of the Dover Toll Plaza would operate at a satisfactory level of service[8] under future (2017) conditions, the 3.5-mile study area section of Turnpike between the Dover Toll Plaza and Exit 1 (Gosling Road) in Newington is capacity-constrained under both 1997 and 2017 future traffic conditions.

Within the framework of an EIS, this current study identifies, evaluates and recommends a long-term transportation and safety solution for this study area that is supported by community stakeholders and addresses the project's purpose and need.

1.3 General Description of Project Area

1.3.1 Study Area

The section of Spaulding Turnpike being studied (**Figure 1.2-2**)[9] is approximately 3.5 miles long extending from just north of Exit 1 in Newington to just south of the Dover Toll Plaza, and includes the Little Bay Bridges. Most of this section of the Turnpike is a limited access[10] facility and consists of two (2) through lanes in each direction separated by a median of varying width. The study area includes five interchange areas (Exits 2, 3, 4, 5 and 6) including a median turnaround (Exit 4N)[11] to accommodate southbound traffic desiring to reverse direction or access Shattuck Way in Newington.

The study area lies geographically in the Seaboard Lowland section of New England, with most of the land lying between sea level and 60 feet above sea level. This area lies within the Great Bay Drainage and Coastal Drainage watersheds, which make up the larger Salmon Falls – Piscataqua Rivers drainage basin. The northern one-third of the study area, located within the portions of Little Bay and Bellamy River, is tributary to the Piscataqua River which drains to the Atlantic Ocean. Other perennial watercourses in Newington include Pickering Brook, Railway Brook, an unnamed stream

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8 Level of service (LOS) is a qualitative measure describing operational conditions within a traffic stream and their perception by a motorist or passenger. Level of service generally describes these conditions in terms of such factors as speed and travel time, density or freedom to maneuver, traffic interruptions, comfort and convenience, and, in doing so, provides an index to quality of traffic flow. Six levels of service are defined ranging in letter designation from LOS A to LOS F, with LOS A representing the best traffic operation and LOS F representing the worst. LOS C describes a stable flow condition and is considered desirable for peak and design hour traffic flow. LOS D is generally considered acceptable where the cost and impacts of making improvements to provide LOS C are deemed unjustified. LOS E reflects traffic operations at capacity.

9 For clarification purposes, a segment of road between the Exit 4 northbound ramp terminals and the existing southbound on-ramp, which was formerly known as River Road and re-named by the Town of Newington as Shattuck Way in 2005 will be referenced in the document as Shattuck Way.

10 The existing ExxonMobil service station located at the Nimble Hill Road/Exit 4 interchange has direct access to the Turnpike and Nimble Hill Road, along with two other parcels in Newington.

11 As part of the Newington Interim Safety Improvement project , the median turnaround was eliminated in 2005.

that flows into the Piscataqua River, and Flagstone Brook. These and other resources are discussed in greater detail in Chapters 3 and 4 of this report. For purposes of taking inventory of environmental resources which might be directly impacted as a result of improving the transportation system, the study area extends approximately 3,000 to 5,000 feet east of the northbound lanes, including the Piscataqua River and Pomeroy Cove, and approximately 3,000 feet west of the southbound lanes, including the General Sullivan Bridge and Little Bay, as well as the median areas. These extents include the interchange areas and connecting roadways.

The 1998 Route 16 Corridor Protection Study and the 2000 Newington-Dover Feasibility Study established the project study area limits by determining that current and future Turnpike traffic operating conditions north of the Dover Toll Plaza were satisfactory. In contrast, there are poor levels of traffic service on the section of Turnpike south of the Dover Toll Plaza and north of Exit 1 in Newington under current and future volume conditions.

These boundaries mark the extent of potential direct impact to environmental resources. They do not, however, limit the evaluation of Travel Demand Management (TDM) measures[12] and mass transit alternatives, which may logically have to extend further to the north or south. For the purpose of evaluating indirect and cumulative impacts, consideration must be given to those areas serviced by, and thus subject to the influence of, the section of the Turnpike under study. As such, a broad regional area (**Figure 1.3-1**) was defined to include 33 municipalities (approximately 785 square miles) within the tri-county area of Strafford, Rockingham and Carroll Counties in the southeast portion of New Hampshire. This area is broadly referred to as the Seacoast area (or socio-economic study area) and was used as a basis to collect and analyze regional socio-economic data in order to provide a context within which to evaluate the proposed Turnpike improvement project and its potential socio-economic impacts (Section 3.3).

1.3.2 Existing Roadway System

The Spaulding Turnpike (NH 16) is a major limited access highway connecting the Seacoast Region with Concord, the Lakes Region and the White Mountains. The Turnpike is also part of the National Highway System and is functionally classified as a principal arterial, serving commuters, tourists and recreational traffic.[13] It is the region's major north-south route of commerce.

12 Travel Demand Management programs aim to improve mobility and access, reduce congestion and air pollution, and provide options for employees to get to work without increasing highway capacity. The most common TDM measures include provisions for park-and-ride lots, discounts or preferential treatment for vehicles serving more than one rider, improved public transit services (*e.g.*, express bus service), work hours management and other incentives which encourage the use of public transit, car-pooling, biking, walking, or simply not making the trip.

13 **Figure 1.3-2** shows the roadway network in the study area, including each road's functional classification.

Poor traffic flow conditions can be attributed to two separate factors: physical infrastructure deficiencies and high traffic volumes. Physical deficiencies along the Turnpike include substandard curvature along interchange ramps, inadequate acceleration and deceleration lanes at interchanges, inadequate weave distances between the interchange ramps, and substandard shoulder widths on the Little Bay Bridges. These factors, combined with high traffic volumes, often result in reduced travel speeds, constrained maneuverability, and congestion during the peak hour conditions, as well as the increased potential for crashes.

1.3.3 Traffic Operations

In addition to the physical deficiencies of the Spaulding Turnpike, the traffic volume demands on the corridor also contribute toward the poor traffic flow. During the commuter weekday peak hours (7:00-8:00 AM, 5:00-6:00 PM), study area motorists traveling along the Spaulding Turnpike currently experience traffic congestion and substantial delay. With the Little Bay Bridges currently carrying in excess of 70,000 vehicles per day, many of the freeway segments and interchanges along the highway experience volume demands that exceed the available capacity of the roadway system.

Exit 6 (Looking North)

Of the 41 individual traffic flow movements (freeway segments, ramps, weave areas, and intersections) evaluated in the study area under the existing conditions (2003) analysis, 17 locations (34 percent) were determined to be deficient in capacity, operating at level of service (LOS) E or F during the weekday morning or evening commuter peak hours. Most notably, traffic operations between Exits 3 and 6 were found to be poor under the existing conditions operating at LOS E.

1.3.4 Future Travel Demand

Traffic operations are expected to continue to deteriorate under future conditions as traffic volumes increase. Traffic forecasts for the year 2025 show that the average annual daily traffic (AADT) on the Little Bay Bridges could increase from its current level of approximately 70,000 vehicles per day to 94,300. This volume of traffic would substantially increase the current level of congestion along the Spaulding Turnpike and its interchanges, and along nearby local roadways such as Dover Point Road, Shattuck Way and Woodbury Avenue. The additional delay experienced by motorists would be expected to expand to more hours of the day and to a greater number of days during the year. Crash frequency would also be expected to increase as a result of the increased level of congestion.

The annualized average daily traffic (AADT) along study area segments of the Spaulding Turnpike for the 2003 Existing and 2025 Design Year conditions is summarized in Table 1.3-1.

Exit 3 (Looking North)

Table 1.3-1
Spaulding Turnpike Average Annual Daily Traffic (2003 and 2025)[1]

Segment	2003 AADT (VPD)[2]	2025 AADT (VPD)
Between Exits 1 and 2	54,700	65,900
Between Exits 2 and 3	52,900	64,700
Between Exits 3 and 4	69,300	88,000
Between Exits 4 and 5 (Little Bay Bridges)	70,650	94,300
Between Exits 5 and 6	71,050	94,600
North of Exit 6	39,800	51,600

Notes:
1 AADTs for 2003 are based on data collected by the NHDOT. AADT's for 2025 (No-Build condition) are based on the Seacoast Regional Travel Demand Model.
2 VPD = vehicles per day.

Safety Issues/Crash Data

Crash data were compiled and reviewed for the seven-year period of January 1997 through December 2003. Over this period, a total of 1,263 crashes were reported within the study area. From 1997 through 2001, the frequency of crashes grew at an average rate of 11 percent per year increasing from 144 crashes (1997) to 220 crashes (2001). Although the overall number of crashes occurring within the study area decreased in 2002 (168 crashes), they increased again in 2003 (187 crashes).

The highest number of crashes reported on the Spaulding Turnpike occurred on the Little Bay Bridges where 159 crashes occurred from 1997 to 2003. The average crash rate observed on the bridges from 1997 through 1999 was approximately 15 crashes per year. That number increased substantially in 2000 to 24 crashes and has increased steadily since to 33 crashes in 2003, representing an overall crash growth rate of 14 percent per year from 1997 to 2003. It is important to note that study area traffic volumes along the Spaulding Turnpike grew at a much lower rate of 2.3 percent per year during this same time period. The fact that the number of crashes is increasing at a rate approximately six times faster than the rate of traffic volume growth is an indicator of the deterioration of the safety along the corridor and the severity of the congestion level.

1.4 Purpose and Need

The project Purpose and Need statement is fundamental to the analysis of the project under NEPA, the Clean Water Act (Section 404), and other environmental regulations. Sections 1.4.1 and 1.4.2 present the Purpose and Need that was developed in conjunction with the ATF, reviewed by the cooperating agencies[14] with no objections and unanimously adopted by the ATF on October 29, 2003.

1.4.1 Purpose

The purpose of this project is to improve transportation efficiency and reduce safety problems, while minimizing social, economic, and environmental impacts, for an approximate 3.5-mile section of the Spaulding Turnpike extending north from the Gosling Road/Pease Boulevard Interchange (Exit 1) in the Town of Newington, across the Little Bay Bridges, to a point just south of the existing Toll Plaza in the City of Dover. Options that include implementing Transportation System Management (TSM) improvements,[15] reusing the General Sullivan Bridge for local motorized and non-motorized traffic, enhancing rail service, improving bus transit service and instituting other TDM strategies that may reduce vehicle trips along the Spaulding Turnpike have been considered, in addition to widening the mainline, widening and/or replacing the Little Bay Bridges, and reconstructing the interchanges.

1.4.2 Need

The Spaulding Turnpike is eastern New Hampshire's major limited access north-south highway, serving as a gateway linking the Seacoast Region with Concord, the eastern portion of the Lakes Region, and the White Mountains. The Turnpike is also part of the National Highway System reflecting its significance as an important transportation link in the state and regional system. Functionally classified as a principal arterial, it is a major commuter route which ties the growing residential areas of Dover-Somersworth-Rochester with the industrial and regional commercial centers in Newington, Portsmouth, and northern Massachusetts. It serves as the major artery for freight into and out of the areas north of the Little Bay Bridges, and is the economic lifeline of the region. It also serves as a major tourist route, providing

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14 The USACOE developed its own, more succinct, basic project purpose for their Section 404 permitting analysis, which states, "To allow for the safe and efficient flow of present and future traffic along the Spaulding Turnpike from Pease Gosling Road to the Dover toll facility" and is included in Appendix A.

15 Transportation System Management (TSM) improvements are generally low-cost measures to reduce congestion and improve safety. TSM improvements are typically limited by the width of the existing right-of-way. Examples of TSM improvements include the construction of turning lanes, re-striping lane uses and installation of traffic signals or roundabouts to improve traffic control and/or traffic flow efficiency.

access to the northern reaches of the state from the seacoast and points south of New Hampshire.

Traffic volumes on the Little Bay Bridges have steadily increased from approximately 30,000 vehicles per day in 1980 to greater than 70,000 vehicles per day in 2003 resulting in high levels of congestion on the bridges and along the Turnpike near and within the interchange areas.

Over the next 20 years this average daily volume is expected to increase to approximately 94,600 vehicles per day. These projections support the conclusion that the existing facility will be increasingly less able to operate at the levels of service and safety for which it was originally designed. During weekday and weekend peak hours of the day, the Turnpike currently operates at unacceptable levels of service (LOS E and/or F) with motorists experiencing severe congestion and long delays within this segment of the corridor.

Exit 4 (Looking East)

The Turnpike has a number of existing geometric deficiencies including substandard shoulder width on the Little Bay Bridges and substandard merge, diverge, and weave areas at the interchanges. Many of the traffic maneuvers required to enter, exit or change lanes along this section of the Turnpike are capacity-constrained under current traffic conditions and contribute to driver discomfort and crashes. Existing acceleration, deceleration and weaving sections along the Turnpike are inadequate by current design standards. Historic crash data indicates that the frequency of vehicle crashes continues to increase raising concerns relative to motorist safety. Due to the nature of the existing facilities, these crashes, as well as vehicle breakdowns create long delays in an area for which there are no viable alternate routes.

In addition to the capacity deficiencies and safety issues, this section of the Turnpike bisects residential and recreational areas in Dover and the residential and commercial/industrial areas in Newington resulting in an inefficient and circuitous use of the Turnpike by people desiring to travel east-west and vice versa. Local connectivity for motorists, pedestrians, and bicyclists from one side of the Turnpike to the other is deficient.

This section of the Turnpike is located in a moderate seismic region, identified as Seismic Performance Category B.[16] The Little Bay Bridges and General Sullivan Bridge, which are classified as major structures, were not designed to meet the current seismic design criteria for this region.

The project is included in the State's Ten-Year Transportation Improvement Program and is the top long-term transportation priority of the Seacoast Metropolitan Planning Organization (MPO).[17] As residential and commercial development and traffic growth along the corridor and within the region continue to increase, traffic operations and safety conditions will deteriorate further, resulting in increased vehicle delays, increased crash frequency, and the potential loss of commerce.

16 American Association of State Highway and Transportation Officials (AASHTO) , Standard Specifications for Highway Bridges, 17th Edition -- 2002.

17 Seacoast Metropolitan Planning Organization (MPO) is comprised of portions of Strafford Planning Commission and Rockingham Planning Commission.

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 the No-Build Alternative. The Selected Alternative is also identified and a summary of the environmental consequences of each alternative from Chapter 4 is provided.

A number of conceptual alternatives were identified in the *March 2004 Scoping Report* and expanded upon in the *January 2005 Rationale Report*. These alternatives provide a reasonable range of solutions to address the purpose and need of the Newington-Dover Spaulding Turnpike project. The basic types of alternatives are listed below and discussed in more detail in the following sections:

- No-Build,
- Implementation of Transportation System Management (TSM) actions,
- Implementation of Travel Demand Management (TDM) actions,
- Providing alternative modes of transportation (a form of TDM),
- Turnpike widening/interchange improvements,
- A combination of these alternatives.

Alternative roadway and bridge-crossing corridors involving relocation of the Spaulding Turnpike and a new bridge crossing location outside the existing Turnpike corridor are not considered viable options because of the existence of the substantial transportation infrastructure in the study area, the current traffic patterns and land uses associated with the existing facility, and the scale and magnitude of environmental and property impacts, along with the cost of a relocated facility.

2.2 Project Scoping

Scoping is the identification of the project purpose, the study area, the issues and a range of alternatives to be considered in the EIS. It also identifies agencies with special expertise or jurisdiction by law, who have been requested to be cooperating agencies in the study. Project Scoping was accomplished through correspondence, telephone calls and formal and informal meetings with Federal, State and local agencies and officials. A formal Scoping meeting for which notices were published in the Federal Register and local papers was held on June 25, 2003 at the Newington Town Hall.

The meeting afforded all stakeholders an opportunity to formally comment on the purpose and need of the project, the study area under consideration, the reasonable range of alternatives to be considered and the key issues involved. Key issues identified included preservation of historic resources, noise impacts, water quality, property impacts, secondary growth impacts, potential for shoreline restoration of filled wetlands for mitigation of wetland impacts, and coordination with NHF&GD planned improvements to Hilton Park.

2.3 General Description of Alternatives

The following is a brief description of the basic types of alternatives that were identified and discussed in the Scoping Report (NHDOT, March 2004) and subsequently considered as part of the initial screening process in the Rationale Report (NHDOT, January 2005). These alternatives included a range of potential actions to address the purpose and need of the Newington-Dover, Spaulding Turnpike improvements. The basic alternatives are:

- No-Build,
- Implementation of Transportation System Management actions,
- Implementation of Travel Demand Management actions,
- Providing alternative modes of transportation,
- Turnpike widening/interchange improvements,
- A combination of these 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 Turnpike corridor including the existing interchanges and local connecting roadways, as well as the Little Bay and General Sullivan Bridges. The No-Build

Alternative will serve as a baseline condition for comparison to other alternatives.

2.3.2 Transportation System Management (TSM) Improvements

Transportation System Management improvements are relatively low-cost measures that are implemented to reduce congestion and improve safety. TSM improvements are typically limited by the width of the existing right-of-way. Examples of TSM improvements include the construction of turning lanes, restriping lane uses, signage, the installation of new or the upgrade of existing traffic signals, and other traffic controls such as roundabouts. In addition, TSM improvements could involve the utilization of Intelligent Transportation Systems (ITS) technology, such as variable message boards and emergency communications, to ease congestion and enhance safety.

TSM improvements are not the solution to the long-term needs of the Spaulding Turnpike study area. However, they would provide immediate localized improvement of safety deficiencies and some traffic congestion relief in advance of the long-term solutions to be approved and constructed.

2.3.3 Travel Demand Management (TDM) Strategies

Travel Demand Management encompasses a variety of strategies that are designed to change personal travel behavior to reduce the demand for automobile use and the need for roadway and bridge 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 other modes of travel. The discussion of TDM measures in this section of the report does not include consideration of major infrastructure investments to provide and expand alternative modes of transportation such as high occupancy vehicles (HOV) lanes, park-and-ride facilities, bus services, and rail service. These measures are discussed separately under Mode Alternatives and in more detail in Section 2.4.4.

Strategies that are designed to change personal behavior include:

- Employer- based measures, which are designed to encourage and support the use of alternatives to driving alone. These measures are most effective in changing commuting behavior if they are implemented through employers.

- Transportation Management Associations are organizations that exist in a variety of sizes and operational structures; they generally use governmental support in combination with private funding which is obtained through cash grants, member dues, fees for services, or in-kind contributions. Ride-share brokerages not only offer area-wide services, but also work with individual employers to implement TDM programs at individual work sites. TMAs support groups of employers that band together to address specific transportation issues in their area by implementing TDM measures for member employers.

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

2.3.4 Mode Alternatives

As part of the analysis of the potential improvements to the Spaulding Turnpike and Little Bay Bridges between Exit 1 and the Dover Toll Plaza, an evaluation of alternative transportation modes was conducted. These alternative modes include rail services, bus services, high occupancy vehicle lanes and reversible lanes. Employer-based programs to encourage employee alternatives to driving alone to work were also assessed. The objective for analyzing these other modes was to understand how they may complement, minimize, or eliminate the need for, or extent of, highway and bridge improvements.

Seven rail corridors have been identified for the evaluation of improved rail transportation as part of the study. Of the seven corridors, three are potential candidates for passenger rail service improvements, two are candidates for fixed guideway transit systems (*i.e.*, light rail or bus rapid transit), and six are candidates for improved freight rail service. Corridors to be evaluated for passenger rail service improvements include the Main Line West that currently hosts the *Downeaster* intercity passenger rail service, the Main Line East, and the Conway Branch. The Newington and Portsmouth branches are candidates for fixed guideway transit systems. The candidate corridors for freight rail improvements include the five listed above plus the Pease Spur.

Commuter bus service to Boston is currently provided by C&J Trailways along the Spaulding Turnpike and I-95 corridors. The service provides connections from Dover and Portsmouth (as well as Newburyport, MA) to Logan Airport and South Station in Boston. C&J Trailways also provides weekend service between Durham and South Station in Boston while the University of New Hampshire (UNH) is in session.

Local bus service is provided by COAST and by the UNH Wildcat Transit. Five local bus routes are operated by COAST in the Portsmouth, Dover, and the Rochester region. Wildcat Transit operates three routes connecting the University of New Hampshire campus, Durham, Dover, Portsmouth and Newmarket.

As part of this study, consideration was given to expanding or otherwise enhancing the current commuter and local bus service. Actions considered include: additional service along the study corridor between Rochester, Dover and Portsmouth; additional park-and-ride lots offering traveler amenities; and overall coordination of commuter bus services, other study area transit services, and park-and-ride lots.

Another strategy to reduce travel demand on the Spaulding Turnpike is to facilitate ride-sharing through the availability of park-and-ride lots. Today there are no existing state (NHDOT supported) park-and-ride lots within the study area. However, nearby park-and-ride lots are located in Portsmouth and Hampton. Potential new park-and-ride locations in Dover and Rochester (in proximity to the Turnpike) and along US 4 in Durham and Lee were also evaluated as part of this study. Potential park-and-ride locations were reviewed in terms of size, availability, capital cost, access to and from the Turnpike, potential to be served by bus and rail, and environmental impacts. Additional amenities considered include provision for lighting, phones, bus shelters, information kiosks, bicycle lockers, and proximity to other commercial services. Park-and-ride lots in New Hampshire offer free parking, which provides an incentive to motorists to use them.

State and local multi-use trails and bicycle routes traverse the study area with the General Sullivan Bridge currently providing the bicycle and pedestrian system connectivity between Durham and Dover to the north and Newington, Portsmouth and Greenland to the south. Corridor roadway and bridge upgrade alternatives will maintain the current system connectivity across Little Bay and the existing local Dover east-west, grade-separated connection for pedestrians and bicyclists between the two segments of Hilton Park, which are currently bisected by the Turnpike. A similar east-west, grade-separated connection will be maintained in Newington. In addition, the multi-use path adjacent to Pomeroy Cove connecting Hilton Park to Dover Point Road will be maintained.

2.3.5 Turnpike Widening / Interchange Improvements

Concepts for addressing existing and future travel demands for the Spaulding Turnpike study area include adding travel lanes to the existing Turnpike and Little Bay Bridges. Alternatives considered involve widening the existing roadway and bridges to provide either three or four lanes in each direction (**Figure 2.3-1**). Relative to the widening alternatives, incorporation of high occupancy vehicle (HOV) lanes and/or reversible lanes to serve immediate or future needs were also considerations.

Current interchange configurations and connecting roads within the study area were evaluated for possible consolidation and design improvements to accommodate the widening and projected traffic demand, as appropriate, based on current American Association of State Highway and Transportation Officials (AASHTO) and NHDOT design standards.

2.3.6 Combination of Alternatives

During the alternatives development process, it became apparent that a combination of alternatives would provide the most benefit to the project and best meet the project's Purpose and Need. Each of the alternatives was therefore evaluated with the potential of combining it with other alternatives, where practical, to provide the most effective range of reasonable alternatives.

2.4 Alternatives Considered

2.4.1 No-Build

The No-Build Alternative is essentially the continuation and perpetuation of the existing conditions and the shortcomings inherent on the existing Turnpike and Little Bay Bridges. The base year 2003 Average Annual Daily Traffic (AADT) volumes range from 52,900 vehicles per day (vpd) between Exits 2 and 3 to over 70,000 vpd between Exits 4 and 6. Segments of the Turnpike between Exits 3 and 6 currently operate at or near capacity during the commuter peak hours. Given that the projected 2025 No-Build AADTs range from 64,700 vpd to 94,600 vpd in the study area, the No-Build Alternative would not meet the project Purpose and Need, and in fact would result in a substantially worse situation relative to transportation safety and mobility.

In terms of overall mobility and safety on the Turnpike, it is important to consider the magnitude of congestion with regard to the number of hours in the day that poor level of service occurs. For example, the existing weekday evening peak demand on the Turnpike actually extends beyond a single hour, covering portions of two hours. This phenomenon, which is known as "peak spreading," occurs when segments of a corridor are so congested that the poor level of service extends into the hour before and following the peak hour. During the 2025 forecast year, peak spreading will become more prevalent and congestion during the weekday evening commute is expected to last up to four hours. A similar condition (up to two hours) will also exist for the weekday morning commute. It is important to note that when peak spreading occurs, actual operating conditions of the highway are somewhat worse (and the number of motorists affected is greater) than what is indicated by evaluating a single one hour period.

Figures 2.4-1 and 2.4-2 depict the 24-hour temporal distribution of respective southbound and northbound traffic volumes on the Little Bay Bridges for the years 2000 and 2025. The figures contrast the unconstrained 2025 peak hour travel demand with the spreading of peak volume hours resulting from the limited two-lane directional capacity of the existing bridges. For example, the peak hour (5:00 PM – 6:00 PM) of northbound congestion in 2000 will increase to approximately four hours (3:00 PM – 7:00 PM) of congestion by 2025. The current average driver delay of approximately 8 minutes traveling northbound during the weekday PM peak hour between Exit 1 and Exit 6 on the Turnpike is expected to increase to over 20 minutes under 2025 traffic conditions. The spread of peak volume hours and peak period congestion reflects a diversion of some of the 2025 peak hour travel demand to alternate routes (such as NH 108, NH 125 and ME 236) based on their capacity to absorb additional peak period traffic. As such, the No-Build Alternative is not considered a viable alternative, but will serve as a baseline condition for comparison to other alternatives.

2.4.2 Transportation System Management

TSM improvements are relatively low-cost measures that are implemented to reduce congestion and improve safety. As part of the study to develop a long-term transportation improvement plan for the Spaulding Turnpike study area, a number of TSM-type actions to improve existing safety and traffic operational conditions in the study area were identified and evaluated. These improvements would be relatively inexpensive and could be implemented generally within the existing right-of-way and in a phased manner over a relatively short time frame. The following program of TSM actions was endorsed by the ATF at their March 31, 2004 meeting:

- Dover, Exit 6, Northbound
- Dover, Exit 6, Southbound
- Newington Interim Safety Improvements
- Newington, Exit 3, Southbound
- Newington, Exits 3-4, Northbound
- Signage

Dover, Exit 6, Northbound

Figure 2.4-3 depicts the extension of the northbound Exit 6W deceleration lane by approximately 400 feet to prevent weekday evening peak hour exiting traffic from queuing back onto the northbound through lane traffic. This modification utilizes the existing shoulder area without affecting the bridge abutment, and improves 2005 LOS from D to C. This action was implemented in June 2005.

Dover, Exit 6, Southbound

Figure 2.4-4 depicts the merging of the two-lane southbound on-ramp at Exit 6 to a single lane prior to the merge with the mainline, coupled with carrying two through lanes on the Turnpike through the Exit 6 Interchange to merge with the single southbound on-ramp. Currently the two through lanes merge to a single lane. Current traffic volumes on the mainline (approximately 2,500 vehicles, morning peak hour) warrant the two lanes, and the approximately 1,500 vehicles entering on the southbound on-ramp can be accommodated in a single lane. The single lane merge operation will be an improvement in comparison to existing conditions. The proposed changes will make it safer and easier for drivers to be in the proper lanes (either outside or inside) when planning to exit at Nimble Hill Road (Exit 4) or Woodbury Avenue (Exit 3). It should be noted that the existing on-ramp from Boston Harbor Road would be closed under this short-term interim condition, except for emergency vehicles. Traffic from Boston Harbor Road and Dover Point Road will access the Turnpike *via* the traffic signal at Spur Road and the southbound on-ramp from US 4. This improvement, scheduled for 2008 implementation, creates a traditional merge condition (operating at LOS D) and reduces the vehicle delays and queuing on both the on-ramp and mainline in comparison to existing conditions. However, this TSM action will not eliminate the capacity-constrained condition on the Little Bay Bridges.

Newington Interim Safety Improvements

The Interim Safety Improvements (**Figure 2.4-5**) address the historic safety and traffic operational problems at Nimble Hill Road and at Shattuck Way[18] due to inadequate weaving distances between these roadways and the median southbound to northbound turnaround (Exit 4N) on the Turnpike. By providing a two-way, grade-separated connection under the Turnpike, between Nimble Hill Road and Shattuck Way, the median turnaround could be eliminated, thus eliminating an unsafe weaving condition. The southbound on-ramp from the grade-separated turnaround from Shattuck Way was also eliminated, which removed another inadequate weave and merge condition, thus improving safety and traffic operations in the area.

18 Formerly known as River Road.

Traffic that previously used the southbound on-ramp utilizes the new alignment of Shattuck Way (west of the Turnpike) and accesses the Turnpike *via* Nimble Hill Road at Exit 4. Project construction was initiated in 2005 and completed in 2006.

Newington, Exit 3, Southbound

Figure 2.4-6 depicts other recommended TSM actions in Newington. Following implementation of the Newington Interim Safety Improvements which eliminate the southbound to northbound turnaround in the median (Exit 4N), the existing Exit 3 southbound deceleration lane to Woodbury Avenue can be extended by approximately 600 feet, improving existing LOS from E to D.

Newington, Exits 3 and 4, Northbound

Within interchange areas, capacity is influenced by the presence and design of auxiliary lanes to facilitate the weaving of traffic across lanes and the deceleration and acceleration of vehicles, respectively, as they exit and enter the Turnpike.

The basic lanes of a highway are the travel lanes along a facility that are needed solely to accommodate the movement of through traffic. Basic travel lanes do not include traffic management lanes such as climbing, acceleration/deceleration, weaving, merging and auxiliary 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 through lanes over an extended length of highway.

Construction of the Newington Interim Safety Improvements was extended to include development of a northbound auxiliary lane between Exit 3 and Exit 4 as depicted in **Figure 2.4-6**. Under this concept, the northbound on-ramp from Woodbury Avenue has been lengthened to create an auxiliary lane extending from the Exit 3 on-ramp to the Exit 4 off-ramp. Previously, the merge from Woodbury Avenue, coupled with the merge from the southbound to northbound median U-Turn on the high speed/inside through lane and the weaving of traffic from this median on-ramp to the Shattuck Way off-ramp, created congestion during the PM peak hour. This congestion caused northbound traffic to queue back through the Exit 2 Interchange area, and resulted in some Woodbury Avenue traffic diverting to Shattuck Way *via* Patterson Lane in an effort to bypass the queued Turnpike traffic and rejoin the Turnpike *via* the Exit 4 northbound on-ramp. With the elimination of the merging and weaving traffic that previously reversed direction and entered the northbound traffic flow from the median, and the extension of the northbound auxiliary lane from Woodbury Avenue to Shattuck Way, the Woodbury Avenue merge of traffic and the exit of traffic at Shattuck Way has improved, and delays and queuing of northbound through traffic reduced.

In conjunction with implementation of the auxiliary lane, the access from Woodbury Avenue to Shattuck Way *via* the Shattuck Way/Patterson Lane connection has been closed to prevent Turnpike traffic from diverting to Shattuck Way to bypass the congestion on the Turnpike only to rejoin the Turnpike at Exit 4. If the Woodbury Avenue-to-Spaulding Turnpike traffic continues to divert to Shattuck Way, then ramp-metering *via* a new traffic signal at the Shattuck Way/Exit 4 on-ramp could be considered to meter on-ramp traffic and discourage non-industrial area generated traffic from diverting to Shattuck Way to access the Turnpike.

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 on the freeway 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

Signage

To reinforce the safety importance of not changing lanes on the Little Bay Bridges and their approaches, it was recommended that existing "Stay In Lane" signs be upgraded to make them more prominent.

It was also recommended that directional signage on the northbound approach to Exit 6 be improved to provide drivers with greater recognition and increased decision-making time as they approach the Exit 6N (Dover Point Road) and 6W (US 4) off-ramps. Some drivers desiring to go west on US 4 or connect to Boston Harbor Road and Dover Point Road have mistakenly taken the first exit ramp (6N) and then reversed direction in proximity to the ramp terminal area on Dover Point Road.

Both of these signage improvements have been implemented.

2.4.3 Travel Demand Management

2.4.3.1 Employer-based Measures

Employer-based programs are designed to encourage and support the use of alternatives to driving alone. TDM programs are generally targeted at work trips because commuters account for most peak-hour travel (the periods of regular roadway congestion) and because work trip patterns are generally consistent from day-to-day. 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, 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.
- Support programs for those who commute *via* alternative modes, such as on-site services (shopping, banking, food services, day care, *etc.*) and guaranteed ride-home programs.
- Variable work arrangements and work hours such as telecommuting, flex-time, and compressed work weeks.

Implementation of TDM programs may occur voluntarily or may be required through governmental regulations. TDM programs can be encouraged through financial incentive programs.

2.4.3.2 Transportation Management Associations

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 may 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 not only offer area-wide services, but also work with individual employers to implement TDM programs at individual work sites. TMAs support 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.

Most work-related travel along the Turnpike corridor is to workplaces at the Pease International Tradeport, in downtown Portsmouth, and in Massachusetts. Massachusetts destinations include downtown Boston and Cambridge, communities along the I-95 (MA 128) and I-495 circumferential highways around Boston, and employers along I-95 and US 1 between Boston and the New Hampshire state line. Based on 2000 Census journey-to-work data, employer-based TDM measures that could have the most impact on the Spaulding Turnpike in the study area would need to be implemented largely at the Tradeport and in downtown Portsmouth.

At the Tradeport, the generation of daily vehicular traffic has been reduced as a result of the implementation of transit service, tenant support of employer-based strategies to reduce SOVs, the development of ancillary commercial activities (such as banking, convenience stores and restaurants) and the provision of pedestrian (sidewalk) and bicycle system connectivity. Since transit service within the study area and at the Tradeport will be expanded as part of the Selected Alternative, additional reductions in vehicular traffic generated at the Tradeport can be expected. However, since current zoning at the Tradeport does not allow residential use, further reductions in daily vehicular traffic resulting from mixed use development which includes residential appears infeasible.

The Pease Development Authority helped create the Greater Portsmouth Transportation Management Association (TMA) in 2002. This organization is now known as Seacoast Commuter Options.[19] The goal of Seacoast Commuter Options is to encourage employees to use other modes of transportation such as transit, carpool or vanpool, as opposed to single occupant vehicles (SOV). Seacoast Commuter Options provides a ride-matching program as well as a guaranteed ride-home program. In addition, they provide information on existing transit services provided by the Cooperative Alliance for Seacoast Transportation (COAST), Wildcat Transit, C&J Trailways, Vermont Transit and Amtrak. Seacoast Commuter Options also helps employers set up "commuter choice initiatives." These initiatives provide tax savings to employers and employees who use alternative modes and do not drive alone to work.

2.4.3.3 Other Measures

The Seacoast Metropolitan Planning Organization (MPO) has created an Alternative Transportation Guide which is available on the Internet. The website[20] contains information regarding ride-matching services, transit, park-and-ride lots and bicycle commuting. The website also includes links to additional websites which contain specific information about each service.

The NHDOT operates a Statewide Ride-share Program through its Bureau of Rail and Transit. The program is approximately 10 years old and has not yet built a substantial database. There are currently about 900 commuters registered for ride-matching.

The state's Ride-share Coordinator (based in NHDOT) also promotes ridership through individual employers by sponsoring transportation events, providing marketing materials, and encouraging employers to adopt TDM strategies, such as guaranteed ride-home programs, parking management, flex-time, and telecommuting.

2.4.4 Mode Alternatives

As part of the analysis of the potential improvements to the Spaulding Turnpike and Little Bay Bridges between Exit 1 and the Dover Toll Plaza, an evaluation of alternative transportation modes was conducted. These alternative modes include rail services, bus services, HOV lanes and reversible lanes. Employer-based programs to encourage employee alternatives to driving alone to work were also assessed. The objective for analyzing these other modes was to understand how they may complement and minimize the need for, and extent of, highway and bridge

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19 Seacoast Commuter Options can be accessed on the internet at www.seacoastcommuteroptions.org
20 www.seacoastmpo.org

improvements. Based on 2025 travel demand projections, current travel characteristics (*e.g.*, time, purpose and frequency of travel, mode of travel, vehicle occupancy, *etc.*) and assessment of the collective impact of various TDM options, three (3) basic travel lanes and one (1) auxiliary lane between Exits 3 and 6 are required northbound and southbound on the Turnpike and Little Bay Bridges to provide satisfactory system LOS D traffic flow characteristics during weekday morning and evening peak hours.

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 preliminary (DEIS) and revised results of the analysis of potential ridership for the various modes, along with a sensitivity analysis of ridership estimates *vis-à-vis* travel time and cost.

The mode options that were selected include four rail options, three HOV lane options, and three bus options. Following establishment of parameters describing the capabilities and limitations of each option, all the options were preliminarily tested individually and in combinations under different roadway and bridge infrastructure scenarios: the existing four-lane condition; a six-lane (three lanes northbound and three lanes southbound) facility with an additional HOV lane; and an eight-lane facility (three basic lanes and one auxiliary lane northbound, and three basic lanes and one auxiliary lane southbound).

The mode options analyzed were chosen based on technology, financing, and infrastructure that are available today and are 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, or park-and-ride facility, to accommodate all potential demand. Similarly, a sufficient number of seats per train or buses were assumed to be available to satisfy projected demand.

Based on the preliminary analysis results as presented in the DEIS, mode options were combined with each other and assessed under the different (four-lane, six-lane with an additional HOV lane and eight-lane) infrastructure scenarios. The range of ridership estimates, summarized in Tables 2.4-1 through 2.4-4; reflects the preliminary sensitivity analysis to travel time and cost. [Section 2.4.6.6 and Tables 2.4-12 and 2.4-13 include the revised ridership and sensitivity analyses.]

The level of service results reported in the tables are reflective of isolated conditions on the Little Bay Bridges as a stand alone facility and assume uninterrupted flow conditions. This analysis is useful for comparing the relative impacts of alternative modes in decreasing potential travel demand within the study area. However, the study area between Exits 3 and 6 is very compact. The actual level of service on the Little Bay Bridges and on the Turnpike between Exits 3 and 6 is governed by the effects of traffic weaving, merging and diverging maneuvers on the approaches, departures and within the interchange areas of Exits 3, 4 and 6. These system-related impacts control overall traffic operations between Exits 3 and 6. As such, the level of service results presented in Tables 2.4-1 through 2.4-4 do not reflect system-wide traffic operations or consider capacity constraints along the Turnpike north and south of the bridges.

2.4.4.1 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, the 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.

Four HOV lane options were conceptually developed and are depicted in the cross-sections in **Figures 2.4-7 and 2.4-8**.

- The first option consists of a six-lane cross-section providing two southbound and two northbound general purpose lanes, and two reversible center lanes which would flow southbound during the weekday morning peak period and flow northbound during the weekday evening peak period (**Figure 2.4-7**). However, 2025 travel demand estimates of 4,000 vehicles per hour in the off-peak direction during summer weekends require three travel lanes for a satisfactory (LOS D) level of service. As such, this option is not viable, and was not pursued.

- The second option consists of a seven-lane cross-section providing three southbound and three northbound general purpose lanes, and a single reversible center lane which would flow southbound during the weekday morning peak period and flow northbound during the weekday evening peak period (**Figure 2.4-7**).

- The third option consists of an eight-lane cross-section that provides concurrent flow HOV lanes in each direction (**Figure 2.4-7**).

Table 2.4-1
2025 Level of Service Summary on Little Bay Bridges, Non-SOV Alternatives Ridership and Roadway Volumes for Four-Lane No-Build Condition

	Morning Peak Hour Southbound				Evening Peak Hour Northbound			
Alternative	Ridership/ Utilization	Diverted Vehicles[1]	Volume[2] with Diversions	LOS[7]	Ridership/ Utilization	Diverted Vehicles[1]	Volume[2] with Diversions	LOS[7]
Existing (2003) – with no non-SOV Alternatives	N/A	N/A	4,025	E	N/A	N/A	4,070	E
No-Build (2025) – with no non-SOV Alternatives	N/A	N/A	4,747	F	N/A	N/A	5,087	F
TDM Program – Moderate[3]	178	178	4,569	F	178	178	4,909	F
TDM Program – Aggressive[3]	311	311	4,436	F	311	311	4,776	F
Bus Alternative 1 – Rochester to Boston[4]	37	31	4,716	F	37	31	5,056	F
Bus Alternative 2 – Rochester to PTC Express[4,5]	18	15	4,732	F	18	15	5,072	F
Bus Alternative 3 – Rochester to Portsmouth Enhanced Local[4]	46	39	4,708	F	46	39	5,048	F
Rail Alternative 1A – Expanded *Downeaster* Service from Dover[6]	71	59	4,688	F	71	59	5,028	F
Rail Alternative 1B – Expanded *Downeaster* Service from Rochester[6]	99	82	4,665	F	99	82	5,005	F
Rail Alternative 2A – Rochester to Portsmouth *via* Rockingham Junction	33	27	4,720	F	33	27	5,060	F
Rail Alternative 2B – Rochester to Portsmouth *via* Turnpike Corridor	158	131	4,616	F	158	131	4,956	F
Combination 1 -- Aggressive TDM and Bus Alts. 1-3	373	363	4,384	F	373	363	4,724	F
Combination 2 -- Aggressive TDM, Bus Alts. 1-3, and Rail Alt. 1B	441	419	4,328	F	441	419	4,668	F

1. The number of diverted vehicles for the bus and rail alternatives equals the projected ridership divided by an average vehicle occupancy rate of 1.2 persons per vehicle.
2. No-Build volume represents total peak hour travel demand. Actual roadway volumes under No-Build conditions are expected to be closer to roadway capacity because many drivers will alter travel behavior to avoid congestion and delays.
3. The Moderate and Aggressive TDM Programs are projected to result in a 4 and 7 percent reduction, respectively, in work trips to Portsmouth, Pease, Kittery, and Boston.
4. All Bus Alternatives assume use of general purpose lanes on Turnpike.
5. Bus Alternative 2 ridership is based on COAST''s CMAQ application for the Spaulding Turnpike Express. Peak hour ridership is net additional trips from adding one peak period bus to provide 25-minute headways throughout most of the peak period.
6. *Downeaster* ridership includes existing ridership.
7. Assumes uninterrupted traffic flow on the Little Bay Bridges as a simplistic measure of comparing alternatives. Assumptions do not accurately reflect the system-related impacts of interchange traffic operations which govern overall traffic level of service along the Turnpike between Exits 3 and 6.

Table 2.4-2
2025 Level of Service Summary on Little Bay Bridges, Non-SOV Alternatives Ridership and Roadway Volumes for Four-Lanes with Busway on General Sullivan Bridge

	Morning Peak Hour Southbound				Evening Peak Hour Northbound			
Alternative	Ridership/ Utilization	Diverted Vehicles[1]	Volume[2] with Diversions	LOS[7]	Ridership/ Utilization	Diverted Vehicles[1]	Volume[2] with Diversions	LOS[7]
Existing (2003) – with no non-SOV Alternatives	N/A	N/A	4,025	E	N/A	N/A	4,070	E
No-Build (2025) – with no non-SOV Alternatives	N/A	N/A	4,747	F	N/A	N/A	5,087	F
TDM Program – Moderate[3]	178	178	4,569	F	178	178	4,909	F
TDM Program – Aggressive[3]	311	311	4,436	F	311	311	4,776	F
Bus Alternative 1 – Rochester to Boston[4]	57	47	4,700	F	57	47	5,040	F
Bus Alternative 2 – Rochester to PTC Express[4,5]	35	29	4,718	F	35	29	5,058	F
Bus Alternative 3 – Rochester to Portsmouth Enhanced Local[4]	75	62	4,685	F	75	62	5,025	F
Rail Alternative 1A – Expanded *Downeaster* Service from Dover[6]	71	59	4,688	F	71	59	5,028	F
Rail Alternative 1B – Expanded *Downeaster* Service from Rochester[6]	99	82	4,665	F	99	82	5,005	F
Rail Alternative 2A – Rochester to Portsmouth *via* Rockingham Junction	33	27	4,720	F	33	27	5,060	F
Rail Alternative 2B – Rochester to Portsmouth *via* Turnpike Corridor	158	131	4,616	F	158	131	4,956	F
Combination 1 -- Aggressive TDM and Bus Alts. 1-3	409	393	4,354	F	409	393	4,694	F
Combination 2 -- Aggressive TDM, Bus Alts. 1-3, and Rail Alt. 1B	467	441	4,306	F	467	441	4,646	F

1. The number of diverted vehicles for the bus and rail alternatives equals the projected ridership divided by an average vehicle occupancy rate of 1.2 persons per vehicle.
2. No-Build volume represents total peak hour travel demand. Actual roadway volumes under No-Build conditions are expected to be closer to roadway capacity because many drivers will alter travel behavior to avoid congestion and delays.
3. The Moderate and Aggressive TDM Programs are projected to result in a 4 and 7 percent reductions, respectively, in work trips to Portsmouth, Pease, Kittery, and Boston.
4. All Bus Alternatives assume use of the General Sullivan Bridge as a busway with local roadway upgrades to provide busway connections.
5. Bus Alternative 2 ridership is based on COAST's CMAQ application for the Spaulding Turnpike Express. Peak hour ridership is net additional trips from adding one peak period bus to provide 25-minute headways throughout most of the peak period.
6. *Downeaster* ridership includes existing ridership.
7. Assumes uninterrupted traffic flow on the Little Bay Bridges as a simplistic measure of comparing alternatives. Assumptions do not accurately reflect the system-related impacts of interchange traffic operations which govern overall traffic level of service along the Turnpike between Exits 3 and 6.

Table 2.4-3
2025 Level of Service Summary on Little Bay Bridges, Non-SOV Alternatives Ridership and Roadway Volumes for Six-Lane Build Condition

	Morning Peak Hour Southbound				Evening Peak Hour Northbound			
Alternative	Ridership/ Utilization	Diverted Vehicles[1,2]	Volume[3] with Diversions	LOS[8]	Ridership/ Utilization	Diverted Vehicles[1,2]	Volume[3] with Diversions	LOS[8]
Existing (2003) – with no non-SOV Alternatives	N/A	N/A	4,025	E	N/A	N/A	4,070	E
No-Build (2025) – with no non-SOV Alternatives	N/A	N/A	4,747	F	N/A	N/A	5,087	F
Build (2025) – with no non-SOV Alternatives	N/A	N/A	5,317	E	N/A	N/A	5,497	E
HOV Lane Alt. A – Toll Plaza to I-95	185	216	5,102	E	204	238	5,259	E
HOV Lane Alt. B – Toll Plaza to Exit 1	320	373	4,944	D	296	345	5,152	E
TDM Program – Moderate[4]	199	199	5,118	E	199	199	5,298	E
TDM Program – Aggressive[4]	348	348	4,969	D	348	348	5,149	E
Bus Alternative 1 – Rochester to Boston[5]	28	23	5,294	E	28	23	5,474	E
Bus Alternative 2 – Rochester to PTC Express[5,6]	18	15	5,302	E	18	15	5,482	E
Bus Alternative 3 – Rochester to Portsmouth Enhanced Local[5]	26	21	5,296	E	26	21	5,476	E
Rail Alternative 1A – Expanded *Downeaster* Service from Dover[7]	47	39	5,278	E	47	39	5,458	E
Rail Alternative 1B – Expanded *Downeaster* Service from Rochester[7]	66	55	5,262	E	66	55	5,442	E
Rail Alternative 2A – Rochester to Portsmouth *via* Rockingham Junction	6	5	5,312	E	6	5	5,492	E
Rail Alternative 2B – Rochester to Portsmouth *via* Turnpike Corridor	27	22	5,295	E	27	22	5,475	E
Combination 1 -- Aggressive TDM and Bus Alts. 1-3	395	387	4,930	D	395	387	5,110	D
Combination 2 -- Aggressive TDM, Bus Alts. 1-3, and Rail Alt. 1B	461	421	4,896	D	461	421	5,076	D
Combination 3 – Combination 2 plus HOV Alt. B	781	794	4,523	D	757	766	4,731	D
Combination 4 – Combination 1 plus HOV Alt. B	715	760	4,557	D	691	732	4,765	D

1. The number of diverted vehicles for the bus and rail alternatives equals the projected ridership divided by an average vehicle occupancy rate of 1.2 persons per vehicle.
2. The number of diverted vehicles for the HOV alternatives includes HOVs already in the traffic stream plus twice the number of induced HOVs. Two SOVs are eliminated for each HOV created.
3. No-Build volume represents total peak hour travel demand. Actual roadway volumes under No-Build conditions are expected to be closer to roadway capacity because many drivers will alter travel behavior to avoid congestion and delays.
4. The Moderate and Aggressive TDM Programs are projected to result in a 4 and 7 percent reductions, respectively, in work trips to Portsmouth, Pease, Kittery, and Boston.
5. All Bus Alternatives assume use of an HOV facility between the Toll Plaza and Exit 1.
6. Bus Alternative 2 ridership is based on COAST's CMAQ application for the Spaulding Turnpike Express. Peak hour ridership is net additional trips from adding one peak period bus to provide 25-minute headways throughout most of the peak period.
7. *Downeaster* ridership includes existing ridership.
8. Assumes uninterrupted traffic flow on the Little Bay Bridges as a simplistic measure of comparing alternatives. Assumptions do not accurately reflect the system-related impacts of interchange traffic operations which govern overall traffic level of service along the Turnpike between Exits 3 and 6.

Table 2.4-4
2025 Level of Service Summary on Little Bay Bridges, Non-SOV Alternatives Ridership and Roadway Volumes for Eight-Lane Build Condition

Alternative	Morning Peak Hour Southbound Ridership/ Utilization	Morning Peak Hour Southbound Diverted Vehicles[1]	Morning Peak Hour Southbound Volume[2] with Diversions	Morning Peak Hour Southbound LOS[7]	Evening Peak Hour Northbound Ridership/ Utilization	Evening Peak Hour Northbound Diverted Vehicles[1]	Evening Peak Hour Northbound Volume[2] with Diversions	Evening Peak Hour Northbound LOS[7]
Existing (2003) – with no non-SOV Alternatives	N/A	N/A	4,025	E	N/A	N/A	4,070	E
No-Build (2025) – with no non-SOV Alternatives	N/A	N/A	4,747	F	N/A	N/A	5,087	F
Build (2025) – with no non-SOV Alternatives	N/A	N/A	5,447	D	N/A	N/A	5,792	D
TDM Program – Moderate[3]	204	204	5,243	D	204	204	5,588	D
TDM Program – Aggressive[3]	357	357	5,090	D	357	357	5,435	D
Bus Alternative 1 – Rochester to Boston[4]	26	22	5,425	D	26	22	5,770	D
Bus Alternative 2 – Rochester to PTC Express[4,5]	18	15	5,432	D	18	15	5,777	D
Bus Alternative 3 – Rochester to Portsmouth Enhanced Local[4]	21	18	5,429	D	20	17	5,775	D
Rail Alternative 1A – Expanded *Downeaster* Service from Dover[6]	39	23	5,424	D	39	23	5,769	D
Rail Alternative 1B – Expanded *Downeaster* Service from Rochester[6]	55	46	5,401	D	55	46	5,746	D
Rail Alternative 2A – Rochester to Portsmouth *via* Rockingham Junction	3	2	5,445	D	3	2	5,790	D
Rail Alternative 2B – Rochester to Portsmouth *via* Turnpike Corridor	14	11	5,436	D	14	11	5,781	D
Combination 1 -- Aggressive TDM and Bus Alts. 1-3	390	385	5,062	C	390	385	5,407	D
Combination 2 -- Aggressive TDM, Bus Alts. 1-3, and Rail Alt. 1B	420	410	5,037	C	420	410	5,382	D

1. The number of diverted vehicles for the bus and rail alternatives equals the projected ridership divided by an average vehicle occupancy rate of 1.2 persons per vehicle.
2. No-Build volume represents total peak hour travel demand. Actual roadway volumes under No-Build conditions are expected to be closer to roadway capacity because many drivers will alter travel behavior to avoid congestion and delays.
3. The Moderate and Aggressive TDM Programs are projected to result in a 4 and 7 percent reductions, respectively, in work trips to Portsmouth, Pease, Kittery, and Boston.
4. All Bus Alternatives assume use of general purpose lanes on Turnpike.
5. Bus Alternative 2 ridership is based on COAST's CMAQ application for the Spaulding Turnpike Express. Peak hour ridership is net additional trips from adding one peak period bus to provide 25-minute headways throughout most of the peak period.
6. *Downeaster* ridership includes existing ridership.
7. Assumes uninterrupted traffic flow on the Little Bay Bridges as a simplistic measure of comparing alternatives. Assumptions do not accurately reflect the system-related impacts of interchange traffic operations which govern overall traffic level of service along the Turnpike between Exits 3 and 6.

- The fourth option consists of a six-lane cross-section with moveable barriers that will allow four lanes of travel in the weekday peak direction of flow (and two lanes of travel in the off peak direction) by borrowing a lane from the off-peak direction for either HOVs or traffic in general (**Figure 2.4-8**).This concept is commonly referred to as a "zipper lane". During the weekends, three lanes would be provided in each direction. It should be noted that a single moveable barrier – as opposed to the median barriers conceptualized in **Figure 2.4-8** – was deemed infeasible. Piers located in the median at Exit 3 and at Exit 6 will be required to support the bridges which span the Turnpike. Such piers preclude the possibility of shifting a single barrier from the southbound side of the Turnpike to the northbound side.

Under Options 2, 3 and 4, three operating scenarios were considered for the north and south termini of the HOV lanes:

- Dover Toll Plaza to I-95 (HOV Alternative A)
- Dover Toll Plaza to Exit 1 (HOV Alternative B)
- Exit 6 (US 4) to Exit 1 (HOV Alternative C)

2.4.4.2 Rail

Based on the information presented in the Scoping and Rationale Reports, four rail alternatives were identified for preliminary analysis. These conceptual rail alternatives were developed to address two complementary goals: divert automobile trips to passenger rail service, and divert freight traffic from truck to rail. Both goals work to address congestion on the Turnpike. Several of these alternatives included sub-options for different alignments, and one sub-option considered Bus Rapid Transit on a fixed guideway as an alternate technology. The alternatives that were developed are listed below:

- Rail Alternative 1: Expanded *Downeaster* Service
  - Rail Alternative 1A: Dover to Boston
  - Rail Alternative 1B: Rochester to Boston *via* Dover
- Rail Alternative 2: Rochester to Portsmouth *via* Dover
  - Rail Alternative 2A: Rochester to Portsmouth *via* Dover and Rockingham Junction (Commuter Rail)
  - Rail/Fixed Guideway Alternative 2B: Rochester to Portsmouth *via* Dover and the Spaulding Turnpike Corridor (Commuter Rail or Bus Rapid Transit)
- Rail Alternative 3: Conway Branch
  Improvements to the Conway Branch, which runs from Rollinsford Junction to North Conway, to support passenger rail service or improved freight rail service

- Rail Alternative 4: Pease Spur
  Restoration of the Pease Spur from the Newington Branch into the Pease Tradeport to not preclude resumption of freight rail service into Pease

Figure 2.4-9 shows the proposed alignments of these four conceptual rail alternatives.

The Scoping Report had also identified the Main Line East as a potential candidate for passenger rail service and improvements to freight rail service. Consideration of passenger rail service along the Main Line East was eliminated because the most viable option, an extension of the Massachusetts Bay Transportation Authority (MBTA) Newburyport Line commuter rail service to Portsmouth, does not address the purpose and need of this study. While the potential for the service was documented in the 1999 study prepared by the Rockingham Planning Commission[21], the action would not help to improve transportation along the 3.5-mile segment of the Turnpike under study. Consideration of freight rail improvements on the Main Line East was eliminated because service on the rail line does not, and would not, directly impact truck traffic volumes in the study area. The majority of truck trips that could potentially be diverted to rail to traverse this line would come from Interstate 95 and do not, or would not, use the Turnpike.

In the development of Rail Alternative 2, several different modal options were considered for each alignment (Rochester-Portsmouth *via* Rockingham Junction and Rochester-Portsmouth *via* the Turnpike Corridor). An initial analysis of Commuter Rail, Light Rail Transit (LRT), and Bus Rapid Transit (BRT) was performed for both alignment options to identify the infrastructure requirements and order-of-magnitude capital cost estimates in each case. In the case of LRT and BRT, it was assumed that a dedicated, fixed guideway would be constructed for the length of the corridor. As a result of this initial analysis, LRT and BRT were eliminated from consideration in Rail Alternative 2A because of the major infrastructure requirements associated with separating the LRT or BRT guideway from the freight rail operations on the corridor. Similarly, LRT was eliminated from consideration in Rail Alternative 2B because of the major infrastructure requirements associated with separating the LRT vehicles from the freight and intercity trains on the Main Line West and crossing the Main Line West track to access the Conway Branch. BRT was carried forward for further analysis in Alternative 2B because the required guideway and crossing of the Main Line West could be constructed at a cost closer to that of commuter rail.

The following sections present brief descriptions of the conceptual rail alternatives that were developed for further analysis, the key infrastructure and equipment requirements associated with the alternatives, and their conceptual

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21 *Commuter Rail Service to Coastal New Hampshire: A Feasibility Study for the Hampton Branch*, Rockingham Planning Commission, June 30, 1999.

capital costs. The capital cost estimates include both infrastructure and equipment costs, and have been developed following the Federal Transit Administration (FTA) guidelines for the preparation of cost estimates. The infrastructure estimates include a 30 percent contingency for unknowns and a 20 percent allowance for survey, design, and construction phase services. As the alternatives are developed further, the cost estimates would be revised and these allowances would be reduced to reflect the development of more detailed plan information. The conceptual capital costs do not include the cost of land acquisition, although acquisition may be required in some cases. The equipment cost estimates reflect typical industry unit costs for orders of all sizes. It has been assumed that NHDOT would combine any equipment orders for this project with other orders to produce larger order sizes; otherwise, a small-order cost premium might be incurred.

Rail Alternative 1 – Expanded *Downeaster* Service

Since the completion of the Rationale Report, the Northern New England Passenger Rail Authority (NNEPRA) and MaineDOT have been developing a capital improvement program that would allow the introduction of a fifth roundtrip between Portland and Boston. This program – Alternative 1C -- includes track improvements in both Maine and New Hampshire. The New Hampshire improvements include upgrades to passing sidings in Dover and Newfields and the replacement of approximately three miles of rail in Dover and Exeter. The total cost of the program is approximately $6 million; the improvements in New Hampshire are approximately $2.0 million of the total cost. With these improvements, NNEPRA has adjusted the schedule of the current four roundtrips and added a fifth roundtrip to the schedule in August 2007 using the existing pool of equipment. The schedule adjustment changed the departure times of the existing morning peak period trip from Portland into Boston approximately one hour earlier. This change allows the first morning train to arrive in Boston around 8 AM. With the change, the first morning train departs Dover at 6:20 AM. These changes make the first Boston-bound trip more attractive for daily commuters.

Rail Alternatives 1A and 1B would build upon the Alternative 1C track improvements constructed in New Hampshire as part of the NNEPRA/Maine DOT *Downeaster* service enhancement plan. These alternatives would enhance the *Downeaster* intercity rail service to/from Boston by adding one round trip (one AM peak southbound trip, one PM peak northbound trip for a total of six round trips) to the enhanced *Downeaster* schedule. The new round trip would originate and terminate in New Hampshire. There are two possible passenger service options in this alternative:

- Rail Alternative 1A would operate passenger service between Dover and Boston, stopping at the existing *Downeaster* stations along the route.

- Rail Alternative 1B would extend the above service onto the Conway Branch to Rochester.

The proposed operating plan, schedule, and fares would be the same between Dover and Boston in both options; in Alternative 1B, the schedule and fare structure would simply be extended to Rochester. Freight rail service could also be indirectly improved through the additional infrastructure investment associated with this alternative.

The infrastructure needs associated with this alternative include minor station modifications in Dover and Durham (Alternatives 1A and 1B); a new station in Rochester (Alternative 1B); and a layover facility in Dover for overnight storage of equipment (Alternatives 1A and 1B). As noted previously, this alternative would take advantage of the recent NNEPRA/Maine DOT track improvements (Alternative 1C) that were implemented as part of the enhanced service plan for the *Downeaster* service. Additional track improvements may also be necessary to support Alternatives 1A and 1B depending on how the new trips fit into the current rail traffic patterns of Pan Am Railways and the Massachusetts Bay Transportation Authority.

The equipment needs are for one additional trainset[22] to operate the service. At present, NNEPRA leases the equipment used for the *Downeaster* service from Amtrak. The pool of available intercity equipment from Amtrak is limited; therefore, it has been assumed that a new set of equipment would need to be purchased. There are two options for the purchase of the equipment: 1) a traditional trainset consisting of a locomotive and coaches or 2) self-propelled diesel rail cars, also called Diesel Multiple Units (DMUs). A trainset consisting of DMU cars would be less expensive than a traditional locomotive hauled trainset. Table 2.4-5 summarizes the estimated capital cost of Rail Alternative 1A assuming the use of DMU equipment.

As shown in Table 2.4-5, the conceptual capital cost of Rail Alternative 1A, with DMU equipment is approximately $11.9 million. The incremental cost of extending service to Rochester (Rail Alternative 1B) is an additional $400,000 for the construction of a station stop in Rochester. The use of traditional rail equipment (locomotive and coaches) rather than DMU equipment would cost an additional $2.9 million, and as previously mentioned, the New Hampshire share of the Alternative 1C track improvement costs is approximately $2.0 million.

22 A trainset is a set of train equipment capable of carrying passengers or freight and providing its own propulsion. Passenger trainsets traditionally consist of a locomotive and one or more passenger coaches. However, diesel multiple unit (DMU) or Electric Multiple Unit (EMU) technology, in which each rail car provides both propulsion and passenger capacity, may also be used. EMUs would require overhead catenary and would be extremely expensive compared to DMUs or traditional equipment.

Table 2.4-5
Capital Costs of Rail Alternative 1A (with DMU equipment)

Item	Capital Cost (2007 dollars)
Rail Alternative 1A	
Infrastructure Subtotal	*$2.0 million*
Contingency and Survey/Design/Construction Services	*$0.9 million*
Infrastructure Total	$2.9 million
Equipment Total	$9.0 million
Grand Total – Rail Alternative 1A	**$11.9 million**

Rail Alternative 2 – Rochester to Portsmouth *via* Dover

This alternative would provide local rail service for commuters between the Rochester, Dover, and Portsmouth areas. Service would be provided on weekdays at 45-minute headways during peak periods and two-hour headways during off-peak periods. There are two possible alignment options for this alternative:

- Rail Alternative 2A would operate along three existing, active rail corridors: the Conway Branch from Rochester to Rollinsford; the Main Line West through Dover to Rockingham Junction; and the Portsmouth Branch to downtown Portsmouth, a total distance of approximately 35 miles. The service would stop at existing stations in Dover and Durham, and would also serve new station stops in Rochester, Somersworth, Newmarket, and two locations in Portsmouth (near the Portsmouth Transportation Center and in downtown Portsmouth).

- Rail Alternative 2B would operate along four existing rail corridors (three active, one abandoned) and along one new rail alignment for a total distance of approximately 24 miles. It would utilize the Conway Branch from Rochester to Rollinsford; the Main Line West to Dover Station; the abandoned Sawyer/Dover Branch to the Spaulding Turnpike right-of-way; a new alignment along the east side of the Turnpike Corridor across Pomeroy Cove and Little Bay on new structures; and the Newington Branch into downtown Portsmouth. The service would stop at the existing station in Dover, and would also serve new station stops in Rochester, Somersworth, at the east end of Gosling Road in Newington, and downtown Portsmouth.

Rail Alternative 2A assumes the operation of a commuter rail service using fully Federal Railroad Administration (FRA)-compliant equipment to take advantage of the existing rail infrastructure that is in place along the alignment. In this option, three trainsets would be required to operate the service, with a fourth set as a spare. For Rail Alternative 2B, two modal options were evaluated: a commuter rail service using fully FRA-compliant equipment to take advantage of the existing rail infrastructure between Dover and Rochester and between Little Bay and Portsmouth, and a BRT service on a dedicated guideway constructed along the Conway Branch, Main Line West, Sawyer/Dover Branch, Turnpike Corridor, and Newington Branch. In Rail Alternative 2B, three commuter rail trainsets or three articulated BRT vehicles would be needed to provide the service, with a fourth set of equipment as a spare in either case. Freight rail service could also be indirectly improved through the infrastructure investments associated with the commuter rail options in this alternative.

The infrastructure needs for Rail Alternative 2A include construction of a second track along the Main Line West from Dover to Rockingham Junction; reconstruction of the Portsmouth Branch; construction of passing sidings on the Conway and Portsmouth Branches; installation of a signal system on the Conway and Portsmouth Branches; modifications to the signal system along the Main Line West; a layover and servicing facility in Dover; modifications to the existing Dover and Durham stations; and construction of five new stations. The modifications to the Dover and Durham stations are assumed to include construction of a new platform and canopy adjacent to the new second track, and the addition of 50 parking spaces. New station stops are assumed to include a new platform, canopy, and approximately 50 parking spaces. These new station stops would be located in Rochester, Somersworth, Newmarket, and at two locations in Portsmouth. The Portsmouth locations would include a station stop near the Portsmouth Transportation Center (at a location which could be served by the COAST Tradeport Trolley), and a stop in downtown Portsmouth.

The infrastructure needs for Rail Alternative 2B (Commuter Rail) include construction of a new rail alignment from the Dover Station to the Little Bay along the Turnpike Corridor; reconstruction of the Newington Branch; construction of passing sidings on the Conway Branch and along the new rail alignment; installation of a signal system on the Conway and Newington Branches and along the new rail alignment; rail crossings of Pomeroy Cove and Little Bay on new structures; a layover and servicing facility in Dover; modifications to the Dover Station; and construction of four new stations. The modifications to the Dover station are assumed to include construction of a new platform and canopy adjacent to the new second track, and the addition of 50 parking spaces. New station stops are assumed to include a new platform, canopy, and approximately 50 parking spaces. These new stations would be located in Rochester, Somersworth, at the east end of Gosling Road in Newington (which would serve the Pease Tradeport and nearby retail areas *via* a shuttle connection), and downtown Portsmouth. Rail Alternative 2B (Commuter

Rail) would likely impact Hilton Park (a Section 4(f) recreational resource) on the north side of the channel, and would impact several other properties along the Turnpike right-of-way between Little Bay and downtown Dover.

The infrastructure needs for Rail Alternative 2B (Bus Rapid Transit) include construction of a new dedicated, fixed guideway from Rochester to Portsmouth along the Conway Branch, Main Line West, the Turnpike Corridor, and the Newington Branch; special guideway bridges across the Main Line West, Pomeroy Cove, Little Bay, and North Mill Pond (in downtown Portsmouth); a storage and servicing facility in Dover; modifications to the Dover Station; and construction of four new stations. The modifications to the Dover station are assumed to include construction of a new bus shelter and turnout, and the addition of 50 parking spaces. New station stops are assumed to include a bus shelter and turnout and approximately 50 parking spaces. These new stations would be located in Rochester, Somersworth, at the east end of Gosling Road in Newington (which would serve the Pease Tradeport and nearby retail areas *via* a shuttle connection), and downtown Portsmouth. Alternative 2B (Bus Rapid Transit) would likely impact Hilton Park and would impact several other properties along the Turnpike right-of-way between Little Bay and Dover and along the Main Line West between Dover and Rollinsford Junction.

Table 2.4-6 summarizes the estimated capital cost of Rail Alternative 2 (infrastructure and DMU equipment):

Table 2.4-6
Capital Costs of Rail Alternative 2 – Portsmouth to Rochester

Item	Capital Cost (2007 dollars)
Rail Alternative 2A (Commuter Rail)	
Infrastructure Subtotal	$113.0 million
Contingency and Survey/Design/Construction Services	$56.5 million
Infrastructure Total	$169.5 million
Equipment Total	$36.0 million
Grand Total – Rail Alternative 2A (Commuter Rail)	**$205.5 million**

Table 2.4-6 Cont'd	
Rail Alternative 2B (Commuter Rail)	
Infrastructure Subtotal	$118.9 million
Contingency and Survey/Design/Construction Services	$59.5 million
Infrastructure Total	$178.4 million
Equipment Total	$36.0 million
Grand Total – Rail Alternative 2B (Commuter Rail)	**$220.2 million**
Rail/Fixed Guideway Alternative 2B (Bus Rapid Transit)	
Infrastructure Subtotal	$165.6 million
Contingency and Survey/Design/Construction Services	$82.8 million
Infrastructure Total	$248.4 million
Equipment Total	$2.3 million
Grand Total – Rail/Fixed Guideway Alt. 2B (Bus Rapid Transit)	**$250.7 million**

Rail Alternative 3 – Conway Branch

This alternative considers improvements to the Conway Branch, which runs from Rollinsford Junction to North Conway, as a way of attracting a passenger service operator or improving freight rail service on the Conway Branch. Total distance from North Conway to Dover *via* the Conway Branch and the Main Line West is approximately 72 miles. The Conway Branch is currently in service from Rollinsford Junction to near Route 28 in Ossipee, and in Conway and North Conway. A 22-mile segment of the Conway Branch between Ossipee and the Albany-Conway Town Line is currently inactive. Restoration of this segment would permit the resumption of freight rail service from Rollinsford to North Conway, improving the connectivity of the freight rail network from northern New Hampshire to the study area and points south and west. Restoration of the Conway Branch would also permit the operation of a passenger rail service which could connect to the *Downeaster* service at Dover.

The NHDOT completed a study in June 2004 that examined the feasibility of re-establishing the 22-mile abandoned segment of the Conway Branch between Ossipee and Conway. The study considered a three-phase approach to the track restoration. Phase 1 would bring the line up to FRA Class I standards to begin operations. This Phase would be sufficient for freight services in the short-term but would limit freight operating speeds to 10 mph and passenger service operating speeds to 15 mph. Phase 2 would bring the line up to Class II standards, permitting 25 mph freight operations and 30 mph passenger operations. This phase could be accomplished at startup and would need to be completed within five years. Phase 3 would include the cost of upgrading the rail to permit regular freight operations involving heavy cars. In the NHDOT study, Phase 1 was estimated to cost about $6.8 million, Phase 2 was projected to cost $1.4 million, and the Phase 3 upgrade was estimated to cost $12.3 million (in 2007 dollars).

For the purpose of this EIS, it was assumed that the track would need to be built to FRA Class IV standards (79 mph maximum passenger train operating speeds where permitted) and maintained to FRA Class III standards (permitting 60 mph passenger operating speeds) to establish an attractive passenger rail service on the Conway Branch. By building to the higher standards, maintenance costs can be kept to a minimum for the initial year of operation. A service plan consisting of two daily round trips, scheduled to meet the *Downeaster* service in Dover, was considered. A morning trip out of North Conway would meet the second southbound *Downeaster* trip departing from Dover to Boston, then would meet the first northbound trip arriving in Dover. The afternoon Conway Branch trip would meet the last southbound *Downeaster* trip from Dover to Boston, then would meet the last northbound trip arriving in Dover. It was assumed that the Conway Branch service would be a seasonal tourist-based service operating daily in the summer and Friday through Sunday during other times of the year.

The infrastructure needs for Rail Alternative 3 include upgrading the track along the 22-mile section between Ossipee and Conway from FRA Class II to Class IV standards; modifications to the Dover Station; and construction of five new stations along the Conway Branch. The modifications to the Dover station are assumed to include construction of a new platform and canopy for a potential second track or siding, and the addition of 50 parking spaces. New station stops are assumed to include a platform, canopy and approximately 50 parking spaces. It was assumed that these new station stops would be located in Rochester, Sanbornville, Ossipee, West Ossipee, and Conway[23]. The equipment needs for Rail Alternative 3 are one set of self-propelled DMU rail cars. Table 2.4-7 summarizes the estimated capital cost of Rail Alternative 3 (infrastructure and equipment). The costs of individual phases of rehabilitation from the NHDOT Feasibility Study are shown separately from the costs of improvements specific to Rail Alternative 3.

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23 There is an existing station stop served by the Conway Scenic Railroad in Conway; however, for the purposes of the capital cost estimate it has been assumed that the infrastructure required at this location would be similar to that required at a new station.

Table 2.4-7
Capital Costs of Rail Alternative 3 – Conway Branch

Item	Capital Cost (2007 dollars)
Initial Work Identified in NHDOT Conway Branch Feasibility Study	
NHDOT Study Phases 1 and 2	$8.7 million
NHDOT Study Phase 3	$12.7 million
Total – NHDOT Conway Branch Feasibility Study	**$21.4 million**
Rail Alternative 3 Improvements (Upgrade from FRA Class II to Class IV)	
Infrastructure Subtotal	$17.7 million
Contingency and Survey/Design/Construction Services	$8.8 million
Infrastructure Total	$26.5 million
Equipment Total	$8.7 million
Total - Rail Alternative 3 Improvements	**$35.2 million**
Grand Total – Conway Branch	**$56.6 million**

Rail Alternative 4 – Pease Spur

In Rail Alternative 4, the Pease Spur Corridor would be preserved from the Newington Branch into the Pease Tradeport to not preclude the resumption of freight rail service into Pease. The Pease Surface Transportation Master Plan[24] included the goal of attracting businesses that could be served by rail to the Tradeport; restoration of the Pease Spur would be an important step towards making this happen. Restoration of the spur would involve off-site improvements including the potential relocation of a segment of the spur to accommodate the grade separation of the Spaulding Turnpike crossing of the spur, as well as reconstruction of the remaining segment of the spur and a segment of track into the Tradeport. The resumption of freight rail service would be dependent on attracting new (or existing) businesses to receive and/or ship materials by rail. The potential freight rail operator would develop an operating plan and schedule based on the requirements of customers on site.

One of the primary considerations in developing the options to preserve the Pease Rail Corridor was to provide a safe grade-separated crossing to replace the existing (out-of-service) at-grade crossing between the rail corridor and the Spaulding Turnpike. To address this concern, two options were considered for the preservation of the Pease Spur Corridor:

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24 Pease Surface Transportation Master Plan, 1994; Updated 2002.

- Alternative 4A – Turnpike over Rail Option: This option would maintain the Pease Spur at-grade and would carry the Spaulding Turnpike over the rail corridor. This option is depicted as part of Alternative 10A (see **Figure 2.4-21**). The rail alignment would follow the existing at-grade alignment. The infrastructure associated with this alternative would include the earth embankment necessary to raise the level of the Turnpike over the rail corridor in the vicinity of the Pease Spur crossing, and construct a new highway bridge to carry the Turnpike traffic over the rail corridor.

- Alternative 4B – Rail over Turnpike Option: This option would carry the rail corridor over the Spaulding Turnpike and the adjacent Shattuck Way on new structures. This option is depicted as part of Alternative 13 (see **Figure 2.4-25**). The grade-separated rail alignment would approximately follow the existing at-grade alignment to the maximum extent possible. The infrastructure associated with this alternative would include two railroad bridges (one over the Spaulding Turnpike and the other over Shattuck Way), construction of earth embankment necessary to raise the railroad over the Turnpike and Shattuck Way and retaining walls to reduce slope impacts to adjacent private properties.

Under both alternatives, all the rail infrastructure, with the exception of the footing for the bridge pier in the Turnpike median (Alternative 4B) would be constructed as part of a future project if and when the Pease Spur is re-activated.

Table 2.4-8 summarizes the estimated capital cost of Rail Alternatives 4A and 4B. The cost of each alternative is broken down into two components: the cost of the rail infrastructure, and the cost of other infrastructure such as embankment, retaining walls, drainage, and structures as appropriate. The rail infrastructure cost only covers the segment from the Newington Branch to the existing spur line on the Tradeport; the cost of any rail reconstruction within the Tradeport (outside the limits of the rail relocation, Alternative 12A) is not included in this estimate. Both cost components are shown as a range of figures, reflecting the variations in track alignment, number of grade crossings, roadway configuration, and earthwork associated with the various roadway alternatives.

Table 2.4-8
Capital Costs of Rail Alternative 4 – Pease Spur

Item	Capital Cost (2007 dollars)
Rail Alternative 4A – Turnpike Over Rail Line	
Rail Infrastructure	$2.3 - $3.4 million
Embankment, Bridge over Railroad (Note: Costs are also included in **Figures 2.6-1 and 2.6-2**)	$7.0 million
Grand Total – Rail Alternative 4A	**$9.3 - $10.4 million**
Rail Alternative 4B – Rail Line Over Turnpike	
Rail Infrastructure	$2.3 - $3.4 million
Bridges, Embankment, Retaining Walls and Drainage (Note: Costs are also included in **Figures 2.6-1 and 2.6-2**)	$4.5 million
Grand Total - Rail Alternative 4B	**$6.8 – $7.9 million**

2.4.4.3 Bus

Three bus alternatives were developed for preliminary analysis. The primary goal of these alternatives was to attract peak-period riders who might otherwise drive along the Spaulding Turnpike corridor in the study area. The alternatives were developed to build upon and complement existing bus services in the area, including C&J Trailways intercity service and local services operated by COAST and Wildcat Transit. One of the proposed alternatives would also build upon an express bus service planned by COAST, which is expected to begin operations in the summer of 2008. The alternatives that were developed are listed below:

- Bus Alternative 1: Expanded Intercity Service
- Bus Alternative 2: Expanded Turnpike Express Service
- Bus Alternative 3: Expanded Local Service

Figure 2.4-10 depicts the proposed routes of these three conceptual bus alternatives.

One other bus alternative was developed initially, and then eliminated from further analysis based on feedback from the local transit operators in the area. The aim of this alternative was to create new local routes that would serve the Pease Tradeport directly from Rochester, Dover and Durham, eliminating the need for transfers to the COAST Tradeport Trolley. A conceptual service plan for the alternative was developed that proposed two new routes, one between Rochester, Dover and the Tradeport, and another between Durham and the Tradeport. Based on feedback received from COAST and Wildcat Transit, this alternative was eliminated in favor of Bus Alternative 3, which improves headways and creates an improved transfer point between existing COAST and Wildcat Transit routes.

The following sections present brief descriptions of the conceptual bus alternatives that were developed for further analysis, the key infrastructure and equipment requirements associated with the alternatives, and their conceptual capital costs. The capital cost estimates include both infrastructure and equipment costs, and have been developed following the FTA guidelines for the preparation of cost estimates. The infrastructure estimates include a 30 percent contingency for unknowns and a 20 percent allowance for survey, design, and construction phase services. As the alternatives are developed further, the cost estimates would be revised and these allowances would be reduced to reflect the development of more detailed plan information. The conceptual capital costs do not include the cost of land acquisition, although acquisition may be required in some cases. The equipment cost estimates reflect typical industry unit costs for orders of all sizes. It has been assumed that NHDOT would combine any equipment orders for this project with other orders to produce larger order sizes; otherwise, a small-order cost premium might be incurred.

It should be noted that all bus alternatives assume the use of common park-and-ride facilities. Therefore, there is a benefit to implementing a combined package of bus improvements because the combined package makes better use of the proposed park-and-ride facilities.

Based on feedback from the local transit operators during the study process, it was determined that some level of operating subsidy would be necessary in order for the operators to provide the proposed service, in addition to the provision of buses and infrastructure. Therefore, conceptual operating costs, revenues, and operating surplus/deficit have been estimated for the three bus alternatives. These order-of-magnitude estimates are based on conceptual operating plan assumptions and approximate unit costs, developed for planning purposes. Further refinement of these operating assistance estimates would be necessary before the proposed bus alternatives are implemented.

Bus Alternative 1 – Expanded Intercity Service

This alternative would provide expanded intercity coach bus service to serve the commuter market between the Rochester-Dover-Portsmouth area and Boston. The route would begin at new park-and-ride facilities located near the Spaulding Turnpike in Rochester (Exit 13) and Dover (Exit 9), and then follow the Turnpike to the existing Portsmouth Transportation Center (PTC). From there, buses would travel express to Boston *via* I-95, making one or two stops in Boston near Haymarket Square and the Financial District before terminating at South Station. Service would be provided at 20-minute headways for two hours in each peak period, and at two-hour headways during off-peak periods. This service could be operated in one of two ways: either as an extension of the existing C&J Trailways Dover-Boston service, or as a stand-alone service by another operator. Fares would be established at rates comparable to those on the existing intercity bus service between Dover, Portsmouth and Boston, as well as the *Downeaster* intercity rail service. This alternative could possibly be enhanced in the future with the development of an HOV lane or dedicated busway or transit lane along the Turnpike corridor to reduce travel time, should the Turnpike be congested.

The infrastructure needs associated with Bus Alternative 1 include construction of two new park-and-ride facilities. The cost of the Dover park-and-ride, which is currently under construction, is $3.4 million. The conceptual cost for a facility in Rochester near Exit 13 ranges from $1.2 to $1.3 million, depending on the location. (Refer to Section 2.4.4.4 for further information on park-and-ride facilities). The equipment needs associated with Bus Alternative 1 vary based on the assumption about how the service is operated. If this alternative was operated as an extension of C&J Trailways service, it is estimated that only one additional bus would be required. If this alternative was operated as a stand-alone service, equipment needs would likely include nine buses (seven to meet the proposed schedule and two spares). Table 2.4-9 summarizes the estimated capital cost and net operating surplus/deficit of Bus Alternative 1 for five years of service. Park-and-ride costs are summarized separately in Section 2.4.4.4.

It should be noted the C&J Trailways has recently submitted a successful Congestion Mitigation and Air Quality (CMAQ) application to fund the extension of intercity bus service from Portsmouth to the Exit 9 park-and-ride facility (described in Section 2.4.4.4) in Dover, north of the Newington-Dover study area. Sixteen daily roundtrips with 30-minute peak hour headways would be provided. The proposed service could be considered as the initial phase of implementing Bus Alternative 1 at a proposed 5-year capital equipment and operating cost of $2.3 million.

Table 2.4-9
Capital and Operating Costs of Bus Alternative 1 – Expanded Intercity Service

Item	Cost (2007 dollars)
Scenario A – Assuming C&J Trailways operates as extension of current Dover-Boston service	
Capital Cost (Equipment)	$496,000
Net Operating Cost/(Surplus) – 5 years	($68,000)
Grand Total – Bus Alternative 1 (Scenario A)	**$430,000**
Scenario B – Assuming operated as a stand-alone service	
Capital Cost (Equipment)	$4.46 million
Net Operating Cost/(Surplus) – 5 years	$117,500
Grand Total – Bus Alternative 1 (Scenario B)	**$4.6 million**

Bus Alternative 2 – Expanded Turnpike Express Service

This alternative would provide expanded express commuter bus service to allow residents in Rochester and Dover to reach jobs at the Pease Tradeport in Portsmouth more quickly than on local COAST routes. It would build on the Spaulding Turnpike Express service that is currently planned by COAST and expected to begin operations in the summer of 2008. The Spaulding Turnpike Express will provide service on generally 30-minute headways from Rochester to Pease/PTC in the morning peak and from Pease/PTC to Rochester in the evening peak. Bus Alternative 2 would build on the Turnpike Express service through the construction of park-and-ride facilities in Rochester and Dover, and through an improvement to either 20-minute headways in the peak hour or 25-minute headways in the peak two-and-a-half hours. This proposed expanded service could be operated with the three buses that are to be acquired by COAST with CMAQ funding for the Spaulding Turnpike Express service, plus one additional bus to provide the improved headways. This alternative could possibly be enhanced in the future with the use of a potential HOV lane or dedicated busway on the Turnpike to reduce travel times, should the Turnpike be congested.

The infrastructure needs associated with Bus Alternative 2 include construction of new park-and-ride lots in Dover and Rochester, the same as in Bus Alternative 1. The equipment costs include the purchase of one transit bus. Table 2.4-10 summarizes the estimated capital cost and net operating surplus/deficit of Bus Alternative 2 for five years of service. Park-and-ride costs are summarized separately in Section 2.4.4.4.

Table 2.4-10
Capital and Operating Costs of Bus Alternative 2 – Expanded Turnpike Express Service

Item	Cost (2007 dollars)
Capital Cost (Equipment)	$353,000
Net Operating Cost/(Surplus) – 5 years	$87,000
Grand Total – Bus Alternative 1 (Scenario B)	**$440,000**

Bus Alternative 3 – Expanded Local Service

This alternative would build on the strengths of three existing transit routes (the COAST Route 2, Wildcat Transit Route 4, and the COAST Tradeport Trolley) by improving headways during peak periods; improving the ability to collect passengers by adding new park-and-rides; and improving the distribution of passengers to the Pease Tradeport by improving the transfer point at the Fox Run Mall in Newington. The COAST Route 2 provides local service from Rochester to Market Square, Portsmouth. The Wildcat Transit Route 4 provides local service from the UNH campus and Durham to downtown Portsmouth. The COAST Trolley provides local service in two connected loops, one serving downtown Portsmouth and the Portsmouth Transportation Center, and the other serving downtown Portsmouth and the Lafayette Road area of Portsmouth. This alternative would improve local service along the Turnpike Corridor by reducing headways to 20 minutes for two hours in each peak period, thereby strengthening the transit connection from Rochester, Dover and Durham to the Tradeport.

The infrastructure associated with Bus Alternative 3 would include construction of a new park-and-ride lot (one near the Turnpike in Rochester), and the relocation and enhancement of the bus transfer point at the Fox Run Mall in Newington. The enhanced transfer point would include two bus bays, a lighted, heated bus shelter, benches, and signage. **Figure 2.4-11** depicts the conceptual layout of this enhanced transfer point. Refinement of the concept for the transfer point would be subject to discussions between the Fox Run Mall ownership, the Town of Newington, and the transit operators. The equipment needs associated with this alternative include the purchase of five transit buses and three replica trolley buses.

Table 2.4-11 summarizes the estimated capital cost (both equipment and infrastructure) and net operating surplus/deficit of Bus Alternative 3 for five years of service. Park-and-ride costs are summarized separately in Section 2.4.4.4.

Table 2.4-11
Capital Costs of Bus Alternative 3 – Expanded Local Service

Item	Cost (2007 dollars)
Fox Run Mall Transfer Point Infrastructure Cost	$115,000
Equipment Total	$2.8 million
Capital Cost Total	$2.9 million
Net Operating Cost/(Surplus) – 5 years	$1.6 million
Grand Total – Bus Alternative 3	**$4.5 million**

2.4.4.4 Park-and-Ride Facilities

One element common to many of the conceptual roadway and transit alternatives is the construction of new park-and-ride capacity along the Spaulding Turnpike corridor in and around the study area. These park-and-ride lots would serve two primary markets: drivers wishing to create carpools or vanpools before traveling on the Turnpike through the study area, or drivers wishing to utilize one of the proposed transit alternatives. In both cases, drivers would leave their automobiles at a park-and-ride facility and continue along the

Turnpike in a shared-ride or transit mode, reducing the number of vehicles and congestion levels on the Turnpike in the study area.

Potential park-and-ride facilities along the Turnpike corridor were considered to serve users of the bus alternatives described in Section 2.4.4.3, as well as drivers forming carpools and vanpools. Facilities were considered in four communities: Dover, Rochester, Durham and Lee (see **Figure 2.4-10**). In Dover, a facility has been proposed near the Turnpike at Exit 9; plans for this facility have been proceeding on a separate track using CMAQ funding, and the construction of this facility is currently underway. In Rochester and in the Durham/Lee area, a number of potential park-and-ride sites were investigated. Some of these sites were explored to a greater extent than others based on the anticipated utilization and the potential to contribute to reduction of trips on the Spaulding Turnpike within the study area. Further descriptions of the facilities investigated in each community are provided in the sections below.

Dover Park-and-Ride Facility

A park-and-ride facility is under construction near Exit 9 of the Spaulding Turnpike in the City of Dover. The facility is located on Indian Brook Drive less than one-half mile west of the Exit 9 interchange (see **Figure 2.4-12**). As noted above, project development for this facility has been proceeding on a separate track from the overall Spaulding Turnpike Improvements Project. It is anticipated that the facility will be served by C&J Transit intercity buses; the planned COAST Turnpike Express bus service; and potentially by Dover community bus service. Estimates of potential usage of such a facility have been developed based on the current C&J Trailways ridership from the downtown Dover location, historic usage of a former C&J terminal on NH 155A, projected usage of the COAST Turnpike Express from Dover, and the estimated number of travelers who would carpool from the site. The facility will be built to accommodate approximately 416 spaces. The estimated capital cost of the facility is approximately $3.4 million (based on bids received in July 2007). This cost includes the park-and-ride lot, land acquisition costs, and a passenger building with restrooms.

Rochester Park-and-Ride Facility

As part of the Spaulding Turnpike Improvements Project, a potential park-and-ride facility along the Turnpike in the City of Rochester has been considered. It is anticipated that such a facility would be served by the planned COAST Turnpike Express bus service and potentially by an extension of C&J Trailways intercity bus service. Such a facility could be either a new lot dedicated only to park-and-ride users, or a facility in which parking is shared with another use; in the latter case, concerns regarding the division of responsibilities or funding for a shared facility would need to be resolved. Based on initial input from the City and transit operators in the area, several potential sites at Exits 12, 13 and 14 were identified for such a facility, including:

- A large parking lot on Industrial Way, off Ten Rod Road, near Exit 14: The lot is located in the center of an industrial park and appears to be lightly used; it might be suitable for shared parking.

- A City-owned parcel on Industrial Way, off Ten Rod Road, near Exit 14: This parcel is undeveloped and might be suitable for a dedicated facility.

- Memorial Baptist Church, located on Ten Rod Road near Exit 14: The Church was previously involved in discussions on possible shared parking for an employer shuttle; this might be a site for future shared parking.

- Two privately-owned parcels near Exit 13: One parcel is to the northeast of the Exit 13 interchange, the other lies to the west. Both sites have good roadway access and could be suitable for either a dedicated or shared facility.

Subsequent discussion and preliminary site assessments generated consensus for either of the two privately owned parcels of land at Exit 13. The estimated demand for such a facility at Exit 13 in Rochester is approximately 200 vehicles. This figure is based on projected ridership on the COAST Turnpike Express service; potential ridership if C&J intercity service is extended to Rochester; and the estimated number of travelers who would carpool from the site. It is assumed that a facility in Rochester would include lighting, phones, bus shelters, information kiosks, and bicycle lockers. Conceptual layouts for a facility at each site are provided in **Figures 2.4-13 and 2.4-14**. The estimated capital cost for a dedicated facility at these sites ranges from $1.2 to $1.3 million (in 2007 dollars).

Durham/Lee Park-and-Ride Facility

Consideration was also given to the possibility of establishing a park-and-ride in the Durham/Lee area. It was anticipated that such a facility would potentially be served by Wildcat Transit Route 4 and by supplemental C&J intercity service that may be implemented between Dover, Durham, Exeter and Boston. Such a facility could be either a new lot dedicated only to park-and-ride users, or a facility in which parking is shared with another use. Based on initial input from the Town of Durham and transit operators in the area, several potential sites were identified for such a facility. These sites included:

- The site of a proposed new Town of Durham library on Old Piscataqua Road, near the US 4/NH108 interchange: The Town of Durham could incorporate shared park-and-ride spaces as it plans its new library.

- The existing Town of Durham outdoor ice rink on Old Piscataqua Road, near the US 4/NH 108 interchange: An existing dirt parking lot behind the rink could be upgraded for a shared-use facility; buses would stop on Old Piscataqua Road rather than enter the lot, due to site constraints.

- Undeveloped Town-owned land off W. Arthur Grant Circle in the Town of Durham, east of the US 4/NH 108 interchange: This area is cleared and has all utilities but has not yet been developed; it may be suitable for a dedicated facility.

- Existing park-and-ride located on US 4 in Lee to the west of the Lee traffic circle.

The estimated demand for such a facility in the Durham/Lee area is approximately 30 to 50 vehicles. This figure is based on an estimate of the number of Wildcat Route 4 riders who might use the facility (if Route 4 served the facility), an estimate of the number of users of the proposed supplemental C&J service who would use the facility, and the projected number of study area travelers who would carpool from the facility. Subsequent discussion with the transit operators and preliminary assessments determined that access to the sites in the Town of Durham would be problematic, and that enhancement and expansion of the existing facility located on US 4 to the west of the Lee traffic circle would be the more viable site.

Rail Stations

The conceptual rail alternatives described in Section 2.4.4.2 would also include provision for park-and-ride spaces at stations other than downtown Portsmouth. However, these locations are not anticipated to be used for carpool or vanpool commuting since most are not directly on, or near, the Spaulding Turnpike. The costs of these park-and-ride spaces are included in the capital costs for the rail alternatives in Section 2.4.4.2.

2.4.5 Ridership Projection Methodologies for Alternative Modes

The following sections describe the preliminary (DEIS) and revised (FEIS) methodologies used to project HOV utilization, reductions in roadway volumes associated with TDM programs, and ridership for various bus and rail service alternatives. These projections were used to calculate reductions in peak hour traffic volumes on the Spaulding Turnpike. Level of service for the reduced traffic volumes was analyzed to determine the potential positive impact of the alternative modes on the need for highway and bridge improvements. The impact of traffic diversions on traffic operations associated with alternative modes forms the basis for recommendations for further study of alternative modes to serve travel demands along the Newington-Dover section of the Turnpike.

2.4.5.1 Rail and Bus Ridership Methodology

The methodology initially used to project bus and rail transit ridership is described in the National Cooperative Highway Research Program (NCHRP) Report 187: *Quick-Response Urban Travel Estimation Techniques and Transferable Parameters*. This mode choice model has been updated as reflected in NCHRP Report 365. Both NCHRP Report 187 and NCHRP Report 365 contain mode choice models based on the relative impedances of using transit or driving. The NCHRP 187 model was previously used for the study of the rail extension from Lowell to Nashua. Because it had been calibrated to New Hampshire conditions, it initially appeared to be appropriate to use for the Newington-Dover study area. Further investigation indicated that the Nashua model was effective with projections of long distance transit travel (such as to Boston) but may have underestimated shorter travel (such as from Dover or Rochester to Pease and Portsmouth). As such, the ridership analysis was rerun using the equations specified in NCHRP Report 365 along with revised input variables as described below, and compared to the preliminary (DEIS) analysis. (See Table 2.4-12.) The process for projecting 2025 ridership for each rail and bus option is presented below.

The 2025 commuter population was projected using the following two steps:

1. The market or service area for each bus or rail station was identified. Each Strafford County town was assigned to the Rochester, Dover or Durham station based on proximity and location "upstream" from the station on the route of the trip. If one of those three stations was not part of a bus or rail alternative, the towns assigned to it were reassigned to the next most appropriate station. For transit alternatives that provided no service from Durham, towns in the Durham service area were assigned to Dover. Similarly, for alternatives with no service to Rochester, Rochester service area towns were assigned to Dover.

2. The 2025 daily population commuting from each market/service area to jobs in Boston, Newington, and Portsmouth was projected from the 2000 journey-to-work (JTW) data based on projected trip growth from the regional travel demand model. The resulting number of trips represented 2025 trips from each service area to Boston, Newington, and Portsmouth. These data were disaggregated to smaller areas in Newington (east and west of the Turnpike) and Portsmouth (Pease Tradeport, downtown, northeast Portsmouth, *etc.*) based on the future distribution of employment used in the regional travel

demand model. Daily trips were converted to peak hour trips based on the ratio of peak hour to daily trips from the 2000 journey-to-work data.

To determine how much of the 2025 commuter population would take transit, the auto and transit impedances for each origin and destination pair were compared. Transit and automobile travel impedances were measured in minutes and included total travel time associated with each trip. Initially, the impedances also included 100 percent of out-of-pocket costs converted to time (minutes) based on a rate of $17.50 per hour for trips to the Portsmouth area and $35.00 per hour for trips to downtown Boston. These values are based on average wage rates for the Portsmouth area (May 2003) and downtown Boston (first quarter 2004). To avoid the risk of overstating commuter aversion to somewhat longer travel times with transit, the average wage rates were reduced by 50% and the analysis re-run.[25] (See Table 2.4-12.)

The following describe what times and costs were included in the calculations of both auto and transit impedances.

1. The auto impedance includes:

   a) Driving travel time from home to workplace.

   b) Incremental or marginal cost of driving (at $0.16 per mile with gas at $2.00 per gallon) – marginal cost is used for the analysis because the use of transit for commuting to work is not expected to reduce the number of vehicles owned by the transit commuter. Therefore, the costs of basic auto ownership, such as insurance and depreciation, are assumed to remain constant and there will only be savings in operating costs for fuel, oil and maintenance. The marginal cost was developed from American Automobile Association data adjusted for the price of gasoline.[26]

   c) Average cost per day for parking ($14.00 in downtown Boston; $2.00 in downtown Portsmouth) – the average cost per day for parking in Boston includes daily costs based on monthly parking rates obtained from the Boston Transportation Department and assuming shared costs for carpoolers. No adjustment was made for commuters who receive free or subsidized parking. The rate for Portsmouth is based on municipal parking rates in effect at the time this analysis was conducted. Updated average parking costs of $17.05 and $3.63 for Boston and Portsmouth, respectively, are reflected in the revised analyses summarized in Table 2.4-12.

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25 1997 USDOT guidance indicates that only 50% of hourly wage should be used for these calculations except for time actually spent waiting at a bus stop. Research has found that use of 100% of wage tends to overstate commuter aversion to somewhat longer travel times with transit.

26 Ridership was calculated using $2.00 per gallon, $3.00 per gallon and $4.00 per gallon assumptions. (See Section 2.4.6.6).

2. The transit impedance includes:

   a) Drive time to station (10 minutes)

   b) Waiting time at station (5 minutes)

   d) Rail or bus travel time based on service plan

   e) Average shuttle travel time of 10 minutes plus 2.5 minute transfer time to shuttle service

   f) Average travel time from rail or bus terminal to final work destination (15 minutes for Boston, 10 minutes for downtown Portsmouth, and 5 minutes for the Pease Tradeport and all other destinations)

   g) Incremental or marginal cost of driving to station (at $0.16 per mile)

   h) Bus or rail fare based on monthly passes if available.

The transit share was then initially calculated for each area by using the logit mode choice equation described in the NCHRP Report 187, "Quick-Response Urban Travel Estimation Techniques and Transferable Parameters" and subsequently recalculated utilizing the updated model as reflected in NCHRP 365. Both model equations define an S- shaped curve which represents the attractiveness of transit based on estimated transit and automobile impedances for travel between two locations. The transit share calculated by the model is applied to the projected peak hour commuter trips to calculate the peak hour transit ridership.

2.4.5.2 High Occupancy Vehicle Utilization Methodology

The physical configuration of the proposed HOV facility (*e.g.*, concurrent flow lane, contraflow lane or separate reversible flow lane) did not factor into the projections of usage. The analysis methodology assumed that, whatever the configuration, there would be sufficient enforcement of restrictions on lane use that would keep the HOV lane free-flowing until 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 following presents the steps used to project 2025 utilization of the HOV lane for the HOV options described previously. The analysis was conducted for southbound travel in the morning peak hour and northbound travel in the evening peak hour. These are the peak flows on the Spaulding Turnpike which provides access from residences in Strafford County to employment in the Pease

Tradeport, City of Portsmouth and northeastern Massachusetts, including Boston.

- Using the regional travel demand model, the number of through trips between the following pairs of locations on the Spaulding Turnpike was calculated:

  - Dover Toll Plaza to I-95
  - Dover Toll Plaza to Exit 1 (Pease Boulevard/Gosling Road)
  - Exit 6 (US 4) to Exit 1 (Pease Boulevard/Gosling Road)

- Through trips were calculated from the 2025 model for both the morning and evening peak hours using a select link analysis for the links comprising the Spaulding Turnpike between the paired locations listed above.

- The number of HOVs in the through traffic stream between the pairs of locations listed above was calculated by multiplying the through volume by 11 percent. Based on the New Hampshire Seacoast Travel Survey conducted in June 2003, approximately 19 percent of respondents who reported they traveled by car traveled in a vehicle with another person. This is equivalent to about 11 percent of vehicles having more than one person.

- Assuming the HOV facility will accommodate 2+ HOVs (two or more persons in each vehicle), all through HOVs were assigned to the HOV facility and all remaining SOVs were assigned to the general purpose lanes.

- The number of HOVs in the HOV lane in the peak hour was increased based on projected time savings for travel in the HOV lane compared to travel in the general purpose lanes. According to literature research, a travel time savings between 5 and 10 minutes results in a 20 to 30 percent increase in the number of HOVs, a travel time savings of 10 to 15 minutes results in a 30 to 40 percent increase in HOVs, and a travel time savings of greater than 15 minutes results in a 40 to 50 percent increase in HOVs.[27] Assuming uncongested operations in the HOV facility, the travel time savings in the HOV lane was prorated based on length of the lane. The HOV lane between the toll plaza and I-95 was assumed to save the full amount of the delay for traveling the entire length of the study corridor.

- Based on the projected travel time saving, the base HOV volume was increased by the appropriate percent indicated above.

- The number of single occupant vehicles in the general purpose lane was reduced to reflect the diversion to HOV trips. Two SOVs were eliminated

27 Wesemann, Larry. "Forecasting Use on Proposed High-Occupancy-Vehicle Facilities in Orange County, California, *Transportation Research Record.* Pp. 1-12.

from the general purpose lanes for each HOV created; all HOVs were assigned to the HOV lane.

- The resulting volume in the general purpose lanes was used to determine the projected level of service in the general purpose lanes with the provision of an HOV facility.

2.4.5.3 Travel Demand Management Methodology

The United States Environmental Protection Agency (USEPA) COMMUTER Model was used to project reductions in work trips to areas served by moderate and aggressive TDM programs. This model calculates the transportation and emissions benefits of Commuter Choice and other voluntary strategies to reduce single occupant vehicle (SOV) commuting. COMMUTER offers two levels of analysis: Regional analyses can be done on programs covering an urban area, a central business district or a highly-traveled corridor. Site-specific analyses enable benefits to be projected for programs at individual worksites. The model, which is used mainly to support air quality analyses, projects the percent reduction in trips based on the share of employees in the area covered by various TDM measures in the following categories:

- Site Walk Access Improvements – preferential parking, improved walk access to transit

- Transit Service Improvements – more frequent and/or faster service to the site

- Financial Incentives – parking cost subsidies, transit fare/pass subsidies, or other financial incentives

- Employer Support Programs – support programs for carpooling, vanpooling, transit, and/or bicycling

- Alternative Work Schedules – flex-time, telecommuting, staggered work hours, and/or compressed work weeks

Measures in the transit service improvements category were not included in this analysis to avoid double counting the ridership projections for bus and rail transit alternatives. The financial incentives category assumes the availability of transit service to the area being analyzed.

The percent reductions obtained from the program were applied to 2025 peak hour trips between Strafford County municipalities and the Pease Tradeport, downtown Portsmouth and downtown Boston based on projected journey-to-work data. The total reductions for each section of the Spaulding Turnpike were subtracted from the projected 2025 No-Build traffic volume to obtain a projected traffic volume with each TDM program.

The following is a list of TDM measures analyzed by the COMMUTER program to develop trip reductions for moderate and aggressive TDM programs. Numbers in parentheses indicate the assumed employer participation rates, respectively, for the moderate and aggressive TDM programs.

- Preferential parking for carpools and vanpools (10 percent; 20 percent)
- Reduced parking fees for carpools/vanpools (15 percent; 30 percent)
- Subsidies for vanpools (15 percent; 30 percent)
- Transit subsidies (15 percent; 30 percent)
- Employer support programs such as on-site transportation coordinator, ride-matching services, and transit schedule and route information (30 percent; 60 percent)
- Alternative work schedules such as flex-time, compressed work weeks, staggered work hours, and telecommuting (10-20 percent; 20-40 percent)

2.4.6 Alternative Modes Ridership and Utilization Projections

The following sections present the results of the application of the methodologies previously described to the HOV, bus and rail alternatives described in Sections 2.4.4.1 through 2.4.4.3. Traffic reductions associated with moderate and aggressive TDM programs were also projected. The initial (DEIS) ridership and utilization projections are summarized in Tables 2.4-1 through 2.4-4 and are described below for each alternative. The tables also include the number of vehicles diverted from the Spaulding Turnpike between Exit 3 and Exit 6 (across the Little Bay Bridges) and the resultant effect of these diversions on roadway level of service. Analyses were conducted for four scenarios: the existing four-lane Turnpike and Little Bay Bridge facility under No-Build conditions (Table 2.4-1); the existing facility with the use of the General Sullivan Bridge as an exclusive busway (Table 2.4-2); a six-lane (three lanes southbound and three lanes northbound) facility (Table 2.4-3); and an eight-lane (four lanes southbound and four lanes northbound) facility (Table 2.4-4). Under the six-lane build scenario, bus ridership was projected assuming use of an HOV facility (a seventh lane) for bus operations.

The traffic volumes across the Little Bay Bridges used in the level of service analyses for No-Build conditions in Tables 2.4-1 through 2.4-4 represent total 2025 peak hour travel demand. These No-Build volumes represent the total desire for travel along the roadway in the peak hour and exceed the peak hour capacity of the existing four-lane roadway. As described in Section 2.4.1, the No-Build Alternative is not considered a viable alternative, but serves as a baseline condition for comparison to other alternatives. Although the No-Build volumes are not limited by the roadway capacity, they are somewhat reduced from build volumes because of No-Build capacity constraints. These capacity constraints result in some shifting of traffic to alternative routes by the travel demand model, but these shifts are not large enough to reduce demand to a level equal to roadway capacity. Actual roadway volumes under No-Build conditions are expected to be closer to roadway capacity as many drivers will shift travel to non-peak times to avoid congestion and long delays. **Figures 2.4-1 and 2.4-2,** presented earlier, illustrate this expected peak hour spreading.

Existing weekday evening peak hour delay on the Turnpike through the study area is approximately eight minutes based on travel time runs conducted for this study. This delay represents the difference between the average travel time with no congestion and the average travel time under congested conditions. Based on the travel demand model output, this delay is projected to increase to about 20 minutes under the 2025 No-Build condition, which would result in congestion and queuing beyond the study area limits (south of Exit 1). Under the six-lane build alternative the delay is expected to decrease to about five minutes under 2025 traffic conditions. This is less than the existing delay because the flow rate per lane under the Six-Lane Alternative is less than under the four-lane existing condition. The eight-lane build scenario does not include any substantial vehicle delay along the Spaulding Turnpike because the Turnpike is projected to operate at LOS D or better. Level of Service D operations allow traffic to operate at free flow speed.

Figure 2.4-8, presented earlier, shows a possible cross-section for a Six-Lane Alternative that would provide for a temporary contraflow or “zipper” lane. This configuration could allow the Six-Lane Alternative to provide the same capacity in the peak direction in peak periods as the Eight-Lane Alternative. The zipper lane would be comprised of two moveable barriers against either side of the median. The moveable barrier on one side of the highway could be shifted toward the outside of the roadway by one lane, and the inside lane could be used to accommodate general traffic traveling in the opposite direction. The moveable barrier would separate the opposing flows. For example, in the evening peak period, the moveable barrier on the southbound side of the highway would be moved between the inside and middle lanes. The inside southbound lane would then be opened to northbound traffic. As a result, the roadway would provide four lanes in the peak northbound direction and two lanes in the off-peak southbound direction. In the morning peak period the configuration would be reversed. In off-peak times, the moveable barriers would be stored against the median allowing three lanes to move in each direction. The initial ridership analyses presented in Table 2.4-1 through 2.4-4 for the Eight-lane Build

Alternative would approximate the use of a zipper lane with the six-lane cross-section.

2.4.6.1 Rail

Rail Alternative 1A (Expanded *Downeaster* Service from Dover)

Rail Alternative 1A would expand existing *Downeaster* train service from Dover and Durham to Boston by providing an additional peak period train. Rail travel time from Dover to Boston is estimated to be approximately 1 hour 30 minutes, while driving time is estimated to be approximately 1 hour and 55 minutes under No-Build conditions. This includes a 20-minute delay for congestion on the Spaulding Turnpike under No-Build conditions (2025). The 20-minute delay for travel along the Turnpike is based on changes in travel time projected by the model and the existing delay of almost eight minutes observed during travel time runs conducted in June 2004. The monthly fare from Dover would be $289.00[28], or $17.00 per one-way trip.

For the No-Build scenarios, the projected peak hour ridership of 71 passengers would result in the diversion of about 59 vehicles from the Spaulding Turnpike. This number of diverted vehicles is not sufficient to result in an improved roadway level of service. This projected (2025) ridership includes current boardings at Dover and Durham. Peak hour ridership is projected to be approximately 47 under the six-lane build scenario and 39 under the eight-lane build scenario. These are less than under the No-Build scenarios because a six-lane facility will operate with less congestion and delay, while the eight-lane scenario will experience no substantial delay.

Rail Alternative 1B (Expanded *Downeaster* Service from Rochester)

Rail Alternative 1B would extend the expanded *Downeaster* service described in Rail Alternative 1A to Rochester. Alternative 1B supplements the existing service from Dover and Durham to Boston with an additional peak period train that also services Rochester. Rail travel time from Rochester to Boston is expected to be about 1 hour and 45 minutes, while driving time from Rochester to Boston is estimated to be approximately 2 hours and 5 minutes, including the 20-minute delay for congestion on the Spaulding Turnpike under No-Build conditions. The monthly fare from Rochester would be $325.00, or $19.12 per one-way trip.

The projected peak hour ridership for this service is 99 passengers under the No-Build scenarios. This results in a diversion of about 82 vehicles from Spaulding Turnpike in the peak hour which is not sufficient to result in an improved roadway level of service. Under the Six- and Eight-lane Build

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28 Based on 2007 fares.

Alternatives, peak hour ridership is projected to be approximately 66 and 55 passengers, respectively. As with Alternative 1A, the ridership projections include existing boardings in Dover and Durham.

Rail Alternative 1C (Expanded *Downeaster* Service *via* Dover)

As part of their capital improvement program, Maine DOT and NNEPRA have upgraded sidings in Dover and Newfields and replaced approximately 5 miles of rail in Dover and Exeter. This work was completed in August 2007. These improvements, combined with similar improvements in Maine, allow NNEPRA to adjust peak hour schedules and to increase weekday service by adding a fifth roundtrip between Portland and Boston. Based on information in the CMAQ application for funding for these improvements, it is estimated that fewer than 10 additional peak-hour riders would be generated by the improvements in the Newington-Dover study corridor. This would result in a diversion of fewer than 10 peak-hour vehicles from the Spaulding Turnpike

Rail Alternative 2A (Rochester to Portsmouth *via* Rockingham Junction)

Rail Alternative 2A would provide new rail service between Rochester and Portsmouth *via* Dover, Durham, Rockingham Junction and the Portsmouth Transportation Center using existing rail infrastructure. Rail travel time from Rochester to Portsmouth would be approximately 60 minutes, while driving time is estimated to be approximately 46 minutes, including the 20-minute delay for congestion on the Spaulding Turnpike under No-Build conditions. The monthly fare from Rochester would be $170.00, or $4.05 per one-way trip. The projected peak hour ridership for this alternative under the No-Build scenarios is 33 passengers, resulting in a diversion of about 27 vehicles from Spaulding Turnpike. This number of diverted vehicles is not sufficient to result in an improved roadway level of service. The projected peak hour ridership under the Six- and Eight-lane Build Alternatives is approximately 6 and 3 passengers, respectively. With limited or no vehicle delay along the Spaulding Turnpike, this alternative has little attraction to commuters because of its relatively long travel time.

Rail Alternative 2B (Rochester to Portsmouth *via* the Turnpike Corridor)

Rail Alternative 2B would provide new rail service between Rochester and Portsmouth *via* the Spaulding Turnpike corridor with stops in Dover and at Gosling Road. Rail travel time from Rochester to Portsmouth would be approximately 45 minutes, while driving time is estimated to be approximately 46 minutes, including the 20-minute delay for congestion on the Spaulding Turnpike under No-Build conditions. The monthly fare from Rochester would be $170.00, or $4.05 per one-way trip. This alternative generates the largest ridership of any of the rail or bus alternatives. Projected peak hour ridership for this alternative under the No-Build scenarios is approximately 158 passengers. This would result in a reduction of about 131 vehicles in the peak hour. This number of diverted vehicles would not improve levels of service on the Spaulding

Turnpike. The projected peak hour ridership for the six- and eight-lane build scenarios is approximately 27 and 14 passengers, respectively.

2.4.6.2 Bus

The projected ridership for the bus alternatives for the No-Build and eight-lane build scenarios is based on the bus operating in the general purpose lanes. For the No-Build with busway scenario, the buses are assumed to use the busway on the General Sullivan Bridge. For the six-lane scenario, the projected ridership is based on the bus operating in an HOV lane between the toll plaza and Exit 1. Because roadway congestion on the Turnpike is greatly reduced under the six-lane scenario, bus ridership is lower than under either No-Build scenario. Under the eight-lane scenario, bus ridership is even lower because ample capacity is provided and projected LOS D operations on the Turnpike permit travel at free flow speed, resulting in no substantial delay.

Bus Alternative 1 (Rochester to Boston)

Bus Alternative 1 would provide service similar to the current C&J Trailways service, with a Rochester stop added and the Newburyport stop removed. Bus travel time from Rochester to Boston is approximately 2 hours and 15 minutes, while driving time is approximately 2 hours and 5 minutes, including the 20-minute delay for congestion on Spaulding Turnpike under No-Build conditions. A ten-ride pass would be $76.00, or $7.60 per one-way trip (C&J Trailways does not currently offer a monthly pass). The projected ridership for this alternative is approximately 37 passengers under the No-Build scenario and approximately 57 passengers under the No-Build scenario with a busway on the General Sullivan Bridge. The projected ridership would result in peak hour diversion of approximately 31 and 47 vehicles, respectively. These diversions would not improve levels of service on the Spaulding Turnpike. The projected ridership for the six- and eight-lane scenarios would be approximately 28 and 26 passengers, respectively.

Bus Alternative 2 (Rochester to Portsmouth)

Bus Alternative 2 would provide an expansion of the planned COAST Rochester-to-Portsmouth Spaulding Turnpike Express service. An additional peak period bus would be added to provide 25-minute headways throughout most of the peak period. Bus travel time from Rochester to the Portsmouth Transportation Center is approximately 1 hour, while driving time is approximately 46 minutes, including an assumed 20-minute delay for congestion on the Spaulding Turnpike under No-Build conditions. The monthly fare from Rochester and Dover would be $52.00, or $1.24 per one-way trip. The projected ridership for increasing this service is approximately 18 passengers under No-Build conditions without the busway on the General Sullivan Bridge and 35 passengers with the busway. These would result in a diversion of approximately 15 and 29 vehicles, respectively, from the Spaulding Turnpike in the peak hour. This number of diverted vehicles would not improve levels of service on the Spaulding Turnpike. The projected ridership is approximately 18 passengers under both the six- and eight-lane scenarios. The projection of ridership for this service is based on projections included in COAST's CMAQ application for the Spaulding Turnpike Express. The base ridership (70) is accounted for in the 2025 No-Build and Build with no non-SOV alternatives (Tables 2.4-1 through 2.4-4).

Bus Alternative 3 (Expanded Local Service)

Bus Alternative 3 would provide expanded local service through improvements to headways on the COAST Route 2, the COAST Pease Tradeport Trolley, and the Wildcat Transit Route 4. These service improvements would be supplemented by new park-and-ride facilities in Rochester, Dover, and Lee or Durham. This alternative would improve or provide service to all major employment centers in the area, including the Tradeport, downtown Portsmouth, and Woodbury Avenue. The monthly fare would be $35.00, or $0.83 per one-way trip. Projected peak hour ridership for this alternative is approximately 46 passengers under the No-Build scenario and 75 passengers under the No-Build scenario with the busway on the General Sullivan Bridge. These projections would result in the diversion approximately 39 and 62 vehicles, respectively, in the peak hour. This number of diverted vehicles would not improve levels of service on the Spaulding Turnpike. Projected ridership with the six- and eight-lane scenarios is approximately 26 and 21, respectively.

2.4.6.3 High Occupancy Vehicle Lanes

As stated previously, the physical configuration of the HOV alternatives (*e.g.* single or dual contraflow lanes, or single concurrent flow lanes) did not affect the ridership projections. The alternatives, as conceptually depicted in **Figures 2.4-7 and 2.4-8**, differ only in width of roadway cross-section and termini for beginning and ending of the lane usage. The HOV alternatives were analyzed for the six-lane build scenario only. The No-Build scenarios do not include any improvements to the Turnpike. Under the eight-lane build scenario, there would be no advantage to providing an HOV facility because there would be no substantial travel time delays.

HOV Alternative A

HOV Alternative A would provide an HOV lane between the Dover Toll Plaza and I-95 (with no access to and from Exit 1). Based on the 2025 travel demand model, approximately 154 HOVs are projected to be traveling southbound between the toll plaza and I-95 in the morning peak hour and approximately 170 HOVs are projected to be traveling northbound in the evening peak hour between I-95 and the toll plaza. A travel delay of about 5 minutes is projected along the corridor under the Six-lane Build Alternative based on the travel demand model. Because the HOV lane runs the entire length of the study corridor, it would provide a travel time savings of approximately 5 minutes. Based on this travel time saving, HOV volumes could be expected to increase by approximately 20 percent. With such an increase, the volume in the HOV lane would be approximately 185 vehicles in the morning peak hour and 204 vehicles in the evening peak hour. This increase in HOV volume would result in the reduction of 31 and 34 vehicles in the total roadway volume for the morning and evening peak hours, respectively. These reductions represent SOV drivers joining other drivers to create new carpools.

Approximately 216 and 238 vehicles would be diverted from the general purpose lanes in the morning and evening peak hours, respectively, under the six-lane build scenario. This diversion estimate assumes that all HOVs use the HOV lane and that two SOVs are eliminated from the general purpose lanes for each HOV created because of the availability of the HOV lane. These diversions would not change projected levels of service in either the morning or the evening peak hour when the roadway would continue to operate at LOS E. Operating conditions in the three general purpose lanes with an HOV lane would be lower than they would be with four general purpose lanes where all traffic would operate at LOS D.

The projected HOV lane volumes fall short of the minimum threshold of 800 vehicles per hour considered necessary to justify installing an HOV facility. The 800-vehicle threshold is based on the assumption that an HOV lane should provide a good level of service to as many people as a general purpose lane could. Assuming a minimum vehicle occupancy rate of two persons per vehicle, 800 vehicles would serve at least 1,600 persons, making its utilization comparable to that of a well utilized SOV lane.

HOV Alternative B

Alternative B was identified to extend between the Dover Toll Plaza and north of Exit 1. This would allow HOVs from the Spaulding Turnpike to reach either Exit 1 (Pease Tradeport) or I-95, but would not accommodate HOVs from US 4. Based on the 2025 travel demand model, approximately 267 HOVs are projected to travel southbound in the morning peak hour and approximately 247 HOVs are projected to travel northbound in the evening peak hour between Exit 1 and the toll plaza. As noted above, a travel delay of about 5 minutes is projected along the corridor under the Six-lane Build Alternative. Because the HOV lane under this alternative does not run the entire length of the study corridor, it would provide a travel time savings of less than 5 minutes. Based on this travel time saving, HOV volumes could be expected to increase no more than 20 percent. With such an increase, the volume in the HOV lane would be approximately 320 vehicles in the morning peak hour and 296 vehicles in the evening peak hour.

These volumes fall short of the 800-vehicle threshold considered necessary to justify installing such a facility.

The projected diversions of traffic from the general purpose lanes to the HOV lanes are based on the assumptions that all HOVs use the HOV lane and that two SOVs are eliminated from the general purpose lanes for each HOV created because of the availability of the HOV lane. Approximately 373 and 345 vehicles, respectively, would be diverted from the southbound general purpose lanes in the morning peak hour and from the northbound general purpose lanes in the evening peak hour. These diversions would improve traffic level of service on the Spaulding Turnpike from LOS E to LOS D for the morning peak hour but would continue LOS E operations in the evening peak hour.

HOV Alternative C

HOV Alternative C would extend from south of Exit 6 to north of Exit 1. This configuration would maximize the number of HOVs which would have access to the HOV lane by making it accessible to US 4 and the Spaulding Turnpike on the north and I-95 and Exit 1 (Pease Tradeport) on the south. However, this configuration cannot be physically accommodated because there is inadequate distance between the Exit 6 southbound on- and northbound off-ramps and the north end of the Little Bay Bridges. Insufficient spacing exists to safely allow weaving movements for vehicles entering the lane from US 4 (Exit 6W southbound on-ramp) or for vehicles exiting the lane to reach the off-ramp to US 4 (Exit 6W northbound off-ramp). No ridership projections are presented for this HOV alternative because of the physical constraints on its implementation.

2.4.6.4 Travel Demand Management

Based on the USEPA COMMUTER model, the moderate and aggressive TDM programs are projected to generate reductions of 4 percent and 7 percent, respectively, in work trips to areas with the programs. These initial reductions were applied to projected 2025 work trips between Strafford County and the Pease Tradeport, downtown Portsmouth, and downtown Boston. The moderate TDM program is expected to eliminate between 178 and 204 respective AM and PM peak hour vehicles on Spaulding Turnpike while the aggressive TDM program is projected to eliminate between 311 and 357 respective AM and PM peak hour trips. These diversions will not change level of service on the Spaulding Turnpike under the No-Build and eight-lane build scenarios. Under the six-lane build (with an added HOV lane) scenario, the aggressive TDM program would improve traffic operations from LOS E to LOS D in the morning peak hour. Neither program would improve traffic operations (LOS E) in the evening peak hour[29].

2.4.6.5 Combined Alternatives

A preliminary analysis of the possible effect of combining alternatives was conducted. Four combinations were considered. The first included the Aggressive TDM Program along with all three bus alternatives. The second combination built on the first and added Rail Alternative 1B (Expanded *Downeaster* Service to Rochester). The third combination added HOV Alternative B to the second combination. This combination would only occur under the six-lane build scenario. The fourth combination added Alternative B to Combination 1. The only difference between Combinations 3 and 4 is that Combination 4 does not include Rail Alternative 1B.

Combination 1 resulted in a total diversion of between about 363 and 393 vehicles. This combination results in no change in level of service under the two No-Build scenarios. It improves operations under the six-lane build scenario to LOS D in the morning and evening peak hours, and improves operations to LOS C in the morning peak hour and LOS D in the evening peak hour under the eight-lane build condition. Combination 2 would divert between about 410 and 441 trips or an additional approximately 48 trips. The Combination 2 diversions would have the same impact on levels of service as the Combination 1 diversions. Combination 3 has the largest impact on diverting vehicles. It adds HOV Alternative B and occurs only under the six-lane build scenario. Under this scenario it diverts between about 766 and 794 vehicles. These diversions would improve levels of service to LOS D in both peak hours. Combination 4, which is the same as Combination 3 except that it does not include Rail Alternative 1B, results in the diversion of 32 (evening peak hour) to 34 (morning peak hour) fewer vehicles than Combination 3. As with Combination 3, the diversions resulting from Combination 4 would improve levels of service to LOS D in both peak hours. These level of service results are for the Little Bay Bridges only (as a stand alone facility assuming uninterrupted traffic flows). The levels of service are not reflective of actual system-wide traffic operations and do not take into account upstream and downstream capacity constraints that influence traffic flow on the Little Bay Bridges and traffic operations between Exits 3 and 6.

In combining bus and rail alternatives, duplications in ridership were eliminated. Therefore, the total transit ridership under the combination alternatives is less than the total of the ridership reported individually for the bus and rail alternatives. In aggregating transit and HOV alternatives under the six-lane build scenario, however, an over-estimation of traffic diversion likely occurs because

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29 Table 2.4-12 also summarizes a revised estimate of vehicle diversions resulting from the aggressive employer-based TDM program based on the USEPA COMMUTER Model.

the HOV and transit alternatives compete for the same commuter market. Commuters who might be attracted to transit might also be attracted to ride-sharing. No information is available regarding the extent of double counting that might occur in aggregating the projections for transit and HOV use.

2.4.6.6 Sensitivity Analyses

Sensitivity tests of the ridership projections to a change in the vehicle operating cost parameter were conducted. The purpose was to initially (DEIS) test the impact of a rise in the price of gasoline from $2.00 to $3.00 per gallon and to test a change in the assumption about using only marginal or operating cost for vehicle cost. The analysis uses operating cost (gas, oil, tires, and maintenance) for calculating the cost per mile of using a vehicle. This approach assumes that no commuters will be able to eliminate the ownership of a vehicle. A sensitivity test was conducted to determine the impact of assuming 10 percent of commuters would save the full cost of owning a vehicle. Incorporating this assumption adds about $0.06 per mile to the vehicle cost. Accounting for a possible increase in the cost of gasoline to $3.00 per gallon adds another $0.05 per mile. The sensitivity test was therefore conducted using a vehicle cost of $0.27 per mile or $0.11 per mile more than the original $0.16 per mile cost (based on $2.00 per gallon) used in the ridership analysis.

The initial test was conducted on Rail Alternative 2B under the No-Build condition because it generates the highest ridership of the transit alternatives. At $0.16 per mile for vehicle cost, Rail Alternative 2B generates approximately 158 passengers and a diversion of 131 vehicles. Using a vehicle cost of $0.27 per mile results in a projected ridership of approximately 260 passengers and a diversion of 217 vehicles. This represents about 102 more passengers and an increased diversion of almost 86 vehicles in the peak hour. This increased diversion is not large enough to have a substantial impact on roadway operating conditions, and would not improve traffic operations.

As a result of the spike in gasoline costs following the gulf coast hurricanes and aftermath during the fall of 2005, a second sensitivity analysis (DEIS) was conducted to test changes only in the cost of gasoline. Unlike the sensitivity analysis discussed above, this scenario assumes that no commuters will be able to eliminate the ownership of a vehicle. Three prices for gasoline were tested: $2/gallon, $3/gallon, and $4/gallon. No other parameters were changed. This test was also conducted on Rail Alternative 2B under the No-Build condition (Table 2.4-1). The projected riderships are 158, 197, and 244, respectively, at gasoline costs of $2/gallon, $3/gallon, and $4/gallon. Note that the difference in ridership at $3/gallon in the analysis presented above (260) versus this analysis (197) represents the impact of assuming that some drivers, who switch to transit, will be able to eliminate ownership of a vehicle as a result.

Revised Analysis Results

The results of the revised[30] ridership and sensitivity analyses are presented in Tables 2.4-12 and 2.4-13. Table 2.4-12 also includes the original (DEIS) ridership projections for comparison. In general, the revised ridership analyses produce higher ridership and a larger number of vehicles diverted from the highway. The largest increase in diversions is 97 additional vehicles. This increase is insufficient to result in any change in projected levels of service or needed roadway improvements.

As can be seen in the table, the changes in model inputs and the mode choice model have little impact on ridership projections for Bus Alternative 1, but result in a large percentage increase in the projections for Alternative 3. Bus Alternative 3 had the highest ridership projection of the three bus alternatives based on the updated model and model inputs. With a busway, this alternative is projected to divert almost 160 vehicles from the Spaulding Turnpike in the peak hour under the revised analysis. This represents an increase of almost 100 vehicles over the original projection in the DEIS. Similar increases occur with the other roadway alternatives for Bus Alternative 3.

Revised projections (based on revised model and input changes) for Bus Alternative 2 ridership are similar to those of Bus Alternative 1. However, direct comparison to the previous (DEIS) projections are inappropriate because the preliminary (DEIS) projections for Alternative 2 were based on ridership projections provided in the CMAQ application for the planned express bus service and the provision of one additional bus, rather than from the modeling process.

The highest vehicle diversions with the rail alternatives are projected for Rail Alternatives 2A and 2B. With no roadway improvements, Rail Alternative 2B is projected to divert over 150 vehicles, an increase of about 20 from the original (DEIS) projections. Rail Alternative 2A is projected to divert a somewhat lower number of vehicles, however, the increase from the original (DEIS) projection matches the largest of any alternative. The two long distance rail alternatives to Boston (Rail Alternatives 1A and 2A) have fewer diversions. The revised projections for both alternatives are about the same and are similar to the original (DEIS) projections.

The vehicle diversions associated with combination alternatives were recalculated based on the results of the revised analyses for the bus and rail alternatives. The SOV diversion associated with the provision of an HOV lane does not change because that analysis is based on differences in travel time with and without an HOV lane. The largest increase in diversions with the

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30 Ridership and peak hour single occupant vehicle (SOV) diversions based on the updated model equation (NCHRP Report 365) and updated model inputs.

combination alternatives is about 50 vehicles in the peak hour with the busway. The combinations with an HOV lane show an increased diversion of about 40 vehicles. The changes in the diversions for the combination alternatives do not result in changes to the projected levels of service or change the need for the roadway improvements identified in the DEIS.

It should be noted that Table 2.4-12 also summarizes a revised estimate of vehicle diversions resulting from the aggressive employer-based TDM program based on the USEPA COMMUTER Model. Default values for parking costs and transit fares, originally used in the DEIS analysis, were replaced by the updated local costs for parking and transit fares. The revised analysis produces a reduction in diverted SOVs of about 55 vehicles or an approximately 17 percent reduction.

A revised sensitivity analysis was also conducted using the updated model (NCHRP 365) and the aforementioned revised variables including updated parking costs and the value of travel time. The sensitivity analysis tested the effect of an increase in gasoline cost to $4.00 per gallon from the base cost of $3.00 per gallon. Although Bus Alternative 3 has the highest projected ridership with the busway, Rail Alternative 2B was used for the revised sensitivity analysis because it was used in the original analysis. The projected ridership under No-Build roadway conditions for Rail Alternative 2B is only slightly less than Bus Alternative 3.

The results of the revised sensitivity test and the original (DEIS) sensitivity test results are shown in Table 2.4-13. An increase in gas cost from $3.00 to $4.00 per gallon yields an increase of seven diverted vehicles from 152 to 159. With the original model, the diversion increased by 43 vehicles from 160 to 203.

The original (DEIS) model analyses assumed that all commuters who shifted to transit saved only the marginal cost of operating a vehicle. The initial sensitivity analysis included a test that assumed that 10 percent of transit commuters could eliminate the ownership of one vehicle and avoid the full cost of owning and operating a vehicle. The supplemental sensitivity analysis revises the manner in how this saving in total vehicle cost for 10 percent of transit users was accounted for. The initial sensitivity analysis calculated ridership and diversions by using a cost that was the weighted average of marginal operating cost (90 percent of users) and full operating cost (10 percent of users). The supplemental sensitivity analysis calculated the ridership of the 90 percent of users who saved the marginal cost and the ridership of the 10 percent who saved the full cost and added the results together. This revised method resulted in essentially no change in the projected vehicle diversion. Both calculations produced an increased diversion of about 10 vehicles over the result with all users saving only the marginal cost of operating a vehicle.

Table 2.4-12
Peak Hour Single Occupant Vehicle (SOV) Diversions Comparison

		Peak Hour SOV Diversions			
			Roadway Build Alternative		
Transit Improvement	Projection	Roadway No-Build	With Busway	With 6 Lanes	With 8 Lanes
Bus Alternative 1	DEIS[1]	31	47	23	23
	Revised[2]	40	72	40	40
Bus Alternative 2	DEIS[3]	15	29	15	15
	Revised	36	42	36	36
Bus Alternative 3	DEIS	39	62	21	18
	Revised	110	159	108	108
Rail Alternative 1A	DEIS	59	59	39	23
	Revised	65	65	55	53
Rail Alternative 1B	DEIS	82	82	55	46
	Revised	67	67	57	53
Rail Alternative 2A	DEIS	27	27	5	2
	Revised	124	124	98	91
Rail Alternative 2B	DEIS	131	131	22	11
	Revised	152	152	121	111
Aggressive TDM	DEIS	311	311	348	357
	Revised[4]	258	258	289	297
HOV Lane Alt. B[5]	DEIS			373	
Combination 1[6]	DEIS	363	393	387	385
	Revised	387	447	416	425
Combination 2[7]	DEIS	419	441	421	410
	Revised	441	490	460	465
Combination 3[8]	DEIS			794	
	Revised			833	
Combination 4[8]	DEIS			760	
	Revised			789	

1 Projections reported in Tables 2.4-1 through 2.4-4 in the Draft Environmental Impact Statement (NCHRP Report 187).
2 Projections made with revised model equation and revised model inputs (NCHRP Report 365).
3 The ridership model was not used for the original Bus Alternative 2 ridership projections. The ridership for this alternative was originally based on the ridership projections provided in the CMAQ application for the planned express bus service and the provision of one additional peak period bus. The revised projections are based on the revised model (equation and inputs).
4 A separate model was used to project diversions due to TDM programs. Inputs to the TDM model were modified to be consistent with the ridership model input changes.
5 The ridership projections for the HOV lane were not based on the mode choice model and, therefore, are not affected by the model revisions.
6 Includes Aggressive TDM and Bus Alternatives 1, 2 and 3.
7 Combination 1 plus Rail Alternative 1B.
8 Combination 2 plus HOV Alternative B.
9 Combination 1 plus HOV Alternative B.

Table 2.4-13
Sensitivity Test Comparison

	Peak Hour SOV Diversion (Rail Alternative 2B)	
Sensitivity Test	DEIS	Revised
$3.00 per Gallon	160	152
$4.00 per Gallon	203	159
$4.00 with 90/10 Average[1]	217	169
$4.00 with 90/10 Split Added[2]	-----	170

1 Weighted average of marginal operating cost (for 90 percent of commuters) and full operating cost (for 10 percent of commuters was used.
2 The ridership of the 90 percent of users who saved the marginal cost and the ridership of the 10 percent of users who saved the full cost were calculated separately and added together.

2.4.7 Summary of Mode Alternatives and Traffic Operations

Based on the preliminary (DEIS) and revised analyses summarized in Tables 2.4-1 through 2.4-4 and Table 2.4-12, there is a wide range of potential peak hour diversions of SOVs from the study area due to the provision of bus, rail, HOV, and TDM alternatives. Under the No-Build scenarios (with and without a busway on the General Sullivan Bridge) and the eight-lane build scenario, no single alternative improves traffic level of service in either AM or PM peak hour. Under the six-lane build scenario, only HOV Alternative B, the Aggressive TDM program, and the four combination alternatives improve the morning level of service from LOS E to LOS D. Only Combination Alternatives 1, 2, 3, and 4 appear to improve the evening level of service from LOS E to LOS D. However, the diversions for Combination Alternatives 3 and 4 are likely to be overstated because the transit modes often serve the same market as ride-sharing programs. No information is available regarding the extent of duplication in ridership projections for the transit and the HOV alternatives.

While traffic level of service on the Little Bay Bridges is indicative of the potential traffic volume decrease due to the provision of alternative modes and useful for comparing the relative impact of alternative modes, overall study area safety conditions and traffic operations will be governed by traffic weaving and merging maneuvers at the interchange areas, especially at Exits 3 and 6. These system-related impacts, which control overall traffic operating conditions in the study area, are not reflected in the level of service and capacity calculation at the Little Bay Bridges.

2.4.7.1 Rail Alternatives

The conceptual rail alternatives were developed to address two complementary goals: diverting automobile trips to passenger rail service, and diverting freight traffic from truck to rail. Both goals work to address congestion on the Spaulding Turnpike. The following sections discuss the degree to which the rail alternatives meet the goals of attracting passenger ridership and diverting freight traffic, respectively.

Attracting Passenger Ridership

The rail alternatives all facilitate passenger rail service in and around the study area, offering the potential to attract ridership and divert automobile trips to passenger rail service. However, some of the alternatives achieve this goal more effectively than others, while some have substantially larger infrastructure and equipment requirements and capital costs than others. The Selected Alternative should have the greatest potential to divert automobile trips to passenger rail with the smallest infrastructure requirements, capital cost, and impact on the environment and private property.

Rail Alternative 1, which would expand the existing *Downeaster* service to better serve commuters in the Dover and Rochester vicinity, is the most viable of the rail alternatives. As noted previously, the Northern New England Passenger Rail Authority (NNEPRA) and Maine DOT are developing a capital improvement program (Alternative 1C) that would allow the introduction of a fifth roundtrip between Portland and Boston. The total cost of the program is approximately $6 million; the improvements in New Hampshire are approximately $2.0 million of the total cost. With these improvements, NNEPRA has adjusted the schedule of the current four roundtrips and added a fifth roundtrip to the schedule in August 2007 using the existing pool of equipment. The schedule adjustment better serves Boston-bound commuters from southern New Hampshire, as well as southern Maine and northern Massachusetts. The fifth roundtrip provides some additional schedule flexibility for the daily commuter. Funding for these improvements through the CMAQ program was pursued in conjunction with MaineDOT and FHWA.

Rail Alternatives 1A and 1B would build upon the improvements being proposed by NNEPRA and Maine DOT. Although the projected ridership and trip diversions for these alternatives are modest in the short term, they build on an existing intercity rail service and improve its viability, suggesting the potential for further ridership gains in the future. If the infrastructure requirements for these alternatives are limited to construction of station stops and a layover facility, the capital costs of the alternative with a Dover terminus (Alternative 1A) range from $11.9 to $14.8 million, depending on the type of equipment used (DMUs vs. traditional locomotive-hauled consists). Extending the service to Rochester (Alternative 1B) would cost an additional $400,000 for a total of $12.3 to $14.8 million, depending on type of equipment. It is recommended that Rail Alternative 1A or 1B be pursued in the future as a separate project, as they are regional in scope and would build on the recommended project-related service improvements of Alternative 1C.

Rail Alternative 2, which included several alignment and mode options, would provide passenger rail service for commuters from Rochester and Dover to Portsmouth. The ridership projections for all of the options under this alternative are relatively small, less than 160 trips per peak hour in the peak direction. The infrastructure requirements associated with this alternative would be substantial, involving the construction or reconstruction of between 24 to 35 miles of track and numerous bridges and grade crossings, and construction of up to five new stations and modifications to one or two existing stations depending upon the option. Based on the high capital costs of these infrastructure improvements ($205.5 million – $250.7 million) and the relatively low ridership expected on the services, Rail Alternative 2 is not being pursued as part of this project.

Rail Alternative 3, which would establish passenger service on the Conway Branch, is expected to attract very few riders who would otherwise travel on the Spaulding Turnpike in the study area. The infrastructure requirements associated with reconstructing the 22-mile abandoned segment of the line between Ossipee and Conway are substantial, particularly the incremental cost ($56.6 million) of upgrading the rail to a condition which would allow an attractive passenger service. The NHDOT has recently completed a Feasibility Study for rehabilitation of the abandoned section of the Conway Branch, which identified a possible incremental approach to restoration. This approach may be feasible for attracting a passenger base and funding improvements over the long term, but it would have no measurable effect on the Spaulding Turnpike corridor in the study area. Therefore, Rail Alternative 3 is not being pursued as part of this project.

Diversion of Freight from Truck to Rail

The movement of freight by truck contributes to the overall traffic volumes and congestion levels on the Spaulding Turnpike within the study area. Currently the vast majority of freight moves through the corridor by truck. If a substantial volume of freight could be diverted from truck to rail, it might be possible to reduce congestion levels on the Spaulding Turnpike within the study area. Several of the rail alternatives could improve the freight rail infrastructure and thereby make freight transportation more attractive. However, some of the alternatives achieve this goal more effectively than others, while some have considerably larger infrastructure requirements and capital costs than others. The alternatives to be carried forward should have the greatest potential to divert freight from truck to rail with the smallest infrastructure requirement, capital cost, and impact on the environment and private property.

The characteristics of the freight demand must be conducive to rail transportation for freight traffic to be successfully diverted from truck to rail. Freight rail is best suited to transporting goods over long distances; moving bulk commodities or goods; and transporting shipments that are not extremely time-sensitive. In New Hampshire, 85 percent of rail traffic originating within the state by volume consists of non-metallic minerals. Likewise, 75 percent of the traffic terminating within the state consists of coal and petroleum. The New Hampshire Northcoast Railroad is an example of a freight railroad that has found a market that is conducive to rail transportation – carrying gravel from Ossipee Aggregates along the Conway Branch to a processing center in Boston. If New Hampshire Northcoast were not operating this service, a substantial number of trucks would be added to the Spaulding Turnpike study corridor, contributing to the congestion problem.

In the context of the Newington-Dover project, the freight market within the study area is generally not conducive to transportation by rail at the present time. The study area is comprised mainly of light industrial uses and retail businesses that either ship or receive small quantities of goods at any one time. The retail establishments receive their shipments from large distribution centers that are centrally located. Their distribution networks to retail locations are set up for delivery by truck. The largest potential users of freight rail service are the Public Service of New Hampshire (PSNH) power plants located on the Newington Branch in Newington and Portsmouth. Plans are underway to convert the PSNH Schiller plant in Portsmouth from coal-fired to wood chip-fired boilers. An ongoing study is examining the economics of shipping the wood chips to the Schiller plant by rail rather than truck.

In areas to the north of the study area, including municipalities located along the Conway Branch, there are a number of existing businesses that transport goods that could potentially be carried by rail. These businesses include propane distribution, lumber yards, and wood chip energy generation operations. The restoration of the Conway Branch to permit freight operations, as proposed in the NHDOT Conway Branch Feasibility Study, could help make freight rail a viable option for these and other businesses along the Spaulding Turnpike corridor. The cost of upgrading the line to accommodate regular freight operations (Class II standards) is approximately $19.4 million and should be pursued as a separate project.

The Pease Tradeport, located to the west of the Spaulding Turnpike in Newington, is a potential location for development of industrial and commercial businesses. This area could be served by freight rail if the short spur between the Tradeport and the existing Newington Branch freight rail line were re-established, as is proposed in Rail Alternative 4. While such a connection is not likely to be used in the short-term, it may be viable in the long-term and is included in the *Pease Surface Transportation Master Plan*. Therefore, the highway alternatives carried forward preserve a rail right-of-way and grade-separated crossing to allow the future redevelopment of a freight rail connection to the Tradeport.

2.4.7.2 Bus Alternatives

The bus alternatives presented in Section 2.4.4.3 would improve travel options for a variety of commuter markets in and around the study area, offering the potential to attract ridership and divert automobile trips to bus service. The initial (DEIS) model analyses showed the maximum projected ridership on the bus alternatives individually to be relatively small: approximately 57 for Bus Alternative 1, 35 for Bus Alternative 2, and 75 for Bus Alternative 3. The revised ridership and sensitivity analyses depicted higher potential ridership values of approximately 86 for Bus Alternative 1, 50 for Bus Alternative 2, and 191 for Bus Alternative 3. However, the infrastructure and equipment requirements associated with these alternatives, and their corresponding capital and operating costs, are relatively modest. Each of the proposed bus alternatives builds on an existing or planned service, and would improve the viability of these services by reducing headways, increasing collection points, or improving the distribution of riders to key destinations. The park-and-ride facilities proposed as part of the bus alternatives can also serve drivers who wish to form carpools and vanpools, further reducing congestion on the Spaulding Turnpike. For these reasons, the three bus improvements have been advanced in this FEIS, taking into account the cost-effectiveness of combining all three bus alternatives in one single package.

2.4.7.3 Rail and Bus Cost Summary

Table 2.4-14 summarizes the estimated costs of the conceptual rail and bus alternatives that were presented in Sections 2.4.4.2 and 2.4.4.3. The cost of a combined Bus Alternatives package, including park-and-rides in Dover and Rochester, is estimated at approximately $10.1 million if C&J Trailways is assumed to be the operator for Bus Alternative 1. If Bus Alternative 1 is assumed to be operated as a stand-alone service, the combined cost is approximately $14.3 million.

2.4.8 Development of Build Alternatives

In developing an initial range of highway alternatives within the Newington-Dover study area, the NHDOT's project team, with input from the City of Dover, Town of Newington and the Advisory Task Force (ATF) decided first to re-examine the nine long-range conceptual interchange alternatives that were developed as part of the Spaulding Turnpike Improvements Feasibility Study (Newington-Dover, 11238) completed by the NHDOT in 2000.[31] (The study also identified short-term "interim" safety improvements in the Exit 4 Interchange area in Newington, which was completed in 2006.) After re-examining the merits of the nine long-term alternatives (seven interchange alternatives in

31 See Appendix I, Feasibility Study Alternatives, February 2000.

Newington and two interchange alternatives in Dover) with input from the ATF, along with each community's officials and residents, it was decided that for Newington, Alternatives 1 thru 5 should be eliminated from further study and

Table 2.4-14
Summary of Costs of Rail and Bus Alternatives

Item	Cost (2007 dollars)[1]
Rail Alternative 1A (with DMU equipment)	$11.9 million
Rail Alternative 1B (with DMU equipment)	$12.3 million
Rail Alternative 1C (NHDOT share of Total $6 million Program)	$2.0 million
Rail Alternative 2A (Commuter Rail)	$205.5 million
Rail Alternative 2B (Commuter Rail)	$220.2 million
Rail Alternative 2B (Bus Rapid Transit)	$250.7 million
Rail Alternative 3 (total of NHDOT Phases 1-3, Rail Alt. 3 improvements)	$56.6 million
Rail Alternative 4A [2] (Turnpike Over Rail)	$9.3 - $10.4 million
Rail Alternative 4B [2] (Rail Over Turnpike)	$6.8- $7.9 million
Bus Alternative 1[3]	$0.43 - $4.6 million
Bus Alternative 2[3]	$440,000
Bus Alternative 3[3]	$4.5 million
Dover and Rochester Park-and-Rides	$4.6- $4.7 million

Notes:
1 Capital costs do not include the cost of land acquisition (with the exception of the Dover park-and-ride).
2 Cost estimate for Rail Alternatives 4A and 4B includes both the cost of rail infrastructure and bridges, embankment, retaining walls and drainage; for further information, see Section 2.4.4.2.
3 Cost estimates for Bus Alternatives 1, 2, and 3 include the net operating cost for five years, and do not include the cost of park-and-ride facilities.

Alternatives 6 and 7 should be carried forward for further evaluation. The stakeholders noted that, on the whole, Alternatives 1 thru 5 were not consistent with the Town of Newington's transportation goals while many of the elements included within Alternatives 6 and 7 better represented the community's overall transportation needs, such as improved local connectivity and safer access to the commercial/industrial land and residential properties adjacent to the corridor. For Alternatives 1 and 2 in Dover, the stakeholders felt both interchange alternatives had identified potential operational and safety improvements that warranted additional consideration and should be carried forward for further evaluation.

In addition to retaining four of the original Feasibility Study interchange alternatives in Newington (Alternatives 6 and 7) and Dover (Alternatives 1 and 2), six new interchange alternatives (Alternatives 8 thru 13) in Newington and one new interchange alternative in Dover (Alternative 3) were developed in concert with members of the ATF and other project stakeholders. These eleven alternatives are described in more detail in the following sections of this document.

In addition to re-examining the interchange alternatives identified in the Feasibility Study, the ATF and the project team concluded that both a six-lane and eight-lane widening of the mainline Turnpike and Little Bay Bridges should be evaluated from a traffic, safety, environmental impact and cost perspective.

With respect to the bridges, both bridge widening and bridge replacement alternatives were developed. These alternatives are described in Section 2.4.9.

System Alternatives

During development of highway and bridge alternatives, both a six-lane cross-section and an eight-lane cross-section were considered.

Six-Lane Options

- **Six-lane Option**- A combination of four lanes (from Exit 6 to the Toll Plaza) and six lanes (from Exit 1 to Exit 6), with six lanes on the Little Bay Bridges;

For the six-lane option, the proposed realignment and widening of the Spaulding Turnpike would begin by extending the existing six-lane section northerly from Exit 1 at Gosling Road through Exit 3 at Woodbury Avenue and Exit 4 at Shattuck Way and Nimble Hill Road, across the Little Bay Bridges, and through the Exit 6 Interchange area to the Toll Plaza in Dover. (**See Figures 2.4-15 and 2.4-15a**)

Eight-Lane Options

- **Eight-lane Option**- A combination of six lanes (from Exit 1 to Exit 3; and from Exit 6 to the Toll Plaza) and eight lanes (from Exit 3 to Exit 6), with eight lanes on the Little Bay Bridges;

For the eight-lane option, the proposed realignment and widening would begin by extending the existing six-lane section on the Spaulding Turnpike northerly from Exit 1 at Gosling Road to Exit 3 at Woodbury Avenue and then transition to an eight-lane section (three basic highway lanes with an auxiliary lane in both directions) north of Exit 3, through Exit 4 at Shattuck Way and Nimble Hill Road, across the Little Bay Bridges, to Exit 6 in Dover. The eight-lane section would then transition to a six-lane section in the Exit 6 Interchange area and match into the existing eight toll lanes at the Dover Toll Plaza. (**See Figures 2.4-15 and 2.4-15b)**

All of the interchange alternatives for the Newington and Dover Segments, as well as the bridge options discussed in the following section, can be incorporated with either the six-lane or the eight-lane mainline options.

2.4.8.1 Highway and Bridge Segments

To allow a straightforward comparison of the various highway and bridge alternatives and options, the study area was divided into three basic segments. The segments are identified as the Newington Segment, the Bridge Segment, and the Dover Segment (**see Figure 2.4-16**) and include possible interchange improvement alternatives as well as mainline widening options.

The Newington Segment involves a section of the study corridor approximately 1.7 miles in length and begins just north of the Exit 1 Interchange at Gosling Road and includes the Exit 2 Interchange with Fox Run Road, the Exit 3 Interchange with Woodbury Avenue and the Exit 4 Interchange ramps that connect to Nimble Hill Road and Shattuck Way. Immediately north of the Newington Segment is the Bridge Segment of the study corridor which is approximately 0.9 of a mile in length beginning near the Exit 4 Interchange area in Newington and ending adjacent to the Exit 5 Hilton Park Interchange area in Dover.

The Bridge Segment involves a 0.3-mile bridge section that includes the area around the existing Little Bay and General Sullivan Bridges, a 0.2-mile bridge approach section of the Spaulding Turnpike corridor in Newington, and a 0.4-mile bridge approach section of the Spaulding Turnpike corridor in Dover.

The Dover Segment begins immediately north of the Bridge Segment and is approximately 0.9 of a mile in length. This Segment extends north from the Exit 5 Interchange to just south of the Dover Toll Plaza and includes the connections to Hilton Park, Boston Harbor Road, US 4, Dover Point Road and the Exit 6 Interchange.

2.4.8.2 Newington Segment

The 1.7-mile Newington Segment begins just north of the Exit 1 Interchange and ends approximately 0.2 of a mile south of the existing Little Bay Bridges **Figure 2.4-16**). The major elements of this Segment involve the widening and/or realignment of the Spaulding Turnpike from the existing six-lane section at the Exit 1 Interchange[32] to six or eight lanes; improved access to the Spaulding Turnpike from the adjacent roadways such as Woodbury Avenue, Arboretum Drive, Nimble Hill Road, and Shattuck Way; improved local connectivity with the segregation of industrial and residential traffic; and the accommodation of a future Pease Spur rail corridor connection with the Newington Branch of the Pan Am Railways System.

Within this Segment, the proposed Spaulding Turnpike mainline alignment is essentially the same for all eight alternatives. All alternatives for this Segment

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32 The existing Spaulding Turnpike transitions from 6 lanes to 4 lanes between Exit 1 and Exit 2.

utilize either six lanes or a combination of six and eight mainline travel lanes, except where additional traffic management lanes (*i.e.*, acceleration, deceleration lanes) are necessary to accommodate traffic movements at the proposed interchanges. The proposed mainline improvements for all eight alternatives begin approximately 0.2 miles north of the Exit 1 (Gosling Road) Interchange. The alignment in this area will primarily consist of a westerly widening of the existing four travel lanes through the Exit 2 Interchange. All alternatives eliminate the existing Exit 2 Interchange at Fox Run Road. A cul-de-sac would be provided for vehicles to reverse direction on Fox Run Road. The existing Exit 2 traffic would be re-routed northerly to Woodbury Avenue to a new improved interchange in the vicinity of the existing Exit 3 (Woodbury Avenue) Interchange. Between the Exit 3 Interchange and the Exit 4 Interchange to Shattuck Way and Nimble Hill Road, the northbound and southbound lanes would be relocated into the existing wide median area (500 feet wide). This will allow for improved geometry, flexibility in developing new interchange options and connections to adjacent local roads, and ease of construction and maintenance of traffic during construction. For all Newington alternatives, the existing bridge that passes over Shattuck Way would be reconstructed and widened in its existing location.

Newington Alternative 6 Revised

Based upon recommendations from the ATF and Newington officials, Alternative 6, developed in 2000 as part of the Spaulding Turnpike Improvements Feasibility Study, was carried forward from the Feasibility Study for further evaluation as part of this EIS study process. The ATF requested that the original Alternative 6 concept be revised to eliminate impacts to the existing water supply storage tank adjacent to Arboretum Drive by shifting the proposed southbound loop-ramp configuration at Woodbury Avenue further to the north. The ATF also asked that the new Alternative 6 Revised (**Figure 2.4-17**) include a southbound on-ramp from Woodbury Avenue (not included with the original Alternative 6). Alternative 6 Revised involves three basic components - the development of a new full interchange at Woodbury Avenue that combines the existing Exits 2 and 3, the reconstruction of the existing Exit 4 Interchange at Nimble Hill Road and Shattuck Way, and the relocation of the currently inactive Pease Spur rail corridor to allow for future rail connectivity to the Pease Tradeport. The proposed Woodbury Avenue Interchange would be a full access interchange that would involve removing the existing Exit 3 Interchange, the reconstruction and widening of Woodbury Avenue for approximately 0.4 of a mile, and the extension of Woodbury Avenue approximately 0.8 of a mile westerly over the Spaulding Turnpike to connect with Arboretum Drive at the northerly end of the Pease Tradeport. The proposed reconstruction of Woodbury Avenue would extend the two existing travel lanes in each direction and the center-turning lane/median from the Fox Run Road intersection through the new interchange area before transitioning back to one travel-lane in each direction as it approaches Arboretum Drive. The Spaulding Turnpike northbound ramps and southbound ramps would connect to Woodbury Avenue at signalized intersections in a diamond-type configuration and a loop configuration, respectively. Access to Patterson Lane from Woodbury Avenue would be closed and a turnaround provided at Patterson Lane's westerly terminus. Two new connections from the proposed Woodbury Avenue extension to the bypassed section of existing Arboretum Drive would be provided.

At the Exit 4 Interchange, the existing substandard northbound and southbound ramps would be reconstructed to a more standard design geometry and connected to Nimble Hill Road and Shattuck Way, which are currently under construction as part of the Interim Safety Improvement project.

The inactive Pease Spur rail crossing currently located between Exit 3 and Exit 4 would be eliminated and a new crossing would be provided approximately 0.5 of a mile to the south. The new crossing and approaches would involve constructing approximately 1.0 mile of a new rail corridor to provide future rail connectivity into the Pease Tradeport. (As part of this project, only the necessary grading, drainage, and rail/highway structures for the future Pease Spur would be completed.) The relocation of the Pease Spur would begin in the vicinity of Patterson Lane and the Newington Branch and extend across Shattuck Way (future at-grade rail crossing) and then traverse under the northbound Woodbury Avenue on-ramp (at the existing Exit 3) and the Spaulding Turnpike and then connect with the existing Pease Rail Spur on the westerly side of the Spaulding Turnpike, near the at-grade crossing of Arboretum Drive.

Newington Alternative 7

Like Alternative 6 Revised described above, Newington Alternative 7 was carried forward from the Feasibility Study for further evaluation (**Figure 2.4-18**). Alternative 7 essentially would replace the existing substandard Exits 2, 3, and 4 Interchanges with one full access "single-point urban interchange"(SPUI) located in the existing median area approximately midway between Exit 3 and Exit 4. This type of interchange is a variation of the more classical signalized diamond interchange that allows one traffic signal (instead of two signals) to control all crossing movements and process relatively high traffic volumes in a relatively compact footprint. The other major components of Alternative 7 involve the construction of 1.1 miles of a new access road, which would connect the existing local roadways, the Pease Tradeport and the industrial area with the Spaulding Turnpike. The new connector road would begin at Shattuck Way on the easterly side of the Turnpike and extend through the new interchange, under the Spaulding Turnpike, and intersect the new Woodbury Avenue and Nimble Hill Road extensions before connecting to Arboretum Drive and the Pease Tradeport on the westerly side of the Turnpike. Woodbury Avenue would be reconstructed and widened northerly from Fox Run Road for 0.4 of a mile and then extended 0.4 of a mile to intersect with the connector road. Nimble Hill Road would be extended southerly 0.5 of a mile to the connector road opposite Woodbury Avenue creating a new signalized four-way intersection. In addition, two direct free-flow ramp connections would be provided between the Spaulding Turnpike and Woodbury Avenue to accommodate the heavy northbound on-ramp and southbound off-ramp traffic volumes. Access to Patterson Lane from Woodbury Avenue would be closed and a turnaround provided at Patterson Lane's westerly terminus. A 0.4-mile section of Shattuck Way would be reconstructed and widened to accommodate turning traffic to the new single-point interchange, and approximately 0.3 of a mile of Arboretum Drive would be relocated to provide connections to the Tradeport. Also the existing northbound and southbound Exit 4 ramps would be discontinued.

The inactive Pease Spur rail crossing currently located between Exit 3 and Exit 4 would be eliminated and a new crossing provided approximately 0.5 of a mile to the south. The new crossing and approaches would involve constructing approximately 1.0 mile of a new rail corridor to provide future rail connectivity into the Pease Tradeport. (As part of this project, only the necessary grading, drainage, and rail/highway structures for the future Pease Spur would be completed.) The relocation of the Pease Spur would begin in the vicinity of Patterson Lane and the Newington Branch and extend westerly across Shattuck Way (future at-grade rail crossing), under the Spaulding Turnpike, under the Woodbury Avenue extension, and then connect with the existing Pease Rail Spur on the westerly side of the Turnpike, near the at-grade crossing at Arboretum Drive.

Newington Alternative 8

Alternative 8 was a variation of the SPUI interchange configuration developed for Alternative 7. All other improvement elements for both Alternatives 7 and 8 would remain identical. Alternative 8 would substitute a "tight diamond" interchange for the SPUI of Alternative 7. This "tight diamond" design was considered because diamond-type interchanges, for locations such as this, are generally less costly than a SPUI configuration due to the reduction in roadway embankment height and structure costs. The diamond interchange for Alternative 8 would have one signal at each of the southbound and northbound ramp terminals where the SPUI would use only one signal. Alternative 8 failed to provide adequate traffic operations and was therefore not brought forward for public discussion.

Newington Alternative 9

Alternative 9 (**Figure 2.4-19**) would involve three basic components - the replacement of the existing substandard Exits 2, 3, and 4 Interchanges with one full-access, combination diamond, and partial cloverleaf interchange located at Woodbury Avenue, the development of a new connector road linking Shattuck Way on the east side of the Turnpike with Arboretum Drive and the Pease Tradeport on the west side, and the grade-separation of the existing and currently inactive Pease Spur rail corridor to allow for future rail connectivity to the Tradeport.

The Exit 3 Spaulding Turnpike northbound ramps and southbound ramps would connect to Woodbury Avenue at signalized intersections in a diamond-type configuration and a loop configuration, respectively. The new connector road would begin at Shattuck Way on the easterly side of the Turnpike and extend for 1.1 miles passing under the Spaulding Turnpike, adjacent to the new Pease Spur rail right-of-way, and intersect at a new signalized four-way intersection with the extension of Woodbury Avenue and the 0.5-mile extension of Nimble Hill Road before connecting to Arboretum Drive and the Pease Tradeport on the westerly side of the Turnpike. Access between Patterson Lane and Woodbury Avenue would be closed. A 0.2-mile section of Shattuck Way would be reconstructed and widened to accommodate turning traffic to the connector road, and approximately 0.2 of a mile of Arboretum Drive would be relocated to provide connections to the connector road.

The inactive Pease Spur RR grade crossing currently located between Exit 3 and Exit 4 would be retained for future connectivity into the Tradeport by raising the existing grade of the Spaulding Turnpike approximately 25 feet to pass over the rail spur and the adjacent connector road.

An option for retaining the southbound off-ramp at Exit 4 was developed to assess the benefits and potential impacts of a more direct southbound connection to Nimble Hill Road. Because of the close proximity of the existing private driveways on Nimble Hill Road to the southbound off-ramp layout creating potential safety and operational problems, a 0.1-mile section of Nimble Hill Road would be relocated behind the existing ExxonMobil service station, as part of the Nimble Hill Road extension south to the new connector road. (Retaining the Exit 4 southbound on-ramp in conjunction with the southbound off-ramp was not considered because of the less than desirable traffic operations (weaving) that would result due to vehicles entering and exiting the Turnpike between the proposed Exit 3 (Woodbury Avenue) southbound off-ramp and the Exit 4 southbound on-ramp.)

Newington Alternative 10

Alternative 10 (**Figure 2.4-20**) involves four basic components - the replacement of the existing substandard Exits 2, 3, and 4 Interchanges with one full-access diamond interchange located at Woodbury Avenue, the reconstruction of the existing northbound ramps at the Exit 4 Interchange at Shattuck Way, the development of a new connector road linking Shattuck Way on the east side of the Turnpike with Arboretum Drive and the Pease Tradeport on the west side, and the grade-separation of the existing and currently inactive Pease Spur rail corridor to allow for future rail connectivity to the Tradeport.

The proposed Woodbury Avenue Interchange would be a full access interchange that would involve removing the existing Exit 3 Interchange and the reconstruction and widening of Woodbury Avenue for approximately 0.4 of a mile and extending Woodbury Avenue approximately 0.3 of a mile westerly over the Spaulding Turnpike to intersect with a new connector road that would link the northerly end of the Tradeport with Shattuck Way and Nimble Hill Road. The proposed reconstruction of Woodbury Avenue would extend the two existing travel lanes in each direction and the center-turning lane/median from the Fox Run Road intersection through the new interchange area before transitioning to left- and right-turning lanes westbound, and two travel lanes eastbound. The Woodbury Avenue and connector road intersection would be signalized. The Spaulding Turnpike northbound ramps and southbound ramps would connect to Woodbury Avenue at signalized intersections in a diamond-type configuration.

The new connector road would begin at Shattuck Way on the easterly side of the Turnpike and extend for 1.1 miles passing under the Spaulding Turnpike, adjacent to the Pease Spur rail right-of-way, and intersecting at a three-way intersection with the 0.5-mile extension of Nimble Hill Road before connecting to Arboretum Drive and the Pease Tradeport on the westerly side of the Turnpike. Access between Patterson Lane and Woodbury Avenue would be closed. A 0.2-mile section of Shattuck Way would be reconstructed and widened to accommodate turning traffic to the connector road, and approximately 0.2 of a mile of Arboretum Drive would be relocated to provide connections to the connector road.

At the existing Exit 4 Interchange, interim safety improvements (under construction in 2005 and 2006) to Shattuck Way (formerly River Road) and the northbound ramps will be utilized to the greatest extent practicable, so as to minimize additional impacts to this area, if any.

The inactive Pease Spur rail at-grade crossing of Shattuck Way currently located between Exit 3 and Exit 4 would be retained for future connectivity into the Tradeport by raising the grade of the Spaulding Turnpike approximately 25 feet to pass over the rail spur and the adjacent connector road.

An option for retaining the southbound off-ramp at Exit 4 was developed to assess the benefits and potential impacts of a more direct southbound connection to Nimble Hill Road. Because of the close proximity of the existing private driveways on Nimble Hill Road to the southbound off-ramp layout creating potential safety and operational problems, a 0.1-mile section of Nimble Hill Road would be relocated behind the existing ExxonMobil service station and provide access to the ExxonMobil facility as part of the Nimble Hill Road extension south to the new connector road. (Retaining the Exit 4 southbound on-ramp in conjunction with the southbound off-ramp was not considered because of the poor traffic operations (weaving) that would result due to vehicles entering and exiting the Turnpike between the proposed Exit 3 (Woodbury Avenue) southbound off-ramp and the Exit 4 southbound on-ramp.)

Newington Alternative 10A

Based on feedback from the ATF and the public, and further study by the project team, Alternative 10 was refined to improve safety and traffic operations and to better address local community concerns. As depicted in **Figure 2.4-21**, Alternative 10 was modified as follows:

The mainline of the Turnpike was shifted approximately 80 feet to the west in order to simplify the construction of the Woodbury Avenue overpass and improve traffic management during construction; the Exit 3 southbound on-ramp was converted from a diamond-type configuration to a loop ramp in order to maximize traffic weaving distance between the Exit 3 on-ramp and the Exit 1 off-ramp; the elevation of the grade-separated railroad right-of-way and industrial traffic connector to Exit 3 was lowered by approximately 8 feet which lowered the mainline profile of the Turnpike (Newington officials requested that the Turnpike grade be lowered to the greatest extent practicable); the Exit 3 Woodbury Avenue/Nimble Hill Road connector was relocated from an alignment paralleling the Pease Spur railroad right-of-way to an alignment paralleling the Turnpike along the to-be-abandoned existing southbound barrel of the Turnpike; a direct off-ramp connection from the Turnpike (southbound) to Nimble Hill Road was provided; and the limits of potential slope impacts were calculated. Access to the ExxonMobil facility would remain from the connector road. Alternative 10A reflects additional engineering study and denotes potential slope impacts.

Newington Alternative 11

Alternative 11 (**Figure 2.4-22**) involves five basic design components - the replacement of the existing substandard Exits 2, 3, and 4 Interchanges with one full-access diamond interchange located at Woodbury Avenue, the reconstruction of the existing northbound ramps at the Exit 4 Interchange at Shattuck Way, the development of a new connector road that links Nimble Hill Road with Woodbury Avenue and the Pease Tradeport, the relocation and extension of Patterson Lane beneath the Exit 3 Interchange connecting Shattuck Way to Arboretum Drive, and the relocation of the currently inactive Pease Spur rail corridor to allow for future rail connectivity to the Pease Tradeport. The proposed Woodbury Avenue Interchange is similar to Alternative 10 and involves removing the existing Exit 3 Interchange and the reconstruction and widening of Woodbury Avenue for approximately 0.4 of a mile and the extension of Woodbury Avenue approximately 0.3 of a mile westerly over the Spaulding Turnpike to intersect with a new connector road that would link the northerly end of the Pease Tradeport with Nimble Hill Road. The proposed reconstruction of Woodbury Avenue would extend the two existing travel lanes in each direction and the center-turning lane/median from the Fox Run Road intersection over the extension of Patterson Lane and the relocation of the Pease Spur rail corridor and through the new interchange area before intersecting with the new connector road. The Woodbury Avenue and Connector Road intersection would be signalized. The Spaulding Turnpike northbound ramps and southbound ramps would connect to Woodbury Avenue at signalized intersections in a diamond-type configuration.

The proposed local traffic connector road would begin at Nimble Hill Road and extend southerly for 1.1 miles, adjacent to the existing inactive Pease Spur right-of-way, and intersect with Woodbury Avenue before connecting to Arboretum Drive and the Pease Tradeport. Patterson Lane would be reconstructed for approximately 0.5 of a mile, intersecting with Shattuck Way then passing under Woodbury Avenue, the Turnpike, and the southbound on-ramp before intersecting with the connector road opposite a 0.2-mile relocation of Arboretum Drive. Access between Patterson Lane and Woodbury Avenue would be closed.

At the existing Exit 4 Interchange, interim improvements (under construction with completion scheduled for 2006) to Shattuck Way (formerly River Road) and the northbound ramps will be utilized to the greatest extent practicable, so as to minimize additional impacts to this area, if any.

The inactive Pease Spur rail at-grade crossing of Shattuck Way currently located between Exit 3 and Exit 4 would be eliminated and a new crossing provided approximately 0.5 of a mile to the south. The new crossing and approaches would involve constructing approximately 1.0 mile of a new rail corridor to retain future rail connectivity into the Pease Tradeport. (At this time only the necessary grading, drainage, and rail/highway structures for the future Pease Spur would be completed.) The relocation of the Pease Spur begins in the vicinity of Patterson Lane and the Newington Branch and extends across Shattuck Way (future at-grade rail crossing) and under Woodbury Avenue, the Spaulding Turnpike, the southbound on-ramp, and extends across the new industrial connector (future at-grade rail crossing), before connecting with the existing Pease Spur on the westerly side of the Spaulding Turnpike.

An option for retaining the southbound off-ramp at Exit 4 was developed to assess the benefits and potential impacts of a more direct southbound connection to Nimble Hill Road. In addition, and because of the close proximity of the existing private driveways on Nimble Hill Road to the southbound off-ramp layout creating potential safety and operational problems, a 0.1-mile section of Nimble Hill Road would be relocated behind the existing ExxonMobil service station as part of the Nimble Hill Road extension south to the new connector road. (Retaining the Exit 4 southbound on-ramp in conjunction with a possible Exit 3 southbound off-ramp was not considered because of the poor traffic operations (weaving) that would result due to vehicles entering and exiting the Turnpike between the proposed Exit 3 (Woodbury Avenue) southbound off-ramp and the Exit 4 southbound on-ramp.)

Newington Alternative 12

Alternative 12 (**Figure 2.4-23**) is similar to Alternative 11 except for the layout of southbound ramps at the proposed Woodbury Avenue Interchange, the connection of proposed improvements between Patterson Lane and the connector road, and the connection to Arboretum Drive. Alternative 12 also involves five basic design components - the replacement of the existing substandard Exits 2, 3, and 4 Interchanges with one full-access, combination diamond, and partial cloverleaf interchange located at Woodbury Avenue, the reconstruction of the existing northbound ramps at the Exit 4 Interchange at Shattuck Way, the development of a new connector road that would link Nimble Hill Road with Woodbury Avenue and the Tradeport, the relocation and extension of Patterson Lane connecting Shattuck Way with the Exit 3 Interchange area and Arboretum Drive, and the relocation of the currently inactive Pease Spur rail corridor to allow for future rail connectivity to the Pease Tradeport. The Spaulding Turnpike northbound ramps and southbound ramps would connect to Woodbury Avenue at signalized intersections in a diamond-type configuration and a loop configuration, respectively. The proposed Woodbury Avenue Interchange would involve removing the existing Exit 3 Interchange and the reconstruction and widening of Woodbury Avenue for approximately 0.4 of a mile and the extension of Woodbury Avenue approximately 0.5 of a mile westerly over the Spaulding Turnpike intersecting with a new connector road before intersecting and ending at Arboretum Drive. The Woodbury Avenue reconstruction would extend the two existing travel lanes in each direction and the center-turning lane/median beginning at the signalized intersection with Fox Run Road, continuing over the extension of Patterson Lane and the new Tradeport rail corridor, through the new interchange area before intersecting with the connector road then transitioning to one lane in each direction at the intersection with Arboretum Drive. A 0.2-mile section of Arboretum Drive would be widened and reconstructed.

The new local traffic connector road would begin at Nimble Hill Road and extend for 0.7 of a mile, adjacent to the existing inactive Pease Spur right-of-way, and intersect at Woodbury Avenue opposite the proposed extension of Patterson Lane creating a four-way signalized intersection. Patterson Lane would be reconstructed for approximately 0.5 of a mile intersecting with Shattuck Way then passing under Woodbury Avenue and the Turnpike before intersecting with Woodbury Avenue opposite the connector road. The existing access between Patterson Lane and Woodbury Avenue on the east side of the Turnpike would be closed.

At the existing Exit 4 Interchange, interim improvements (under construction with completion scheduled for 2006) to Shattuck Way (formerly River Road) and the northbound ramps will be utilized to the greatest extent practicable, so as to minimize additional impacts to this area, if any.

The inactive Pease Spur crossing currently located between Exit 3 and Exit 4 would be eliminated and a new crossing provided approximately 0.5 of a mile to the south. The new crossing and approaches would involve constructing approximately 1.0 mile of a new rail corridor to retain future rail connectivity into the Pease Tradeport. (At this time only the necessary grading, drainage, and rail/highway structures for the future Pease Spur would be completed.) The relocation of the Pease Spur would begin in the vicinity of Patterson Lane and the Newington Branch and extend across Shattuck Way (future at-grade rail crossing), under Woodbury Avenue and the Spaulding Turnpike, and extend across the new industrial connector (future at-grade rail crossing), before connecting with the existing Pease Rail Spur on the westerly side of the Spaulding Turnpike.

An option for retaining the southbound off-ramp at Exit 4 was developed to assess the benefits and potential impacts of a more direct southbound connection to Nimble Hill Road. Because of the close proximity of the existing private driveways on Nimble Hill Road to the southbound off-ramp layout creating potential safety and operational problems, a 0.1-mile section of Nimble Hill Road would be relocated behind the existing ExxonMobil service station as part of the Nimble Hill Road extension south to the new connector road. Retaining the Exit 4 southbound on-ramp in conjunction with a possible Exit 3 southbound off-ramp was not considered because of the poor traffic operations (weaving) that would result due to vehicles entering and exiting the Turnpike between the proposed Exit 3 (Woodbury Avenue) southbound off-ramp and the Exit 4 southbound on-ramp.

Newington Alternative 12A

Based on feedback from the ATF and the public, and further study by the project team, Alternative 12 was refined to improve safety and traffic operations and to better address local community concerns. As depicted in **Figure 2.4-24**, Alternative 12 was modified as follows:

- The mainline of the Turnpike was shifted approximately 80 feet to the west in order to simplify the construction of the Woodbury Avenue overpass and improve traffic management during construction.

- The elevation of the proposed grade-separated railroad and industrial traffic connector to Exit 3 was lowered by approximately 8 feet, which lowered the mainline profile of the Turnpike.

- The proposed grade-separated railroad and industrial traffic connector road to Exit 3 was shifted approximately 900 feet to the north to improve the constructability of the Exit 3 interchange and to avoid an existing utility corridor paralleling Patterson Lane on the north.

- The local traffic connector road to the Tradeport was realigned to avoid the potential prime wetland area located west of Railway Brook.

- The west end of Patterson Lane would connect to River Road.

- The Exit 3 Woodbury Avenue/Nimble Hill Road connector road was relocated from an alignment paralleling the Pease Spur to an alignment paralleling the Turnpike along the, to be abandoned, existing southbound barrel of the Turnpike.

- A direct off-ramp connection from the Turnpike (southbound) to Nimble Hill Road was provided.

- Access to the ExxonMobil facility would remain from the local traffic connector road.

Newington Alternative 13

Alternative 13 was initially developed and proposed by Town of Newington officials who desired a simpler configuration, more convenient local access to the Turnpike from Nimble Hill Road, and a lower profile of the Turnpike at the Pease Spur crossing in comparison to all of the other Newington Alternatives. The concept, as depicted is **Figure 2.4-25** and as refined by the project team, entails the following:

- Exit 4 northbound and southbound on and off-ramps to the Turnpike from Shattuck Way and Nimble Hill Road, respectively.

- A reconfigured Exit 3 interchange that extends Woodbury Avenue westerly to maintain the Tradeport connection.

- Elimination of the local connector between Nimble Hill Road and Exit 3/Woodbury Avenue. This connection would be provided *via* the Nimble Hill Road – Shattuck Way connection constructed in 2006 and includes connecting to Woodbury Avenue *via* Shattuck Way and Piscataqua Drive; and provision for the future railroad connection to the Tradeport by elevating the Pease Spur track over the Turnpike. This would allow the profile of the Turnpike to remain at its approximate existing elevation and avoid the need to elevate the Turnpike to span over the Pease Spur as depicted in Alternatives 10A and 12A.

- Access to the ExxonMobil facility would be from the existing driveway (restricted to right-turn entering and right-turn exiting) on Nimble Hill Road, and from a new local connector road forming the fourth leg of the intersection of Nimble Hill Road, the southbound ramps, and Shattuck Way. It should be noted that the original concept developed by the Town included an industrial traffic connector road, paralleling Patterson Lane, to provide a direct connection between Shattuck Way and Woodbury Avenue. The connector was envisioned to form the fifth leg of an at-grade signalized intersection of Woodbury Avenue and the northbound ramps. However, the traffic operations of such an at-grade five-leg intersection would require a 7-lane cross-section on Woodbury Avenue and severely impact the historic Isaac Dow House and Beane Farm. As such, the at-grade industrial connector road was deemed infeasible and eliminated from the concept. The Nimble Hill Road/Exit 4 southbound off and on-ramps to the Turnpike as proposed in the Town's concept were located just to the south of the ExxonMobil facility. Following evaluation, these ramps were relocated to the north of the ExxonMobil facility in close proximity to the existing Nimble Hill Road. The ramp relocation would have less impact on abutting property. This ramp location also increases the distance between the southbound Exit 4 on-ramp and the Exit 3 off-ramp thus improving traffic operations, and would offer future flexibility to access potential future development of the former drive-in site along the existing (to be discontinued) southbound section of the Turnpike.

2.4.8.3 Dover Segment

The Dover Segment (**Figure 2.4-16**) begins immediately north of the Bridge Segment and is approximately 0.9 of a mile in length. This Segment extends north from the Exit 5 Interchange to just south of the Dover Toll Plaza and includes the connections to Hilton Park, Boston Harbor Road, Dover Point Road and the Exit 6 Interchange. The major elements of this Segment involve the widening and/or realignment of the Spaulding Turnpike from the existing four lanes to six or eight lanes; improved access to the Spaulding Turnpike from the adjacent roadways such as US 4, Boston Harbor Road, and Dover Point Road (both on the east and west sides of the Turnpike); and improved local connections by providing for full east/west connectivity at the Exit 6 Interchange, and between the local roads on both sides of the Turnpike at Dover Point, which will also serve the two sides of Hilton Park.

Within the Dover Segment, the Spaulding Turnpike mainline alignment would be essentially the same for all three Dover alternatives. All alternatives would utilize a six-lane or a combination of six and eight mainline travel lanes, except where additional traffic management lanes are necessary to accommodate traffic movement at the proposed Exit 6 Interchange. The proposed mainline improvements for all three alternatives would begin approximately 0.4 of a mile north of the Little Bay Bridges at Dover Point at the end of the Bridge Segment, and widen the existing four lanes to either six or eight travel lanes. All the alternatives would eliminate the existing Exit 5 Hilton Park northbound interchange and Cote Drive northbound access to the Turnpike at Exit 6. The Exit 5 traffic would be re-routed *via* either a new connector road under the

Spaulding Turnpike linking the two sections of Hilton Park and the adjacent residential areas to Dover Point Road/Boston Harbor Road or *via* an at-grade connector road that would parallel the east side of the Turnpike connecting Hilton Park with Dover Point Road on the east.

The proposed connector road options that link the easterly and westerly sides of Hilton Park and Dover Point are included as part of the Dover Interchange Alternatives 1, 2, and 3.

Dover Alternative 1

Based upon recommendations from the ATF and Dover officials, Alternative 1 (**Figure 2.4-26**), developed in 2000 as part of the *Spaulding Turnpike Improvements Feasibility Study*, was carried forward for further evaluation as part of this EIS study process.

Alternative 1 involves three basic components - the development of a new full interchange at Exit 6 (Dover Point Road), the elimination of the existing Exit 5 ramps at Hilton Park and Wentworth Terrace, as well as the Cote Drive northbound access, and establishment of improved local access and connectivity between the east and west sides of Dover Point. The proposed Exit 6 Interchange would be a combination diamond and two-lane loop-ramp (Northbound to Westbound) configuration, developed to maximize free-flow traffic movements to the extent practicable given the existing resource and property constraints. The interchange involves reconstructing and widening the Turnpike overpass (which currently only accommodates westbound traffic) into a two-way roadway beginning in the vicinity of Pineview Drive and extending westerly over the Spaulding Turnpike for approximately 0.9 of a mile to US 4 at the Scammell Bridge. Signalized intersections would be provided at the US 4/Spur Road/Boston Harbor Road intersection, at the southbound on-ramp for the westbound overpass traffic, and at the Dover Point Road/new northbound on-ramp intersection with the new at-grade connector road to Hilton Park. For the Spaulding Turnpike northbound traffic exiting at Exit 6, traffic would leave the Turnpike on a two-lane collector-distributor road that would split to eastbound and westbound free-flow ramps, which would then merge with Dover Point Road. The westbound free-flow ramp would be a two-lane off-ramp. The Exit 6 existing southbound off-ramp to Spur Road would be retained. The existing southbound on-ramp from Boston Harbor Road would be closed and all traffic would be re-routed northerly along Boston Harbor Road to the signalized intersection with US 4 where traffic would access US 4, Spur Road, Dover Point Road or the southbound on-ramp to the Turnpike. A new northbound on-ramp would be provided from Dover Point Road to the Turnpike just south of the Toll Plaza, which would require the relocation of approximately 0.1 of a mile of Homestead Lane northerly to Pineview Road. The existing Homestead Lane intersection with Dover Point Road would be eliminated. The southbound traffic entering onto the Turnpike from Exit 6 would merge onto the widened Turnpike as a two-lane on-ramp.

With the Exit 5 ramps and the southbound one-way access road that extends (west to east) between the General Sullivan Bridge and Little Bay Bridge approaches (under the Little Bay Bridges) eliminated under this alternative, local access to Dover Point, Hilton Park (on the east) and Wentworth Terrace is provided by constructing a new connector road beginning in the vicinity of Wentworth Terrace and extending northerly, adjacent to the northbound barrel of the Spaulding Turnpike, approximately 1.0 mile to intersect with Dover Point Road at a signalized intersection opposite the new Exit 6 northbound on-ramp. The function of the existing pathway adjacent to Pomeroy Cove will be accommodated by the new connector road.

The Boston Harbor Road and Spur Road approaches would be shifted easterly from their current intersection with US 4 to allow for two lanes of traffic storage in each direction at the intersection without requiring widening of the Scammell Bridge over the Bellamy River.

Dover Alternative 2

Similar to Alternative 1 described above, Dover Alternative 2 was carried forward from the 2000 Feasibility Study for further evaluation (**Figure 2.4-27**). Alternative 2 involves three basic components: the development of a new full interchange at Exit 6 and Dover Point Road, the elimination of the existing Exit 5 ramps at Hilton Park and Wentworth Terrace, as well as the Cote Drive northbound access and the establishment of improved local access and connectivity between the east and west sides of Dover Point. The proposed Exit 6 Interchange would be a full access diamond-type interchange that would involve reconstructing and widening the Turnpike overpass (which currently only accommodates westbound traffic) into a two-way roadway beginning in the vicinity of Homestead Lane and extending westerly over the Spaulding Turnpike for approximately 0.7 of a mile to US 4 at the Scammell Bridge. Signalized intersections would be provided at the Spur Road/Boston Harbor Road intersection, at the southbound on-ramp (for westbound traffic), at the northbound off and on-ramp intersection, and at the Dover Point Road intersection (when warranted) located approximately 650' east of the northbound ramps. The Exit 6 existing southbound off-ramp to Spur Road would be retained. The existing southbound on-ramp from Boston Harbor Road would be closed and all traffic would be re-routed northerly along Boston Harbor Road to the signalized intersection with US 4 where traffic would access US 4, Spur Road, Dover Point Road or the southbound on-ramp to the Turnpike. The southbound traffic entering onto the Turnpike from Exit 6 would merge onto the widened Turnpike as a two-lane on-ramp. A new northbound on-ramp would be provided from Dover Point Road to the Turnpike just south of the Toll Plaza.

With the elimination of the Exit 5 ramps and the southbound one-way access road that extends between the approaches to the General Sullivan and Little Bay Bridges, local access to Dover Point, Hilton Park (on the east) and Wentworth Terrace would be provided by constructing a new two-way connector road under the Little Bay Bridges where the existing pedestrian, bicycle and vehicular (one-way, west to east) connection abuts the channel. This roadway would connect Dover Point Road with Hilton Park and Wentworth Terrace on the east side of the Turnpike. An alternative location of providing this local east-west connection involved constructing a new two-way connector road under the Spaulding Turnpike approximately 1,200 feet north of the Little Bay Bridge in the vicinity of K9 Kaos (**Figure 2.4-27)**. This alternative was discarded due to lack of support by local Dover officials and citizens, the need to raise the Turnpike grade approximately 25 feet and the additional cost. It should be noted that the existing pedestrian, bicycle and parkland connection adjacent to the channel as well as the existing pathway between Pomeroy Cove and the northbound lanes of the Turnpike would be retained.

Dover Alternative 3

Alternative 3 (**Figure 2.4-28**) is very similar to Alternative 2, described above, with the exception that Alternative 3 would provide a new connector road that would link Spur Road with Boston Harbor Road by passing under US 4 approximately 250 feet west of the southbound on-ramp. This variation of Alternative 2 would allow the elimination of the traffic signal at the Spur Road/Boston Harbor Road intersection and reconfiguration of this intersection to right-turn access and egress to US 4 only. The modification would allow US 4 eastbound traffic to flow freely onto the Spaulding Turnpike and provide a local connection for motorized and non-motorized traffic free of conflict with interchange-related traffic flows. Alternative 3 involves the same basic components as Alternative 2: the development of a new full interchange at Exit 6 and Dover Point Road, the elimination of the existing Exit 5 ramps at Hilton Park and Wentworth Terrace, as well as the Cote Drive northbound access, and the establishment of improved local access and connectivity between the east and west sides of Dover Point. The proposed Exit 6 Interchange would be a full access diamond-type interchange. This would involve reconstructing and widening the Turnpike overpass (which currently only accommodates westbound traffic) into a two-way roadway beginning in the vicinity of Homestead Lane and extending westerly over the Spaulding Turnpike for approximately 0.7 of a mile to US 4 at the Scammell Bridge. Signalized intersections would be provided at the southbound on-ramp for the Dover Point Road westbound traffic, at the northbound off- and on-ramp intersection, and at the Dover Point Road intersection located approximately 650 feet east of the northbound ramps. The Exit 6 existing southbound off-ramp that connects to Spur Road would be retained. The existing southbound on-ramp from Boston Harbor Road would be closed and southbound traffic would be re-routed to a new southbound on-ramp from the Spur Road Connector to the southbound on-ramp to the Spaulding Turnpike. The southbound traffic entering onto the Turnpike from Exit 6 would merge onto the widened Turnpike as a two-lane on-ramp. A new northbound on-ramp is provided from Dover Point Road to the Turnpike just south of the Toll Plaza.

With the elimination of the Exit 5 ramps and the southbound one-way access road that extends between the approaches to the General Sullivan and Little Bay Bridges under this alternative, local access to Dover Point, Hilton Park (on the east) and Wentworth Terrace would be provided by constructing a new two-way connector road beneath the Turnpike as previously described under Alternative 2. In similar fashion, the existing pathway between Pomeroy Cove and the northbound lanes of the Turnpike would be retained.

2.4.8.4 Bridge Segment

The 0.9-mile Bridge Segment (**Figure 2.4-16**) begins approximately 0.2 of a mile south of the Little Bay Bridges and ends approximately 0.4 of a mile north of the bridges. The fourteen alternatives for the Bridge Segment can be grouped into three basic categories:

- Rehabilitating and widening the existing bridges (six alternatives),
- Replacing the existing bridges on-line (six alternatives), or
- Replacing the existing bridges off-line (two alternatives)

The first two categories are described as "On-Line" since they would utilize a portion of the existing mainline bridge/roadway footprint, and the third category is described as "Off-Line" since it would be constructed completely outside the existing mainline footprint west of the existing Little Bay Bridges.

Four bridge/roadway alignments were considered in the development of the bridge widening and replacement alternatives, three on-line alignments and one off-line alignment. The alignments are described as follows:

- On-Line Widen East – this alignment would hold the west edge of the existing roadway at the existing bridges and construct the new wider roadway to the east of this line. (See **Figures 2.4-29 and 2.4-30**)

- On-Line Widen West - this alignment would hold the east edge of the existing roadway at the existing bridges and construct the new wider roadway to the west of this line. (See **Figures 2.4-31 and 2.4-32**)

- On-Line Widen Both Sides – this alignment would hold the existing roadway centerline at the existing bridges and construct the new wider roadway by widening equally on both sides. (See **Figures 2.4-33 and 2.4-34**)

- Off-Line – this alignment would construct the new wider roadway approximately 130 feet west of the existing alignment allowing construction of a new bridge in a single phase of construction. (See **Figure 2.4-35.**)

For each On-Line alternative, bridge widening and replacement alternatives were developed. To consider a range of alternatives that reuse versus remove the historic General Sullivan Bridge, four alternatives were developed for each on-line alignment: a widening alternative and a replacement alternative that retains the General Sullivan Bridge; and a widening alternative and replacement alternative that includes a new multi-use pathway and removal of the General Sullivan Bridge.

For the Off-Line alternative, two "signature" bridge replacement alternatives were developed. These alternatives were developed at the request of the ATF to provide a distinctive and aesthetic gateway between the two communities. (See **Figure 2.4-36.**)

The bridge options for the various alternatives are described below:

Little Bay Bridges - Widening Alternatives

The construction for the bridge widening alternatives, with or without a multi-use path would consist of widening the existing Little Bay Bridges using concrete piers, haunched steel girders, and a concrete deck. The new construction would visually match the appearance of the existing bridges and the existing profile (60 mph design speed) would be maintained. While maintaining the existing vertical clearance over the waterway, the existing Little Bay Bridges would be rehabilitated including replacing the bridge deck, modifying the steel girders to upgrade the pin and hanger connections, repainting the steel girders, and seismically retrofitting the existing pier columns. The construction would occur in phases, maintaining traffic on the existing bridges during construction of the widening, and moving the traffic to the widened section of the bridge during rehabilitation of the existing bridges. The Widen East and Widen West alternatives could be constructed in two phases; the Widen Both Sides alternative would require three phases of construction. These alternatives have the lowest construction costs since they reuse the existing bridges.

Little Bay Bridges – Replacement On-Line

The construction of the on-line replacement bridge alternatives, with or without a multi-use path, consists of removal of the existing Little Bay Bridges and construction of a new bridge using concrete piers, haunched steel girders, and a concrete deck. The new construction would be visually similar to the appearance of the existing bridges. See **Figure 2.4-37** for an elevation drawing of the existing bridges. These alternatives would improve the stopping sight distance over the bridge to a 70 mph design speed that would require flattening the curve over the bridge by raising the roadway elevation approximately 5 feet at the abutments.

The new bridges would be constructed in phases and traffic maintained in the same manner as for the rehabilitation alternatives. Maintenance of traffic would be more difficult than with the rehabilitation options due to the profile raise.

Little Bay Bridges – Replacement Off-Line

The off-line bridge replacement alternatives include two "signature" structures. To qualify as signature structures, these alternatives should present unique visual elements in the bridge. The first signature alternative consists of multiple concrete arches supporting the bridge deck. This structure presents a dramatic appearance from Hilton Park and Shattuck Way, but would go largely unnoticed by the traffic traveling over the bridge. The second signature option consists of a cable-stayed bridge which would present a dramatic appearance due to the height of the central tower and the harped cables extending to the bridge deck. This alternative would be visible from Hilton Park and from the traffic traveling over the bridge. Due to the proximity to the airport at the Pease Tradeport, the height of a cable-stayed option may need to be limited in order to conform to airspace restrictions. The width of the proposed structure would also be greater than typical for this type of structure. These alternatives would be substantially more expensive due to their unique construction requirements. A 70 mph (design speed) stopping sight distance would be provided on these structures.

General Sullivan Bridge

The General Sullivan Bridge has been closed to motorized vehicular traffic since 1984. It remains open to non-motorized traffic and other recreational uses, and has been identified as one of the state's most important historic resources. The bridge has experienced considerable deterioration to the deck, girder and truss members, extensive substructure (pier) deterioration below the water line, impacted rust in the truss connections, loss of section on the floor beams, and peeling of the lead paint system on the bridge. The bridge will require major rehabilitation and continuing maintenance in order to remain as a functioning part of the transportation system for motorized vehicles or bicycles and pedestrians.

Other Bridge Options

In addition to the range of alternatives described above, three bridge options were considered to address ATF and public comments and concerns. These options were studied conceptually, but were not advanced beyond the conceptual phase. They include:

- **Double Decker Bridge Option** - This option would modify and utilize the existing Little Bay Bridges to carry three or four lanes of traffic in the northbound direction and construct a new three or four-lane upper level bridge deck, over the existing bridges, to carry the southbound traffic. The option was suggested as a way to minimize property impacts at the Dover end of the structure by reducing the overall widening footprint. A conceptual review of this option concluded that there would not be any substantial reduction in property impacts. Additionally, maintenance of traffic during construction would be more difficult than other options and construction costs would be substantially higher. The option was presented at an ATF meeting and was dismissed from further consideration.

- **Tunnel Option** - This option would construct a new six- or eight-lane tunnel with full shoulders to carry northbound and southbound traffic under Little Bay. The option was not formally developed, but was conceptually evaluated for comparatives costs. It was presented at an ATF meeting, but was not carried forward due to the high construction costs ($400 million or more) and the difficulty associated with its construction and maintenance.

- **Utilizing the General Sullivan Bridge to carry peak hour traffic** - The ATF asked that an option be considered that would utilize the existing General Sullivan Bridge to carry two lanes of peak hour traffic southbound in the morning and northbound in the evening. This option was not formally developed, but the feasibility of the concept was evaluated. This option was not carried forward due to the existing vertical geometry of the General Sullivan Bridge that limits driver sight distance (45 mph) and the existing narrow width of the structure (24′ curb-curb and 30′-7″ clear between trusses).

2.5 Initial Screening of Alternatives

In an effort to narrow the broad range of alternatives described in Section 2.4, a macro-level analysis was conducted on these alternatives. This evaluation considered technical analyses, cost, public input and resource agency review.

2.5.1 Public Review of Alternatives

In accordance with NEPA, the review of alternatives for the Newington-Dover project has included an extensive process for review and input by the public, as well as regulatory agencies. Numerous meetings were held by the NHDOT and the FHWA as the project progressed from initial conceptual ideas to a more comprehensive and defined set of alternatives. This section describes the variety of meetings conducted as part of this review process during which information was presented or distributed to the various agencies or general public in attendance. (See Chapter 8 for a comprehensive listing of the public meetings.)

2.5.1.1 FHWA and NHDOT Oversight

The FHWA and the NHDOT are the responsible Federal and State agencies for oversight and development of the EIS for the Newington-Dover project. These agencies also provide support and technical review for this project, particularly in the case of transportation issues. In addition, review and input are sought from the Federal Transit Administration, Regional Planning Commissions and staff that reside within the local communities. Review meetings serve as a preliminary forum to consider all project related materials, ideas and design concepts developed.

The project team, including NHDOT's consultants, met periodically to review project-related information and solicit input regarding highway design criteria, alternatives for the Little Bay and General Sullivan Bridges, alternative roadway designs, and alternatives incorporating TSM and TDM measures. In response, revisions were made or additional studies conducted, as appropriate, to supplement this study.

2.5.1.2 Federal and State Resource Agencies

As discussed in the Scoping Report issued in March 2004, early coordination with resource agencies was established in the context of the NEPA scoping process. A formal Notice of Intent to prepare an EIS was published in the Federal Register on May 13, 2003. Following this official notice, as well as a public notice published in the local newspapers, a Scoping Meeting was held on June 25, 2003 with the public and appropriate local, State, and Federal agencies, which were invited to attend. This initial Scoping Meeting provided an opportunity to formally take comment on the purpose and need of the project, the study area under consideration, the alternatives to be considered and the key issues involved. In August 2004, following recognition of their role in the Pease Tradeport, consultation with the Federal Aviation Administration (FAA) was initiated.

Since that initial Scoping Meeting, thirty-one Resource Agency Meetings have been held to provide an opportunity for the agencies to review the development and screening of project alternatives. These meetings are typically held at NHDOT headquarters in Concord. Some of these Resource Agency Meetings were held locally with the intent of providing a more convenient forum for members of the public or local officials who wanted to attend, and an opportunity for Resource Agency staff to observe areas of concern within the study area. Actual dates and locations of these meetings are listed in Chapter 8 of this report along with the topics of discussion.

Both federal and state environmental resource agencies are responsible for making or reviewing permitting decisions based on state and federal laws and regulations or providing technical expertise. They also ultimately serve to protect natural, cultural, and socio-economic resources potentially affected by the project. The agencies are focused on ensuring that the project has the least impacts possible, while providing a practicable solution that meets the project purpose and need. Tables 2.5-1 and 2.5-2 list these agencies and their areas of responsibility.

Table 2.5-1
Federal Agencies and their Areas of Responsibility

Federal Agency	Federal Level Responsibility
US Environmental Protection Agency – Region 1*	Wetlands, Air Quality, Water Quality, Waste Management
US Army Corps of Engineers*	Wetlands, Water Quality
US Fish & Wildlife Service*	Fisheries, Wildlife, Threatened or Endangered Species
Federal Emergency Management Agency	Floodplains
National Marine Fisheries Service*	Fisheries/Essential Fish Habitat
US Coast Guard*	Marine Navigation
Federal Aviation Administration*	Air Traffic Control, Pease Tradeport

* Have been identified as a Cooperating Agency on this project.

Table 2.5-2
State Agencies and their Areas of Responsibility

State Agency	State Level Responsibility
NH Department of Environmental Services*	Wetlands, Air Quality, Water Quality, Waste Management, Coastal Resource Issues and Coastal Zone Management Consistency
NH Natural Heritage Bureau	Threatened or Endangered Plant Species
NH Division of Historical Resources*	Historical and Archaeological Resources
NH Office of Energy and Planning*	Floodplains, Land Use Planning
NH Department of Safety, Bureau of Emergency Management	Flood Emergency Response
NH Fish & Game Department*	Fisheries, Wildlife, Threatened or Endangered Wildlife Species
NH Department of Resources & Economic Development	Parks and Recreation

* Have been identified as a Cooperating Agency on this project.

2.5.1.3 Advisory Task Force

An Advisory Task Force (ATF) was established early in the project to provide a forum for the local communities to be closely involved with the technical review and progression of the EIS. The ATF is made up of a total of fifteen members. These members represent the general public, local officials, State and Federal agencies, and interested stakeholders including local residents, regional planning commissions, chambers of commerce, local transit providers, the Pease Development Authority, and the Great Bay Estuarine Research Reserve.

ATF meetings have been held on a regular basis in Dover and Newington since April 2003, approximately every two to three months, to present and distribute project-related information and to listen to stakeholders and address their issues. The meetings are held in the evenings, are advertised in the local newspapers, are open to the general public and public participation is encouraged. The role of the task force is to collect input from their respective constituencies, and to provide input and guidance to the NHDOT in developing a comprehensive solution that will balance the needs of the community and the region, consistent with the purpose and need of the project.

Seventeen ATF meetings have been held to date within Newington and Dover. Actual dates and locations of these meetings are listed in Chapter 8 along with the topics of discussion.

2.5.1.4 Public Informational Meetings

In addition to the oversight and public input generated through the meetings and groups listed above, additional Public Informational Meetings (PIM) were held during the first three phases of the Newington-Dover EIS. These meetings provided an additional avenue through which the public could offer its comments, ask questions or express concerns about the project to NHDOT, FHWA and their consultants. The June 25, 2003 Project Scoping Meeting in Newington served to initiate the public participation component of the project. Since that time, in addition to the ATF meetings, public informational meetings were held in Dover on November 12, 2003, June 30, 2004, May 18, 2005 and November 7, 2005, and in Newington on July 1, 2004, May 19, 2005 and November 9, 2005. Items discussed during these meetings included the project purpose and need, the study area, sensitive environmental resources, project alternatives, constraints analysis and the alternatives proposed for further study in the Draft EIS, a suggested Preferred Alternative, proposed noise mitigation and proposed wetland impact mitigation. (See Chapter 8 for a summary of meeting highlights.)

2.5.2 Environmental Constraints

In developing the conceptual alternatives, both engineering and environmental (natural, cultural, and socio-economic resources) constraints were considered. Preliminary information on environmental baseline conditions was described in the March 2004 Scoping Report and was subsequently used during the development and screening of alternatives. Chapter 3 of this EIS contains a detailed description of the affected environment of the study area.

The conceptual design of the Newington-Dover roadway and bridge alternatives looked first to avoid environmental resources within the engineering constraints of widening the existing corridor and bridges. Indeed, certain alternatives were ruled out early and not carried forward for detailed study based on their obvious and substantial impacts. One example is the alternative of replacing the Little Bay Bridges to the east of their current alignment. By inspection, it was determined that this alternative would have unacceptable adverse impacts to Hilton Park (a Section 4(f) resource) and the Little Bay marine environment. Thus, this alternative was eliminated from further analysis, since a feasible and less impacting alternative (*i.e.* widen/replace to the west) was available.

In other cases, alignments and geometry were adjusted, within current AASHTO and NHDOT design standards, to avoid or minimize impacts to important resources and properties. This process is iterative and on-going. Alternatives have been and will continue to be further refined throughout the EIS and final design processes to reduce environmental impacts to the maximum extent practical.

2.5.3 Highway Widening and Interchange Improvements Evaluation

The highway alternatives developed for the Dover and Newington segments (previously described) were screened at a macro-level and compared to one another for their ability to meet the project's Purpose and Need while minimizing potential impacts to study area resources. The screening process included comparative assessment of the following areas: potential impact on the natural environment, cultural resources, parkland and recreation areas; wildlife habitat; property impacts; traffic operations, transportation system efficiency and safety; local connectivity; community support; and cost. The process was conducted within a dynamic public participation process involving many stakeholders: residents of Dover and Newington, ATF members, representatives from the SRPC and RPC, State and Federal resource agency representatives, representatives of area public transit operators including COAST and the UNH Wildcat Transit, the USCG, and FAA, as well as, FHWA and the NHDOT. Community input was facilitated and channeled *via* regularly scheduled project ATF meetings, public informational meetings, and meetings and field trips with the resource agency representatives. The evaluations and screening process were open and incremental in nature, and amounted to a "give and take" exchange by most stakeholders in striving to discover the most practicable transportation solutions that achieve the best possible balance of benefits and impacts. As some alternatives were being discarded for various impact-related reasons, other alternatives were being created or modified from previous alternatives. The process was open, dynamic and subject to continual review.

Alternative 1 in Dover was eliminated due to its impacts on groundwater, wetlands, residential properties and historic properties, its poor local connectivity, lack of community support and cost. Alternatives 6 Revised, 7, 8, and 9 in Newington were similarly dismissed. Alternative 6 Revised lacked good connectivity between the industrial area and the Turnpike, and between Nimble Hill Road and Woodbury Avenue. It also introduced considerable impact to Pease land in the area of Exit 3 and considerable cost due to the relocation of the Pease Spur rail line. Alternative 7 had an adverse visual impact due to its elevation above the adjacent terrain, would have provided a free-flowing direct southbound connection to Woodbury Avenue which is counter to the community objective of calming traffic entering Woodbury Avenue, was the most costly of all alternatives, and included a two-lane northbound on-ramp from Woodbury Avenue to the Turnpike which would have resulted in a problematic traffic merging condition prior to the Little Bay Bridges. Both Alternatives 6 Revised and 7 fell out of favor with Newington officials during the review process due to their impacts and complexities. Alternative 8 attempted to reduce the scale of Alternative 7 by substituting a compact diamond interchange for a single-point urban interchange. Alternative 8 failed from a traffic operations perspective and was never brought forward for public discussion. Alternative 9 had several traffic operational shortcomings including a problematic two-lane loop ramp for southbound exiting traffic at Exit 3, and the elimination of access to Shattuck Way at Exit 4.

On the other hand, the assessment of highway alternatives and relative comparison of one alternative with another identified a number of positive characteristics and benefits common to Alternatives 2 and 3 in Dover and Alternatives 10, 11 and 12 in Newington:

- Improved safety and traffic operating conditions
- Improved local connectivity
- Higher levels of community support
- Less environmental impacts
- Less impacts to public lands and cultural resources
- Reasonable cost

Based on this screening and evaluation, the highway alternatives were reduced to the following:

- Alternative 2 (**Figure 2.4-27**) in Dover
- Alternative 3 (**Figure 2.4-28**) in Dover
- Alternative 10 (**Figure 2.4-20**) in Newington
- Alternative 11 (**Figure 2.4-22**) in Newington
- Alternative 12 (**Figure 2.4-23**) in Newington

Subsequent analysis and review further refined these alternatives. Alternatives 11 and 12 were very similar, differing only in the configuration of the southbound on-ramp at Exit 3 (diamond-type under Alternative 11 and a single-lane loop ramp under Alternative 12), and the location/alignment of the Exit 3 roadway connector to the Tradeport (east of Railway Brook under Alternative 11 and west of Railway Brook under Alternative 12). The single lane loop ramp under Alternative 12 maximizes the distance between southbound traffic entering the Turnpike at Exit 3 and southbound traffic exiting the Turnpike at Exit 1. The location of the Tradeport connector roadway east of Railway Brook (under Alternative 11) avoids the potential impact to prime wetlands located west of the brook, therefore, Alternative 12 was modified to reflect this alignment. Having melded the best elements of Alternatives 11 and 12 into a revised Alternative 12A, Alternative 11 was dismissed from further consideration.

Alternative 10 was further refined, as previously described (see Section 2.4.8.2), and evolved into Alternative 10A. Alternative 13, as previously described (Section 2.4.8.2), was developed by Town of Newington officials and refined by the project team. Alternatives 2 and 3 were reassessed to compare the traffic operations of the northbound Exit 6 diamond-type off-ramp with the operations of a two-lane loop ramp. The diamond-type off-ramp configuration was retained based on satisfactory traffic operations, safety considerations and cost. Based on these additional refinements, the following highway alternatives were advanced for further development and detailed evaluation:

- Alternative 2 **(Figure 2.4-27)** in Dover
- Alternative 3 **(Figure 2.4-28)** in Dover
- Alternative 10A **(Figure 2.4-21)** in Newington
- Alternative 12A **(Figure 2.4-24)** in Newington
- Alternative 13 **(Figure 2.4-25)** in Newington

2.5.4 Bridge Alternatives Evaluation

As discussed in Section 2.4.8.4, fourteen bridge alternatives were developed. These consisted of six On-line Bridge Widening Alternatives, six On-line Bridge Replacement Alternatives, and two Off-line Signature Bridge Alternatives. The estimated costs and impacts of each of these alternatives were calculated and then compared in order to determine which alternatives were cost-effective, minimized impacts and would be progressed for further study.

In comparison, the On-line Widening Alternatives and the On-line Replacement Alternatives have similar impacts, but the Widening Alternatives have substantially lower costs. Evaluating the options, the added costs for the Replacement Alternatives do not justify the minimal improvement they provide in stopping sight distance (SSD) -- increasing stopping sight distance from 60 mph to

70 mph. The posted speed limit is 50 mph, which is appropriate for the study area land use and the close spacing of interchanges. Therefore, the On-line Replacement Alternatives were eliminated in favor of the On-line Widening Alternatives.

Within the On-line Widening Alternatives, the costs are similar; therefore, the differentiating factors are the impacts to Hilton Park and the estuarine wetlands near Bloody Point. Both the Widen East and Widen Both Sides Alternatives have greater impacts to these resources than the Widen West Alternatives. Widening to both sides is also more difficult to construct while maintaining traffic. As such, the Widen East and Widen Both Sides Alternatives were eliminated in favor of the Widen West Alternatives.

The difference between the remaining two On-line Widen West Alternatives is the disposition of the General Sullivan Bridge. One alternative removes the General Sullivan Bridge and provides an integrated multi-use path on the widened bridge, while the other alternative rehabilitates the General Sullivan Bridge and utilizes it as a multi-use path and recreation facility. The alternative that removes the General Sullivan Bridge has lower initial costs and lower long-term maintenance costs, but the alternative that retains the General Sullivan Bridge has a high degree of community support and would not adversely impact the historic structure. Both alternatives were progressed for further study.

The Off-line Signature Bridge Alternatives, concrete arch and cable-stayed, offer a gateway or unique visual element, the opportunity to adjust the Turnpike profile to increase SSD from 60 mph to 70 mph, and potential mitigation for the removal of the General Sullivan Bridge. However, these alternatives have substantially higher costs and greater property and parkland impacts than any of the other alternatives, and the current 60 mph stopping sight distance is adequate for the 50 mph speed limit. Thus, these off-line bridge replacement alternatives were not carried forward for further detailed study.

In summary, the following bridge alternatives were advanced for further study and detailed evaluation:

- Widen/rehabilitate the Little Bay Bridges and rehabilitate the General Sullivan Bridge

- Widen/rehabilitate the Little Bay Bridges and remove the General Sullivan Bridge.

2.5.5 Lane Requirements and Mode Option Evaluation

2.5.5.1 Eight-lane vs. Six-lane Options

Preliminary traffic screenings were conducted at the onset of developing the conceptual alternatives to determine the number of travel lanes that would be required on the Spaulding Turnpike to carry the projected 2025 traffic volumes. These screenings were conducted based on the methodologies and procedures defined in the 2000 Highway Capacity Manual[33] for freeway segments, primarily focusing on the Little Bay Bridges. Initial analysis results[34] (Tables 2.5-3 and 2.5-4) indicated that the six-lane options (three basic travel lanes in each direction), in conjunction with a combination of TSM and TDM alternatives that reduce peak hour travel demands, would not be sufficient to accommodate the future traffic volume demands between Exits 3 and 6 on the Turnpike. Providing insufficient capacity on the mainline of the Turnpike would result in system-wide failures at the freeway ramp junctions and eventually on the local street network.

In addition to evaluating freeway capacity in the initial screening process, a general system-wide geometric review was completed that focused more specifically on the traffic volume demands and associated geometrics required to carry the demands to and from Exits 3, 4, and 6. It was determined that the required acceleration and deceleration lengths needed to safely transition the on and off-ramps between exits and in the immediate vicinity of the Little Bay Bridges requires the extension of these auxiliary lanes across the bridges. This finding complements the initial screening of mode alternatives (Table 2.4-3) which indicated that six lanes, combined with TDM and transit alternatives, would be adequate to service future travel demands only if traffic flows were uninterrupted and not subject to traffic changing lanes and entering and exiting at interchange areas. These findings indicate that the eight-lane option (three basic travel lanes and one auxiliary lane in each direction) would be required to safely accommodate traffic volume demands for the year 2025 between the relatively close spacing of Exits 3, 4 and 6. Interchange alternatives were then conceptually developed based on this conclusion and further refined through the EIS process.

33 2000 Highway Capacity Manual, Special Report 290, Transportation Research Board, Washington, DC.

34 Tables 2.5-3 and 2.5-4 summarize a preliminary analysis of concepts and options that assisted the Advisory Task Force in developing consensus on the basics of a Preferred Alternative – 6-lane or 8-lane cross-section; rehabilitation and widening of the LBB, or new bridge (off-line); rehabilitation or removal of the GSB; level of transit and TDM, *etc.* Estimated impacts, cost, level of local support and issues for each option were identified, discussed and compared. It should be noted that Alternatives 10A, 12A, and 13 had yet to be developed at that time.

Table 2.5-3
Eight-Lane Options

	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
LITTLE BAY BRIDGE	WIDEN / REHABILTIATE	WIDEN / REHABILTIATE	WIDEN / REHABILTIATE	NEW BRIDGE (OFF LINE)	NEW BRIDGE (OFF LINE)
GENERAL SULLIVAN BRIDGE	REMOVE	REMOVE	REHABILTATE	REMOVE	REMOVE
CROSS SECTION WIDTH	142-146 FT.;169 FT. WITHIN BRIDGE PATHWAY	142-146 FT.;169 FT. WITHIN BRIDGE PATHWAY	142-146 FT.	142-146 FT.;169 FT. WITHIN BRIDGE PATHWAY	142-146 FT.;169 FT. WITHIN BRIDGE PATHWAY
MODERATE EMPLOYER TDM	NO	YES	YES	NO	YES
AGRESSIVE EMPLOYER TDM	NO	NO	NO	NO	NO
TRANSIT	NO	YES	YES	NO	YES
LOS LIFE @ BRIDGE	2037	2040	2040	2037	2040
SYSTEM LOS	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
FUTURE FLEXIBILITY FOR BORROW LANE/MANAGED LANE	YES	YES	YES- FUTURE MANAGED LANES ALTERNATIVES RENDER FUTURE TRANSIT USE OF GSB IMPRACTICAL	YES	YES
CONSTRUCTION COST (1)	$128.6 M	$149.5 M TOTAL ($10.6M - BUS; $10.3M - RAIL)	$160.5M TOTAL ($10.6M - BUS; $10.3M - RAIL;$11.0M GSB REHAB)	$173.6M	$192.7M TOTAL ($10.6M - BUS; $10.3M - RAIL)
ADDITIONAL MAINTENANCE/ OPERATIONS COST	NO	NO	YES	NO	NO
CONSTRUCTIBILITY (2)	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
RELATIVE IMPACTS	SLIGHTLY GREATER THAN 6-LANE OPTIONS	SLIGHTLY GREATER THAN 6-LANE OPTIONS	SLIGHTLY GREATER THAN 6-LANE OPTIONS	GREATER IMPACTS THAN OTHER 8-LANE OPTIONS	GREATER IMPACTS THAN OTHER 8-LANE OPTIONS
PRIVATE PROPERTY	REQUIRES TAKING OF 3 BUILDINGS (1 BUSINESS, 1 RESIDENCE, 1 GARAGE)	REQUIRES TAKING OF 3 BUILDINGS (1 BUSINESS, 1 RESIDENCE, 1 GARAGE)	REQUIRES TAKING OF 3 BUILDINGS (1 BUSINESS, 1 RESIDENCE, 1 GARAGE)	REQUIRES TAKING OF 10 BUILDINGS (1 BUSINESS, 5 RESIDENCES, 4 GARAGES)	REQUIRES TAKING OF 10 BUILDINGS (1 BUSINESS, 5 RESIDENCES, 4 GARAGES)
HILTON PARK	RELOCATING THE GRADE-SEPARATED CONNECTOR OR REUSE OF THE EXISTING ROADWAY APPROACH TO THE GSB WILL MINIMIZE IMPACTS.	RELOCATING THE GRADE-SEPARATED CONNECTOR OR REUSE OF THE EXISTING ROADWAY APPROACH TO THE GSB WILL MINIMIZE IMPACTS.	RELOCATING THE GRADE-SEPARATED CONNECTOR WILL MINIMIZE IMPACTS.	RELOCATING THE GRADE-SEPARATED CONNECTOR WILL MINIMIZE IMPACTS.	RELOCATING THE GRADE-SEPARATED CONNECTOR WILL MINIMIZE IMPACTS.
4(f) ISSUE of GSB REMOVAL	YES	YES	NO	YES	YES
COMMENTS			TRANSIT REUSE OF GSB SHOULD BE EXPLORED FOR TRAFFIC MANAGEMENT DURING CONSTRUCITON. TRANSIT OPERATORS MAY PREFER TURNPIKE OVER USE OF GSB.	REQUIRES APPROXIMATELY 1000' OF WEST SIDE RETAINING WALL AT HILTON PARK. CONSTRUCTION COST ASSUMES NEW ARCH BRIDGE. SIGNATURE BRIDGE AESTHETICS.	REQUIRES APPROXIMATELY 1000' OF WEST SIDE RETAINING WALL AT HILTON PARK. CONSTRUCTION COST ASSUMES NEW ARCH BRIDGE SIGNATURE BRIDGE AESTHETICS.
ATF COMMENTS	SINGLE MODE SOV APPROACH NO SUPPORT	SUPPORT FOR TRANSIT & TDM	SUPPORT FOR TRANSIT & TDM	SINGLE MODE SOV APPROACH NO SUPPORT	MOST EXPENSIVE OPTION IMPROVES BRIDGE PROFILE FHWA NOTED CONCERN WITH COST OF NEW SIGNATURE BRIDGE AND PRUDENCY OF REMOVING GSB [4(f)]

(1) ASSUMES ALTERNATIVES 10 (NEWINGTION) AND 3 (DOVER) IN 2004 DOLLARS.
(2) ASSUMES ALTERNATIVES 10 (NEWINGTON) AND 3 (DOVER); ALTERNATIVES 11 AND 12 (NEWINGTON) ARE RELATIVELY DIFFICULT TO CONSTRUCT.

Table 2.5-4
Six-Lane Options

	OPTION 6	OPTION 7 CENTER LANE CONTRA FLOW HOV	OPTION 8 CONCURRENT HOV LANES	OPTION 9 BORROW LANE (ZIPPER) (4)	OPTION 10 PEAK HOUR SHOULDER USE (5)
LITTLE BAY BRIDGE	WIDEN / REHABILTIATE	WIDEN / REHABILTIATE	WIDEN / REHABILTIATE	WIDEN / REHABILTIATE	WIDEN / REHABILTIATE
GENERAL SULLIVAN BRIDGE	REHABILITATE	REMOVE	REMOVE	REHABILTATE	REHABILTATE
CROSS SECTION WIDTH	118-122 FT.	148-152 FT.;167 - 173 FT. WITHIN BRIDGE PATHWAY. COMPARABLE TO 8-LANE X-SECTION	146 -158 FT. (175 FT. WITHIN BRIDGE / PATHWAY	124-128 FT.	132 FT.
MODERATE EMPLOYER TDM	YES	YES	YES	YES	YES
AGRESSIVE EMPLOYER TDM	YES	YES	YES	YES	YES
TRANSIT	YES	YES	YES	YES	YES
LOS LIFE @ BRIDGE (3)	2025 - 2026	2029 -2031	2029 -2031	2040 - 2042 (CAPACITY EQUIVALANT TO 8-LANES)	2040 - 2042 (CAPACITY EQUIVALANT TO 8-LANES)
SYSTEM LOS	DEFICIENT	DEFICIENT	DEFICIENT	SATISFACTORY	SATISFACTORY
FUTURE FLEXIBILITY FOR BORROW LANE/MANAGED LANE	NONE	YES	YES		YES - RECONSTRUCT PEAK HOUR SHOULDER USE TO BORROW LANE/HOV USE BEYOND 2041.
CONSTRUCTION COST (1)	$148.3M TOTAL ($10.6M - BUS; $10.3M - RAIL;$10.0M GSB REHAB)	SIMILAR TO 8-LANES $149.5 M TOTAL ($10.6M - BUS; $10.3M - RAIL)	SIMILAR TO 8-LANES $149.5 M TOTAL ($10.6M - BUS; $10.3M - RAIL)	SIMILAR TO 6-LANES $148.3 M TOTAL	SIMILAR TO 6-LANES $148.3 M TOTAL
ADDITIONAL MAINTENANCE/ OPERATIONS COST	YES	YES	YES	YES	NO
CONSTRUCTIBILITY (2)	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
RELATIVE IMPACTS	SLIGHTLY LESS THAN 8-LANE LBB WIDEN/REHAB OPTIONS	SIMILAR TO 8-LANE LBB WIDEN / REHAB OPTIONS	SIMILAR TO 8-LANE LBB WIDEN / REHAB OPTIONS	SLIGHTLY LESS THAN 8-LANE LBB WIDEN/REHAB OPTIONS	SLIGHTLY LESS THAN 8-LANE LBB WIDEN/REHAB OPTIONS
PRIVATE PROPERTY	REQUIRES TAKING OF 3 BUILDINGS (1 BUSINESS, 1 RESIDENCE, 1 GARAGE)	REQUIRES TAKING OF 3 BUILDINGS (1 BUSINESS, 1 RESIDENCE, 1 GARAGE)	REQUIRES TAKING OF 3 BUILDINGS (1 BUSINESS, 1 RESIDENCE, 1 GARAGE)	REQUIRES TAKING OF 3 BUILDINGS (1 BUSINESS, 1 RESIDENCE, 1 GARAGE)	REQUIRES TAKING OF 3 BUILDINGS (1 BUSINESS, 1 RESIDENCE, 1 GARAGE)
HILTON PARK	RELOCATING THE GRADE-SEPARATED CONNECTOR WILL MINIMIZE IMPACTS.	RELOCATING THE GRADE-SEPARATED CONNECTOR OR REUSE OF THE EXISTING ROADWAY APPROACH TO THE GSB WILL MINIMIZE IMPACTS.	RELOCATING THE GRADE-SEPARATED CONNECTOR OR REUSE OF THE EXISTING ROADWAY APPROACH TO THE GSB WILL MINIMIZE IMPACTS.	RELOCATING THE GRADE-SEPARATED CONNECTOR WILL MINIMIZE IMPACTS.	RELOCATING THE GRADE-SEPARATED CONNECTOR WILL MINIMIZE IMPACTS.
4(f) ISSUE of GSB REMOVAL	NO	YES	YES	NO	NO
COMMENTS	TRANSIT REUSE OF GSB SHOULD BE EXPLORED FOR TRAFFIC MANAGEMENT DURING CONSTRUCTION. POST CONSTRUCTION, TRANSIT OPERATORS MAY PREFER TURNPIKE UNTIL CONGESTION BUILDS.	HOV RIDERSHIP APPROXIMATES 50% OF MINIMUM VOLUME TO JUSTIFY HOV LANE.	HOV RIDERSHIP APPROXIMATES 50% OF MINIMUM VOLUME TO JUSTIFY HOV LANE. ENFORCEMENT OF HOV SHOULDER COULD BE CHALLENGING.	TRANSIT REUSE OF GSB SHOULD BE EXPLORED FOR TRAFFIC MANAGEMENT DURING CONSTRUCTION. POST CONSTRUCTION, TRANSIT OPERATORS MAY PREFER TURNPIKE.	TRANSIT REUSE OF GSB SHOULD BE EXPLORED FOR TRAFFIC MANAGEMENT DURING CONSTRUCTION. POST CONSTRUCTION, TRANSIT OPERATORS MAY PREFER TURNPIKE.
ATF COMMENTS	SUPPORT FOR TRANSIT & TDM SUPPORT FOR NARROWER CROSS SECTION CONCERN WITH OPERATIONS AND CAPACITY	INFEASIBLE DUE TO INSUFFICIENT RIDERSHIP AND COMPACTNESS OF STUDY AREA WIDE CROSS SECTION LITTLE/NO SUPPORT	INFEASIBLE DUE TO INSUFFICIENT RIDERSHIP AND COMPACTNESS OF STUDY AREA WIDE CROSS SECTION LITTLE/NO SUPPORT	OPERATIONAL AND MAINTENANCE COSTS LITTLE SUPPORT FHWA RESERVATION	COST-EFFICIENT SAFETY RESEARCH GENERAL SUPPORT FHWA RESERVATION

(1) ASSUMES ALTERNATIVES 10 (NEWINGTION AND 3 (DOVER) IN 2004 DOLLARS.
(2) ASSUMES ALTERNATIVES 10 (NEWINGTON) AND 3 (DOVER); ALTERNATIVES 11 AND 12 (NEWINGTON) ARE RELATIVELY DIFFICULT TO CONSTRUCT.
(3) RANGE REFLECTS MODERATE TO AGGRESSIVE TDM.
(4) ZIPPER LANE OPEN TO ALL TRAFFIC.
(5) PEAK HOUR SHOULDER USE OPEN TO ALL TRAFFIC.

Even though the Six-Lane Alternative fails to meet the basic project purpose, impacts associated with this project “footprint” were calculated for several important environmental resources. While expansion of the highway from a total of the existing four lanes to a proposed eight lanes might be expected to have twice as much impact as expansion from four lanes to six, this is not the case. Table 2.5-5 shows that the actual differences between the two system alternatives are relatively minor.

Table 2.5-5
Six vs. Eight-Lane Key Environmental Impacts

Resource	Measure	Total 8-Lane Impact	Total 6-Lane Impact	Percent Difference
Wetland Impacts	Fill/Dredge (Acres)	20.4	19.7	3.5%
Wildlife	Unfragmented Lands (Acres)	9.0	8.7	3.4%
Groundwater	Impacted Stratified-Drift Deposits (Acres)	15.2	14.6	4.1%
Noise	Number of Impacted Receptors	86	86	0%
Right-of-Way	Number of Residences Acquired	0	0	0%
	Number of Businesses Acquired	2	2	0%
Secondary Growth	2025 Total Population (Socio-Economic Study Area)	280,745	280,237	0.2%

The data in Table 2.5-5 summarizes the total impacts for both the six-lane and eight-lane cross-sections using highway layout Alternative 13 in Newington and Alternative 3 in Dover (see **Figures 2.4-15a and 2.4-15b**). It is also assumed that the General Sullivan Bridge would be rehabilitated. (This is the preferred highway layout alternative. See Section 2.7.)

Note that the differences between the six- and eight-lane options are less than 5 percent. Thus, while the eight-lane option would impact a total of 20.4 acres of freshwater wetlands, the six-lane would have a very similar impact - about 19.7 acres. The same pattern is true for all other environmental resources tested. While this may not immediately seem intuitive, it must be understood that the number of interchanges in the study area demands that appropriate acceleration and deceleration lanes be incorporated into the design. Thus, the six-lane cross-section is often equivalent to the eight-lane cross-section in order to allow adequate space for vehicles to safely enter and exit the highway.

It is important to note that public and agency comments requested analysis of a six-lane cross-section. However, two facts ultimately lead to the conclusion that a six-lane option is not tenable and should be eliminated from further consideration: 1) the six-lane option cannot accommodate the 2025 design year traffic volumes, and therefore does not meet the basic project purpose, and 2) environmental analysis demonstrates that the differences in impacts between the eight and six-lane options are minor. It was therefore determined that further consideration of the six-lane options was not warranted.

2.5.5.2 Mode Options

Based on the study of potential ridership and its effect on highway operations, bus service, rail service, the use of HOV lanes and employer-based TDM programs either alone or in combination with each other, do not eliminate the need to widen the bridges and the Turnpike to three general purpose lanes and one auxiliary lane in each direction between Exits 3 and 6 (eight-lane option), if acceptable system-wide levels of service are to be achieved for the 2025 design year. Some of the mode options would help minimize the length of time each day during which congestion occurs, but peak hour congestion would remain.

From a rail perspective, Alternative 1C would increase daily *Downeaster* service, improve commuter peak hour service, and is the next logical step in establishing the necessary infrastructure for future service improvements such as Alternatives 1A or 1B. As such, Alternative 1C has been recommended as an early action[35]; this alternative provides approximately 18 percent of the estimated peak hour vehicle diversion of Alternative 1A, at approximately 15 percent of the cost.

Expanded intercity bus service (Alternative 1) between Rochester and Boston will improve an already good commuter service. Increasing peak hour service and providing new park-and-ride facilities will enhance this service and the express bus service (Alternative 2) between Rochester and Portsmouth is planned by COAST in 2008. Also, reducing headways and providing better connectivity (Alternative 3) will enhance local bus service. Bundling all three bus service enhancements has an estimated capital and operating assistance cost ranging from $5.4 to $9.5 million depending on whether the expansion of intercity bus service (Alternative 1) is an extension of existing service or new service. New park-and-ride facilities (Dover and Rochester) will cost an additional $4.6 to $4.7 million. (The Durham/Lee park-and-ride cost has not been determined.) All three bus alternatives are being advanced as potential cost-effective means of reducing peak hour travel demand within the study area.

High Occupancy Vehicle (HOV) alternatives extending between the Dover Toll Plaza and Exit 1 in Newington, combined with an aggressive employer-based TDM program, Bus Alternatives 1, 2 and 3, and Rail Alternative 1-B, do not divert enough traffic to allow two or three general purpose lanes in each direction plus an HOV lane(s) to provide a satisfactory system level of

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35 Service was initiated in August 2007.

service (LOS D) along the Turnpike during weekday morning and evening commuting periods. Analyses and computer model simulations of Turnpike and interchange operations reveal system failure due to the lack of connectivity across the Little Bay Bridges of auxiliary traffic management lanes at Exits 3, 4 and 6 that allow traffic to safely and efficiently enter, exit, and change lanes in proximity to the interchanges. In addition, the cross-section footprints **(see Figure 2.4-7)** of seven-lane (three lanes in each direction and a contraflow, center lane HOV) and eight-lane (three general purpose lanes in each direction and one (1) concurrent HOV lane in each direction) HOV facilities are greater than the standard eight-lane typical cross-sections (see **Figure 2.3-1**), resulting in greater impacts. HOV ridership estimates are approximately 50 percent of the minimum volume considered necessary to justify exclusive HOV facilities and the concepts lack public support. As such, HOV alternatives were not carried forward.

Since HOV alternatives were deemed infeasible for the 2025 design year, borrow lane (zipper lane) and peak hour shoulder use alternatives were developed and analyzed in hopes of satisfying design LOS requirements and reducing the footprint and impacts of Turnpike improvements (**see Figure 2.4-8).** Both concepts would provide four traffic lanes in the peak direction during the peak hours of traffic and would have cross-section widths less than the standard eight-lane typical (**see Figure 2.3-1).** Peak shoulder use would be less costly since the borrow (zipper) lane would incur additional operational costs related to equipment, daily deployment, maintenance, incident management and storage facilities (to be located in the median) for deployment vehicles and maintenance equipment. However, FHWA, citing safety research and concerns with the implementation of both concepts as permanent long-term solutions, and the relatively small difference (14 to 18 feet) in width between the borrow lane and peak shoulder use alternatives as compared to the eight-lane typical section, was not supportive of either concept as a long-term transportation solution. As such, the borrow lane (zipper lane) and peak hour shoulder use alternatives were dropped from further consideration.

2.5.6 Identification of a Reasonable Range of Alternatives

To summarize the results of the initial development, refinement, review and screening of alternatives, the following alternatives were endorsed by the ATF (June 23, 2004) and were carried forward into the development of the EIS for further detailed evaluation:

- The No-Build Alternative, which essentially serves as a basis for purposes of comparison with the Build Alternatives.

- Transportation Systems Management (TSM) measures, as described previously, that address current traffic operational and safety problem areas.

- Travel Demand Management (TDM) measures, which will provide alternatives to single occupancy vehicular travel. Specifically, the following measures were carried forward:
  - Rail Alternative 1A – Expanded *Downeaster* Service to Dover
  - Rail Alternative 1B – Expanded *Downeaster* Service to Rochester
  - Rail Alternative 1C – Expanded *Downeaster* Service to Dover (NNEPRA/MaineDOT proposal)
  - Restoration or preservation of the Pease Spur railroad corridor.
  - Bus Alternative 1 – Expanded Intercity Bus Service (Rochester-Boston).
  - Bus Alternative 2 – Expanded Express Bus Service (Rochester-Portsmouth).
  - Bus Alternative 3 – Expanded Local Bus Service.
  - Promotion of employer-based measures utilizing incentives to encourage employees not to commute alone.
  - New park-and-ride facilities in Rochester, Dover, and Durham or Lee. (These facilities are carried forward as part of the three Bus Alternatives.)

- Bridge Alternatives – Both located to the west side of the existing Little Bay Bridges:
  - Rehabilitation and widening of the Little Bay Bridges to either six[36] or eight lanes with the General Sullivan Bridge Rehabilitation.
  - Rehabilitation and widening of the Little Bay Bridges to either six[36] or eight lanes with the General Sullivan Bridge Removed.

- Highway Alternatives – Either six[36] or eight lanes along the Turnpike and Little Bay Bridges for the following Alternatives:
  - Alternative 2 (**Figure 2.4-27**) in Dover
  - Alternative 3 (**Figure 2.4-28**) in Dover
  - Alternative 10A (**Figure 2.4-21**) in Newington
  - Alternative 12A (**Figure 2.4-24**) in Newington
  - Alternative 13 (**Figure 2.4-25**) in Newington

36 As previously noted, 6-lane alternatives were deemed infeasible in meeting the project purpose and need, and the differences in environmental impacts between 6- and 8-lane alternatives are relatively minor. As such, the 6-lane alternatives were used for comparative purposes, but dropped from further consideration.

These alternatives were evaluated in more detail and subject to additional agency and public input to determine associated impacts, costs, and permitting issues which are documented in Chapter 4. A summary of the environmental impacts of the alternatives carried forward in this EIS is provided in **Figure 2.5-1**.

2.6 Project Costs

A detailed breakdown of the estimated project costs in 2007 dollars for the Six-Lane and the Eight-Lane Alternatives is shown in **Figures 2.6-1** and **2.6-2.** The costs are broken out for the three Project Segments and include:

- For the Newington Segment, Alternatives 10A, 12A and 13.
- For the Bridge Segment there are two options:
  - The Westerly Little Bay Bridge Widening Alternative with the option to rehabilitate and retain the General Sullivan Bridge for use as a multi-use path.
  - The Westerly Little Bay Bridge Widening Alternative with the option to remove the General Sullivan Bridge and provide for a multi-use path on the Little Bay Bridge.
- For the Dover Segment, Alternatives 2 and 3

The figures depict transportation infrastructure improvement costs related to the reconstruction and widening of the Spaulding Turnpike, bridge widening and rehabilitation, new interchange ramps, the construction of local connecting roadways, and for the accommodation of the Pease RR Spur, should it be reactivated. **Figures 2.6-1 and 2.6-2** also identify costs related to the implementation of TDM measures including expanded rail and bus service. Right-of-way, design and construction engineering costs as well as costs associated with mitigating the project impacts to the environment are also identified.

For the approximate 1.0-mile section of the Turnpike just south of Exit 4 in Newington, and the 0.6-mile section of the Turnpike just north of the Exit 6 northbound off-ramp in Dover (**Figures 2.4-15a and 2.4-15b**), the mainline design layouts for the Build Alternatives are essentially the same and include six lanes. For the remaining mainline section of the Turnpike between Exit 4 and Exit 6 (approximately 1.8 miles), the primary differences in costs when comparing the Six-Lane Alternative with the Eight-Lane Alternative is essentially the cost associated with constructing an additional 12-foot travel lane in each direction.

Each of the interchange layouts proposed for the Newington and Dover Segments is the same for the Six-Lane and Eight-Lane Alternatives except for where and how the ramps are merged for the Six or the Eight-Lane Alternative.

The right-of-way impacts and associated costs are based on a proposed right-of-way for the eight-lane widening for each of the Segment Alternatives. The park-and-ride lot costs for the six-lane or the eight-lane layout are the same.

For the Six-Lane Alternatives, the range for the low and the high cost (construction, right-of-way and engineering) is estimated to be from $198.2 to $230.5 million. For the Eight-Lane Alternatives, the range for the low and the high cost is estimated to be from $213.2 to $245.4 million.

The estimated cost of the Selected Alternative which includes the mainline widening and reconstruction (the general purpose lanes plus an auxiliary lane in each direction), interchange reconfigurations, bridges, modifications to local roadways, expansion of bus transit and rail service, as well as engineering, right-of-way and environmental mitigation is approximately $228.7 million.

2.7 Selected Alternative

2.7.1 Description of and Rationale for Selected Alternative

Through the course of numerous public meetings (17 Advisory Task Force meetings, seven Public Informational meetings, and a Dover City Council meeting) and the Joint Public Hearing conducted on September 21, 2006 in Dover, input has been received that favored various aspects of the improvement alternatives. Major issues have been contemplated concerning access, the configuration of the interchanges, environmental impacts, right-of-way requirements, the elevation of the Turnpike (opposition expressed towards elevating the Turnpike due to associated noise and visual impacts), the fate of the General Sullivan Bridge (whether to remove or rehabilitate), six lanes versus eight lanes on the Little Bay Bridges, and a multi-modal approach to meeting transportation needs.

Based on the evaluation of the reasonable range of project alternatives, and on public comments, input from resource agencies, the Advisory Task Force, Rockingham Regional Planning Commission, and Strafford Regional Planning Commission, and considering safety, transportation efficiency, cost, impacts to the environment, impacts to private property, permitting issues, and community support, the following combination of transportation elements has been determined to represent the Selected Alternative. It best balances the impacts and issues in addressing the project's Purpose and Need:

- Rehabilitate/Widen the Little Bay Bridges (LBB) to eight lanes (three general purpose lanes plus an auxiliary lane in each direction) maintaining the existing easterly edge of the bridge and widening entirely to the west.
  - Eight lanes on the bridges would provide an adequate level of service (LOS D) for the projected travel demand in 2025 and would offer satisfactory levels of service for an additional 10 to 12 years beyond the design year (based on extrapolating the projected traffic growth).
  - The three general purpose lanes plus an auxiliary lane in each direction (*i.e.,* eight lanes in total) on the Turnpike would extend between Exits 3 and 6. Six lanes in total would extend south of Exit 3 to match into the exiting cross-section of the Turnpike at Exit 1 and would extend north through Exit 6 to the Dover toll plaza.
  - The existing profile of the Little Bay Bridges (suitable for 60 mph design criteria) would be maintained, as would the existing vertical clearance over the channel.
  - The bridge rehabilitation would involve replacing the existing bridge decks, modifying the steel girders to upgrade the pin and hanger connections, repainting the steel girders, and seismically retrofitting the existing pier columns.
  - Bridge construction would be completed in two phases with traffic maintained on the existing bridges while the proposed bridge widening is constructed and traffic shifted onto the widened section of the bridge while the existing bridges are rehabilitated.
  - Widening westerly (towards the General Sullivan Bridge) would minimize the impacts to Little Bay and Hilton Park.
  - The Advisory Task Force, City of Dover, Town of Newington, regional planning commissions, resource agencies, and the general public support the aforementioned bridge concept since it, in conjunction with the proposed TDM recommendations, addresses the long-term transportation needs of the corridor.
  - Eight lanes with full shoulders on the bridge provide future flexibility should the travel demand for HOV or contraflow lanes materialize beyond the design year (2025).
  - Cost of the Little Bay Bridge Rehabilitation and widening is estimated to be approximately $63.0 million.

- The cost of the Turnpike approaches leading to and from the LBB (Bridge Segment) are estimated to be an additional approximately $15.6 million.

- Rehabilitate the General Sullivan Bridge (GSB) to a six-ton loading capacity to continue to function as a pedestrian/bicycle/recreational facility and to accommodate emergency response and maintenance vehicles from Newington
  - The GSB is a historic landmark structure. It is the second highest rated historic bridge in the state (as recognized by NHDHR and FHWA), eligible for the National Register of Historic Places, and identified as a highly valued Section 4(f) resource[37].
  - The GSB is currently an important bike/pedestrian connection across Little Bay and is used for fishing and other recreational activity. These transportation connections and recreational activities will be more pleasurable on the GSB in comparison to the use of a multi-use path attached to the widened Little Bay Bridges, which will carry a large volume of vehicles at highway speed.
  - Retaining the GSB as part of the Selected Alternative requires the removal of the GSB's northerly approach embankment and wingwalls to facilitate the proposed reconstruction of a local access connector under the LBB. The existing concrete wingwall along the approach embankment would be removed essentially exposing the back of the GSB abutment. With the removal of the northerly approach embankment, a new 280-foot long pedestrian/bike path including a 155-foot pedestrian/bicycle structure is proposed that would connect the northerly end of the GSB with the local access road sidewalk and with Hilton Park.
  - The estimated cost to rehabilitate the GSB to a six-ton capacity is approximately $26.0 million. The rehabilitation would involve the complete replacement of the deck and supporting structural system (*i.e.* floor beams and stringers), other miscellaneous repairs to the structural steel to arrest future corrosion, cleaning and painting the entire structure, and repairing the substructure (patching spalls and repointing the masonry). A seismic retrofit to primarily prevent the potential collapse of the structure will include at a minimum, a bearing retrofit. The net additional cost to the project of rehabilitating the GSB is estimated to be approximately $10.9 million, or approximately 4.8 percent of total project costs taking into account $5.7 million for the structure's removal and $9.4 million to replace the recreational connection across the Bay with a 16-foot wide multi-

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37 Section 4(f) designates special USDOT legislative protection for historical resources and publicly-owned recreation areas/wildlife refuges.

use path attached to the Little Bay Bridges. This does not take into account the cost of the necessary mitigation should the GSB be removed, which would further reduce the net cost difference.

- FHWA, NHDHR, SRPC and the City of Dover have advocated for the GSB preservation. More members of the public have voiced support for the bridge's rehabilitation than for its removal citing its landmark status, and historic and recreational importance in the area.
- From a Section 4(f) perspective, a feasible and prudent alternative to not removing the GSB has been developed. Therefore, a proposal to remove the GSB would fail this regulatory test.

- Alternative 3 in Dover
  - This Alternative provides a full service interchange at Exit 6 and improves both system and local connectivity for the neighborhoods on both sides of the Turnpike and US 4, and for travelers heading easterly on US 4 towards Dover and northerly on the Turnpike.
  - The proximity of the signalized diamond-type interchange at Exit 6 necessitates the closing of the Cote Drive on-ramp to the Turnpike.
  - A two-lane northbound off-ramp widening to provide dual left and right turn lanes at its intersection with US 4 is proposed to handle the heavy volume of traffic exiting the northbound Turnpike at Exit 6.
  - A new two-way bridge (replacing the existing westbound only bridge) would be constructed to carry US 4 over the Turnpike.
  - Signals would be installed at the northbound ramps and at the southbound on-ramp. A third signal could potentially be required at the Dover Point Road intersection to provide safe egress for the neighborhood.
  - A bridge would be constructed to carry US 4 over a new local connector roadway between Spur Road and Boston Harbor Road. This grade-separated facility provides a local connection for the neighborhoods north and south of US 4 and eliminates the need for a traffic signal at the Boston Harbor Road/ US 4 intersection, where turns would be restricted to right turns in and out only. A short on-ramp from this local connector to the southbound on-ramp from US 4 would maintain convenient access from the Dover Point neighborhoods and Hilton Park, while reducing some of the traffic demand at the Boston Harbor Road/ US 4 intersection.
  - The Exit 5 off and on-ramps would be discontinued. The proximity of these ramps to the reconfigured Exit 6 would create traffic operational and safety problems. In addition, upgrading the geometry of the Exit 5 interchange to current standards would

impact Hilton Park and the Wentworth Terrace neighborhood. Access to the park and Wentworth Terrace will be provided *via* a new two-way local connector road traversing under the Little Bay Bridges adjacent to the channel. A section of Hilton Drive extending north from the existing ramps to the existing pump station will be retained to create a loop road for trucks to more easily exit the Wentworth Terrace neighborhood.

- An underpass utilizing the existing traveled way beneath the Little Bay Bridges is proposed to connect the east and west sides of Hilton Park and the residential neighborhoods. The existing roadway would be widened to accommodate two-way travel at a design speed of 20 mph. This underpass location provides the benefit of utilizing an existing grade-separated crossing as opposed to locating a grade-separated crossing further north, which would necessitate elevating the Turnpike and increasing noise and aesthetic concerns for the surrounding properties. The existing east-west pedestrian and bicycle connection at this location will be maintained.

- New sidewalks are proposed along the west side of Dover Point Road between Hilton Park and the existing sidewalk opposite the Division of Motor Vehicles (DMV) property; along the north side of Spur Road between the Bayview Park parking area and the Scammell Bridge; along the west side of the connector road between Spur Road and Boston Harbor Road; along the new two-way connector beneath the Little Bay Bridge; and along east side of Hilton Drive connecting to the reconstructed walkway along Pomeroy Cove.

- This alternative avoids impacts to Pomeroy Cove and minimizes impacts to wetlands and private property to the extent practicable. Approximately 8.3 acres of impacts to wetlands are estimated. No homes or full acquisitions of residential properties are required. Two businesses (a barn, which houses a dog kennel, will be physically impacted by the Turnpike widening and a bath/kitchen retail business where the rear portion of the building is impacted) will need to be acquired. Retaining walls, ranging from 6 to 14 feet in height, are proposed along the west side of the Turnpike to reduce slope impacts on the properties between the Turnpike and Dover Point Road. Retaining walls, ranging from 4 to 18 feet in height, are proposed along the east side of the Turnpike to avoid impacts to Pomeroy Cove and to limit slope impacts on the properties in the Dover Point Road/Cote Drive neighborhood. The existing bicycle/pedestrian path abutting Pomeroy Cove and connecting Hilton Park and Wentworth Terrace to Dover Point Road would be maintained.

- Sound barriers are proposed on both the east and west sides of the Turnpike between the LBB and Exit 6 which will mitigate for the elevated noise levels. Sound barriers are also proposed on both the east and west sides of the Turnpike north of Exit 6.
- The construction cost of Alternative 3 is estimated to be approximately $43.7 million.

- Alternative 13 in Newington
  - This alternative provides a reconfigured full service interchange at Exit 3 (Woodbury Avenue), a northern access into the Tradeport, and maintains on and off-ramps to provide full access at Nimble Hill Road and Shattuck Way at Exit 4.
  - This alternative also eliminates the ramps at Exit 2 (rerouting traffic to Exit 3), and includes provisions for a future Railroad Spur over the Turnpike into the Pease Tradeport should the need arise. Right-of-way and easements will be procured as part of the project and a portion of the railroad bridge's pier foundation will be constructed within the median of the Turnpike. An agreement between the NHDOT and the PDA with concurrence from FHWA will also be secured as part of the project to outline a shared cost arrangement should the rail spur be constructed in the future.
  - Sidewalks are proposed on both sides of Woodbury Avenue between Fox Run Road and Exit 3. Sidewalk on the north side of the roadway will be extended through the interchange, across the Turnpike and into the Tradeport on Arboretum Drive.
  - The ExxonMobil gas station/convenience store will continue to operate at its current location. However, access to the station from the Nimble Hill Road ramps will be limited to right-turns into and right-turns exiting from the existing driveway. A local roadway, which would also provide access to the gas station, Thermo Electron, and one other parcel (with existing direct access to the Turnpike) is also proposed. This local roadway could also provide access to the former drive-in property *via* the roadbed of the existing southbound Turnpike should that property be developed in the future.
  - Woodbury Avenue would be reconstructed to extend the two existing lanes in each direction with a center-raised median from the Fox Run Road intersection through the Exit 3 interchange area. A reduced cross-section is proposed in front of the Isaac Dow house and Beane Farm property to minimize impacts to these two historic resources.
  - In conjunction with the Interim Safety Improvement project, this alternative improves local connectivity by providing a direct

connection (via Shattuck Way) between the east and west sides of the Turnpike, and provides a local connection between Woodbury Avenue and the Tradeport.

- With a full northern access into the Tradeport at Exit 3, the satisfactory level of service at Exit 1 is extended beyond 2025, since a portion of the traffic load at Exit 1 will be accommodated at the newly configured Exit 3.
- Bridge work will include the construction of a 3-span structure to carry Woodbury Avenue over the Turnpike, and widening and rehabilitation of the structure carrying the Turnpike over Shattuck Way.
- Two signals are proposed, one each at the intersection of the northbound and southbound Exit 3 ramps with Woodbury Avenue.
- No full right-of-way acquisitions (buildings or parcels) are envisioned. However, approximately 29 acres of Tradeport land in the Exit 3 Interchange area will be impacted to construct the improvements.
- Approximately 11.8 acres of wetlands are impacted with this alternative.
- The construction cost of Alternative 13 is estimated to be approximately $47.9 million.

- Of the various Transportation System Management elements that were identified for the project:
  - Improving the deceleration condition and signing at northbound Exit 6W have been completed.
  - Improving the signing on the LBB to emphasize the "no lane change zone" on the bridge has been completed.
  - The Interim Safety Improvement Project at Exit 4 in Newington was completed in 2006. As part of the project, an auxiliary lane between Exits 3 and 4 northbound was constructed to improve traffic merging from Woodbury Avenue onto the Turnpike.
  - One other TSM element that is recommended will provide short-term relief at Exit 6 by re-striping the Exit 6 southbound on-ramp area to create two through lanes on the Turnpike and a one-lane on-ramp from US 4. Temporary closure of the southbound on-ramp from Boston Harbor Road would be required. This would cost approximately $100,000 and is scheduled for implementation in 2008
- A number of Travel Demand Management actions are proposed to complement the bridge and roadway infrastructure improvements. Early

implementation of these actions will also provide greater options to study area commuters during construction.

- A new park-and-ride facility consisting of 416 spaces is under construction at the Exit 9 area in Dover. The facility is being constructed as a separate project under the CMAQ program. Construction is underway with completion scheduled in 2008 to complement the COAST express bus service and Dover's planned downtown transit loop service.
- A park-and-ride facility consisting of approximately 200 spaces is proposed for the Exit 13 area in Rochester. The NHDOT recommends that this project be addressed either under the CMAQ program or as part of the Rochester 10620H project (currently planned to advertise in 2008).
- A park-and-ride facility consisting of approximately 30 to 50 spaces is recommended for the US 4/NH 125 intersection area in Lee to accommodate travelers using US 4 eastbound. The NHDOT also recommends advancement of this project under the CMAQ program.
- To improve bus service in the seacoast area and reduce peak hour headways to provide a more attractive and reliable mass transit mode of travel, three bus alternatives will be advanced with capital investments and consideration of operating subsidies up to a maximum of five years.
  - Bus Alternative 1 involves expanded intercity service for Rochester, Dover, Portsmouth and Boston to serve the commuter market. A CMAQ application for this expanded service between Dover and Portsmouth was submitted by C&J Trailways to provide 16 additional daily trips. Service is planned for 2008. NHDOT strongly supports this application for inclusion in the CMAQ program. This service could next be extended to Rochester to coincide with the construction of the Exit 13 park-and-ride facility. If C&J were the operator of the extended service to Rochester, the extension could likely be accomplished with the addition of one bus at a capital and operating cost of approximately $430,000.
  - Bus Alternative 2 involves expanding the 2008 planned COAST express bus service among Rochester, Dover, and Portsmouth to reduce headways during the peak period for the planned express commuter bus service. An additional bus and a maximum of five years of operating assistance for the extra service are estimated to cost approximately $440,000. NHDOT supports the funding of this additional service through the CMAQ program and/or project-related funding.

- Bus Alternative 3 involves improving connectivity and headways for three existing bus routes: COAST Route 2 service between Rochester and Portsmouth, Wildcat Transit Route 4 service between Durham and Portsmouth, and COAST Tradeport Trolley services which connects these two routes with the Tradeport. By adding 3 buses to the COAST service, 2 buses to the Wildcat service, and 3 trolleys, headways could be reduced to 20 to 25 minutes in the peak periods. Additionally, an enhanced and relocated transfer point could be established at the Fox Run Mall. The estimated cost of these improvements, including a maximum of five years of operating assistance is $4.5 million. NHDOT supports funding for this bus alternative through the CMAQ program and/or project-related funding.

- Expansion of the *Downeaster* service was also proposed. A joint-sponsored CMAQ project (total cost $6.0 million) by the Maine DOT, NHDOT and NNEPRA (Rail Alternative 1C) funded track and siding improvements in Maine and New Hampshire which allows NNEPRA to operate a fifth weekday roundtrip (current service is four roundtrips per weekday) between Portland and Boston. In addition, commuter peak period service improves with the arrival of the weekday AM commuter train in Boston at 8:00 AM, as opposed to 9:00 AM which was the former schedule. The NHDOT has advanced this effort through a CMAQ application,[38] with service initiated in August 2007.

- To support the promotion of employer-based measures to encourage travel other than by SOV, it is proposed that funding for the seacoast area TMA, Seacoast Commuter Options, be provided to help extend the service for a maximum period of five years. The TMA is aggressively promoting its ride-share and guaranteed-ride-home programs and meeting with Seacoast employers to offer cost-effective commuting alternatives. This extension of funding could be accomplished through the CMAQ program or with project-related funds.

- The total estimated construction cost for the Selected Alternative is $196.2 million. The cost of right-of-way acquisition, engineering, TDM/TSM measures and mitigation is estimated to be an additional $32.5 million. (See **Figure 2.6.2**.)

38 Actual NHDOT share of improvements is approximately $2.0 million.

2.7.2 Environmental Summary of Selected Alternative

Detailed descriptions of the impacts associated with the various project alternatives are presented in Chapter 4. A brief summary is presented below and in **Figure 2.5-1**.

The No-Build Alternative serves as the baseline condition for comparing impacts of the Six- and Eight-lane widening alternatives. In general, future impacts to most resources would be avoided (*e.g.*, losses of wetlands or impacts on historical resources) with selection of the No-Build Alternative. In the case of some resources, the quality of an environmental resource may actually decline under the No-Build Alternative. For example, microscale (local) air quality problems would be expected to increase with the No-Build Alternatives due to higher levels of congestion and concomitant mobile source air pollution. Over the next 20 years the average daily volume of traffic is expected to increase from approximately 70,000 (2003) to approximately 94,600 (2025) vehicles per day. This traffic projection supports the conclusion that the existing facility will be increasingly less able to operate at the levels of service and safety for which it was originally designed. During weekday and weekend peak hours of the day, the Turnpike currently operates at unacceptable levels of service (LOS E and/or F) with motorists experiencing severe congestion and long delays within this segment of the corridor. This condition will be further exacerbated with the No-Build Alternative. Also, noise generated by the highway will continue to increase even if the No-Build Alternative is pursued. In the case of noise impacts, the Build Alternative includes provisions for the construction of noise barriers in Dover which would not otherwise be constructed to mitigate this problem.

To analyze impacts to environmental resources, an eight-lane roadway cross-section was assumed for the Build Alternative. It was determined that a six-lane cross section would not meet the project purpose and need, and this option was discarded during the development of the reasonable range of alternatives. A comparison between the six and eight-lane cross-sections was performed, which demonstrated very little differences associated with key environmental resources (see Table 2.5-5). However, impacts associated with a six-lane cross section were determined for socio-economic effects, particularly for the analysis of indirect (secondary) impacts.

Socio-economics

The Selected Alternative would require acquisition of one commercial property and a portion of a second commercial property, including a barn, both in Dover. Local tax bases would be reduced by approximately $2.2 million. The resultant effect on Newington's tax revenue would be less than

$9,000, while the effect in Dover would be approximately $22,000. Indirect economic effects, *i.e.*, “secondary” or “induced” growth, may result in an additional 1,865 people and 1,897 jobs within the region influenced by this improved segment of the Spaulding Turnpike by the year 2025. This additional growth is a very small fraction of the amount of overall growth predicted for the region even if the Turnpike is not improved (*i.e.*, a total of approximately 92,841 new residents by 2025 under the No-Build Alternative).

Farmlands

There will be no active farmlands affected by the project, although 2.7 acres of prime farmland soils would be lost in Newington. These areas are not and have not been used for agriculture for decades or longer. The mitigation for the wetland impacts resulting from the project does involve the permanent conservation of the Tuttle Farm on Dover Point, the oldest continuously-operated farm in the country.

Wetlands

Wetland impacts resulting from the Selected Alternative are estimated to be approximately 21 acres, including impacts from the Turnpike improvements, construction of barriers to mitigate noise impacts, and estuarine impacts resulting from expansion of the bridge piers. None of the project alternatives would affect vernal pools, which are essential breeding habitat for certain types of salamanders and wood frogs. Most of this wetland impact will occur in areas directly adjacent to the existing Turnpike corridor and are therefore already impacted to some degree. Some wetlands, in fact, appear to have formed as a result of the original Turnpike construction. However, the construction of a new interchange in Newington will impact a substantial forested and riparian system associated with Pickering and Railway Brooks.

Restoration of Railway Brook is proposed as mitigation (approximately 3,100 linear feet of perennial stream), and approximately 150 to 250 acres of land preservation in Dover and Newington will help to offset these wetland impacts.

Wildlife

Given that the project area is relatively urbanized, impacts to wildlife habitat will be minor. No travel corridors were identified in the study area, and the vast majority of the area is already fragmented to the point that only relatively common, urban species would be affected. Certain portions of the study area do contain early successional habitat, which is relatively uncommon when compared to the amount of forested cover in the northeastern US. However, there could be some adverse effect resulting from the construction of the proposed Newington (Exit 3) interchange due to increased fragmentation.

Threatened and Endangered Species

Only one known location of a state-threatened plant species, the prolific knotweed (*Polygonum prolificum*) was mapped within the limits of the Selected Alternative. Field searches for this population were unsuccessful, and the population is thought to be extirpated. Habitat for the New England cottontail, a possible candidate for Federal threatened or endangered status, was located by field study, but impacts to the species are expected to be minimal since the habitat quality is marginal.

Surface Waters

The study area is essentially defined by major surface waters including the Bellamy River, the Piscataqua River and the Little Bay. Additionally, six smaller watercourses were identified, all in Newington (Paul Brook, Railway Brook, Pickering Brook, Flagstone Brook and two unnamed streams).

A comparison of the estimated existing and proposed increases in impervious area associated with the Selected Alternative shows that for most streams, including Railway Brook, Flagstone Brook, Paul Brook and the two unnamed tributaries, there would be a minimal increase in impervious area (*i.e.*, < 1.0 percent of drainage area). Much of the new impervious area in the Newington area would occur in the lower Pickering Brook watershed. The additional impervious area associated with Alternatives 13 (the Selected Alternative), would represent 4.2 percent of this watershed area. Currently, about 19.0 percent of the lower Pickering Brook watershed (*i.e.*, east of Railway Brook) is estimated to be comprised of impervious area. Based on estimated impervious area changes, Alternative 13 would likely generate the least amount of impact to the surface waters in the study area.

The various streams on the Newington side of the project area primarily support the more tolerant warm-water fish species and other aquatic organisms. The benthic communities were determined to have low diversity and comprised of the more tolerant species that typically prevail in poor stream habitat conditions or where water quality conditions are diminished due to upstream pollution sources. Given the proposed water quality treatment measures for highway runoff, minimal impacts are anticipated to the aquatic resources in this stream.

Marine Resources

An extensive hydrodynamic model was developed for this EIS to investigate the potential effects of the project on the Little Bay/Great Bay Estuary. The model predicted only minimal changes in tidal conditions as a result of the Selected Alternative (*i.e.*, the extension of the existing Little Bay Bridge piers). While the model predicts that the pier extensions may change tidal maxima, the predicted changes are on the order of 0.1 to 0.2 inches, depending on the tidal condition and the location in the estuary. Similarly, current velocities and directions are expected to change only minimally.

Considering the relatively small magnitude of change that the hydrodynamic model predicts, it is expected that biotic changes will also be minimal. Relative to the total tidal range (approximately 9 feet), this is a negligible change. Additionally, the model demonstrates that this magnitude of change is less than the total change experienced in the estuary prior to the General Sullivan Bridge construction. However, the expansion of the bridge piers will directly impact approximately 17,000 square feet of benthic habitat.

Navigation

Hydrodynamic modeling results indicate that current velocity maxima will increase by no more than 0.5 feet per second, with changes typically only 0.3 feet per second. These potential changes represent only a slight change from the estimated 10 feet per second maximum tidal current under existing conditions. The model predicts that current speeds will increase in some areas near the piers, while the speeds will decrease in other areas. Additionally, the model predicts that current directions will not change substantially, at least at the scale that can be resolved by the model.

Vertical and lateral clearances in the main navigation channel through the bridge area will be maintained so as not to impact navigation. Taken together with the results of the hydrodynamic modeling, it can be concluded that the project will have only minimal effects on navigation, and should not create situations that are more hazardous than the present conditions.

Floodplain

The Selected Alternative would affect a total of 1.2 acres of 100-year floodplain (3.9 acre-feet). The majority of this impact is associated with the expansion of the bridge piers. The floodplain impacts are considered minor in the context of the tremendous volume of Little Bay and will have a negligible effect on the base flood elevations in the area. Any effect on flooding would be influenced by changes to the hydraulic characteristics of the channel (accounted for in the hydrodynamic model), rather than by displacing floodplain volumes.

Groundwater Resources

There are no impacts to public water supply wells associated with the Selected Alternative. However, the majority of Dover Point and a portion of the study area in Newington are mapped as a stratified-drift aquifer, a landform generally capable of producing substantial yields of groundwater. The Selected Alternative would result in approximately 14.1 acres of new impervious surface area over these deposits, which might affect the recharge of the aquifer. To help reduce this potential impact, NHDOT will examine the use of infiltration technology during final design of the reconstructed drainage system.

Air Quality

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

The proposed project satisfies transportation conformity requirements because the proposed project's air quality emissions were evaluated as an improvement in the NHDOT's State Transportation Improvement Program (STIP) for fiscal years 2007-2010, which was reviewed by USEPA and found to be in conformance by the US Department of Transportation.

Noise

During public meetings leading up to the publication of the Draft EIS, and at the Public Hearing in September 2006, noise impacts generated from the Turnpike were frequently raised by residents of the study area as one of their main concerns. The Traffic Noise Model utilized for this EIS indicated that several portions of the study area are already adversely affected by noise levels. Predicted noise levels under the 2025 Build Alternative would not create any new impacts, but would perpetuate the problem. Noise barriers have therefore been proposed where practicable based on their effectiveness and cost. Four such barriers are planned in Dover to mitigate noise impacts.

Community Resources

Two important recreational resources are located within the study area – Hilton Park and Bayview Park – both in Dover. The Selected Alternative would avoid acquisition of new right-of-way from Hilton Park, although a small permanent easement and temporary impacts to the park would be unavoidable during construction. New right-of-way and grading would be required on the Bayview Park property (a.k.a., the Bellamy River Wildlife Management Area, owned by the NHF&GD), totaling less than ½ acre.

Sidewalks to the park, a new driveway and expanded parking are proposed to improve accessibility to the park.

Cultural Resources

The Selected Alternative manages to avoid direct impacts to all but a few historic properties (*i.e.,* properties determined eligible for listing on the National Register of Historic Places). Most notably, the Selected Alternative proposes to rehabilitate the historic General Sullivan Bridge as a bicycle and pedestrian facility, preserving a valuable and highly significant historic resource. Other impacted properties include the Beane Farm, Isaac Dow House and the Portsmouth Water Booster Station in Newington and the Ira Pinkham House in Dover. While incidental property impacts occur in all of these cases, only one structure, a barn associated with the Ira Pinkham House will be directly impacted by the project.

In addition to the historic structures, much of the study area has been determined sensitive or probably sensitive for archaeological resources, both historic and Native American. The Selected Alternative would affect up to 18 such areas (approximately 44 acres of disturbance). Further information on these potential resources will be compiled following the FHWA's ROD as more detailed design is developed and the potentially impacted areas solidified.

Hazardous Materials

Given the long history of land use in the area, particularly the commercial/industrial and military use in Newington, there is some potential for the project to affect properties with a history of hazardous materials contamination. For the most part, the Selected Alternative avoids direct impacts to such properties, and there would be no impact to human or ecological health. Up to 20 properties may be further studied during final design in order to accurately define the risk relative to the possibility of encountering contamination from hazardous materials.

Beneficial Effects

The Selected Alternative would result in a number of beneficial effects.

Safety and Traffic Operations

The Selected Alternative will result in safer and more efficient traffic operations in comparison to the No-Build Alternative.

- Substandard shoulder areas on the Little Bay Bridges and bridge approaches will be eliminated.

- Interchanges will be consolidated (Exits 2 and 3; Exits 5 and 6), improving spacing between interchanges, eliminating substandard geometry and providing the necessary traffic management lane between Exits 3 and 6 to enable safe lane changes required by traffic entering and exiting the Turnpike. Traffic congestion and delays will be reduced and air quality will be improved.
- Connections to the Turnpike system will be improved at Exit 3 (Woodbury Avenue/Tradeport) and Exit 6 (US 4/Dover Point Road) improving system efficiency and eliminating circuitous travel.
- Local roadway connections will be improved:
  - Woodbury Avenue – Arboretum Drive (Tradeport).
  - Extension of Shattuck Way (Newington) and conversion to two-way traffic. (Construction was completed in 2006.)
  - Two-way Hilton Park connector adjacent to channel.
  - Two-way connector between Spur Road and Boston Harbor Road (Dover).
- Improved pedestrian connections will be provided:
  - Connecting the east and west sides of Hilton Park.
  - Rehabilitation of the General Sullivan Bridge will maintain the important connection across the Bay.
  - Connecting the Spur Road and Boston Harbor Road neighborhoods with Bayview Park.
  - New sidewalk along Woodbury Avenue extending from Fox Run Road and running across the Turnpike to connect the Tradeport on Arboretum Drive.
  - New sidewalk along Dover Point Road connecting Hilton Park with existing sidewalk on Boston Harbor Road, and with Spur Road *via* the new local connector road.
- Future planning and accommodation for a rail connection traversing above the Turnpike between the Newington Branch line and the Pease Tradeport.
- Reduced travel demand and improved air quality from expanded bus service and employer-based travel demand management (TDM) programs during construction.
- Travel time during the peak hours of the day will be improved from the current approximately 10 minutes required to travel the 3.5-mile section of the Turnpike to approximately 4 minutes. In the future (2025), travel time is expected to be reduced from approximately 21 minutes (No-Build) to approximately 4 minutes with the Selected Alternative.

Environmental Benefits

In addition to the safety and traffic operational benefits summarized above, certain beneficial environmental effects will result from the improved traffic operations of the Turnpike. For example, the reduced congestion will help to reduce transportation-related air emissions, which, at the local scale, are directly related to traffic congestion. Similarly, transportation-related energy consumption is more efficient in areas of decreased congestion.

Project-related environmental mitigation will help to offset impacts to natural resources. For example, as discussed previously, approximately 150 to 250 acres of land will be permanently protected as a result of the project's proposed mitigation. Railway Brook, a former branch of Pickering Brook, will be restored to replace lost stream and wetland habitat. Also, protection of the Tuttle Farm will help preserve an historic part of New Hampshire's agricultural heritage.

Other substantial beneficial elements include:

- Noise barriers in Dover to alleviate highway-related noise impacts to residential areas;
- Rehabilitation of the historic General Sullivan Bridge to allow its continued use as a pedestrian, biking and recreational facility; and
- Eleven extended detention basins to treat stormwater runoff and improve water quality.

3

Affected Environment

3.1 Introduction

This chapter provides a description of the existing or baseline conditions in the study area. Current traffic and transportation conditions as well as natural, socio-economic, and cultural resources are described. It is this affected environment that the impacts of the various project alternatives will be evaluated against (see Chapter 4).

3.2 Transportation

This section summarizes existing and future traffic conditions, levels of service, and infrastructure conditions and needs of the Spaulding Turnpike and its interchanges from Exit 1 at Gosling Road in Newington to Exit 6 at US 4 in Dover. The data collection efforts include the New Hampshire Seacoast Travel Survey[39] (Section 3.2.1.1), vehicle classification counts, and weekday 24-hour, AM peak hour, and PM peak hour traffic volume counts. In addition, crash statistics based on state and local police reports have been reviewed and summarized.

The Traffic Volumes Section (3.2.2) summarizes existing 2003 traffic volumes, the results of the existing traffic operations evaluation, and the development of appropriate existing and future design hour volumes. In addition, Section 3.2.2.5 describes the traffic forecasting model used for this study and the analysis of future traffic operations for the year 2025.

The infrastructure conditions and needs assessment includes a discussion of the existing highway facility layout and identifies geometric deficiencies along the corridor. This assessment also includes a description of the pavement conditions and a summary of major bridge conditions within the study area.

39 New Hampshire Seacoast Travel Survey, administered by Resource Systems Group, Inc., June 2003.

The TDM Section 3.2.6 describes the existing park-and-ride, rail, and bus services in the area. Employer-based programs to encourage employee alternatives to driving alone to work are also presented in this section.

3.2.1 Traffic Data Collection

Due to the size and scope of this study, an extensive data collection program was required. This information is crucial to determine existing travel patterns, characteristics, and facility level of service. The data collection program consisted of the New Hampshire Seacoast Travel Survey, and a compilation of traffic volumes and vehicle classification counts. Details of each component are discussed briefly below. Survey and count data were collected by the NHDOT, the RPC, the SRPC, and Resource Systems Group (RSG), acting as a consultant for the planning commissions.

3.2.1.1 New Hampshire Seacoast Travel Survey

In June 2003, the two regional planning commissions and RSG initiated the New Hampshire Seacoast Travel Survey. The survey was a web-based questionnaire that asked respondents for details on their most recent trip to the Seacoast area and what preferences they may have towards alternative ways of making this trip in the future (*i.e.* commuter rail, express bus, car-pooling, *etc.*).

A broad cross-section of respondents from the area population was obtained for the survey by recruiting at various locations including local public areas, toll booths, and public transportation centers. Recruiting methods at these locations included flyer handouts where respondents were provided with instructions to log onto the web site from home or work and complete the survey at a later time, and face-to-face recruitment where respondents could take the survey on a laptop computer provided on location. In addition, various local businesses and municipal organizations also participated in the survey *via* email invitation.

From June 6, 2003 through June 23, 2003 approximately 58,845 flyers or invitations were handed out to participate in the survey at 22 locations. With an initial goal of 1,000 responses, the survey was successfully completed with an overall response rate of 2.6 percent representing roughly 1,537 completed surveys.

Detailed characteristics of the drivers on the Spaulding Turnpike were drawn from the responses to the survey. Questions relating to travel frequency, trip purpose, vehicle occupancy, and potential mass transit ridership were asked. The results of the New Hampshire Seacoast Travel Survey are briefly discussed below. It is important to note that of those who responded to the survey, 75 percent were full or part-time residents of the New Hampshire Seacoast area. In addition, 53 percent of the trips described by the respondents included crossing the Little Bay Bridges.

Frequency of Travel

A total of 65 percent of the survey respondents stated that they traveled within the Seacoast Travel Survey area four or more times per week. Approximately 18 percent traveled within the survey area 1 to 3 times per week. The remaining 17 percent completed a Seacoast area trip fewer than 3 times per month.

Mode of Travel

Respondents were asked to define their primary mode of transportation when completing a Seacoast area trip. The majority, 78 percent, responded that they drove alone and 19 percent responded that they drove or rode with others. The remaining three percent either rode a bus (two percent, 27 responses) or biked, walked, or used some other means of transportation.

Trip Purpose

Work-related trips were reported as the primary trip purpose by the respondents at 73 percent. Other trip types (such as school, shopping, personal business, and recreation) make up the remaining 27 percent of the trip purposes.

Vehicle Occupancy

The majority (78 percent) of the respondents indicated that they made their respective trips alone. Of the 22 percent that traveled with passengers, 14 percent drove with one passenger, five percent drove with two passengers, and three percent drove with three or more passengers.

3.2.1.2 Vehicle Classification

The classification of vehicles by type (*i.e.* passenger car, single unit truck, tractor-trailer, bus) is an important part of the data collection program, specifically for use in air quality and noise studies along the Turnpike. Vehicle classification counts have been conducted by the NHDOT in 2002 at two locations along the Spaulding Turnpike – between Exits 1 and 2, and on the Little Bay Bridges. The counts show that approximately 55 percent of the daily, morning peak hour, and evening peak hour traffic volumes on the Spaulding Turnpike are passenger vehicles. Approximately 40 percent of the traffic is made up of pick-up trucks, sport utility vehicles (SUV), and light trucks such as delivery trucks or box trucks (two axles). The remaining five percent of the traffic consists of heavy trucks (two-axle six tires and larger) and buses.

3.2.2 Traffic Volumes

The purpose of this section is to establish and evaluate the existing traffic conditions within the study area. The following includes a discussion on traffic volume trends, the results of the existing conditions traffic operations evaluation, and the development of an appropriate design hour volume condition.

3.2.2.1 2003 Base Year Traffic Volumes

The NHDOT maintains a permanent traffic volume recorder station (24-hour operation) along the Spaulding Turnpike in Newington at the Little Bay Bridges (Station #331001). To supplement the data from this count station, temporary automatic traffic recorder counts or weekday AM and PM peak period manual traffic counts were conducted at each interchange (Exits 1 through 6). The majority of these supplemental counts were performed in May and June 2003. Hence, the weekday peak hour traffic volume networks and analyses presented herein for the 2003 Existing Conditions reflect the June condition. The 2003 weekday morning and evening peak hour traffic volumes at each of the study area intersections are presented in **Figures 3.2-1 and 3.2-2**.

Review of the peak hour and daily volumes recorded on the Little Bay Bridges in June 2003 reveals that the weekday morning peak hour volume (5,660 vehicles per hour) on the Spaulding Turnpike accounts for 7 percent of the total daily volume (78,600 vehicles per day) with roughly 70 percent traveling southbound and 30 percent northbound. The portion of daily traffic observed during the weekday evening peak hour volume (6,340 vehicles per hour) is slightly higher at 8 percent with 65 percent traveling northbound and 35 percent traveling southbound.

3.2.2.2 Existing Traffic Operations

The volume of traffic along the Spaulding Turnpike indicates the importance of the corridor to the regional transportation system, but gives little indication of the quality of traffic flow. To assess the quality of traffic flow along the corridor and other study area roadways, capacity analyses were conducted to determine how well the Spaulding Turnpike serves the traffic demands placed upon it. The traffic performance measures and the evaluation criteria used in the operational analyses are based on the methodology in the *2000 Highway Capacity Manual*[40].

A primary result of the capacity analysis is the determination of level of service (LOS), which is a qualitative measure describing operational conditions within a traffic stream and their perception by a motorist or passenger. Level of service generally describes these conditions in terms of such factors as speed and travel time, density or freedom to maneuver, traffic interruptions, comfort and convenience, and, in doing so, provides an index to quality of traffic flow. Six levels of service are defined ranging in letter designation from LOS A to LOS F, with LOS A representing the best traffic operation and LOS F representing the worst. LOS C describes a stable flow condition and is considered desirable for peak and design hour traffic flow. LOS D is generally considered acceptable where the cost and impacts of making improvements to provide LOS C are deemed unjustified. LOS E reflects traffic operations at capacity. The results of the freeway segment analysis are summarized in Table 3.2-1 and **Figures 3.2-3 and 3.2-4**. These figures graphically show the freeway segments that experience capacity deficiencies during the 2003 weekday morning and evening peak hours, and the segments that currently have substandard geometric features, which are discussed in Section 3.2.4.

The freeway segment analysis results reveal poor operating conditions (LOS E or F) along the Spaulding Turnpike between Exits 2 and 6. During the 2003 AM peak hour, the corridor is at capacity (LOS E) in the southbound direction between Exits 6 and 3. During the 2003 PM peak hour, volume demands along the corridor exceed capacity in the northbound direction between Exits 4 and 6. Consequently, rolling vehicle queues along the Turnpike northbound during the weekday PM peak hour; resulting from the system capacity constraints between Exits 4 and 6, regularly extend southerly blocking the Exit 2 and Exit 3 northbound on-ramps. Although this condition is not reflected in the isolated facility analysis methodology, these northbound segments of the Turnpike (Exits 2 through 3) also fail during the weekday PM peak hour. In addition to the freeway segments being at or near capacity, capacity analyses for the four weave segments on the Spaulding Turnpike between Exits 4 and 6 (southbound, AM peak hour, at Exit 4 approaching Nimble Hill Road, southbound, AM peak hour, between Exits 4 and 4N, northbound, PM peak hour, between Exits 4N and 4, and northbound, PM peak hour, between Cote Drive and Exit 6N) indicate that all four weave areas operate at LOS E or F during the 2003 weekday peak hours.

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40 2000 Highway Capacity Manual, Transportation Research Board, Washington, D.C.

Table 3.2-1
2003 Existing Conditions-Freeway Segment Analysis Summary

Segment	Weekday Period	Direction	Node to Node[1]	Volume	LOS[2]
Exit 1 to Exit 2	AM Peak Hour	NB	1A – 2A	1645	B
		SB	2E – 1B	3055	D
	PM Peak Hour	NB	1A – 2A	3320	D
		SB	2E – 1B	1590	B
Exit 2 to Exit 3	AM Peak Hour	NB	2B – 3A	1495	B
		SB	4D – 3C	3880	E
	PM Peak Hour	NB	2B – 3A	3155	D (E)[3]
		SB	4D - 3C	2305	C
Exit 4N to Exit 4 NB and Exit 4 to 3 SB	AM Peak Hour	NB	4A – 4B	1765	C
		SB	4E – 4D	3975	E
	PM Peak Hour	NB	4A – 4B	4050	E
		SB	4E – 4D	2440	C
Exit 4 to Exit 5 (Little Bay Bridges)	AM Peak Hour	NB	4C – 5A	1635	B
		SB	5C – 4G	4025	E
	PM Peak Hour	NB	4C – 5A	4070	E
		SB	5C – 4G	2270	C
Exit 5 to Exit 6N	AM Peak Hour	NB	5B – 6A	1665	B
		SB	6D – 5C	2505	C
	PM Peak Hour	NB	5B – 6A	4105	E
		SB	6D – 5C	1160	B
North of Exit 6W	AM Peak Hour	NB	6C – Toll	900	A
		SB	Toll – 6D	2530	C
	PM Peak Hour	NB	6C – Toll	2375	C
		SB	Toll – 6D	1200	B

Notes:
1 See **Figures 3.2-3 and 3.2-4**.
2 Level of Service.
3 Isolated facility analyses do not account for impacts associated with system deficiencies and failures. Field observations have confirmed that Ramp Nodes 2B and 3A and Freeway Segment 2B to 3A are regularly blocked by the rolling queue of vehicles on the Turnpike, resulting from system capacity constraints at Exits 4 through 6.

The breakdown in the 2003 peak hour traffic flow and congestion associated with the main line capacity between Exits 3 and 6 also extends to interchange traffic operations, as summarized in Table 3.2-2.

As shown in the table, LOS E or F conditions exist during the 2003 AM peak hour at the Exit 3 southbound off-ramp, the Nimble Hill Road southbound on and off-ramps, and the Shattuck Way southbound on-ramp. During the 2003 PM peak hour, interchange breakdowns (LOS E or F) occur at the Exit 2 northbound on-ramp, Exit 3 northbound on-ramp, Exit 4N northbound on-ramp, Exit 6 northbound on-ramp, and Exit 6N northbound off-ramp.

Table 3.2-2
2003 Existing Conditions - Ramp Junctions Analysis Summary

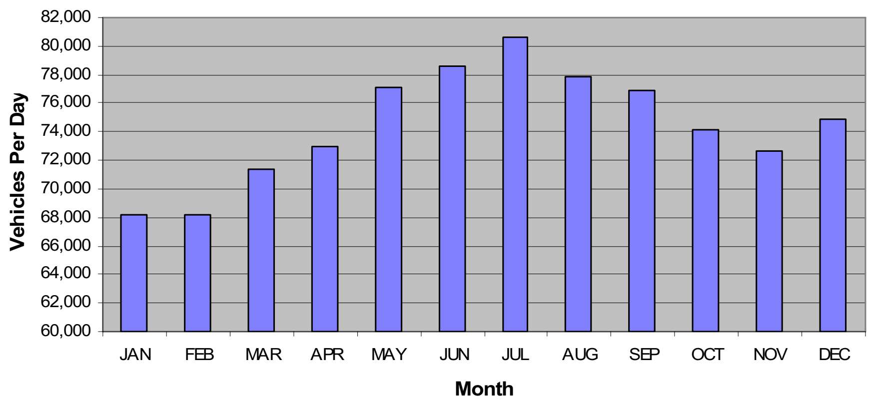
Interchange Movement	Node[1]	Weekday Time Period	LOS[2]
<u>Exit 2</u>			
NB off-ramp	2A	AM Peak Hour	B
NB on-ramp	2B		B
NB off-ramp	2A	PM Peak Hour	D
NB on-ramp	2B		C (F)[3]
<u>Exit 3</u>			
NB on-ramp	3A	AM Peak Hour	B
SB off-ramp	3C		E
NB on-ramp	3A	PM Peak Hour	D (F)[3]
SB off-ramp	3C		C
<u>Exit 4</u>			
NB 4N on-ramp	4A	AM Peak Hour	B
NB 4 off-ramp	4B		B
NB Shattuck Way on-ramp	4C		B
SB 4N off-ramp	4D		D
SB Nimble Hill Rd on-ramp	4E		E
SB Nimble Hill Rd off-ramp	4F		F
SB Shattuck Way on-ramp	4G		F
		PM Peak Hour	
NB 4N on-ramp	4A		F
NB 4 off-ramp	4B		D
NB Shattuck Way on-ramp	4C		D
SB 4N off-ramp	4D		C
SB Nimble Hill Rd on-ramp	4E		C
SB Nimble Hill Rd off-ramp	4F		C
SB Shattuck Way on-ramp	4G		C
<u>Exit 5</u>			
NB on-ramp	5B	AM Peak Hour	B
NB off-ramp	5A		B
NB on-ramp	5B	PM Peak Hour	D
NB off-ramp	5A		D
<u>Exit 6</u>			
NB (Cote Drive) on-ramp	6A	AM Peak Hour	B
NB 6N off-ramp	6B		B
NB 6W off-ramp	6C		B
SB Spur Rd off-ramp	6D		B
NB (Cote Drive) on-ramp	6A	PM Peak Hour	E
NB 6N off-ramp	6B		E
NB 6W off-ramp	6C		D
SB Spur Rd off-ramp	6D		A

Notes:
1 See **Figures 3.2-3 and 3.2-4**.
2 Level of Service
3 Isolated facility analyses do not account for impacts associated with system deficiencies and failures. Field observations have confirmed that Ramp Nodes 2B and 3A and Freeway Segment 2B to 3A are regularly blocked by the rolling queue of vehicles on the Turnpike, resulting from system capacity constraints at Exits 4 through 6.

3.2.2.3 Seasonal Variations and Growth Trends

Examination of the monthly variation in the 2003 average weekday traffic on the Little Bay Bridges shows July as the peak month with an ADT of 80,600 vehicles per day. The months of June and August have the next highest volumes, being roughly 3 percent lower than July. The monthly variation in the average weekday traffic observed on the Little Bay Bridges in 2003 is shown graphically in **Exhibit 3.2-1**.

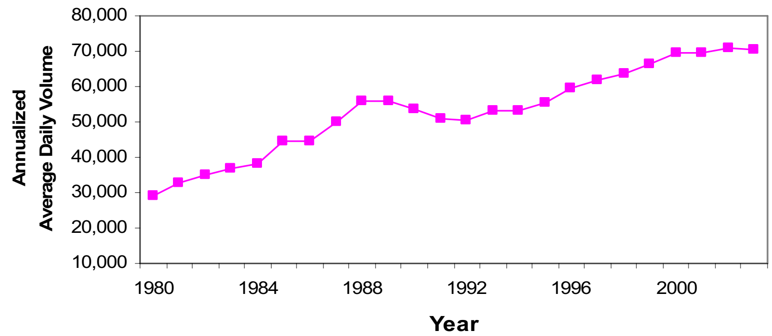
Exhibit 3.2-1
Monthly Variations
Spaulding Turnpike at Little Bay Bridges
2003 Average Weekday Volume



I

In addition to reviewing seasonal trends, historical traffic growth trends were also examined. The NHDOT permanent traffic recorder count station on the Little Bay Bridges provided historical traffic volume data from 1979 to 2003. During this time period the annualized average daily traffic (AADT) grew from 29,500 to 70,650 vehicles per day. The growth in AADT is depicted in **Exhibit 3.2-2**. The AADT over the 24-year period revealed an average annual growth rate of approximately 3.7 percent. More recently, the annual rate of traffic growth has decreased. During the 1993 to 2003 ten-year period, traffic increased annually at an average growth rate of approximately 2.9 percent. Since 1998, traffic has increased at an average annual rate of approximately 2.1 percent per year.

Exhibit 3.2-2
Spaulding Turnpike at Little Bay Bridges
Average Annual Daily Traffic Growth



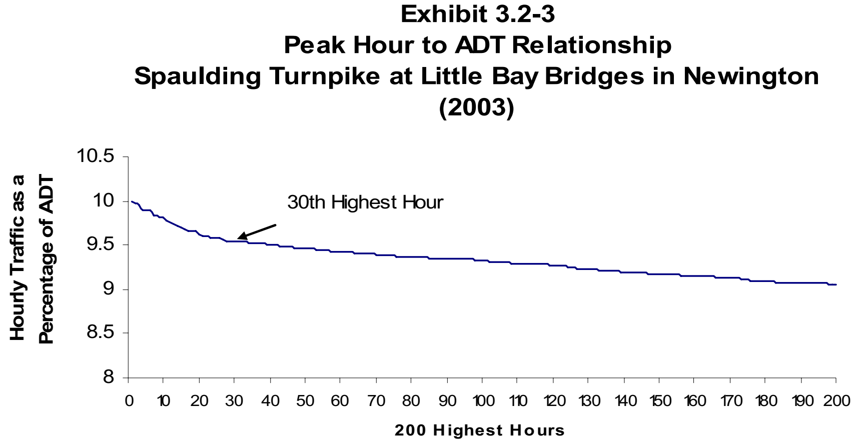
2003

3.2.2.4 Design Hourly Volumes

The unit of measure used to evaluate and design roadway facilities is an hourly traffic volume or vehicles per hour (vph). However, because hourly traffic volumes can vary over the course of the day and throughout the year, it is necessary to select an appropriate design hourly volume condition. The hourly traffic volume used for the purpose of design should not be exceeded very often or by very much. On the other hand, it should not be so high that the volume of traffic would rarely be high enough to make full use of the facility. It would be wasteful to design an improvement based on the maximum peak hour traffic of the design year, yet the use of the average hourly traffic would result in an inadequate design.

The procedure used to evaluate traffic volume demands on a roadway system, as described in *A Policy on Geometric Design of Highways and Streets,*[41] is to establish a 30th highest hour volume as the future design condition. Given the economic considerations involved in the planning and design of roadway facilities, this design criteria is selected since the 30th highest hourly volume generally reflects a "point of diminishing return" in that a substantial increase in capacity would accommodate only very few periods of higher traffic volumes. This condition is reflected in the curve shown in **Exhibit 3.2-3**, which tends to steepen quickly to the left of the 30th highest hour, indicating much higher traffic volumes for the inclusion of only a few more of the higher hourly volumes while the curve flattens to the right indicating many hours in which the volume is not much lower than the 30th highest hour.

41 American Association of State Highway and Transportation Officials, A Policy on Geometric Design of Highways and Streets, Washington, D.C.



Based on the data collected at the NHDOT permanent count station located adjacent to the Little Bay Bridges in Newington, the 30th highest hour volume is approximately 9.5 percent of the average daily traffic (ADT). The Directional Design Hourly Volume (DDHV) split shows approximately 62 percent of the total hourly traffic traveling in the peak direction (*i.e.* southbound in the weekday morning peak hour and northbound in the weekday evening peak hour).

Table 3.2-3 shows the 2003 base year Average Weekday Traffic (AWDT) along the Spaulding Turnpike, which ranges from a low of 39,850 vehicles per day north of Exit 6 to a high of 71,050 vehicles per day between Exits 5 and 6. The Design Hourly Volume (DHV) ranges from approximately 3,800 to 6,800 vehicles per hour and the DDHV ranges from approximately 2,400 to 4,200 vehicles per hour.

Comparing the 2003 DDHVs to the June 2003 peak hour traffic volumes noted in **Figures 3.2-1 and 3.2-2** indicates that the peak directional volumes are quite similar. It can therefore be said that the June data evaluated under the existing conditions approximate the 30th highest hour for analysis purposes.

The future year condition for this project has been identified as 2025. DHV and DDHV for segments of the Spaulding Turnpike were developed for the forecast condition based on traffic projections provided by the Seacoast Regional Travel Demand Model (Section 3.2.2.5). The DHV and DDHV will be used to determine the basic lane requirements for segments of the Spaulding Turnpike under the future year condition.

Table 3.2-3
2003 Design Hourly Traffic Volumes

Spaulding Turnpike Segment	AWDT[1]	DHV[2]	DDHV[3]
Between Exits 1 and 2	54,700	5,200	3,200
Between Exits 2 and 3	52,900	5,100	3,200
Between Exits 3 and 4	69,300	6,600	4,100
Between Exits 4 and 5 (Little Bay Bridges)	70,650	6,700	4,200
Between Exits 5 and 6	71,050	6,800	4,200
North of Exit 6	39,850	3,800	2,400

Notes:
1 AWDT = Average Weekday Traffic (vehicles per day).
2 DHV = Design Hourly Volume (9.5% of ADT).
3 DDHV = Directional Design Hourly Volume (62% of DHV).

3.2.2.5 Traffic Modeling

The Seacoast Regional Travel Demand Model is an integrated set of travel demand and land use models that helps predict travel behavior (*i.e.*, how people travel by car, bus, *etc.*) and travel demand (*i.e.*, how many people want to travel on a certain road or by a certain mode) within the MPO region. In 2003, the Seacoast MPO undertook the task of updating the Model to include and reflect the latest census data, traffic volume counts, and travel demand behaviors within the region. System-wide data on roadways, bus services, rail systems, land use, and social and economic characteristics within the region were collected to update the existing base model condition. In addition, the New Hampshire Seacoast Travel Survey conducted in June 2003 provided an up-to-date source of information on existing passenger vehicle and transit ridership characteristics within the project study area.

The Model was calibrated to represent the year 2000 weekday morning and weekday evening commuter peak hour conditions. Calibration of a travel demand model is considered complete when the computer-generated volumes reasonably represent actual ground counts. Calibration standards[42] published by the FHWA provide guidance in determining if a model is within acceptable limits of error. Ground counts from approximately 6 percent of the roadway links in the Model (339 counts out of 5,883 one-way links) were used in the calibration process. Upon review of the 2000 Model results, both the weekday morning and evening peak hour model volumes were found to meet or exceed the FHWA guidelines. Therefore, it was determined that the 2000 Model accurately reflected the actual traffic volume

42 Calibration and Adjustment of System Models, Federal Highway Administration, December 1990.

conditions within the study area and could be used for planning and forecasting purposes.

The 2000 calibrated Model was then used to develop traffic forecasts for the years 2005 and 2025. The 2005 traffic projections were used to assess short term, low-cost TSM alternatives to improve traffic operations efficiency and increase safety. The 2025 traffic projections were used to evaluate potential new or improved transportation services and strategies within the study area.

Growth forecasts and land use assumptions (including housing, employment, and population) for the 2005 and 2025 scenarios were developed by the Seacoast MPO. The Model projects traffic volume growth rates for the Turnpike between 0.85 and 1.35 percent per year from 2003 to 2025. By comparison, the average daily traffic volumes along the corridor for the most recent 24-year period (1979 to 2003) have been growing at an average annual rate of approximately 3.7 percent. However, more recently, the average annual rate of traffic growth has declined. During the 1993 to 2003 ten-year period, traffic increased annually at an average growth rate of approximately 2.9 percent. Since 1998, traffic has increased at an average annual rate of approximately 2.1 percent per year. Future traffic volume growth rates reflect updated (2004) projections of changes in land use developed by regional planning staff[43] in concert with municipal planning officials throughout the seacoast region. These lower growth rates are consistent with developing areas as they become more urbanized.

In addition, the Model's future year highway network was modified to include planned transportation improvements that are included in the state's most recent Ten-Year Transportation Plan and expected to occur by 2005 and 2025 respectively. A sample of these improvement projects within the MPO region include the Spaulding Turnpike Exit 4 Interim Safety Improvements, Spaulding Turnpike construction of Exit 10 and easterly connection, the Exit 11 to Exit 16 Spaulding Turnpike improvements in Rochester and the US 1 Bypass reconstruction in Portsmouth.

Table 3.2-4 compares the 2003 traffic volumes to the projected 2025 travel demand. As shown, the 2025 AADT for the Spaulding Turnpike ranges from a low of approximately 51,600 vpd north of Exit 6 to a high of approximately 94,600 vpd between Exits 5 and 6. Within the study area, the 2025 DHV's range from approximately 4,900 vph to 9,000 vph, and the DDHV's range from approximately 3,000 vph to 5,600 vph. Travel demand increases from 2003 to 2025 are expected to range from 19 to 33 percent.

▼

43 Rockingham Planning Commission and Strafford Regional Planning Commission.

Table 3.2-4
2025 Average Weekday and Design Hour Volumes (No-Build)

	2003			2025		
Turnpike Segment	AADT[1]	DHV[2]	DDHV[3]	AADT[1]	DHV[2]	DDHV[3]
Between Exits 1 and 2	54,700	5,200	3,200	65,900	6,300	3,900
Between Exits 2 and 3	52,900	5,100	3,200	64,700	6,200	3,800
Between Exits 3 and 4	69,300	6,600	4,100	88,000	8,400	5,200
Between Exits 4 and 5 (Little Bay Bridges)	70,650	6,700	4,200	94,300	9,000	5,600
Between Exits 5 and 6	71,050	6,800	4,200	94,600	9,000	5,600
North of Exit 6	39,850	3,800	2,400	51,600	4,900	3,000

Notes:
1 AADT - Average Annual Daily Traffic expressed in vehicles per day.
2 DHV - Design Hour Volume expressed in vehicles per hour.
3 DDHV - Directional Design Hour Volume expressed in vehicles per hour.

3.2.3 Crash Statistics

Crash statistics compiled by the NHDOT are based on information provided by the New Hampshire Department of Safety (NHDOS) and may not include minor crashes that are unreported. For the purpose of this study, NHDOT crash records were used, as well as those from the Dover, Newington, and Portsmouth Police Departments.

Statistics for the five-year period of January 1992 through December 1996 were previously reported in the Spaulding Turnpike Improvements Feasibility Study (February 2000). That study reported a total of 575 crashes within the study area from 1992 through 1996. To supplement this older data, the most recent five-year period of available crash data, January 1997 through December 2001, was compiled, reviewed, and reported in the Scoping Report (March 2004). That updated information showed a substantial increase in the number of crashes with 908 crashes reported within the study area from 1997 through 2001, which represents a 58 percent increase over the previous five years.

Since the completion of the Scoping Report, crash data for the most recent two-year period, January 2002 through December 2003, was also compiled and reviewed. Over this two year period, an additional 355 crashes occurred within the study area, resulting in a total of 1,263 crashes for the seven year period from 1997 through 2003. **Figure 3.2-5** provides a summary of the 1997 through 2003 crash data.

While caution should be applied when attempting to relate crash trends to potential causes, the following trends (1997 – 2003) have been identified:

- The number of crashes within the study area steadily increased at an average rate of 11 percent per year from 1997 through 2001 beginning with 144 crashes in 1997 and ending with 220 crashes in 2001. During this same time period, traffic volumes along the Spaulding Turnpike increased on average by approximately three percent per year. The fact that crashes are occurring at nearly four times the rate of traffic growth suggests a deterioration of safety along the corridor.

- The number of study area crashes in 2002 decreased to 168. However, there were no decreases in the number of crashes along the Turnpike. The major decreases in the number of crashes were predominantly observed along Woodbury Avenue and Gosling Road. In 2003, the number of crashes reported in the study area increased to 187.

- The highest number of crashes reported on the Spaulding Turnpike occurred on the Little Bay Bridges where 159 crashes occurred from 1997 through 2003. During the years 1997, 1998, and 1999, approximately 15 crashes per year occurred on the bridges. This number increased substantially to 24 and 33 crashes per year respectively, for the years 2000 and 2003. Other segments of the Turnpike experienced much lower crash rates generally ranging between 5 and 65 crashes over the seven-year analysis period.

- The frequency of crashes on the Little Bay Bridges and bridge approaches is increasing. The five-year (1997 to 2001) average frequency of crashes on the bridges and bridge approaches is approximately 28 crashes per year. The 1999 – 2003 (five-year) average frequency of crashes increased to 37 per year — an increase of approximately 32 percent.

- There was one reported fatality reported within the study area, which occurred along Dover Point Road, south of Boston Harbor Road on Saturday, October 19, 2002. Based on the NHDOT records, this crash occurred between two vehicles during daylight hours on a rainy day, with a wet pavement surface. It was a rear-end type collision that resulted in one fatality and two people injured.

- Crash frequency is equally distributed among the four seasons of the year.

- The road surface condition was reported as dry for 939 crashes (74 percent), wet for 217 crashes (17 percent), and snow or ice for 86 crashes (7 percent). The road conditions for the 21 remaining crashes (2 percent) are unknown.

3.2.4 Geometric Deficiencies

Existing geometric deficiencies within the project limits were identified by comparing the existing horizontal and vertical geometry with the desirable design criteria found in the 2004 AASHTO *Policy on Geometric Design of Highways and Streets*, and based on the NHDOT design standards for the applicable classifications of roadway.

Figure 1.3-2 depicts the Functional Classifications for the roadways within the study area. These classifications are useful in determining the applicable design standards for each roadway. The Spaulding Turnpike falls under the functional classification of Principal Arterial (other Urban Freeways and Expressways). Within the project limits, the Spaulding Turnpike is influenced by the close spacing of interchanges, the density of the surrounding roadway network, and the surrounding industry, population centers and land use.

The roadways that access the Spaulding Turnpike at the five interchanges within the project limits vary in classification. These range from Nimble Hill Road, a local roadway at Exit 4, to US 4 which is classified as "Other (urban) Principal Arterial" at Exit 6. As a result of this range of classifications, there is also a range of design criteria for evaluating the deficiencies of each roadway.

Five roadway classifications were identified for use in identifying existing geometric deficiencies. These five classifications, and their corresponding design criteria, are listed in Table 3.2-5.

The following is a summary of the existing geometric deficiencies, listed south to north, according to the AASHTO Policy and NHDOT Design Standards.

3.2.4.1 Spaulding Turnpike Mainline

The existing horizontal and vertical mainline alignments support the freeway design speed of 60 mph. On existing facilities, the design speed is the maximum safe traveling speed that can be maintained on the highway based on the existing horizontal and vertical geometrics. On new facilities, the selection of a design speed should also be based on the highway classification, the terrain, the level of congestion and potential future improvements to adjacent roadway segments. The selected design speed then dictates the allowable minimum design criteria for the particular highway classification. The design speed is not the same as the posted speed limit. The posted speed limit is generally set 5 to 10 mph below the design speed. The operating speed is the speed that is normally observed on the facility and it is generally higher than the posted speed limit.

Table 3.2-5
Roadway Design Criteria for Evaluation of Existing Roadway Deficiencies[1]

	Local Roads	Collectors	Minor Arterials	Principal Arterials (Other)	Ramps	Principal Arterials (Freeway)
Rural / Urban:		**Urban**	**Urban**	**Urban**		**Urban**
Project Roadways:	Fox Run Road Patterson Lane Nimble Hill Road Boston Harbor Rd Spur Road Dover Point Road	Gosling Road Shattuck Way	Woodbury Ave Dover Point Rd (Northeast of Exit 6)	US 4		Spaulding Turnpike
Design Speed:	30 – 50 mph	30 – 50 mph	40 – 50 mph	50 – 60 mph	50 mph at nose 30 mph on-ramp	60 mph
Maximum Grade:	8%	7% - 9%	5% desirable	4% desirable	6% - 8%	4% desirable
Minimum Grade:	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%
Minimum Radius:	215 ft	250 ft	535 ft	930 ft	235 ft	1,200 ft
Maximum Superelevation:	8%	4%	4%	4%	6%	8%
Lane Width:	11 ft to 12 ft	11 ft to 12 ft	12 ft	12 ft	20 ft – 28 ft[2]	12 ft
Shoulder Width:	2 ft to 6 ft	4 ft to 6 ft	4 ft to 6 ft	6 ft to 10 ft	---	10 ft to 12 ft
Access Control:	None	None	Desired	Desired	Required	Required

Structures Criteria

Minimum Vertical Clearances:		
	Over Major Roadways:	16 ft-6 in
	Over Minor Roadways:	14 ft-6 in
	Over Railroads:	22 ft-6 in
Minimum Grade on Bridge:		1%

Notes:
1 From 2004 AASHTO *Policy on Geometric Design of Highways and Streets*
2 20-foot curb-to-curb width or 28-foot uncurbed width on-ramps.

The mainline lanes are 12 feet wide, and the shoulders vary in width throughout the corridor. The outside shoulders are generally 10 feet wide with the exception of the approaches to the Little Bay Bridges where the shoulders taper down to meet the deficient 2-foot shoulders on the bridges. The inside shoulders narrow from 10 feet down to 4 feet wide from Exit 2 to Exit 4N. North of the Little Bay Bridges the inside shoulders are 5 feet wide measured from travel lane to face of concrete barrier. The inside shoulders reduce to 4 feet wide from the north end of the median barrier to the end of the grass median between Exit 6 and the Dover Toll Plaza. The shoulder widths and vertical alignment of the Little Bay Bridges are discussed later in this section.

3.2.4.2 Interchanges

Exit 2 - Fox Run Road

Exit 2 consists of a northbound right-in /right-out ramp system to Fox Run Road. The right-in /right-out southbound ramps served the former Pease Air Force Base, but are currently closed to traffic.

Northbound Off-Ramp

- The existing 150-foot radius off-ramp is adequate for only 25 mph. To provide for the minimum design speed of 30 mph, a 235-foot radius ramp is required. The existing deceleration lane is 400 feet long, a minimum design length of 480 feet is required to safely decelerate traffic from 60 mph.

- The close proximity of a major commercial drive near the end of the off-ramp introduces potential safety concerns due to stopped and turning vehicles at the ramp terminus.

Northbound On -Ramp

- The length of the existing northbound on-ramp acceleration lane (400 feet) is not adequate to allow vehicles to accelerate from 30 mph to 60 mph. A minimum desirable acceleration length is 910 feet.

Exit 3 – Woodbury Avenue

Exit 3 consists of a high speed connection from Woodbury Avenue onto the Northbound Turnpike, and a high speed left-hand Exit from the Southbound Turnpike to Woodbury Avenue.

Northbound On-Ramp

- There are no geometric deficiencies with this on-ramp.

Southbound Off-Ramp

- The left-hand off-ramp is uncommon and unexpected by drivers unfamiliar with the area. Left-hand off-ramps are discouraged in the AASHTO Policy, particularly where there are right lane off-ramps in the area, as is the case in Newington.

- The left-hand off-ramp is formed with a 25:1 taper. A longer taper, or even the formation of a parallel off-ramp lane would be more desirable since this is a major diverge location.

Exit 4

The Exit 4 interchange area until recently consisted of three separate ramp configurations located just south of the Little Bay Bridges. Exit 4N, Exit 4 southbound, and Exit 4 northbound provided the ability for southbound traffic to reverse direction as well as to access Nimble Hill Road and Shattuck Way. The ramps had numerous geometric deficiencies that led to operational problems and a poor safety record. The Exit 4 deficiencies, identified below have been addressed by the Newington Interim Safety Improvement Plan, which was completed in 2006. **Figure 2.4-5** depicts the improvement and Section 3.2.4.3 discusses the proposed improvements.

Exit 4N

- Exit 4N consisted of a southbound-to-northbound reverse direction loop ramp in the median between the two sides of the Turnpike .
- The loop-ramp radius was only 210 feet, supporting an approximately 27 mph vehicle operating speed, however, the parallel deceleration lane length of 570 feet was more than adequate (400 feet desirable).
- Total acceleration, deceleration and weave distance of approximately 1,500 feet between the southbound Exit 4 on-ramp and Exit 4N was deficient (approximately 2,800 feet required). The mirror image existed on the northbound side between Exit 4N and the Exit 4 off-ramp to Shattuck Way.
- The short weaves involving the high speed inside lanes introduced operational and safety concerns due to vehicles changing lanes within a short distance and mixing with higher speed through vehicles.

Exit 4 – Southbound at Nimble Hill Road

Exit 4 southbound consisted of a southbound right-in/right-out ramp system directly to and from Nimble Hill Road.

- The southbound off-ramp deceleration lane length of 350 feet was inadequate for the low speed (10-15 mph) curve radius (120 feet) entering Nimble Hill Road. A minimum ramp radius of 235 feet (30 mph) and deceleration length of 430 feet is desirable.
- There was a very short weave section (350 feet existing/1,600 feet desired) between the southbound on-ramp that entered the Turnpike from Shattuck Way and the Exit 4 off-ramp to Nimble Hill Road. The safety concerns over the weave were heightened by the high speed of exiting traffic coming off the Little Bay Bridge mixing with the often low speed truck traffic entering the Turnpike from the industrial areas on Shattuck Way.

- The southbound on-ramp from Nimble Hill Road was a low speed (10 to 15 mph) ramp and contrasted with the required rapid acceleration to enter the flow of high speed vehicles on the Turnpike, where a substandard parallel acceleration lane existed (500 feet existing/910 feet desired). This was particularly true when the entering vehicles were attempting to weave across to Exit 4N in the median to reverse direction, or to connect to Woodbury Avenue at Exit 3, which is also a left-hand exit.

- There is an ExxonMobil gas station entrance located within approximately 200 feet of the off-ramp nose of the Nimble Hill Road exit. Traffic turning into or out of the gas station from Nimble Hill Road can interfere with other higher speed vehicles using the off-ramp. The gas station also had an entrance directly onto the Turnpike that is less than 80 feet south of where the Exit 4 southbound acceleration lane begins. Southbound vehicles accelerating from Nimble Hill Road would face the possibility that vehicles would enter the Turnpike directly into their path from the gas station.

Exit 4 – Northbound at Shattuck Way

Exit 4 northbound consisted of a northbound right-in / right-out ramp system to a modified T-intersection with Shattuck Way.

- The northbound on-ramp had a 100-foot radius that corresponds to a design speed just over 20 mph. The sharp ramp radius in combination with the upgrade (3.5 percent) onto the Little Bay Bridges reduced the ability of entering vehicles to adequately accelerate to freeway speeds. This was of particular concern at this location since Shattuck Way generates a relatively high number of trucks, including loaded fuel trucks, due to the industry located off of Shattuck Way.

- The northbound off-ramp only had a 25 mph design speed (180-foot radius). A ramp radius of 235 feet to allow for 30 mph vehicle speeds is desirable. Horizontal sight distance was deficient since the intersection with Shattuck Way was only approximately 210 feet from the off-ramp nose.

- The layout of this interchange was unconventional since the exiting vehicles were not required to yield or stop as they access Shattuck Way. This pre-existing condition was required due to the inadequate deceleration and storage length. The vehicles entering the interchange from the south on Shattuck Way were under stop sign control. After stopping, these vehicles would be required to accelerate between gaps in the free-flowing exiting vehicles to access the northbound Turnpike entrance ramp. The safety concerns were magnified by the limited sight distance from the Shattuck Way stop sign to the vehicles exiting the Turnpike and by the high number of trucks accessing the Turnpike from Shattuck Way. An improved interchange layout would maximize the length of the off-ramp and bring the off-ramp vehicles to a stop at a T-intersection.

- The Exit 4 northbound/Shattuck Way intersection was a safety concern because of limited sight distances, lack of traffic control, and mix of fast and slower moving vehicles.

Little Bay Bridges Geometric Deficiencies

- Both bridges lack adequate shoulders. The existing right and left shoulders are 2 feet southbound and 2 feet 3 inches northbound, measured from the travel lane to the face of curb. The desirable shoulders would be 10 to 12 feet wide on the outside and 4 to 6 feet wide on the inside (for the existing two-lane directional layout).

- The profile of the Little Bay Bridges provides adequate stopping sight distance for vehicles traveling 60 mph. The bridges continue to rank high on the list of concerns among the traveling public. The poor safety record may be explained by the combined effect of profile, lack of adequate shoulders, high traffic volumes with resulting small gaps between vehicles, excessive speeds, number of decision points (exits, merges, and weave areas), inadequate traffic merging and weaving areas on the approaches to the bridges, and environmental factors such as freezing on the bridge surface, high winds, and motorist distraction by the views of the bay. The Little Bay Bridges and bridge approaches have the highest number of crashes within the study area.

Exit 5 Northbound

Exit 5 northbound consists of a northbound right-in/ right-out ramp system serving Wentworth Terrace and the east side of Hilton Park.

- The short 400-foot deceleration lane terminates in a sub-20 mph (60-foot radius) off-ramp. The combined result of these two factors yields higher than acceptable vehicle speeds along the off-ramp and contributes to the potential for rear-end collisions when motorists slow down on the Turnpike in anticipation of the slow speed ramps. A minimum ramp radius of 235 feet (30 mph) and deceleration length of 430 feet is desirable.

- The northbound on-ramp has a 50-foot radius that has a design speed just over 15 mph. This sharp radius in combination with a substandard parallel acceleration lane (600 feet) reduces the ability of entering vehicles to adequately accelerate to freeway speeds. A minimum ramp radius of 235 feet (30 mph) and acceleration length of 910 feet is desirable.

- The connector road under the bridges between the east and west sides of Hilton Park is one-way from west to east and therefore limits circulation and requires use of the Turnpike.

Exit 6 Northbound -- Dover Point Road and US 4

Exit 6 northbound consists of an eastbound Dover Point Road off-ramp followed by a westbound US 4 off-ramp. There is access to the Turnpike from a short on-ramp from the Dover Point Road/Cote Drive neighborhood just south of the Exit 6N ramp.

- The on-ramp is located on the inside of a mainline curve and is so close to the high speed and high use off-ramp at Exit 6 that it introduces a very dangerous weave condition. The on-ramp acceleration distance is also inadequate.

- Exit 6W carries heavy traffic volumes in one lane around the 300-foot radius curve designed for 30 mph. There is adequate deceleration distance provided on the approach to the exit; however, during peak periods, existing traffic queues extend from the off-ramp back into the deceleration lane interfering with the through traffic on the Turnpike and traffic exiting at Exit 6N. This condition was addressed as part of the Dover TSM Exit 6 northbound action (**Figure 2.4-3**).

Exit 6 Southbound

Exit 6 southbound consists of a southbound off-ramp south of the Dover Toll Plaza. This ramp connects to Spur Road, and then to US 4 at a signalized intersection opposite Boston Harbor Road near the Scammell Bridge.

Southbound access to the Turnpike at Exit 6 southbound from US 4 is *via* a ramp system that first merges one lane from US 4 eastbound with one lane from Dover Point Road westbound. Southbound Turnpike traffic from Boston Harbor Road then enters creating a two-lane ramp which then merges to form a single lane ramp. The resulting one lane ramp then forms one of the two southbound lanes on the mainline. The two southbound mainline lanes from the Toll Plaza are also merged into one lane just prior to the introduction of the Exit 6 southbound on-ramp. The combination of vehicles merging and inadequate lane capacity during the AM peak hour creates congestion and delay.

3.2.4.3 Interim Safety Improvement Project

Some of the geometric deficiencies on the Newington side of the study area have been addressed by the Interim Safety Improvement Project that was recently completed in 2006. The project (as depicted in **Figure 2.4-5**) accomplishes the following:

- The Exit 4N reverse direction loop ramp in the median has been closed. This eliminates the dangerous weaves[44] between Exit 4N and Exit 4.

- Shattuck Way has been realigned to intersect Nimble Hill Road, eliminating the direct connection from Shattuck Way to the southbound Turnpike. This eliminates the dangerous weave between the on-ramp from Shattuck Way and the Nimble Hill Road off-ramp.

- The Shattuck Way Extension has been widened for two-way traffic to provide access from one side of the Turnpike to the other. This eliminates the need for Exit 4N and allows vehicles to access sections of Newington and Woodbury Avenue on either side of the Turnpike without having to travel on the Turnpike.[43]

- The northbound Exit 4 ramps have been reconfigured to improve storage, the curve radii, and design speeds. The intersection of the ramps and Shattuck Way form a tee intersection.

- Shattuck Way has been realigned and widened to include a left turn lane for the northbound on-ramp.

- The southbound Exit 4 ramps have been reconfigured to improve deceleration and acceleration lengths. The southbound on-ramp from Nimble Hill Road has been separated from the Turnpike mainline by a raised island. This island extends south of the ExxonMobil gas station drive to provide all entering vehicles with sufficient acceleration distance prior to entering the mainline of the Turnpike.[43]

- Nimble Hill Road has been widened to include a wider shoulder and turn lanes in the vicinity of the new intersection formed with the realigned Shattuck Way Extension.

These interim safety improvements do not address the current or projected capacity needs of the Turnpike corridor, and are intended as near term solutions to address serious existing safety concerns.

▼

44 The two-way operation of Shattuck Way Extension, and the reconfigured deceleration and acceleration lanes at Exit 4, southbound were opened to traffic in November 2005.

3.2.5 Infrastructure Deficiencies

The development of the Spaulding Turnpike has occurred in stages that have largely been driven by the size and type of the structure crossing Little Bay. The Turnpike was originally a two-lane facility when the General Sullivan Bridge was constructed in 1935. In 1953, the two-lane facility was expanded in Newington to a median divided four-lane facility. It was then expanded to be a median divided four-lane facility in both Newington and Dover when the current southbound Little Bay Bridge was built in 1966. When the northbound Little Bay Bridge was constructed in 1984, the General Sullivan Bridge was closed to motor vehicles and the Turnpike approaches were realigned with the Little Bay Bridges. Much of the current Spaulding Turnpike mainline roadway section still predates the Little Bay Bridges. The most recent substantial roadway modifications were related to the reconstruction of the Scammell Bridge over the Bellamy River (completed in 1999). That project included improvements to the ramp system from US 4, Boston Harbor Road and Dover Point Road to the Spaulding Turnpike southbound.

3.2.5.1 Roadway

Much of the existing Turnpike pavement structure is over 40 years old. Regular maintenance of the surface through scheduled paving projects has maintained the surface condition, however the condition of the base materials and the suitability of the pavement structure, as compared to modern pavement design standards, is unknown.

There is no known concrete base under the pavement, but there are still rails and ties under the pavement where the at-grade railroad (Pease Spur) once crossed both sides of the Turnpike in Newington. There are known areas where there are poor subsoils, including an area between Exit 5 and 6 in Dover, where brick rubble was used as fill material beneath the roadway.

The existing drainage structures are as old as the roadway and may require replacement due to their condition, especially where salt water exposure regularly occurs. The capacity of the drainage pipes may also be deficient at some locations due to the amount of impervious area that has been added from development in the area.

3.2.5.2 Bridges

General Sullivan Bridge

The General Sullivan Bridge (200/023) was constructed in 1935. The structure consists of nine spans with a total bridge length of 1528 feet. The spans consist of steel deck trusses, and a three-span continuous truss with a through arch truss over the main navigation channel. The main navigation span is 275 feet with a vertical clearance to mean high water of 48 feet 9 inches in the center 100 feet and 35 feet 6 inches in the center 200 feet (**Figure 3.2-6**). The bridge is the second highest ranked[45] historic bridge in the state and has been determined eligible for the National Register of Historic Places.

The existing roadway width is 24 feet curb-to-curb with approximate 4-foot sidewalks (2 feet 11 inch sidewalk width at the through truss). Potential roadway widening is limited by a clear width of 30 feet 7 inches at the through truss (**Figure 3.2-7**). The roadway profile over the bridge consists of 4 percent approach and departure grades with a 500-foot vertical curve, which meets the AASHTO standards for a design speed of 45 mph.

With the construction of the northbound Little Bay Bridge and due to its poor condition, the General Sullivan Bridge was closed to motor vehicle traffic in 1984, but currently remains open to pedestrians, bicyclists and other recreational activity. The superstructure exhibits deterioration and section loss at the deck, steel stringers, steel floor beams, steel trusses (particularly impacted rust at the connections) and the piers exhibit extensive cracking, scaling, and cavitations below the water line.

The structure is deemed seismically vulnerable[46] due to its non-redundant truss members, rocker bearings, and unreinforced granite/concrete piers.

Little Bay Bridges

The Little Bay Bridges (201/024 northbound, 201/025 southbound) which carry the northbound and southbound Turnpike over Little Bay, consist of two bridges built in phases. The first phase, which constructed the foundations for both bridges and the current southbound superstructure, was built in 1966. The second phase, which constructed the northbound superstructure, was constructed in 1984. Both bridges have nine spans with a total span of 1,589 feet. The main navigation span is 275 feet with a vertical clearance to mean high water of 46 feet 8 inches in the center 100 feet and 45 feet 1 inch in the center 200 feet (**Figure 2.4-37**).

The existing roadway width is 28 feet curb-to-curb on the southbound structure and 28 feet 6 inches on the northbound structure (**Figure 3.2-8**). The roadway profile over the bridge consists of 3.5 percent approach and

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45 NHDOT, Historic Bridge Inventory, Unpublished Report, August 2, 1999.
46 FHWA-RD-94-052, "Seismic Retrofitting Manual for Highway Structures: Part 1 – Bridges," December 2006.

departure grades with an 1100-foot vertical curve, which meets the AASHTO standards for a design speed of 60 mph.

Both bridges have a Federal Sufficiency Rating of 63.3[47] and are noted as being Functionally Obsolete due to their narrow width. The bridges are showing signs of minor deterioration, particularly in steel girders and the pin and hanger assemblies at the expansion joints. At the time of substructure construction (1966), there were no design requirements for seismic resistance. A review of current standards indicates that the structure does not meet the current standards for seismic design, specifically, the pin and hanger connections, rocker bearings, pier columns, and pier bases.

Other Bridges

Three other bridges are located within the study limits: US 4 Westbound over the Turnpike, the Turnpike over Shattuck Way, and the northbound Turnpike over Woodbury Avenue. Important features for each of these bridges are listed in Table 3.2-6.

Table 3.2-6
Other Bridges in the Study Area

Roadway Feature Crossed	US 4/ Spaulding Turnpike	Spaulding Turnpike/ Shattuck Way	Spaulding Turnpike NB/ Woodbury Avenue
Year Built	1956 (Rehab 1989)	1983	1956 (Rehab 1996)
Bridge No.	181/039	103/124	112/107
Length	240 ft.	48 ft.	218 ft.
Number of Spans	4	1	3
Bridge Width	48.3 ft.	104.3 ft.	41 ft.
Vertical Clearance	16.9 ft.	15.1 ft.	14.5 ft.
Sufficiency Rating	98.0	87.4	85.9

3.2.6 Travel Demand Management (TDM)

3.2.6.1 Park-and-Ride Lots

To support those who travel by carpool, vanpool, or bus, the NHDOT operates 25 park- and-ride lots (including some that are owned by other entities). Although there are no park-and-ride lots located within the study area, there are several located nearby that could service the motorists utilizing the Spaulding Turnpike (**Figure 3.2-9)**. Table 3.2-7 summarizes the

47 The Federal Sufficiency Rating is a weighted number that considers the bridge's structural adequacy, safety, serviceability, and importance. The numerical value ranges from 100 (new) to 0 (not in service).

Table 3.2-7
Park-and-Ride Lot Inventory and Utilization

Town	Location	Paved	Lights	Public Transit	Number of Spaces	Occupancy Summer 2003	Occupancy Fall 2004	Services
I-95 Corridor								
Portsmouth	PTC - NH 33 at I-95 Exit 3A	Yes	Yes	Yes	975	624	738	P, S, B, T
Portsmouth	NH 33 at I-95 Exit 3B	Yes	Yes	No	50	10	12	P, B
Hampton	Timber Swamp Road at I-95 Exit 2	Yes	Yes	No	103	21	19	P
NH 9								
Barrington	NH 9 across from Calef's Country Store	Yes	Yes	No	20	10	6	P (nearby)
US 4								
Lee	West of the Lee Traffic Circle	No	Yes	No	25	4	6	—
NH 125								
Epping	NH 125 at NH 101 Exit 7	Yes	Yes	No	246	45	44	P, S, B
Out of State								
Newburyport, MA	MA 113 at I-95 Exit 57	Yes	Yes	Yes	460	460*	460*	P, S,T
Saco, ME	Industrial Road at I-95 Exit 5	Yes	No	Yes	135	NA	NA	P (nearby)
York, ME	ME 91	Yes	Yes	No	152	NA	NA	P (nearby)

PTC - Portsmouth Transportation Center.
Services: P = Phone; S = Shelter; B = Bike Racks and Lockers; T= Lot serviced by C&J Trailways, which provides commuter transit service in the corridor.
NA - Not Available.
* Occupancy rate reported at 100% by Mass Highway Department.
See **Figure 3.2-9.**

existing nearby park-and-ride facilities and their current utilization levels. The table also describes the amenities provided at each location.

The largest of the nearby park-and-ride facilities is located at the Portsmouth Transportation Center on NH 33, just west of I-95/Exit 3A. This park-and-ride lot provides roughly 975 paved spaces, lighting, a bus shelter, bike racks and lockers, and public telephones. Public transit service is provided by C&J Trailways and COAST. Data collected by the NHDOT in the fall of 2004 indicates that this lot currently experiences a 75 percent average daily utilization rate.

The other nearby park-and-ride lots are substantially smaller ranging in size from 20 spaces in Barrington (NH 9), 25 spaces in Lee (Traffic Circle), 50 spaces in Portsmouth (NH 33), 103 spaces in Hampton (I-95 Exit 2), and 246 spaces in Epping (NH 125). None of these facilities have the extensive amenities that are provided at the Portsmouth Transportation Center and none are serviced by public transportation. The lack of public transportation may contribute toward the lower utilization rates at these locations. The 2004 data collected by the NHDOT shows utilization rates ranging from 18 percent in Epping to 30 percent in Barrington.

One element common to many of the conceptual roadway and transit alternatives is the construction of new park-and-ride capacity along or near the Spaulding Turnpike corridor in and around the study area. These park-and-ride lots would serve two primary markets: drivers wishing to create carpools or vanpools before traveling on the Turnpike through the study area, or drivers wishing to utilize one of the proposed transit alternatives. In both cases, drivers would leave their automobiles at a park-and-ride facility and some would continue along the Turnpike in a shared-ride or transit mode, reducing the number of vehicles and congestion levels on the Turnpike in the study area.

3.2.6.2 Bus Transit Services

Within the study area, there are both public and private bus transit services serving Newington, Dover, Durham, Portsmouth, and Rochester (**Figure 3.2-10**). These services include local, commuter, and intercity bus services and local trolley service in Portsmouth. Local bus service primarily services the Portsmouth, Newington, Dover and Durham (University of New Hampshire) areas. Commuter bus service routes offer service from Portsmouth, Durham and Dover to Boston. The intercity services operate along the I-95 corridor from Maine through Portsmouth to Boston and New York City. Trolley service is specific to the Portsmouth area. The services provided are described in the following sections.

COAST

COAST serves the seacoast region of New Hampshire (Rockingham and Strafford Counties) and Berwick, Maine. COAST runs five local bus routes serving Portsmouth, Dover, Newington, Newfields, Greenland, Stratham, Exeter, Newmarket, Rochester, Farmington and Berwick, Maine. Two year-round and one seasonal trolley bus routes are also operated by COAST in the Portsmouth area. In addition, COAST provides on-demand Americans with Disabilities Act (ADA) services.

The local bus services generally operate from 6 AM to 7 PM weekdays although Route 2 (Rochester-Portsmouth) service operates until approximately 9 PM weekdays. The Lafayette Road Trolley operates weekdays from 7 AM to 9 PM and the Pease Tradeport Trolley operates weekdays from 6 AM to 8 PM. Limited Saturday service is also offered. The seasonal trolley service operates seven days a week from 10:30 AM to 5:30 PM.

Fares on the local bus service are $1.00 per trip with a monthly pass offered at $35. Cash-paying riders in Somersworth are charged an additional $0.10 per trip or a surcharge of $5.00 on a monthly pass. Fares for the two year-round trolleys are free. The fare for the seasonal trolley is $0.50 with a three day pass available for $2.00. Children under 5 ride free and fares are half price for seniors and disabled individuals.

A brief description of each route is provided in the following paragraphs.

Routes and Services

Bus Route 1: Nine roundtrips are offered along this route between 5:35 AM and 6:30 PM weekdays. The service operates from the Dover Transportation Center to Sullivan Street/Pine Hill Road in Berwick with stops in Dover, Somersworth, and Berwick. Transfers to the Route 2 bus and Wildcat Transit's Route 3 bus are available at both the Market Square and Shaw's/ Central Avenue stops in Dover. Total trip time from along the route is approximately 40 minutes.

Bus Route 2: Service along this route is provided weekdays from 5:47 AM to 9:35 PM and Saturdays from 6:47 AM to 9:37 PM. The route operates from Market Square in Portsmouth to the Lilac Mall in Rochester with intermediate stops in Portsmouth, Newington, Dover, Somersworth and Rochester. There are ten northbound trips from Portsmouth to Rochester and nine southbound trips weekdays. In addition, there are two early weekday morning northbound trips from the Dover Transportation Center to Rochester and one late weekday evening northbound trip from Market Square to the Dover Transportation Center. There is one additional early weekday morning southbound trip between the Dover Transportation Center and Fox Run Mall, and one additional late weekday evening southbound trip between Rochester and the Dover Transportation Center. On Saturdays, four roundtrips are operated between Portsmouth and Rochester. Additionally, there is one early morning northbound trip between Dover Transportation Center and Rochester, one midday northbound trip between Market Square and Shaw's/Central Avenue, and one midday southbound trip between Shaw's/Central Avenue and Market Square. Transfers are available to COAST Routes 6 and 7, the COAST trolleys, and Wildcat Transit Routes 3 and 4 along the service corridor. Total trip time from Portsmouth to Rochester is approximately 82 minutes.

<u>Bus Route 6</u>: Service along this route is provided weekdays between 5:50 AM and 6:36 PM. The route operates from the Main Street fire station in Farmington to the Lilac Mall in Rochester with intermediate stops in both communities. A total of eight roundtrips are provided along the entire route. Transfers to the Route 2 bus are available at the Lilac Mall. Total trip time is approximately 31 minutes.

<u>Bus Route 7</u>: Service along this route is provided weekdays from 7:30 AM to 7:33 PM. The route operates from the Fox Run Mall in Newington to the Exeter Train Station with intermediate stops in Greenland, Stratham, Newmarket, and Exeter. Four trips are offered both westbound and eastbound, with the final eastbound trip terminating in Newmarket. Transfers to COAST Route 2, the trolleys, and Wildcat Transit Route 4 are available at the Fox Run Mall. A transfer to Wildcat Route 5 is available at the Downtown Gazebo/NH 108 stop in Newmarket. Total trip time from Newington to Exeter is approximately 80 minutes.

<u>Dover Community Routes</u>: The COAST Dover Community Bus Routes provide weekday local service to several areas of Dover. The three Dover Community Routes include Dover North, Dover South, and Dover West. The service consists of one inbound morning trip and one outbound afternoon trip on each route. The morning runs start at approximately 6:30-6:45 AM and the afternoon runs at approximately 2:25 PM. Trip time over each route is between 50 and 70 minutes.

<u>COAST Trolley Service</u>: COAST operates two year-round and one seasonal trolley route. The two year-round routes operate weekdays from 6:00 AM to 9:00 PM and on Saturdays from 7:00 AM to 8:00 PM. The Lafayette Road service in Portsmouth operates from Market Square to Hillcrest Estates with intermediate stops along Middle Street and Lafayette Road. There are 14 weekday roundtrips and six Saturday roundtrips. Total one-way travel time is approximately 18 minutes inbound and 23 minutes outbound. Transfers to COAST Route 2, the Pease Tradeport trolley, and Wildcat Transit Route 4 are available at the Market Square stop.

The Pease Tradeport service operates from Market Square to Fox Run Mall with intermediate stops on Islington Street, Plains Avenue, Greenland Road, Grafton Drive, Corporate Drive, Rochester Avenue, New Hampshire Avenue, Exeter Street, Gosling Road, the Portsmouth Transportation Center, Pease Tradeport (multiple stops), and Fox Run Mall. There are 12 weekday and six Saturday roundtrips. The one-way outbound travel time to Fox Run Mall is approximately 33 minutes. The return trip time is approximately 35 minutes. Transfers to COAST Route 2, the Lafayette Road trolley, and Wildcat Transit Route 4 are available at the Market Square stop. Other transfer points include the Plaza 800 stop on Islington Street (COAST Route 4) and the Portsmouth Transportation Center (C&J Trailways).

The third trolley route is the seasonal downtown Portsmouth service. Daily service is provided from the end of June through early September. On both weekdays and weekends, the service operates from 10:30 AM to 5:30 PM, with no service from 2:30 PM to 3:00 PM. Trolleys depart on the hour and half hour from Market Square to many of the city's attractions including its historic parks, neighborhoods and waterfronts. Service is provided every 30 minutes.

ADA Services: COAST also operates on-demand ADA services for customers that are not able to use the regularly scheduled services. A customer may call COAST and schedule an ADA trip to meet their needs.

Existing Ridership

Table 3.2-8 presents annual ridership for the various COAST routes and services. The three most current years (FY 2004 – FY 2006) are provided. Note that COAST's fiscal year runs from October 1st to September 30th.

Table 3.2-8
COAST Bus and Trolley Annual Ridership (FY 2004 – FY 2006)

Route	FY 2004	FY 2005	FY 2006
Route 1 (Dover-Somersworth-Berwick)	28,002	31,336	30,803
Route 2 (Rochester-Somersworth-Dover-Newington-Portsmouth)	93,532	100,956	118,413
Route 6 (Farmington-Rochester)	10,414	10,322	9,842
Route 7 (Exeter-Stratham-Newmarket-Greenland-Newington)	5,126	4,976	5,481
COAST Trolley (Pease Tradeport and Lafayette Road Routes)	81,286	93,781	123,191
COAST Trolley (Downtown Loop Route)	2,583	2,505	2,938
Dover Community Routes	31,035	38,107	38,927
ADA Services	41,939	34,884	24,836
Total Ridership	293,917	316,867	354,431

Recently Initiated and Proposed Services

COAST initiated the updated Pease Tradeport and Lafayette Trolley routes in June, 2003. Other future service plan modifications include a CMAQ-funded program to implement a Downtown Transit Loop in Dover. COAST also plans to implement the Turnpike Express, another CMAQ-funded project, to operate three express buses during peak periods on the Spaulding Turnpike between Rochester and the Portsmouth Transportation Center at Pease Tradeport. This project is scheduled to be implemented in late 2008.

Wildcat Transit

Routes and Services

Wildcat Transit is a public transit service operated by the University of New Hampshire. It serves the university campus and local communities including Durham, Dover, Portsmouth, and Newmarket. They operate three public transit routes (Routes, 3, 4 and 5). The service frequency varies depending on the academic calendar. During UNH's academic school year, the three routes are operated daily. Each route has eight to nine weekday roundtrips between 7:00 AM and 10:00 PM. There are four roundtrips on Saturdays and Sundays. During the winter months, some service runs until 2:00 AM. A reduced service plan is operated during UNH's scheduled semester breaks. During reduced service periods, there are two runs per day on weekdays and no weekend service. Wildcat buses circulate through the core UNH campus before departing on their routes. Fares are $1.00 per ride for all routes and free with a UNH ID card.

Bus Route 3A: Service along this route is provided weekdays from 6:55 AM to 10:55 PM. The route operates between UNH McConnell Hall and Dover *via* Route 108 and back to McConnell Hall *via* Route 155, making 38 intermediate stops. This route provides nine round trips daily.

Bus Route 3B: Service along this route is provided weekdays from 6:45 AM to 9:59 PM. This route operates between UNH McConnell Hall and Dover *via* Route 155 and back to McConnell Hall *via* Route 108, making 40 intermediate stops. This route provides nine round trips daily.

Bus Route 4A: Service along this route is provided weekdays from 6:40 AM to 10:15 PM. The route operates between UNH McConnell Hall and Portsmouth Market Square *via* the Malls at Fox Run Mall, then back to McConnell Hall via Fox Run Mall and Plaza 800, making 29 intermediate stops. This route provides eight round trips daily.

Bus Route 4B: Service along this route is provided weekdays from 7:45 AM to 11:14 PM. The route operates between UNH McConnell Hall and Portsmouth Market Square *via* the Fox Run Mall and Plaza 800, then back to

McConnell Hall *via* Fox Run Mall, making 29 intermediate stops. This route provides eight round trips daily.

Bus Route 5: Service along this route is provided weekdays from 7:00 AM to 10:54 PM. The route operates between UNH McConnell Hall and Portsmouth/Newmarket and back to McConnell Hall, making 15 intermediate stops. This route provides 16 round trips daily.

Bus Routes 4A and 4B are the only routes that use the Spaulding Turnpike and the Little Bay Bridges. Many of the Route 4 (A and B) stops in Newington and Portsmouth are shared with COAST services. Wildcat Transit Routes 3 and 4 provide transfers to COAST services.

Existing Ridership

Table 3.2-9 presents the annual ridership for Wildcat Transit Routes 3, 4 and 5. Full-year ridership is presented for Fiscal Years 2001 through 2004, while projected ridership for Fiscal Year 2005 is shown based on actual data for the first six months of the year. Note that Wildcat Transit's fiscal year runs from July 1st through June 30th and coincides with the University of New Hampshire academic year (*i.e.*, Fiscal Year 2006 represents the 2005–2006 academic year).

Annual ridership on Wildcat Transit Routes 3, 4 and 5 has been growing steadily in recent years and consists mainly of students, facility and staff traveling to and from the campus for commuting, shopping and recreational trips. Ridership has doubled since 2002, and continues to increase. Most recently, 2007 ridership increased approximately 16 percent above 2006 levels.

Table 3.2-9
Wildcat Transit Annual Ridership

Route	UNH Routes 3, 4, 5 Ridership
FY 2001	110,486
FY 2002	128,929
FY 2003	142,216
FY 2004	157,949
FY 2005	174,889
FY 2006	222,331
FY 2007	257,249

Recently Initiated and Proposed Services

UNH has recently converted six on-campus (25 passenger) diesel buses to compressed natural gas (CNG), supported by an on-campus refueling station. Off campus, Wildcat Transit has also converted eight diesel buses to biodiesel fuel. Future fleet conversion plans may include hybrid vehicles.

C & J Trailways

Routes and Services

C & J Trailways, a privately owned bus company, offers commuter bus service from Dover and Portsmouth, as well as Newburyport, MA to Boston's Logan Airport and South Station. This service utilizes seven state-owned coaches, as well as C&J owned vehicles. More than 60 trips are operated between Boston and the Seacoast communities on weekdays and more than 50 are operated on weekends. The service plan is summarized in Table 3.2-10.

Table 3.2-10
C&J Trailways
Commuter Bus Schedule Summary

Inbound To Boston	Total Daily Trips to Logan Airport	Total Daily Trips to South Station
Weekday:		
from Dover	0	12
from Portsmouth	19	19
from Newburyport	19	19
Weekend:		
from Dover	0	6
from Portsmouth	19	13
from Newburyport	19	13

Table 3.2-10 Con't

Outbound From Boston	From Logan Airport	From South Station
Weekday:		
to Dover	4	15
to Portsmouth	19	17
to Newburyport	19	17
Weekend:		
to Dover	4	11
to Portsmouth	18	12
to Newburyport	18	12

General Notes:

1 In some cases the number of inbound and outbound trips is not equal between destinations because C&J Trailways offers additional trips/stops to serve specific markets (*e.g.*, late evening outbound trips to Dover).

2 Twelve trips each day serve both Logan Airport and South Station in Boston, so the total number of trips operated is less than the sum of the total trips serving Logan Airport and total trips serving South Station.

3 In addition to the service between Boston, Newburyport, Portsmouth, and Dover, C&J Trailways offers one round trip per day between Boston-North Station and the University of New Hampshire in Durham on Fridays, Saturdays and Sundays during the UNH academic year.

Bus stops and facilities are located in Dover and Portsmouth, New Hampshire and Newburyport and Boston, Massachusetts. The state-owned Portsmouth Transportation Center serves as C & J's bus terminal and administrative offices. The Transportation Center includes ticket agents, information on local areas of interest and an approximately 975-space parking facility for commuters.

C & J currently provides commuter bus service to Dover and operates the Dover Transportation Center. This facility is also a stop for Amtrak's *Downeaster* and the COAST and Wildcat transit lines. The Newburyport terminal, which includes over 400 park-and-ride spaces, is located at the interchange of MA 113 and Interstate 95 (Exit 57). There is also a small ticket office in Newburyport. The Boston terminal is located at South Station. This facility includes Amtrak Northeast Corridor intercity train service, MBTA commuter rail service, and the MBTA Red Line and Silver Line.

C& J also operates one express round trip between Durham, New Hampshire and Boston North Station. The service runs Friday, Saturday and Sunday only during the UNH academic year.

Existing Ridership

C& J Trailways' ridership is approximately 350,000 passengers per year with the ridership derived from Dover, Portsmouth and Newburyport as follows:

Dover:	4 percent
Portsmouth:	60 percent
Newburyport:	36 percent

Approximately 65 percent of the riders travel to South Station while 35 percent are traveling to Logan Airport.

Vermont Transit

Routes and Services

Vermont Transit, a private bus operator, provides service from Maine, New Hampshire, and Vermont to Boston and New York City. Within the region, Vermont Transit provides bus service to Portsmouth along I-95. This service however, is primarily an intercity service for long distance travelers to Boston and New York. Vermont Transit has bus stops and facilities throughout New Hampshire, Vermont, Maine and Massachusetts. Stops and terminals along the route that serve the study area include:

- Portsmouth, New Hampshire – A stop at the Federal Cigar Store at 10 Ladd Street.

- Portland, Maine – The terminal is located at 950 Congress Street.

- Newburyport, Massachusetts – The terminal at the interchange of MA 113 and Interstate 95 (Exit 57) is shared with C&J Trailways.

- Boston, Massachusetts – The service operates from South Station.

Existing Ridership

Actual current ridership data for the service was not available. Representatives of Vermont Transit estimated that the annual ridership from Maine south through Portsmouth is approximately 170,000 riders, with approximately 10 percent of the riders (17,000) boarding or alighting in the Portsmouth area.

Other Transit Services

The NH 16 Corridor Protection Study recommended that existing bus systems be preserved and enhanced within the NH 16 corridor, and that bus service be established from Portsmouth (Pease Tradeport) to North Conway. To date, the NHDOT has been unable to negotiate with a bus operating company to provide such a service.

3.2.6.3 Rail Transit Service

Amtrak operates intercity passenger rail service between Portland, Maine and Boston, Massachusetts for the Northern New England Passenger Rail Authority (NNEPRA). This service, known as the *Downeaster*, operates along the Main Line West Corridor just north of the study area. No other passenger rail services currently operate within or adjacent to the study area.

As discussed in Chapter 2, several rail corridors have been identified for the evaluation of passenger and freight rail services as part of this study. The corridors to be evaluated include the Main Line West, Main Line East (Hampton Running Track), the Conway Branch, the Portsmouth Branch, the Newington Branch, the Pease Spur, and the Sawyer/Dover Branch. These seven rail corridors are shown in **Figure 2.4-9**. The following sections summarize the existing *Downeaster* passenger rail service and the existing conditions along the rail corridors being evaluated.

Downeaster

Route and Service

Regular service on the *Downeaster* intercity passenger rail service commenced on December 15, 2001. Prior to its implementation, passenger rail service between Portland, Maine and Boston, Massachusetts had not operated since 1965. The service includes a total of ten stops including the termini at North Station in Boston and Portland in Maine. The stops are at Portland, Old Orchard Beach, Saco, Wells, Dover, Durham, Exeter, Haverhill, Anderson Transportation Center (Woburn), and Boston (North Station).

Five daily round trips are presently scheduled to make the 114-mile trip in 2 hours and 30 minutes. The fifth trip was added in August 2007. A one-way fare from Dover to Portland is approximately $12.00 and from Dover to Boston is approximately $17.00. A discounted ten-trip pass is available for $100 for use between Dover and Portland and $151 between Dover and Boston. There is also a monthly commuter pass that costs $188 for the Dover to Portland trip and $289.00 for the Dover to Boston trip.[48]

Existing Ridership

Table 3.2-11 summarizes the ridership on the *Downeaster* service for 2004-2006. In its fifth full year of operation, monthly ridership in 2006 varied from a low of approximately 23,387 trips in January to a high of approximately 33,410 trips in August. The ridership was fairly consistent throughout the year, and has grown from 248,571 passengers in 2004 to 341,476 in 2006, an average of 18.7% per year.

Table 3.2-11
***2004-2006 Downeaster* Ridership (One-way Trips)**

	Passengers		
Month	2004	2005	2006
January	17,182	17,363	23,387
February	20,694	18,581	25,487
March	20,962	20,733	26,817
April	23,659	23,109	30,175
May	20,383	22,158	27,183
June	21,061	23,961	28,568
July	17,050	26,967	31,783
August	23,979	28,678	33,410
September	20,557	30,372	29,380
October	22,615	28,557	27,818
November	19,860	27,479	29,154
December	20,569	25,695	28,314
Total	248,571	293,653	341,476

▼

48 Source: www.amtrakdowneaster.com, November 15, 2005.

Recently Initiated and Proposed Services

NNEPRA and MaineDOT have developed a business plan addressing the long-term sustainability of the *Downeaster* intercity passenger rail service. This plan examines opportunities to improve the overall performance of the existing intercity rail service. As part of the plan, NNEPRA is considering service changes and enhancements to attract additional ridership. As previously described in Chapter 2, NNEPRA and MaineDOT initiated approximately $6 million of track improvements that allowed the addition of a fifth daily roundtrip between Portland and Boston. The construction was completed in August 2007. Other potential service improvements may be considered, but are subject to the successful resolution of operational, funding and jurisdictional issues between NNEPRA, MaineDOT, the Massachusetts Bay Transportation Authority (MBTA), Amtrak and Pan Am Railways.

Main Line West Corridor

The Main Line West is part of Pan Am Railways Freight Main Line that extends from eastern New York to northern Maine. Freight service is operated by Springfield Terminal Railway (STRY), a subsidiary of Pan Am Railways. Several through freight trains along with local freight service are operated daily over the route. The New Hampshire Northcoast Railroad (NHN) also operates freight trains over this line. Amtrak also operates the *Downeaster* intercity passenger service on this line.

The infrastructure for the Main Line West Rail Corridor is in excellent condition, having been recently upgraded to support the initiation of the passenger rail service. The maximum authorized speed is 60 mph where the track geometry and other conditions allow. The MBTA has examined the feasibility of extending the Haverhill Line commuter rail service to Plaistow on several occasions. These efforts are currently on hold as the City of Nashua and the NHDOT pursue a commuter rail service extension from Lowell to Nashua.

Main Line East Corridor

The Main Line East is an active freight line that extends from the Portsmouth Line and Yard in Portsmouth to the Foss Manufacturing site in Hampton. This line is approximately 10 miles long and is currently used for freight service. The Main Line East is owned by Boston & Maine Corporation (B&MC) and operated by STRY. South of Hampton to the state line, the rail line is abandoned and the right-of-way has been acquired by NHDOT. The rail bridge across the Merrimack River in Massachusetts has been out of service for a number of years and will require extensive rehabilitation or replacement to become operational.

The physical condition of the infrastructure along the line is poor. Train speeds are limited to 5 mph due to the condition of the track. In New Hampshire, the four underpass bridges, five crossings, and track structure along the active line would require substantial improvements to support passenger rail service. In addition, complete reconstruction of the line would be required between Hampton and the MBTA commuter rail station in Newburyport. A signal and communications system would also be required. Operational, funding, and jurisdictional issues among the MBTA, NHDOT, and GRS would also need to be addressed.

Conway Branch Corridor

The Conway Branch extends from Rollinsford where it connects with the Main Line West to Conway a distance of approximately 72 miles. There are two active segments and one inactive segment along the branch. The infrastructure along the 42-mile segment between Rollinsford and Ossipee, owned by NHN, is in good condition. The line has been gradually rehabilitated by NHN in two distinct segments. The initial work, completed in the 1980’s, upgraded the segment between Rochester and Ossipee. Between 1994 and 1999, NHN completed an upgrade of the segment from Rochester to Rollinsford. The track structure can support up to a maximum authorized speed of 40 mph, where conditions permit, for freight operations. Additional improvements may be necessary to support passenger rail service depending on the type of service proposed.

As mentioned above, the middle section of the corridor from Ossipee to Conway has been out of service since 1972. A complete rehabilitation of the line’s infrastructure would be required to support the resumption of rail service.

The infrastructure along the northern section, owned and operated by the Conway Scenic Railroad (CSR) is in good condition. The current track structure can support up to 25 mph maximum authorized track speed where conditions permit. Additional improvements may be necessary to support passenger rail service depending on the type of service proposed.

Newington Branch

The Newington Branch is an active freight line that extends from the town of Newington to the Portsmouth Branch in Portsmouth. This 3.5-mile branch is owned by B&MC and operated by the STRY. It runs just east of the Spaulding Turnpike. Historically, this branch formed the southern section of the rail line that connected Portsmouth with Dover. The line crossed Little Bay just east of the existing General Sullivan Bridge. The rail bridge was removed in 1934. The infrastructure along the line is generally poor. Freight train speeds are limited to 5 mph.

Portsmouth Branch

The Portsmouth Branch is an active freight line that extends from Newfields on the Main Line West through the Portsmouth Yard to the Newington Branch. It connects with the Main Line East at Portsmouth Yard. This 10-mile segment of track is owned by B&MC and operated by the STRY. The condition of the infrastructure along this branch is poor. Train speeds are limited to a maximum of 5 mph.

Sawyer/Dover Branches

The former Sawyer Branch extended from the 2nd Street Yard in Dover on the Main Line West south to Sawyer Mill on the Bellamy River, a distance of 1.5 miles. It was abandoned in the mid-1970's. The Dover Branch continued south of Sawyer Mill to Dover Point. It was abandoned in 1941. Spur Road and a portion of the Spaulding Turnpike have been built over this former five-mile branch.

Pease Spur

The Pease Spur extends from the Newington Branch into the Pease Tradeport. The initial 1.6 miles of track is still in place but is out of service. A portion of the spur crosses the Spaulding Turnpike at grade. This rail crossing has been removed and paved over. Some of the track still exists on the Tradeport site but is in poor condition.

Current Rail Initiatives

Several prior studies documenting the feasibility and cost of passenger rail service to the Seacoast Region of New Hampshire have been completed over the past 10 years. These prior studies included:

- *Restoration of Passenger Rail Service between Boston, Massachusetts and Portland, Maine*, a series of reports including an Environmental Assessment prepared for the Maine Department of Transportation by Vanasse Hangen Brustlin, Inc., 1995.

- *Commuter Rail Service to Coastal New Hampshire: A Feasibility Study for the Hampton Branch*, prepared for the Rockingham Planning Commission, June 1999.

The MaineDOT Portland-Boston study efforts completed in the mid-1990's resulted in the December 2001 implementation of the *Downeaster* intercity passenger rail service. The RPC study of commuter rail service concluded that the service is feasible and that the state and region should develop a plan towards implementation.

There are no current study efforts to extend commuter rail service within the Seacoast Region. The MBTA has recently been focusing on the preservation and enhancement of the existing system. On the intercity rail front, NNEPRA and MaineDOT continue to work on improvements to the *Downeaster* service. These improvements included the capital improvement program to support a fifth round trip described in Chapter 2, and a recent Memorandum of Understanding (MOU) among NNEPRA, C&J Trailways, and Concord Trailways to promote a systems approach to bus/rail transportation in the corridor.

In addition, the feasibility of extending the Haverhill Line commuter rail service to Plaistow has been evaluated on several occasions by the MBTA. With the reconstruction of the track between Haverhill (Massachusetts) and Portland (Maine) to support the Boston to Portland intercity service, the extension of commuter rail service to Plaistow has become more feasible. The Boston to Portland intercity project addressed a number of the track and signal and communications system issues that the studies for the Plaistow project previously encountered. Track and signal improvements associated with the Boston to Portland project allow trains to operate at speeds up to 60 mph.

3.2.6.4 Ride-Share Program

The NHDOT operates a Statewide Ride-Share Program through its Bureau of Rail and Transit. The program is approximately 10 years old, but has not yet built a substantial database. There are currently about 900 commuters registered statewide for ride-matching, but no information is available on the number of carpool/vanpool groups that have been formed through the program.

The state's Ride-Share Coordinator also promotes ridership through individual employers by sponsoring transportation events, providing marketing materials, and encouraging employers to adopt TDM strategies, such as guaranteed ride-home programs, parking management, flex-time, and telecommuting. In this process, the state mainly targets rural areas, and depends on the Regional Planning Commissions to work with the employers in the urbanized areas.

3.2.6.5 Transportation Management Association (TMA) Initiatives

The Pease Development Authority helped create the Greater Portsmouth Transportation Management Association (TMA) in 2002. This organization is now known as Seacoast Commuter Options. The goal of Seacoast Commuter Options is to work with area employers to encourage employees to use other modes of transportation, such as transit, carpool or vanpool, as opposed to SOVs. Seacoast Commuter Options provides a ride-matching program as well as a guaranteed ride-home program. In addition, they provide information on existing transit services provided by COAST, Wildcat Transit, C&J Trailways, Vermont Transit and Amtrak. Seacoast Commuter Options also helps employers set up Commuter Choice Initiatives. These initiatives such as flexible work schedules and telecommuting are supported in part by the USDOT and USEPA and provide tax savings to employers and employees who use alternative modes and do not drive alone to work.

3.2.6.6 Other Initiatives

The Seacoast MPO has created an Alternative Transportation Guide available on the Internet. The web site, http://www.rpc-nh.org/Transit/seacoast-transit-home.htm, contains information regarding ride-matching services, transit, park-and-ride lots and bicycle commuting. The website also includes links to additional websites which contain specific information about each service.

The Seacoast Area Bicycle Routes (SABR) organization is very active in promoting and supporting bicycle routes in the Seacoast area. Their goal is to "promote a safe and effective bicycle transportation network by encouraging a community approach."

3.3 Socio-Economic Conditions

3.3.1 Socio-Economic Study Area

The socio-economic study area for this project has both a regional and local component. The broader regional area includes 33 municipalities within the tri-county area of Strafford, Rockingham and Carroll Counties, in the southeast portion of New Hampshire. The more localized project study area is as described in Chapter 1 and includes portions of the Town of Newington and the City of Dover that border the 3.5-mile section of the Spaulding Turnpike being evaluated for upgrading. These study areas are shown in **Figures 1.2-2 and 1.3-1**.

The 33-community socio-economic study area was used as a basis to collect and analyze regional socio-economic data in order to provide a context within which to evaluate the proposed highway improvement project and its potential secondary impacts. The socio-economic study area includes the New Hampshire portion of the Portsmouth-Rochester, NH-ME Primary Metropolitan Statistical Area (PMSA), as well as seven additional towns that lie outside the PMSA. This PMSA designation was established by the US Office of Management and Budget (OMB) based on population thresholds reached within the region and its core cities, as well as the determination that "adjacent communities within the region have a high degree of social and economic integration with these core areas." Beginning in 2000, all metropolitan areas were redefined as core based statistical areas (CBSAs).

As of June 2003, criteria were established that divided the Portsmouth-Rochester PMSA into newly created New England city and town areas (NECTAs). These NECTAs can be further defined as either metropolitan or micropolitan statistical areas. Each metropolitan statistical area must have at least one urbanized area of 50,000 or more inhabitants. Each micropolitan statistical area must have at least one urban cluster of at least 10,000 but less than 50,000 population. Based on these new definitions, the former Portsmouth-Rochester, NH-ME PMSA has been divided into two primary subareas that include the Portsmouth, NH ME Metropolitan NECTA and the Rochester Dover, NH-ME Metropolitan NECTA. However, these two NECTAs do not include the exact configuration of towns that existed under the former PMSA designation.

While these newly created NECTAs will facilitate future analysis, data gathered by the Census Bureau and other agencies have not yet been aggregated based on these revised geographic boundaries. Therefore, for purposes of this analysis, the 1999 PMSA definition, combined with several additional communities, was determined to be the most appropriate socio-economic study area for conducting a review of baseline conditions related to the proposed highway improvement project.

Certain types of economic data presented in this report, such as employment by industry, rely on published information at the PMSA level as being the best available data due to privacy restrictions. In some instances, the PMSA is also referred to as the Portsmouth Labor Market Area (LMA), which is the name used by New Hampshire Employment Security (NHES) for the same geographic region.

The socio-economic study area is limited to New Hampshire communities for several reasons. In Journey-to-Work data compiled by the US Census Bureau (see Section 3.3.6), it was noted that Strafford County residents commuting to work in Maine declined 36% (to 2,825) and Rockingham County residents commuting to work in Maine also declined by 36% (to 1,713) between 1990 and 2000.

During the same time period the number of Maine residents commuting to work in Strafford County increased by less than 1% between 1990 and 2000 (4,467 in 2000), but more than 7,760 residents of Maine (an increase of 32%) worked in Rockingham County in 2000.

In evaluating economic and social impacts of the proposed widening of the Spaulding Turnpike, an important aspect relating to possible impacts was use of the Little Bay Bridges for travel between work and home. Consequently, the key factor for including Maine in the study area was the use of the Little Bay Bridges by residents of Strafford County traveling to work in Maine and by Maine residents commuting to work in Strafford County.

A detailed evaluation of journey to work patterns indicated that approximately 30% of Strafford County residents commuting to Maine worked in communities adjacent to Strafford County (Acton, Alfred, Berwick, Eliot, Lebanon, North Berwick, Sanford and South Berwick). In order to reach these locations, alternative roadways, rather than the Little Bay Bridges, would likely be used to commute between home and work. The other large work location for Strafford County residents was Kittery, Maine (40% of Strafford County residents commute to Maine or 1,206 individuals). Once again an examination of journey to work data indicated that most of the Strafford County residents that worked in Kittery lived in Strafford County communities adjacent to Maine (Dover, Farmington, Rochester, Rollinsford and Somersworth – 879 individuals or 72% of Strafford County workers that commute to Kittery). It is expected that these Strafford County residents would use a variety of local and state roads rather than the Little Bay Bridges, to travel between Kittery and home. In a similar manner it was determined that many of the residents of Maine that commute to work in Strafford County, are employed in New Hampshire communities (Dover, Farmington, Rochester, Rollinsford and Somersworth) adjacent to Maine. For example, 35% of Maine commuters that work in Strafford County live in Berwick, South Berwick and Eliot.

Based on this evaluation of journey to work data it was determined that the study area should not include Maine communities.

3.3.2 Population and Demographic Characteristics

3.3.2.1 Historical Population Trends

Changes in total population for the socio-economic study area were examined over the last 30 years in order to identify long-term trends within the region. As illustrated in Table 3.3-1, the study area experienced growth within all three decades between 1970 and 2000. However, there was a considerable decline in the rate of growth during the last 10-year period from

1990 to 2000. There was also a decrease in the actual number of people added to the total base population during this time period. Overall, there were net increases of approximately 27,800 and 34,100 during the 1970s and 1980s, respectively, as compared with only 16,200 during the 1990s. This represents growth rates for each decade of 19.8 percent, 20.2 percent, and 8 percent, respectively. Total growth within the study area between 1970 and 2000 was 78,000, an increase of 55.5 percent, which represents an average annual rate of growth of 1.5 percent. During the same time period (1970 – 2000), population in the State of New Hampshire increased by over 498,000. This represents an increase of 68 percent, or approximately a 2.3 percent average annual rate of growth.

Within the Strafford County portion of the socio-economic study area, the City of Rochester absorbed the largest portion of total population growth adding approximately 10,500 people between 1970 and 2000. Other communities that experienced consistent population gains in all three decades included the Town of Barrington and the City of Dover, which had population increases of approximately 5,600 and 6,000, respectively, during that 30-year time period. The Town of Durham also experienced substantial population growth, some portion of which is attributable to students enrolled at the University of New Hampshire (UNH). Approximately 4,500 residents, or 36 percent of the town's total population, were identified by the Census Bureau as residing in non-institutional group quarters in 2000. This represents only a portion of the students residing in the community who attend the University; the remainder live in conventional housing and thus are not as readily identifiable within the Census' enumeration. In the Rockingham County area, the Town of Hampton had the largest population gain adding almost 7,000 people between 1970 and 2000. Other notable increases were also experienced in the communities of Exeter, Stratham, Newmarket, and Epping.

A relatively small percentage of the study area's total population was identified as residing in group quarters. Approximately 7,500 people, or 3.6 percent of the population, lived in group quarters as of 2000. However, only 2,200 of that total (29 percent) were housed in institutional facilities while the remaining 5,300 (71 percent) lived in non-institutional facilities. The majority of this latter category, approximately 4,500, was associated with UNH, as discussed previously in this section.

One anomaly in the data involved population change in the City of Portsmouth. The city experienced a decrease in population between 1980 and 2000, with a decline of 5,141 people during the latter decade. The majority of this population loss is most likely attributable to the closing and realignment of Pease Air Force Base, now Pease International Tradeport, which was decommissioned in 1991. Prior to its closure, total military personnel and dependents residing on the Base numbered 4,666. These residents would

Table 3.3-1
Total Population 1970-2000
Socio-Economic Study Area

	Population				Change				% Change				Avg. Annual Change	
	1970	1980	1990	2000	70-80	80-90	90-00	70-00	70-80	80-90	90-00	70-00	90-00	70-00
Barrington	1,865	4,404	6,164	7,475	2,539	1,760	1,311	5,610	136.1%	40.0%	21.3%	300.8%	1.9%	4.7%
Dover	20,850	22,377	25,042	26,884	1,527	2,665	1,842	6,034	7.3%	11.9%	7.4%	28.9%	0.7%	0.9%
Durham	8,869	10,652	11,818	12,664	1,783	1,166	846	3,795	20.1%	10.9%	7.2%	42.8%	0.7%	1.2%
Farmington	3,588	4,630	5,739	5,774	1,042	1,109	35	2,186	29.0%	24.0%	0.6%	60.9%	0.1%	1.6%
Lee	1,481	2,111	3,729	4,145	630	1,618	416	2,664	42.5%	76.6%	11.2%	179.9%	1.1%	3.5%
Madbury	704	987	1,404	1,509	283	417	105	805	40.2%	42.2%	7.5%	114.3%	0.7%	2.6%
Middleton	430	734	1,183	1,440	304	449	257	1,010	70.7%	61.2%	21.7%	234.9%	2.0%	4.1%
Milton	1,859	2,438	3,691	3,910	579	1,253	219	2,051	31.1%	51.4%	5.9%	110.3%	0.6%	2.5%
New Durham	583	1,183	1,974	2,220	600	791	246	1,637	102.9%	66.9%	12.5%	280.8%	1.2%	4.6%
Rochester	17,938	21,560	26,630	28,461	3,622	5,070	1,831	10,523	20.2%	23.5%	6.9%	58.7%	0.7%	1.6%
Rollinsford	2,273	2,319	2,645	2,648	46	326	3	375	2.0%	14.1%	0.1%	16.5%	0.0%	0.5%
Somersworth	9,026	10,350	11,249	11,477	1,324	899	228	2,451	14.7%	8.7%	2.0%	27.2%	0.2%	0.8%
Strafford	965	1,663	2,965	3,626	698	1,302	661	2,661	72.3%	78.3%	22.3%	275.8%	2.0%	4.5%
Subtotal Strafford	**70,431**	**85,408**	**104,233**	**112,233**	**14,977**	**18,825**	**8,000**	**41,802**	**21.3%**	**22.0%**	**7.7%**	**59.4%**	**0.7%**	**1.6%**
Brentwood	1,468	2,004	2,590	3,197	536	586	607	1,729	36.5%	29.2%	23.4%	117.8%	2.1%	2.6%
East Kingston	838	1,135	1,352	1,784	297	217	432	946	35.4%	19.1%	32.0%	112.9%	2.8%	2.6%
Epping	2,356	3,460	5,162	5,476	1,104	1,702	314	3,120	46.9%	49.2%	6.1%	132.4%	0.6%	2.9%
Exeter	8,892	11,024	12,481	14,058	2,132	1,457	1,577	5,166	24.0%	13.2%	12.6%	58.1%	1.2%	1.5%
Greenland	1,784	2,129	2,768	3,208	345	639	440	1,424	19.3%	30.0%	15.9%	79.8%	1.5%	2.0%
Hampton	8,011	10,493	12,278	14,937	2,482	1,785	2,659	6,926	31.0%	17.0%	21.7%	86.5%	2.0%	2.1%
Hampton Falls	1,254	1,372	1,503	1,880	118	131	377	626	9.4%	9.5%	25.1%	49.9%	2.3%	1.4%
Kensington	1,044	1,322	1,631	1,893	278	309	262	849	26.6%	23.4%	16.1%	81.3%	1.5%	2.0%
New Castle	975	936	840	1,010	-39	-96	170	35	-4.0%	-10.3%	20.2%	3.6%	1.9%	0.1%
Newfields	843	817	888	1,551	-26	71	663	708	-3.1%	8.7%	74.7%	84.0%	5.7%	2.1%
Newington	798	716	990	775	-82	274	-215	-23	-10.3%	38.3%	-21.7%	-2.9%	-2.4%	-0.1%
Newmarket	3,361	4,290	7,157	8,027	929	2,867	870	4,666	27.6%	66.8%	12.2%	138.8%	1.2%	2.9%

Table 3.3-1 (continued)

	Population				Change				% Change				Avg. Annual Change	
	1970	1980	1990	2000	70-80	80-90	90-00	70-00	70-80	80-90	90-00	70-00	90-00	70-00
North Hampton	3,259	3,425	3,637	4,259	166	212	622	1,000	5.1%	6.2%	17.1%	30.7%	1.6%	0.9%
Northwood	1,526	2,175	3,124	3,640	649	949	516	2,114	42.5%	43.6%	16.5%	138.5%	1.5%	2.9%
Nottingham	952	1,952	2,939	3,701	1,000	987	762	2,749	105.0%	50.6%	25.9%	288.8%	2.3%	4.6%
Portsmouth	25,717	26,254	25,925	20,784	537	-329	-5,141	-4,933	2.1%	-1.3%	-19.8%	-19.2%	-2.2%	-0.7%
Rye	4,083	4,508	4,612	5,182	425	104	570	1,099	10.4%	2.3%	12.4%	26.9%	1.2%	0.8%
Stratham	1,512	2,507	4,955	6,355	995	2,448	1,400	4,843	65.8%	97.6%	28.3%	320.3%	2.5%	4.9%
Subtotal Rockingham	**68,673**	**80,519**	**94,832**	**101,717**	**11,846**	**14,313**	**6,885**	**33,044**	**17.2%**	**17.8%**	**7.3%**	**48.1%**	**0.7%**	**1.3%**
Brookfield	198	385	518	604	187	133	86	406	94.4%	34.5%	16.6%	205.1%	1.5%	3.8%
Wakefield	1,420	2,237	3,057	4,252	817	820	1,195	2,832	57.5%	36.7%	39.1%	199.4%	3.4%	3.7%
Subtotal Carroll	**1,618**	**2,622**	**3,575**	**4,856**	**1,004**	**953**	**1,281**	**3,238**	**62.1%**	**36.3%**	**35.8%**	**200.1%**	**3.1%**	**3.7%**
Study Area Total	**140,722**	**168,549**	**202,640**	**218,806**	**27,827**	**34,091**	**16,166**	**78,084**	**19.8%**	**20.2%**	**8.0%**	**55.5%**	**0.8%**	**1.5%**
County Totals														
Carroll County	18,548	27,931	35,410	43,666	9,383	7,479	8,256	25,118	50.6%	26.8%	23.3%	135.4%	2.1%	2.9%
Rockingham County	138,951	190,345	245,845	277,359	51,394	55,500	31,514	138,408	37.0%	29.2%	12.8%	99.6%	1.2%	2.3%
Strafford County	70,431	85,408	104,233	112,233	14,977	18,825	8,000	41,802	21.3%	22.0%	7.7%	59.4%	0.7%	1.6%

Source: US Census

NOTE: Towns listed within Rockingham and Carroll counties are only those within the socio-economic study area. All municipalities within Strafford County are within the socio-economic study area.

have been included in Portsmouth's population base for census enumeration purposes. Approximately 6,000 additional personnel and dependents associated with the facility resided off the base in other communities in southeastern New Hampshire and southern Maine. Although the exact decline in the region's population associated with the Base closing cannot be determined, it no doubt was a substantial factor in reducing the effective rate of growth within the study area between 1990 and 2000. However, this decline in population has since been reversed by growth that occurred in the latter part of the decade.

Table 3.3-1 also presents the Strafford, Rockingham and Carroll County subregions of the study area's total population growth. It is interesting to note that population growth in Strafford County, in absolute numbers, has consistently exceeded that of the Rockingham County portion of the study area for all three decades examined. The data also illustrates that while the population growth rate of Rockingham County as a whole has generally exceeded Strafford County's rate of growth, the greatest proportion of Rockingham's growth has occurred in communities that are located outside of the regional study area. A further intricacy of this trend is revealed when the population loss of approximately 5,100 experienced by the City of Portsmouth during the 1990s is accounted for by eliminating this negative growth figure from the remainder of the Rockingham portion of the study area. Doing so reveals that population in the remaining communities actually increased by approximately 12,000, which exceeded Strafford County's increase of 8,000 for the same time period. This suggests that the trends of the 1970s and 1980s, where population growth in the Strafford portion of the study area exceeded that of Rockingham's, have moderated somewhat with both subregions of the study area moving toward more equivalent population gains. In fact, without Portsmouth's loss during the 1990s, the Rockingham portion of the study area grew at an average annual rate of 1.2 percent (versus 0.7 percent with Portsmouth included), which exceeded Strafford's annual rate of growth of 0.7 percent during that decade.

Only two towns in Carroll County - Brookfield and Wakefield - are included in the regional study area. The total population within these two towns increased by approximately 3,200 between 1970 and 2000, with Wakefield absorbing the largest proportion (2,832) of that growth. Although Carroll County has the smallest total population (43,666 in 2000) of the three counties that included communities within the study area, it had the highest rate of growth of the three over the last 30 years, as well as during some of the intermediate decades for which data is presented in Table 3.3-1. In fact, Carroll County's actual population increase of 8,256 between 1990 and 2000 slightly exceeded that of Strafford County's increase of 8,000 during that decade. This is an indication that real estate market conditions within Strafford and Rockingham Counties have fostered increased residential growth in the northern portion of the region, where more affordable housing is still available in proximity to the metropolitan employment centers in the southern portion of the study area.

3.3.2.2 Households

The trends associated with household growth within the study area present a notable contrast to those related to population changes that were discussed above. Although both the rate of population and household growth has slowed over the last few decades, the rate of new household formation has decreased at a considerably slower pace, as exhibited in Table 3.3-2. For example, population in the study area increased by 20.2 percent between 1980 and 1990, while the number of households increased by 28.1 percent. During this time period population growth represented approximately 70 percent of household growth. In the following decade, between 1990 and 2000, population and household growth rates in the study area dropped to 8 percent and 13.9 percent respectively. As a result, population growth represented only 57 percent of household growth during that decade. The change in these rates of growth over the last two decades is a reflection of trends relating to decreasing household size.

Support of this trend is represented by changes in the number of persons per household, which is illustrated in Table 3.3-2. As the data shows, the average number of persons per household decreased in almost every study area community between 1990 and 2000. The only municipalities that experienced an increase in household size were Durham, Brentwood, New Castle, Newfields, and Stratham. Durham's increase may be attributable to students at UNH, who typically share housing units in a communal fashion, as opposed to an increase in the size of conventional family households in the community.

This decline in household size has several potential implications for long-term planning related to transportation facilities. The first is that a continued decline in population growth for the study area, which is discussed in a subsequent section, will not necessarily result in a corresponding decrease in the number of new households and new housing units created within the study area in the future. The second is that a decreasing household size may reduce the average number of vehicle trips typically associated with specific housing types such as single and multi-family dwellings, however, verification of this conclusion would require a more detailed survey of household commuting characteristics in the study area.

3.3.2.3 Income and Economic Need

The state's median household income increased by approximately 36 percent between 1990 and 2000, as exhibited in Table 3.3-3. Each of the three counties in the study area either equaled or exceeded that rate of increase over the last decade. However, in actual terms, both Carroll and Strafford County had median income levels that were equivalent to only 80.0 percent and 90.5 percent respectively, of the statewide median. In contrast, Rockingham County exceeded the state's median by approximately 18 percent in 2000.

At the municipal level, the table also presents each community's 2000 median income as a percentage of its respective county's median income level. Of those that were below the county median, all were within 90 percent of that benchmark. The lowest percentages were registered in Farmington and Rochester at 91.4 percent and 90.6 percent respectively.

The same comparison for Rockingham County municipalities in the study area shows that five of the 16 communities had household incomes below the county-wide median (only a subset of Rockingham County communities were included in the socio-economic study area). Four of these had incomes that were below 90 percent of the county's median. However, incomes in all four towns still exceeded the county-wide medians for Strafford County and Carroll County. In Carroll County, the median household incomes of both Brookfield and Wakefield exceeded their county's median income level in 2000.

With regard to the change in *per capita* income levels, both Carroll and Rockingham County's growth rates, 56.2 percent and 50.6 percent respectively, were slightly higher than the statewide increase of 49.4 percent between 1990 and 2000. Strafford County's rate of increase however, lagged behind at 46.3 percent. Strafford County also had a correspondingly greater number of municipalities in the study area that had *per capita* incomes that were below the county-wide average.

One indication of economic need within a community is the number of people with incomes considered to be below the poverty level. Poverty level thresholds are established by the US Census Bureau based on a set of income thresholds that vary by family size. Poverty thresholds do not vary geographically, but are updated annually for inflation. The poverty thresholds, by household size, in 2000, were as follows: one person $8,787; two persons $11,234; three persons $13,737; four persons $17,600; five persons $20,804. Table 3.3-4 represents the number of residents in the study area communities who had household incomes below the poverty level at the time of the 2000 census. Overall, 7.3 percent of the

Table 3.3-2
Total Households and Household Size 1980-2000
Socio-Economic Study Area

	Total Households							Average Persons Per Household			
				Change		% Change				Change	% Change
	1980	1990	2000	80-90	90-00	80-90	90-00	1990	2000	90-00	90-00
Barrington	1,502	2,217	2,767	715	550	47.6%	24.8%	2.80	2.70	-0.10	-3.6%
Dover	8,307	10,346	11,542	2,039	1,196	24.5%	11.6%	2.36	2.26	-0.10	-4.2%
Durham	2,072	2,365	2,887	293	522	14.1%	22.1%	2.70	2.80	0.10	3.7%
Farmington	1,579	2,067	2,134	488	67	30.9%	3.2%	2.77	2.69	-0.08	-2.9%
Lee	751	1,278	1,469	527	191	70.2%	14.9%	2.92	2.81	-0.11	-3.8%
Madbury	340	489	535	149	46	43.8%	9.4%	2.87	2.82	-0.05	-1.7%
Middleton	247	398	526	151	128	61.1%	32.2%	2.97	2.74	-0.23	-7.7%
Milton	808	1,301	1,440	493	139	61.0%	10.7%	2.84	2.72	-0.12	-4.2%
New Durham	423	684	805	261	121	61.7%	17.7%	2.89	2.75	-0.14	-4.8%
Rochester	7,703	10,196	11,397	2,493	1,201	32.4%	11.8%	2.58	2.47	-0.11	-4.3%
Rollinsford	776	979	1,043	203	64	26.2%	6.5%	2.70	2.54	-0.16	-5.9%
Somersworth	3,790	4,374	4,704	584	330	15.4%	7.5%	2.56	2.43	-0.13	-5.1%
Strafford	558	994	1,281	436	287	78.1%	28.9%	2.99	2.82	-0.17	-5.7%
Subtotal Strafford	**28,856**	**37,688**	**42,530**	**8,832**	**4,842**	**30.6%**	**12.8%**				
Brentwood	549	752	906	203	154	37.0%	20.5%	2.92	3.01	0.09	3.1%
East Kingston	366	472	625	106	153	29.0%	32.4%	2.88	2.85	-0.03	-1.0%
Epping	1,158	1,859	2,053	701	194	60.5%	10.4%	2.74	2.66	-0.08	-2.9%
Exeter	4,215	5,025	5,900	810	875	19.2%	17.4%	2.43	2.32	-0.11	-4.5%
Greenland	711	1,020	1,211	309	191	43.5%	18.7%	2.71	2.63	-0.08	-3.0%
Hampton	4,118	4,992	6,474	874	1,482	21.2%	29.7%	2.43	2.28	-0.15	-6.2%
Hampton Falls	466	532	711	66	179	14.2%	33.6%	2.83	2.64	-0.19	-6.7%
Kensington	437	556	657	119	101	27.2%	18.2%	2.92	2.87	-0.05	-1.7%
New Castle	338	341	413	3	72	0.9%	21.1%	2.16	2.42	0.26	12.0%
Newfields	276	300	517	24	217	8.7%	72.3%	2.96	3.00	0.04	1.4%
Newington	252	292	293	40	1	15.9%	0.3%	2.64	2.55	-0.09	-3.4%
Newmarket	1,757	2,924	3,373	1,167	449	66.4%	15.4%	2.45	2.37	-0.08	-3.3%
North Hampton	1,217	1,374	1,660	157	286	12.9%	20.8%	2.65	2.57	-0.08	-3.0%

Table 3.3-2 (continued)

	Total Households							Average Persons Per Household			
				Change		% Change				Change	% Change
	1980	1990	2000	80-90	90-00	80-90	90-00	1990	2000	90-00	90-00
Northwood	786	1,148	1,347	362	199	46.1%	17.3%	2.72	2.70	-0.02	-0.7%
Nottingham	649	1,032	1,331	383	299	59.0%	29.0%	2.83	2.78	-0.05	-1.8%
Portsmouth	9,498	10,311	9,933	813	-378	8.6%	-3.7%	2.40	2.03	-0.37	-15.4%
Rye	1,737	1,918	2,174	181	256	10.4%	13.3%	2.38	2.35	-0.03	-1.3%
Stratham	811	1,880	2,308	1,069	428	131.8%	22.8%	2.72	2.75	0.03	1.1%
Subtotal Rockingham	**29,341**	**36,728**	**41,886**	**7,387**	**5,158**	**25.2%**	**14.0%**				
Brookfield	139	205	239	66	34	47.5%	16.6%	2.82	2.53	-0.29	-10.3%
Wakefield	856	1,195	1,682	339	487	39.6%	40.8%	2.61	2.53	-0.08	-3.1%
Subtotal Carroll	**995**	**1,400**	**1,921**	**405**	**521**	**40.7%**	**37.2%**				
Study Area Total	**59,192**	**75,816**	**86,337**	**16,624**	**10,521**	**28.1%**	**13.9%**				
County Totals											
Carroll County	11,084	14,283	18,387	3,199	4,104	28.9%	28.7%	2.45	2.34	-0.11	-4.5%
Rockingham County	66,471	89,259	104,586	22,788	15,327	34.3%	17.2%	2.72	2.63	-0.09	-3.3%
Strafford County	28,856	37,688	42,531	8,832	4,843	30.6%	12.9%	2.60	2.50	-0.10	-3.8%

Source: US Census
Note: Towns listed within Rockingham and Carroll counties are only those within the socio-economic study area. All municipalities within Strafford County are within the socio-economic study area.

Table 3.3-3
Median Household and *Per Capita* Income 1990-2000
Socio-Economic Study Area

	Household Income					*Per Capita* Income					
Strafford County	**1990**	**2000**	**% of County in 2000**	**Change 90-00**	**% Change 90-00**		**1990**	**2000**	**% of County in 2000**	**Change 90-00**	**% Change 90-00**
Barrington	$35,542	$50,630	113.0%	$15,088	42.5%	Barrington	$14,033	$21,012	102.6%	$6,979	49.7%
Dover	$31,507	$43,873	97.9%	$12,366	39.2%	Dover	$15,413	$23,459	114.6%	$8,046	52.2%
Durham	$42,477	$51,697	115.4%	$9,220	21.7%	Durham	$12,774	$17,210	84.0%	$4,436	34.7%
Farmington	$31,112	$40,971	91.4%	$9,859	31.7%	Farmington	$12,166	$16,574	80.9%	$4,408	36.2%
Lee	$43,421	$57,993	129.4%	$14,572	33.6%	Lee	$17,153	$23,905	116.7%	$6,752	39.4%
Madbury	$42,208	$57,981	129.4%	$15,773	37.4%	Madbury	$16,695	$26,524	129.5%	$9,829	58.9%
Middleton	$33,125	$43,942	98.1%	$10,817	32.7%	Middleton	$11,604	$18,415	89.9%	$6,811	58.7%
Milton	$32,888	$44,194	98.6%	$11,306	34.4%	Milton	$12,397	$18,092	88.3%	$5,695	45.9%
New Durham	$34,857	$52,270	116.7%	$17,413	50.0%	New Durham	$12,919	$22,139	108.1%	$9,220	71.4%
Rochester	$30,807	$40,596	90.6%	$9,789	31.8%	Rochester	$13,395	$18,859	92.1%	$5,464	40.8%
Rollinsford	$37,741	$48,588	108.4%	$10,847	28.7%	Rollinsford	$16,697	$24,444	119.4%	$7,747	46.4%
Somersworth	$32,886	$42,739	95.4%	$9,853	30.0%	Somersworth	$13,495	$19,592	95.7%	$6,097	45.2%
Strafford	$37,500	$52,270	116.7%	$14,770	39.4%	Strafford	$13,771	$22,139	108.1%	$8,368	60.8%
Rockingham County											
Brentwood	$43,654	$68,971	118.6%	$25,317	58.0%	Brentwood	$16,112	$22,027	82.6%	$5,915	36.7%
East Kingston	$43,654	$65,197	112.1%	$21,543	49.3%	East Kingston	$15,713	$28,844	108.2%	$13,131	83.6%
Epping	$36,860	$50,739	87.3%	$13,879	37.7%	Epping	$14,208	$21,109	79.2%	$6,901	48.6%
Exeter	$36,121	$49,618	85.3%	$13,497	37.4%	Exeter	$18,531	$27,105	101.7%	$8,574	46.3%
Greenland	$47,125	$62,172	106.9%	$15,047	31.9%	Greenland	$19,637	$31,270	117.3%	$11,633	59.2%
Hampton	$40,929	$54,419	93.6%	$13,490	33.0%	Hampton	$18,371	$29,878	112.1%	$11,507	62.6%
Hampton Falls	$55,682	$76,348	131.3%	$20,666	37.1%	Hampton Falls	$23,736	$35,060	131.5%	$11,324	47.7%
Kensington	$44,773	$67,344	115.8%	$22,571	50.4%	Kensington	$17,645	$29,265	109.8%	$11,620	65.9%
New Castle	$47,344	$83,708	144.0%	$36,364	76.8%	New Castle	$24,726	$67,695	254.0%	$42,969	173.8%
Newfields	$42,237	$71,375	122.7%	$29,138	69.0%	Newfields	$15,821	$28,687	107.6%	$12,866	81.3%
Newington	$41,607	$59,464	102.3%	$17,857	42.9%	Newington	$17,954	$30,172	113.2%	$12,218	68.1%

Table 3.3-3 (continued)

	Household Income					*Per Capita* Income					
Rockingham County (Con't)	**1990**	**2000**	**% of County in 2000**	**Change 90-00**	**% Change 90-00**		**1990**	**2000**	**% of County in 2000**	**Change 90-00**	**% Change 90-00**
Newmarket	$32,348	$46,058	79.2%	$13,710	42.4%	Newmarket	$15,078	$22,085	82.9%	$7,007	46.5%
North Hampton	$47,072	$66,696	114.7%	$19,624	41.7%	North Hampton	$23,672	$34,187	128.3%	$10,515	44.4%
Northwood	$31,768	$52,270	116.7%	$20,502	64.5%	Northwood	$12,562	$22,139	108.1%	$9,577	76.2%
Nottingham	$41,761	$52,270	116.7%	$10,509	25.2%	Nottingham	$15,708	$22,139	108.1%	$6,431	40.9%
Portsmouth	$30,591	$45,195	77.7%	$14,604	47.7%	Portsmouth	$15,557	$27,540	103.3%	$11,983	77.0%
Rye	$42,143	$63,152	108.6%	$21,009	49.9%	Rye	$28,020	$36,746	137.9%	$8,726	31.1%
Stratham	$51,567	$76,726	131.9%	$25,159	48.8%	Stratham	$23,104	$33,270	124.8%	$10,166	44.0%
Carroll County											
Brookfield	$39,653	$52,132	130.4%	$12,479	31.5%	Brookfield	$14,993	$25,745	117.4%	$10,752	71.7%
Wakefield	$28,171	$42,500	106.3%	$14,329	50.9%	Wakefield	$12,992	$21,507	98.1%	$8,515	65.5%
Carroll County	$28,145	$39,990		$11,845	42.1%	Carroll County	$14,041	$21,931		$7,890	56.2%
Rockingham County	$41,881	$58,150		$16,269	38.8%	Rockingham County	$17,694	$26,656		$8,962	50.6%
Strafford County	$32,812	$44,803		$11,991	36.5%	Strafford County	$13,999	$20,479		$6,480	46.3%
New Hampshire	$36,329	$49,467		$13,138	36.2%	New Hampshire	$15,959	$23,844		$7,885	49.4%

Source: US Census

Note: Towns listed within Rockingham and Carroll counties are only those within the socio-economic study area. All municipalities within Strafford County are within the socio-economic study area.

**Table 3.3-4
Poverty Status by Age (2000)
Socio-Economic Study Area**

		Below Poverty Level				% Below Poverty Level		
Strafford County	**Total Population***	**Under 5**	**5 to 18**	**65 and over**	**Total**	**Total**	**Under 5**	**65 and over**
Barrington	7,441	10	401	0	411	5.5%	0.1%	0.0%
Dover	26,079	154	1,856	183	2,193	8.4%	0.6%	0.7%
Durham	8,110	8	2,229	9	2,246	27.7%	0.1%	0.1%
Farmington	5,727	55	423	67	545	9.5%	1.0%	1.2%
Lee	4,114	23	171	17	211	5.1%	0.6%	0.4%
Madbury	1,501	7	76	4	87	5.8%	0.5%	0.3%
Middleton	1,433	16	79	9	104	7.3%	1.1%	0.6%
Milton	3,903	62	227	18	307	7.9%	1.6%	0.5%
New Durham	2,200	5	91	16	112	5.1%	0.2%	0.7%
Rochester	28,140	244	1,797	316	2,357	8.4%	0.9%	1.1%
Rollinsford	2,644	0	87	11	98	3.7%	0.0%	0.4%
Somersworth	11,334	130	743	122	995	8.8%	1.1%	1.1%
Strafford	3,620	8	8	15	31	0.9%	0.2%	0.4%
Rockingham County								
Brentwood	2,728	9	75	16	100	3.7%	0.3%	0.6%
East Kingston	1,769	4	73	0	77	4.4%	0.2%	0.0%
Epping	5,459	29	120	31	180	3.3%	0.5%	0.6%
Exeter	13,777	54	591	97	742	5.4%	0.4%	0.7%
Greenland	3,196	7	164	19	190	5.9%	0.2%	0.6%
Hampton	14,804	65	657	148	870	5.9%	0.4%	1.0%
Hampton Falls	1,875	0	47	8	55	2.9%	0.0%	0.4%
Kensington	1,875	8	71	8	87	4.6%	0.4%	0.4%
New Castle	999	0	6	0	6	0.6%	0.0%	0.0%
Newfields	1,546	6	38	0	44	2.8%	0.4%	0.0%
Newington	776	0	32	4	36	4.6%	0.0%	0.5%
Newmarket	8,019	43	589	37	669	8.3%	0.5%	0.5%
North Hampton	4,248	0	104	37	141	3.3%	0.0%	0.9%
Northwood	3,623	12	25	10	47	1.3%	0.3%	0.3%
Nottingham	3,674	0	17	6	23	0.6%	0.0%	0.2%
Portsmouth	20,244	138	1,490	255	1,883	9.3%	0.7%	1.3%
Rye	5,132	24	149	8	181	3.5%	0.5%	0.2%
Stratham	6,344	0	68	6	74	1.2%	0.0%	0.1%
Carroll County								
Brookfield	605	0	7	2	9	1.5%	0.0%	0.3%
Wakefield	4,203	18	243	37	298	7.1%	0.4%	0.9%
Study Area Total	**211,142**	**1,139**	**12,754**	**1,516**	**15,409**	**7.3%**	**0.5%**	**0.7%**

Source: US Census
* Population for whom poverty status is determined

study area's population, in 2000, was living below the poverty level. However, this average is skewed higher due to the large number of college students in Durham who responded to the census, but do not necessarily reside there on a year-round basis.

A more detailed perspective regarding households in poverty within the project area is presented in Table 3.3-5. The data in this table identifies the poverty rate of residents in Block Groups (BG) that comprise the project area in Dover and Newington, as well as the area in Portsmouth (that is not in the study area) that abuts the project area along Gosling Road. Overall, the project area had a poverty rate of 7.1 percent in 2000, as compared to 7.3 percent for the study area as a whole. However, two BGs in Portsmouth, 6941 and 6942, had poverty rates that were substantially higher than the study area at 13.3 percent and 28 percent respectively. Also higher, but to a lesser degree, was BG 6931 that had a poverty rate of 9.4 percent.

Several of these Block Groups are the location of subsidized housing for low-income residents, which contributes to the higher rates of poverty in those areas. In Portsmouth, off Gosling Road, is Gosling Meadows, a US Department of Housing and Urban Development (HUD) supported housing project that contains 124 housing units occupied by low-income families. The project is fully occupied at this time and there are no plans for expansion.

The other subsidized housing in the project area is the Great Bay School, which is located on Woodbury Avenue in Newington. This facility provides vocational training for developmentally disabled individuals and operates a group residential home on the site, which contains 12 single occupancy rooms that are fully occupied. The facility also provides training for approximately 100 developmentally disabled individuals, who do not reside at the school.

3.3.3 Population Projections

This section presents an overview of population projections for the study area that were prepared by the NH Office of Energy and Planning (NHOEP) in March of 2003. The NHOEP's projections are the primary source of this type of data prepared by a governmental agency within New Hampshire for the purpose of estimating long-term growth trends. For comparison purposes, projections developed by Woods & Poole Economics, Inc. (W&P), a private data analysis firm, have also been included. The W&P projections are available at the county level only, whereas NHOEP's projections are available at both the county and municipal levels of geography. The W&P projections were prepared in 1998.

**Table 3.3-5
Poverty Status by Age (2000)
Project Area Block Groups**

			Below Poverty Level				% Below Poverty		
Town	Block Group	Total	Under 5	5 to 18	65 and over	Total	Total	Under 5	65 and over
Newington	6853	776	0	32	4	36	4.6%	0.0%	0.5%
Portsmouth	6931	978	0	67	25	92	9.4%	0.0%	2.6%
	6941	1,276	18	152	0	170	13.3%	1.4%	0.0%
	6942	835	40	190	4	234	28.0%	4.8%	0.5%
	6952	595	0	6	6	12	2.0%	0.0%	1.0%
	6953	36	0	0	0	0	0.0%	0.0%	0.0%
Dover	8112	3,747	0	85	18	103	2.7%	0.0%	0.5%
	8122	1,980	13	69	0	82	4.1%	0.7%	0.0%
Block Group Total		10,223	71	601	57	729	7.1%	0.7%	0.6%
Study Area Total		**200,225**	**1,139**	**12,754**	**1,516**	**15,409**	**7.3%**	**.5%**	**0.7%**

Source: US Census

The NHOEP projections are essentially based on the assumption that historical growth trends will remain approximately the same in the future. NHOEP first projects state level growth based on migration patterns and natural increases in the population. This statewide projection is then allocated down to the county and municipal levels based on historic absorption patterns and input obtained from regional planning agencies.

In contrast, the W&P projections are based on a national model that links population growth to expected economic conditions within all counties throughout the country. The W&P model represents an export-based approach to forecasting employment in a given region. Projected growth in regional export industries (*i.e.* manufacturing, mining, and agriculture) are used to estimate employment in non-export industries (*i.e.* retail, construction, transportation, and communications). Population growth is in turn projected based on the anticipated demand for employment within these economic sectors, as well as traditional cohort analysis of births and deaths.

Table 3.3-6 presents NHOEP population projections from 2000 to 2025 with intermediate estimates given for years 2010 and 2020. These projections suggest that the study area population will increase by 60,074 within this 25-year horizon. During the prior 30 years, the study area's population increased by approximately 78,100 (Table 3.3-1). The Strafford County portion of the study area's population is projected to increase by approximately 30,600 individuals during the planning period, while the

Table 3.3-6
Population Projections 2000-2025
Socio-Economic Study Area

	Actual	Projected Population			Change			% Change			Avg. Annual Change		
	2000	2010	2020	2025	00-10	10-20	00-25	00-10	10-20	00-25	00-10	10-20	00-25
Barrington	7,475	8,680	9,860	10,420	1,205	1,180	2,945	16.1%	13.6%	39.4%	2%	1%	1%
Dover	26,884	28,930	30,150	30,680	2,046	1,220	3,796	7.6%	4.2%	14.1%	1%	0%	1%
Durham	12,664	13,980	15,480	16,180	1,316	1,500	3,516	10.4%	10.7%	27.8%	1%	1%	1%
Farmington	5,774	6,650	7,500	7,890	876	850	2,116	15.2%	12.8%	36.6%	1%	1%	1%
Lee	4,145	4,730	5,360	5,660	585	630	1,515	14.1%	13.3%	36.6%	1%	1%	1%
Madbury	1,509	1,740	1,940	2,030	231	200	521	15.3%	11.5%	34.5%	1%	1%	1%
Middleton	1,440	1,710	1,980	2,110	270	270	670	18.8%	15.8%	46.5%	2%	1%	2%
Milton	3,910	4,550	5,170	5,470	640	620	1,560	16.4%	13.6%	39.9%	2%	1%	1%
New Durham	2,220	2,820	3,500	3,820	600	680	1,600	27.0%	24.1%	72.1%	2%	2%	2%
Rochester	28,461	31,630	35,070	36,690	3,169	3,440	8,229	11.1%	10.9%	28.9%	1%	1%	1%
Rollinsford	2,648	2,910	3,210	3,350	262	300	702	9.9%	10.3%	26.5%	1%	1%	1%
Somersworth	11,477	12,090	12,930	13,530	613	840	2,053	5.3%	6.9%	17.9%	1%	1%	1%
Strafford	3,626	4,220	4,770	5,040	594	550	1,414	16.4%	13.0%	39.0%	2%	1%	1%
Subtotal Strafford	**112,233**	**124,640**	**136,920**	**142,870**	**12,407**	**12,280**	**30,637**	**11.1%**	**9.9%**	**27.3%**	**1%**	**1%**	**1%**
Brentwood	3,197	3,710	4,040	4,190	513	330	993	16.0%	8.9%	31.1%	1%	1%	1%
East Kingston	1,784	2,060	2,310	2,430	276	250	646	15.5%	12.1%	36.2%	1%	1%	1%
Epping	5,476	6,210	6,660	6,860	734	450	1,384	13.4%	7.2%	25.3%	1%	1%	1%
Exeter	14,058	15,430	16,680	17,230	1,372	1,250	3,172	9.8%	8.1%	22.6%	1%	1%	1%
Greenland	3,208	3,700	4,180	4,380	492	480	1,172	15.3%	13.0%	36.5%	1%	1%	1%
Hampton	14,937	16,630	18,180	18,880	1,693	1,550	3,943	11.3%	9.3%	26.4%	1%	1%	1%
Hampton Falls	1,880	2,170	2,440	2,580	290	270	700	15.4%	12.4%	37.2%	1%	1%	1%
Kensington	1,893	2,180	2,470	2,570	287	290	677	15.2%	13.3%	35.8%	1%	1%	1%
New Castle	1,010	1,130	1,230	1,280	120	100	270	11.9%	8.8%	26.7%	1%	1%	1%
Newfields	1,551	1,750	1,910	1,980	199	160	429	12.8%	9.1%	27.7%	1%	1%	1%
Newington	775	870	950	990	95	80	215	12.3%	9.2%	27.7%	1%	1%	1%
Newmarket	8,027	8,910	9,530	9,810	883	620	1,783	11.0%	7.0%	22.2%	1%	1%	1%
North Hampton	4,259	4,870	5,310	5,510	611	440	1,251	14.3%	9.0%	29.4%	1%	1%	1%
Northwood	3,640	4,110	4,520	4,700	470	410	1,060	12.9%	10.0%	29.1%	1%	1%	1%

Table 3.3-6 (continued)

	Actual	Projected Population			Change			% Change			Avg. Annual Change		
	2000	2010	2020	2025	00-10	10-20	00-25	00-10	10-20	00-25	00-10	10-20	00-25
Nottingham	3,701	4,360	4,920	5,170	659	560	1,469	17.8%	12.8%	39.7%	2%	1%	1%
Portsmouth	20,784	22,210	24,380	25,390	1,426	2,170	4,606	6.9%	9.8%	22.2%	1%	1%	1%
Rye	5,182	5,750	6,150	6,330	568	400	1,148	11.0%	7.0%	22.2%	1%	1%	1%
Stratham	6,355	7,280	8,060	8,410	925	780	2,055	14.6%	10.7%	32.3%	1%	1%	1%
Subtotal Rockingham	**101,717**	**113,330**	**123,920**	**128,690**	**11,613**	**10,590**	**26,973**	**11.4%**	**9.3%**	**26.5%**	**1%**	**1%**	**1%**
Brookfield	604	760	910	960	156	150	356	25.8%	19.7%	58.9%	2%	2%	2%
Wakefield	4,252	5,110	6,020	6,360	858	910	2,108	20.2%	17.8%	49.6%	2%	2%	2%
Subtotal Carroll	**4,856**	**5,870**	**6,930**	**7,320**	**1,014**	**1,060**	**2,464**	**20.9%**	**18.1%**	**50.7%**	**2%**	**2%**	**2%**
Study Area Total	**218,806**	**243,840**	**267,770**	**278,880**	**25,034**	**23,930**	**60,074**	**11.4%**	**9.8%**	**27.5%**	**1%**	**1%**	**1%**

County Projections by NH Office of Energy and Planning

	Estimated	Projected Population			Change			% Change			Avg. Annual Change		
	2000	2010	2020	2025	00-10	10-20	00-25	00-10	10-20	00-25	00-10	10-20	00-25
Carroll County	43,666	51,260	59,000	61,850	7,594	7,740	18,184	17.4%	15.1%	41.6%	2%	1%	1%
Rockingham County	277,359	313,130	343,320	356,800	35,771	30,190	79,441	12.9%	9.6%	28.6%	1%	1%	1%
Strafford County	112,233	124,650	136,920	142,870	12,417	12,270	30,637	11.1%	9.8%	27.3%	1%	1%	1%
Total	**435,258**	**491,050**	**541,260**	**563,545**	**55,782**	**50,200**	**128,262**	**12.8%**	**10.2%**	**29.5%**	**1%**	**1%**	**1%**

County Projections by Woods & Poole Economics, Inc.

	Estimated	Projected Population			Change			% Change			Avg. Annual Change		
	2000	2010	2020	2025	00-10	10-20	00-25	00-10	10-20	00-25	00-10	10-20	00-25
Carroll County	40,720	46,140	51,650	54,460	5,420	5,510	13,740	13.3%	11.9%	33.7%	1%	1%	1%
Rockingham County	279,030	314,330	350,200	368,550	35,300	35,870	89,520	12.7%	11.4%	32.1%	1%	1%	1%
Strafford County	111,450	119,530	127,810	132,090	8,080	8,280	20,640	7.2%	6.9%	18.5%	1%	1%	1%
Total	**433,200**	**482,010**	**531,680**	**557,125**	**48,800**	**49,660**	**123,900**	**11.3%**	**10.3%**	**28.6%**	**1%**	**1%**	**1%**

Source: NH Office of State Planning 2003 and Woods & Poole Economics, Inc. 1998
Note: Towns listed within Rockingham and Carroll counties are only those within the socio-economic study area. All municipalities within Strafford County are within the socio-economic study area.

Rockingham portion is expected to experience a smaller increase of approximately 27,000 residents.

The growth rate of the study area is projected to be slightly higher in the first decade between 2000 and 2010 at 11.4 percent, followed by a slower rate of increase of 9.8 percent for the following ten years between 2010 and 2020. Overall, the study area's population is projected to grow at a rate of 27.5 percent within the 25-year planning period (2000-2025), a rate that is approximately half of the historical growth rate (55.5 percent from 1970-2000) for this area.

Due to the nature of the methodology used by NHOEP, towns and cities projected to absorb the largest amount of future growth are essentially the same ones that have historically done so. In Strafford County, these include Rochester, Dover, Farmington, Durham, Barrington, and Somersworth although the total projected increases in Dover and Barrington have been reduced considerably from previous growth levels. A similar scenario is true for the projected population of the Rockingham portion of the study area. One prominent change in this area involves the City of Portsmouth, where total population is projected to increase by approximately 4,600 by 2025. This level of increase is questionable given the limited amount of developable land remaining in the city coupled with the typically high cost of purchasing housing.

Also illustrated in Table 3.3-6 is a comparison of countywide projections prepared by NHOEP and W&P for Carroll, Rockingham and Strafford Counties. It should be noted that since the W&P projections were completed in 1998 they begin with a base year that is different from NHOEP's. Overall, both sets of projections arrive at comparable long-term growth levels for the combined total populations of all three counties, which are within a difference of less than 5,000 by 2025 (128,300 versus 123,900). However, there are considerable differences exhibited when examining the distribution of the projected growth within each county. NHOEP estimates that Rockingham's population change will be approximately 79,500 (2000-2025) versus an estimated increase of approximately 89,500 by W&P, a difference of 10,000. Conversely, W&P places Strafford County's population growth at approximately 10,000 less and Carroll County's at approximately 5,000 less than NHOEP's respective projections for 2025.

3.3.4 Housing Characteristics

Within the study area's overall housing growth there was a considerable difference between the number of units added to the supply during the 1980s and 1990s. As Table 3.3-7 indicates, approximately 21,000 units were added during the 1980s as compared with approximately 6,300 during the 1990s, a

Table 3.3-7
Change in Total Housing Units 1980-2000
Socio-Economic Study Area

	Total Units			Change			% Change			Avg. Annual Change		
	1980	1990	2000	80-90	90-00	80-00	80-90	90-00	80-00	80-90	90-00	80-00
Barrington	1,957	2,640	3,147	683	507	1,190	34.9%	19.2%	60.8%	3.0%	1.8%	2.4%
Dover	8,759	11,307	11,924	2,548	617	3,165	29.1%	5.5%	36.1%	2.6%	0.5%	1.6%
Durham	2,144	2,508	2,923	364	415	779	17.0%	16.5%	36.3%	1.6%	1.5%	1.6%
Farmington	1,800	2,260	2,337	460	77	537	25.6%	3.4%	29.8%	2.3%	0.3%	1.3%
Lee	906	1,393	1,534	487	141	628	53.8%	10.1%	69.3%	4.4%	1.0%	2.7%
Madbury	359	528	543	169	15	184	47.1%	2.8%	51.3%	3.9%	0.3%	2.1%
Middleton	508	654	706	146	52	198	28.7%	8.0%	39.0%	2.6%	0.8%	1.7%
Milton	1,177	1,767	1,815	590	48	638	50.1%	2.7%	54.2%	4.1%	0.3%	2.2%
New Durham	984	1,231	1,309	247	78	325	25.1%	6.3%	33.0%	2.3%	0.6%	1.4%
Rochester	8,153	11,076	11,836	2,923	760	3,683	35.9%	6.9%	45.2%	3.1%	0.7%	1.9%
Rollinsford	819	1,040	1,060	221	20	241	27.0%	1.9%	29.4%	2.4%	0.2%	1.3%
Somersworth	4,016	4,719	4,841	703	122	825	17.5%	2.6%	20.5%	1.6%	0.3%	0.9%
Strafford	667	1,266	1,564	599	298	897	89.8%	23.5%	134.5%	6.6%	2.1%	4.4%
Subtotal Strafford	**32,249**	**42,389**	**45,539**	**10,140**	**3,150**	**13,290**	**31.4%**	**7.4%**	**41.2%**	**2.8%**	**0.7%**	**1.7%**
Brentwood	590	778	920	188	142	330	31.9%	18.3%	55.9%	2.8%	1.7%	2.2%
East Kingston	390	494	648	104	154	258	26.7%	31.2%	66.2%	2.4%	2.8%	2.6%
Epping	1,343	2,059	2,215	716	156	872	53.3%	7.6%	64.9%	4.4%	0.7%	2.5%
Exeter	4,406	5,346	6,107	940	761	1,701	21.3%	14.2%	38.6%	2.0%	1.3%	1.6%
Greenland	734	1,082	1,244	348	162	510	47.4%	15.0%	69.5%	4.0%	1.4%	2.7%
Hampton	6,962	8,599	9,349	1,637	750	2,387	23.5%	8.7%	34.3%	2.1%	0.8%	1.5%
Hampton Falls	485	591	729	106	138	244	21.9%	23.4%	50.3%	2.0%	2.1%	2.1%
Kensington	456	585	672	129	87	216	28.3%	14.9%	47.4%	2.5%	1.4%	2.0%
New Castle	362	399	488	37	89	126	10.2%	22.3%	34.8%	1.0%	2.0%	1.5%
Newfields	281	324	532	43	208	251	15.3%	64.2%	89.3%	1.4%	5.1%	3.2%
Newington	273	320	305	47	-15	32	17.2%	-4.7%	11.7%	1.6%	-0.5%	0.6%
Newmarket	1,859	3,285	3,457	1,426	172	1,598	76.7%	5.2%	86.0%	5.9%	0.5%	3.2%
North Hampton	1,302	1,495	1,782	193	287	480	14.8%	19.2%	36.9%	1.4%	1.8%	1.6%
Northwood	874	1,791	1,905	917	114	1,031	104.9%	6.4%	118.0%	7.4%	0.6%	4.0%
Nottingham	712	1,314	1,592	602	278	880	84.6%	21.2%	123.6%	6.3%	1.9%	4.1%
Portsmouth*	9,880	11,369	10,186	1,489	-1,183	306	15.1%	-10.4%	3.1%	1.4%	-1.1%	0.2%
Rye	2,362	2,443	2,645	81	202	283	3.4%	8.3%	12.0%	0.3%	0.8%	0.6%
Stratham	848	1,917	2,371	1,069	454	1,523	126.1%	23.7%	179.6%	8.5%	2.1%	5.3%
Subtotal Rockingham	**34,119**	**44,191**	**47,147**	**10,072**	**2,956**	**13,028**	**29.5%**	**6.7%**	**38.2%**	**2.6%**	**0.6%**	**1.6%**
Brookfield	207	274	280	67	6	73	32.4%	2.2%	35.3%	2.8%	0.2%	1.5%
Wakefield	2,472	3,158	3,331	686	173	859	27.8%	5.5%	34.7%	2.5%	0.5%	1.5%
Subtotal Carroll	**2,679**	**3,432**	**3,611**	**753**	**179**	**932**	**28.1%**	**5.2%**	**34.8%**	**2.5%**	**0.5%**	**1.5%**
Study Area Total	**69,047**	**90,012**	**96,297**	**20,965**	**6,285**	**27,250**	**30.4%**	**7.0%**	**39.5%**	**2.7%**	**0.7%**	**1.7%**

Source: US Census

* The decline in Portsmouth's total housing units is primarily attributable to the closing of Pease Air Force Base

Note: Towns listed within Rockingham and Carroll counties are only those within the socio-economic study area. All municipalities within Strafford County are within the socio-economic study area.

decline of more than two-thirds within a ten-year period. There was an even greater decrease in the rate of growth over these two decades, which declined from 30.4 percent to 7 percent respectively. From an annual perspective, the rate of housing growth decreased from 2.7 percent during 1980s to 0.7 percent in the 1990s.

Total housing growth in the Strafford County portion of the socio-economic study area slightly exceeded that of the Rockingham County portion in both decades (see Table 3.3-7). Overall, Strafford area communities saw an increase of 13,290 units between 1980 and 2000, while Rockingham added 13,028 during that time. However, if the decrease of 1,183 in Portsmouth's housing supply (primarily due to the closing of Pease AFB) is eliminated, the above scenario is reversed, with Rockingham's growth slightly exceeding Strafford's (14,211 versus 13,290, respectively) over the 20-year period.

It is unlikely that the growth rates experienced during the 1970s and 1980s will be repeated again within the foreseeable future. This is due to several reasons: a diminishing land supply, changes in financial lending practices for housing construction, escalating costs of housing construction, considerable changes in land use regulations in study area towns since the boom growth of the 1980s, and the fact that more communities are taking a pro-active approach to manage growth, especially residential growth, and preserve open space.

Table 3.3-8 provides a more detailed breakdown of the study area's housing supply with regard to year-round and seasonal units, and occupancy. As the data indicates, approximately 70 percent of the study area's housing supply is comprised of single-family dwellings as compared to 30 percent that are multi-family. This split is equivalent for both the Strafford and Rockingham County portions of the study area.

Approximately 7,600 units of the total housing supply were classified as seasonal units, indicating that they are only occupied for a portion of the year. This represented approximately 8 percent of the total housing stock of the study area in 2000. The largest concentration of seasonal homes in the Rockingham portion of the study area are located in the seacoast town of Hampton, which had approximately 2,500 of these units. The other towns with a sizeable number of seasonal units are found in Rye, which also lies along the seacoast, as well as Northwood and Nottingham. In Carroll County, the town of Wakefield has over 1,600 seasonal housing units, which represent approximately 48 percent of the town's total housing supply. In Strafford County, notable concentrations of seasonal homes are found in the northern communities of Milton and New Durham, as well as the Town of Barrington in the central portion of the county.

Table 3.3-8
Summary of Housing Units, 2000 Census
Socio-Economic Study Area

	Total Units (Year-round and Seasonal)					Year-round Units				Seasonal Units	
	Total	Single-Family*	% Total	Multi-Family**	% Total	Total	Occupied	Vacant	Rate	Total	% Total
Barrington	3,147	2,922	92.9%	225	7.1%	2,833	2,756	77	2.7%	314	10.0%
Dover	11,924	6,278	52.7%	5,646	47.3%	11,827	11,573	254	2.1%	97	0.8%
Durham	2,923	1,866	63.8%	1,057	36.2%	2,907	2,882	25	0.9%	16	0.5%
Farmington	2,337	1,847	79.0%	490	21.0%	2,243	2,146	97	4.3%	94	4.0%
Lee	1,534	1,271	82.9%	263	17.1%	1,479	1,466	13	0.9%	55	3.6%
Madbury	543	469	86.4%	74	13.6%	541	534	7	1.3%	2	0.4%
Middleton	706	705	99.9%	2	0.3%	529	516	14	2.6%	177	25.1%
Milton	1,815	1,641	90.4%	174	9.6%	1,502	1,456	46	3.1%	313	17.2%
New Durham	1,309	1,290	98.5%	18	1.4%	840	817	22	2.6%	469	35.8%
Rochester	11,836	8,374	70.8%	3,462	29.2%	11,730	11,434	296	2.5%	106	0.9%
Rollinsford	1,060	729	68.8%	331	31.2%	1,054	1,033	21	2.0%	6	0.6%
Somersworth	4,841	2,795	57.7%	2,046	42.3%	4,832	4,687	145	3.0%	9	0.2%
Strafford	1,564	1,501	96.0%	63	4.0%	1,317	1,281	36	2.7%	247	15.8%
Subtotal Strafford	**45,539**	**31,688**	**69.6%**	**13,851**	**30.4%**	**43,634**	**42,581**	**1,053**	**2.4%**	**1,905**	**4.2%**
Brentwood	920	906	98.5%	14	1.5%	917	911	6	0.7%	3	0.3%
East Kingston	648	633	97.7%	15	2.3%	639	629	10	1.6%	9	1.4%
Epping	2,215	1,895	85.6%	320	14.4%	2,115	2,047	68	3.2%	100	4.5%
Exeter	6,107	3,995	65.4%	2,112	34.6%	6,029	5,898	131	2.2%	78	1.3%
Greenland	1,244	1,047	84.2%	198	15.9%	1,226	1,204	23	1.9%	18	1.4%
Hampton	9,349	6,051	64.7%	3,298	35.3%	6,807	6,465	342	5.0%	2,542	27.2%
Hampton Falls	729	707	97.0%	22	3.0%	720	704	16	2.2%	9	1.2%
Kensington	672	635	94.5%	36	5.4%	667	656	10	1.5%	5	0.7%
New Castle	488	456	93.4%	35	7.2%	456	444	15	3.3%	32	6.6%
Newfields	532	488	91.7%	44	8.3%	530	516	14	2.6%	2	0.4%
Newington	305	271	88.9%	33	10.8%	302	294	7	2.3%	3	1.0%
Newmarket	3,457	1,872	54.2%	1,585	45.8%	3,424	3,379	45	1.3%	33	1.0%
North Hampton	1,782	1,655	92.9%	127	7.1%	1,718	1,671	47	2.7%	64	3.6%
Northwood	1,905	1,750	91.9%	155	8.1%	1,416	1,347	69	4.9%	489	25.7%
Nottingham	1,592	1,557	97.8%	35	2.2%	1,338	1,331	7	0.5%	254	16.0%
Portsmouth	10,186	4,966	48.8%	5,217	51.2%	10,148	9,874	271	2.7%	38	0.4%
Rye	2,645	2,362	89.3%	283	10.7%	2,277	2,176	101	4.4%	368	13.9%
Stratham	2,371	2,000	84.4%	371	15.6%	2,352	2,306	46	2.0%	19	0.8%
Subtotal Rockingham	**47,147**	**33,246**	**70.5%**	**13,900**	**29.5%**	**43,081**	**41,852**	**1,228**	**2.9%**	**4,066**	**8.6%**
Brookfield	280	280	100.0%	0	0.0%	242	237	6	2.5%	38	13.6%
Wakefield	3,331	3,155	94.7%	175	5.3%	1,730	1,684	45	2.6%	1,601	48.1%
Subtotal Carroll	**3,611**	**3,435**	**95.1%**	**175**	**4.9%**	**1,972**	**1,921**	**51**	**2.6%**	**1,639**	**45.4%**
Study Area Total	**96,297**	**68,369**	**71.0%**	**27,926**	**29.0%**	**88,687**	**86,354**	**2,332**	**2.6%**	**7,610**	**7.9%**

Source: US Census
* Single-family includes detached and attached units, mobile homes and "other" units
** Multi-Family includes all non-owner occupied housing with two or more units per structure
Note: Towns listed within Rockingham and Carroll counties are only those within the socio-economic study area. All municipalities within Strafford County are within the socio-economic study area.

Identifying changes in the amount of seasonal housing within the study area is complicated by the fact that the Census Bureau has changed its definition of these units over time, as well as the fact that most communities do not typically track the construction of new seasonal units within the building permit process. A review of census estimates of seasonal housing units between 1980 and 2000 suggests that the total has decreased by approximately 1,100 units. Some of this decline is due to the definitional change that occurred during this time period. However, some of this change is also likely attributable to the conversion of seasonal to year-round units. The potential for this type of conversion to continue has ramifications for long-term planning of transportation facilities.

The final housing characteristic presented in Table 3.3-8 relates to the vacancy rate of housing within the study area. As of 2000, the vacancy rate for year-round units was 2.6 percent, which represents approximately 2,300 vacant units. This is a relatively low vacancy rate and is indicative of the "tightening" of the area housing market, which over the last few years has resulted in an increase in the sales price of homes as well as monthly rental costs, issues that are discussed in a subsequent section. Vacancy rates were relatively comparable for both the Strafford and Rockingham portions of the study areas at 2.4 percent and 2.9 percent respectively.

Tables 3.3-9 and 3.3-10 indicate that housing costs rose steadily throughout the socio-economic study area with home sales prices increasing annually by approximately 8 percent between 1992 and 2002. Strafford County consistently had lower average prices throughout the decade, in comparison to Rockingham County, although its rate of appreciation (119.6 percent) during this time exceeded Rockingham County (106.6 percent). This is an indication of the role that the Strafford housing market plays in offering more affordable housing.

3.3.5 Local Land Use

The composition of the existing land use (Tables 3.3-11 and 3.3-12) varies dramatically between the Newington and Dover portions of the study area. Newington's portion of the study area is heavily industrialized and also includes a substantial amount of commercial development, as well as a residential component. Conversely, Dover's existing land use within the study area is comprised almost entirely of residential development along with a few scattered commercial and office facilities. **Figure 3.3-1** shows land use zoning in both communities.

Table 3.3-9
Average Home Sales Prices 1992-2002
Rockingham, Strafford and Seacoast Areas *

	Strafford Area			Rockingham Area			Seacoast Area		
	Avg. Sale Price	Total Units	Avg. DOM	Avg. Sale Price	Total Units	Avg. DOM	Avg. Sale Price	Total Units	Avg. DOM
1992	$84,543	782	128	$116,639	534	126	$135,342	615	101
1993	$82,302	1,012	140	$117,665	748	143	$143,471	749	116
1994	$87,093	1,085	138	$112,533	906	131	$149,979	940	115
1995	$83,287	942	148	$114,962	855	147	$155,568	961	129
1996	$92,232	1,129	234	$127,014	1,328	163	$166,787	938	181
1997	$100,309	1,368	180	$133,946	1,501	254	$182,548	1,065	202
1998	$106,774	1,469	167	$147,217	2,017	162	$193,916	1,271	226
1999	$120,648	1,722	138	$163,313	1,940	142	$213,261	1,307	136
2000	$140,265	1,579	118	$188,096	1,794	129	$243,935	1,310	126
2001	$166,041	1,546	119	$209,932	1,823	121	$268,943	1,196	127
2002	$185,626	1,699	119	$240,937	1,836	126	$299,319	1,296	123
Change 92-02	$101,083			$124,298			$163,977		
% Change	119.6%			106.6%			121.2%		
Avg. Annual Change	8.2%			7.5%			8.3%		

Source: National Association of Realtors
DOM = Days on Market
*Strafford Area includes Barrington, Brookfield, Dover, Durham, Farmington, Lee, Madbury, Middleton, Milton, New Durham, Rochester, Rollinsford, Somersworth, Strafford, and Union.
Rockingham Area includes Atkinson, Brentwood, Danville, East Kingston, Epping, Exeter, Fremont, Hampstead, Kensington, Kingston, Newfields, Newton, Nottingham, Plaistow, Raymond, Sandown, South Hampton and Stratham.
Seacoast Area includes Greenland, Hampton, Hampton Falls, New Castle, Newington, Newmarket, North Hampton, Portsmouth, Rye, and Seabrook.

Table 3.3-10
Median Monthly Gross Rent 1993-2003
Socio-Economic Study Area and the Cities of Rochester and Portsmouth

Median Gross Rent - 2003						
# Bedrooms	Study Area	Carroll County	Strafford County	Rockingham County	City of Rochester	City of Portsmouth
0	$563	NA	$580	$555	NA	NA
1	$731	$556	$719	$776	$682	$842
2	$899	$729	$857	$1,009	$837	$1,071
3	$1,148	$929	$1,043	$1,280	$939	$1,280
4+	$1,430	NA	$1,304	NA	NA	NA
All	$844	$650	$789	$939	$771	$1,071
Change in Gross Rent for a Two-Bedroom Unit 1993-2003						
Rent 1993	$564	$532	$543	$631	$685	$584
Rent 2003	$899	$729	$857	$1,009	$837	$1,071
Change 93-03	$335	$197	$314	$378	$152	$487
% Change	59.4%	37.0%	57.8%	59.9%	22.2%	83.4%
Annual Change	4.8%	3.2%	4.7%	4.8%	2.0%	6.3%

Source: 2003 Residential Rental Cost Survey, NH Housing Finance Authority.

3.3.5.1 Newington

The Newington portion of the project area is bisected by the Spaulding Turnpike and bordered by the water bodies of the Piscataqua River and Little Bay. The land area on the east side of the Turnpike is zoned primarily for industrial, waterfront industrial, office, and commercial uses, but there is also a small residential zone for a pre-existing enclave of approximately 15 houses along Patterson Lane. Zoning on the west side of the Turnpike in the vicinity of Nimble Hill Road is primarily single-family residential, although a portion of the office zone extends into this area as well.

Given its location at the intersection of two major highways (Interstate 95 and the Spaulding Turnpike), as well as its proximity to a deep-water port on the Piscataqua River, the Newington portion of the project area has long been the focus of commercial and industrial development. The port area contains several large fuel-storage tank farms, an electrical power generating plant, as well as other major manufacturing and warehousing operations. Commercial uses include two regional shopping malls, as well as a substantial amount of freestanding retail and service establishments that include a number of national chain stores.

Existing land use on the west side of the Turnpike is predominantly residential, although there is also approximately 150,000 sq. ft. of light manufacturing, as well as a gas station/convenience store located in the office zone that extends a short distance along this side of the highway. Of the total 72 housing units in the Newington portion of the project area, 61 are single-family housing units and 11 are contained in multi-family dwellings of two to three family structures.

As illustrated in Table 3.3-11, there are 143 properties classified as non-residential in the Newington portion of the project area, including 26 vacant parcels. These properties have a total assessed value of approximately $457 million and contain over 2.7 million square feet of buildings.[49] Residential properties have an assessed value of approximately $11.3 million for a combined value of $468.6 million within the Newington portion of the project area. This represents approximately 84.6 percent of the town's total taxable valuation (which is approximately $553.7 million) as reported in the 2002 annual town report.

There are an estimated 114 acres of undeveloped land remaining in the commercial and industrial zoning areas within the Newington project area (see Table 3.3-11). The largest contiguous block of this undeveloped land is owned by Public Service Company of New Hampshire, which controls approximately

49 This building square footage understates the total non-residential building area since information regarding several of the larger industrial facilities was not available in town records.

82 acres. Available mapping of this land indicates that although a portion of this site is constrained by wetlands, there appears to be sufficient upland to construct approximately an additional 100,000 square feet. The remaining 32 acres of undeveloped land are scattered in smaller parcels that probably do not have potential for substantial future development. On the west side of the Turnpike there is an undeveloped parcel, approximately 16 acres in size, that was formerly used as a drive-in theater.

Based on discussions with the town planner in Newington, there are no anticipated plans for major economic initiatives or rezoning within this portion of the project area. The town has recently begun the process of updating its master plan, which was last revised in 1990. The town did recently coordinate the extension of Shattuck Way, which runs parallel to Woodbury Avenue and which was intended to remove industrial traffic from that roadway. Shattuck Way presently extends from the Exit 4 interchange to Piscataqua Drive. The town has planned for a future southern extension of this roadway from Piscataqua Drive to Gosling Road, which follows the town line between Newington and Portsmouth.

Table 3.3-11
Property Inventory - Town of Newington Study Area[1]

Residential						
				Assessed Value		
Type of Property	**# Properties**	**# Units**	**Acreage**	**Land**	**Building**	**Total**
Single Family	61	61	127	$5,064,604	$4,873,255	$9,937,859
2-3 Family	5	11	5	$366,830	$468,300	$835,130
Vacant*	8	0	108	$464,582	$46,100	$510,682
Total	**74**	**72**	**240**	**$5,896,016**	**$5,387,655**	**$11,283,671**

Non-Residential						
				Assessed Value		
Type of Property	**# Properties**	**Bldg. Sq. Ft.**	**Acreage**	**Land**	**Building**	**Total**
Retail/Service	20	1,741,547	203	$36,264,391	$89,211,841	$125,476,232
Restaurant/Lodging	5	56,789	17	$3,324,368	$2,797,880	$6,122,248
Office	4	67,941	16	$2,774,489	$3,435,794	$6,210,283
Warehouse	8	248,219	27	$3,329,147	$7,958,303	$11,287,450
Industrial[2]	76	558,723	234	$41,516,619	$249,983,502	$291,500,121
Other Commercial	2	29,888	9	$584,138	$1,632,991	$2,217,129
Institutional	2	65,898	34	$1,888,128	$1,495,033	$3,383,161
Vacant	26	0	114	$11,114,188	$0	$11,114,188
Total	**143**	**2,769,005**	**654**	**$100,795,468**	**$356,515,344**	**$457,310,812**

Source: Town of Newington assessment records, September 2003

1 There is some building value on vacant land due to several properties that have minor structures/improvements but no residences.

2 The building square footage of industrial structures does not contain several of the larger power plant and manufacturing facilities because this information is not available.

3.3.5.2 Dover

Existing land use patterns in the Dover portion of the project area represent a stark contrast to that which exists in Newington. Dover's land area is also bisected by the Spaulding Turnpike and bordered by the Piscataqua River and Little Bay. However, with the exception of a few non-residential developments, existing land use within the area is comprised entirely of residential dwellings.

Zoning within the area allows for both single and multi-family dwellings. There is also a small business zone that lies west of the Turnpike along Dover Point Road, which encompasses several of the existing commercial establishments in the area. Businesses in the area include a restaurant, Division of Motor Vehicles (DMV) building, two home furnishing stores, two small marinas, and two service organizations. There is also a state park (Hilton Park) at the tip of Dover Point and some conservation land (Bayview Park), which is managed by the NH Fish & Game Department.

Table 3.3-12 provides a summary of existing land uses within the Dover portion of the project area. As the data illustrates, there are 483 residential properties containing 629 dwelling units. Approximately 75 percent (462) of these units are single-family dwellings but a notable percentage (21percent, or 130 units) are condominiums. Almost all of the condominium units are contained in a single development located on Spur Road, at the intersection of US 4 and the Spaulding Turnpike. There are 18 mobile homes in the project area, almost all of which are located in a small mobile home park, which is adjacent to the west side of the Turnpike but accessed *via* Boston Harbor Road. As shown in the table, there is only 25 acres remaining of undeveloped land, based on information contained in the city's assessment records. The assessed value of residential land and buildings in the Dover portion of the project area is approximately $76.8 million. Non-residential development has an assessed value of approximately $6.3 million; however, almost half of that amount ($3.1 million) is non-taxable since it is in public ownership. Therefore, the combined assessed value of taxable property in the project area is approximately $79.9 million, which represents 4.3 percent of the city's $1.85 billion in net assessed value as of 2003.

3.3.6 Commuting Patterns

A review of journey-to-work commuting data (Tables 3.3-13 and 3.3-14) shows that approximately 76 percent (82,699) of all workers living in the socio-economic study area are also employed at businesses located within the socio-economic study area. This indicates there is a strong internal movement of socio-economic study area residents to employment activities located within the socio-economic study area. In Strafford County, the number of residents working outside the county increased by approximately 20 percent between 1990 and 2000. The largest portion of this increase represented workers going to Rockingham County, which received approximately 65 percent of all outbound commuters from Strafford County as of 2000. There was a decrease in the number of Strafford County residents commuting to Maine during the decade, which may be attributable to the reduction in workforce at the Portsmouth Naval Shipyard in Kittery, Maine.

The Portsmouth-Rochester Metropolitan area has become much more integrated from an economic perspective, particularly within the last 10 years. Commuting patterns show that over three quarters of all people living in the metropolitan

Table 3.3-12
Property Inventory - City of Dover Study Area

Residential						
				Assessed Value		
Type of Property	**# Properties**	**# Units**	**Acreage**	**Land**	**Building**	**Total**
Single Family	462	462	159	$27,432,000	$27,088,100	$54,520,100
Mobile Homes	2	18	2	$232,900	$656,200	$889,100
Condominiums	3	130	35	$6,311,500	$11,849,300	$18,160,800
2-3 Family	5	11	4	$605,400	$649,800	$1,255,200
4 Family	2	8	2	$448,700	$415,100	$863,800
Vacant	9	0	22	$1,061,800	$0	$1,061,800
Total	**483**	**629**	**224**	**$36,092,300**	**$40,658,500**	**$76,750,800**

Non-Residential						
				Assessed Value		
Type of Property	**# Properties**	**Bldg. Sq. Ft.**	**Acreage**	**Land**	**Building**	**Total**
Retail/Service	2	15,597	2	$369,400	$532,800	$902,200
Restaurant/Lodging	1	871	1	$337,900	$962,000	$1,299,900
Office	2	4,579	1	$135,900	$158,700	$294,600
Other Commercial	2	7,796	2	$433,500	$157,300	$590,800
Municipal	3	960	4	$312,700	$148,700	$461,400
State	5	2,556	35	$2,330,900	$341,100	$2,672,000
Vacant	3	0	3	$94,400	$0	$94,400
Total	**18**	**32,359**	**48**	**$4,014,700**	**$2,300,600**	**$6,315,300**

Source: City of Dover Assessment Records - 2003

study area also work within the area. This transportation linkage is especially prevalent amongst residents of Strafford County, many of whom commute south to jobs located in Rockingham County. While this trend is also true for residents of the Rockingham County portion of the metropolitan area, there is a somewhat higher percentage of people living in Rockingham County that commute outside the socio-economic study area to employment locations in Massachusetts and elsewhere in New Hampshire.

Two major factors have helped to shape the commuting patterns mentioned above. The first is that a substantial portion of the business and job growth in the metropolitan study area has occurred within Rockingham County. This observation is illustrated by the closure of the Pease Air Force Base and its redevelopment as the Pease International Tradeport in Portsmouth/ Newington, where the number of jobs created since 1990 account for approximately 20 percent of the net job growth over the last decade within the socio-economic study area. Combined with this higher job growth in the southern tier is a commensurate increase in the cost of housing. Housing costs in Rockingham County have remained consistently higher than those in Strafford and Carroll Counties over the last decade. This fact has attracted sustained residential growth to the northern portion of the socio-economic study area, which has supported an expanding workforce of commuters who require access to the regional transportation system.

3.3.7 Environmental Justice

In accordance with Executive Order 12898 and subsequent procedures developed by the US Department of Transportation, activities that have the potential to generate a disproportionately high and adverse effect on human health or the environment shall include explicit consideration of their effects on minority, elderly and low-income populations. In making an assessment of whether or not Environmental Justice has been served, information regarding race, color or national origin, and income level is obtained where relevant, appropriate and practical. Specific consideration is given to those populations that are most directly served or affected by the proposed action.

In order to evaluate potential Environmental Justice impacts of the Project Alternatives, 2000 Census data has been collected at the Block Group (BG) level for the portion of the study area in Dover, Newington, and Portsmouth that have the potential to be directly impacted by transportation system improvements. There are eight Block Groups for which data was gathered to examine potential disproportionate impacts on areas of racial minorities and low-income individuals. Overall, these eight BGs had an average minority population of 3.8 percent which was slightly higher that the study area's 3.4 percent average. From an income perspective, the eight BGs had an average poverty rate of 7.1 percent in 2000 as compared to 7.3 percent for the study area as a whole.

Several of these Block Groups include subsidized housing for low-income residents, which contributes to the higher rates of poverty in those areas. In Portsmouth, off Gosling Road, is Gosling Meadows, a HUD-supported housing project, which contains 124 housing units occupied by low-income families. The project, which is adjacent to the study area, is fully occupied at this time and there are no plans for expansion.

The other subsidized housing in the study area is the Great Bay School, which is located on Woodbury Avenue in Newington. This facility provides vocational training for developmentally disabled individuals, and operates a group residential home on the site, which contains 12 single occupancy rooms that are fully occupied. The facility also provides training for approximately 100 developmentally-disabled individuals, who do not reside at the school.

Table 3.3-13
Place of Work for Workers 16 Years and Over – 2000, Socio-Economic Study Area

Place of Residence	Worked in Study Area	Worked Outside Study Area	Total	% Total In Study Area	% Total Outside Study Area
Barrington	3,370	822	4,192	80.4%	19.6%
Dover	12,422	2,600	15,022	82.7%	17.3%
Durham	4,928	930	5,858	84.1%	15.9%
Farmington	2,257	484	2,741	82.3%	17.7%
Lee	1,730	609	2,339	74.0%	26.0%
Madbury	687	116	803	85.6%	14.4%
Middleton	548	202	750	73.1%	26.9%
Milton	1,625	320	1,945	83.5%	16.5%
New Durham	782	377	1,159	67.5%	32.5%
Rochester	12,571	1,890	14,461	86.9%	13.1%
Rollinsford	1,179	302	1,481	79.6%	20.4%
Somersworth	4,733	988	5,721	82.7%	17.3%
Subtotal Strafford	**46,832**	**9,640**	**56,472**	**82.9%**	**17.1%**
Brentwood	815	577	1,392	58.5%	41.5%
East Kingston	407	554	961	42.4%	57.6%
Epping	1,964	1,074	3,038	64.6%	35.4%
Exeter	5,000	2,322	7,322	68.3%	31.7%
Greenland	1,391	307	1,698	81.9%	18.1%
Hampton	4,504	3,282	7,786	57.8%	42.2%
Hampton Falls	515	464	979	52.6%	47.4%
Kensington	461	552	1,013	45.5%	54.5%
New Castle	339	113	452	75.0%	25.0%
Newfields	573	231	804	71.3%	28.7%
Newington	339	122	461	73.5%	26.5%
Newmarket	3,729	1,204	4,933	75.6%	24.4%
North Hampton	1,628	632	2,260	72.0%	28.0%
Portsmouth	8,908	2,869	11,777	75.6%	24.4%
Rye	1,584	732	2,316	68.4%	31.6%
Stratham	2,253	867	3,120	72.2%	27.8%
Subtotal Rockingham	**34,410**	**15,902**	**50,312**	**68.4%**	**31.6%**
Brookfield	162	131	293	55.3%	44.7%
Wakefield	1,295	695	1,990	65.1%	34.9%
Subtotal Carroll	**1,457**	**826**	**2,283**	**63.8%**	**36.2%**
Study Area Total	**82,699**	**26,368**	**109,067**	**75.8%**	**24.2%**

Source: US Census

NOTE: Towns listed within Rockingham and Carroll counties are only those within the socio-economic study area. All municipalities within Strafford County are within the socio-economic study area.

Table 3.3-14
Change in County-to-County Commuting Patterns, 1990 and 2000
Strafford, Rockingham and Carroll Counties

Residents Commuting From:

Strafford County	1990	2000	% Total	Change	% Change
Residents Working in County	32,488	34,364	59%	1,876	5.8%
Residents Commuting Out	20,047	24,039	41%	3,992	19.9%
Total	52,535	58,403	100%	5,868	11.2%
Commuting To:					
Belknap County	205	371	2%	166	81.0%
Carroll County	325	376	2%	51	15.7%
Hillsborough County	870	1,146	5%	276	31.7%
Merrimack County	671	1,193	5%	522	77.8%
Rockingham County	11,343	15,537	65%	4,194	37.0%
Other New Hampshire	153	110	0%	-43	-28.1%
Maine	4,421	2,825	12%	-1,596	-36.1%
Massachusetts	1,578	2,104	9%	526	33.3%
Other Outside NH	481	377	2%	-104	-21.6%
Rockingham County					
Residents Working in County	67,438	78,659	53%	11,221	16.6%
Residents Commuting Out	64,087	70,044	47%	5,957	9.3%
Total	131,525	148,703	100%	17,178	13.1%
Commuting To:					
Belknap County	163	137	0%	-26	-16.0%
Carroll County	34	155	0%	121	355.9%
Hillsborough County	13,088	16,816	24%	3,728	28.5%
Merrimack County	2,277	3,753	5%	1,476	64.8%
Strafford County	4,060	4,254	6%	194	4.8%
Other New Hampshire	237	235	0%	-2	-0.8%
Maine	2,689	1,713	2%	-976	-36.3%
Massachusetts	40,179	41,689	60%	1,510	3.8%
Other Outside NH	1,360	1,292	2%	-68	-5.0%

Commuting to Jobs In:

Strafford County	1990	2000	% Total	Change	% Change
Residents Working in County	32,488	34,364	74%	1,876	5.8%
Nonresidents Commuting In	10,781	12,125	26%	1,344	12.5%
Total	43,269	46,489	100%	3,220	7.4%
Commuting From:					
Belknap County	463	460	4%	-3	-0.6%
Carroll County	581	1,125	9%	544	93.6%
Hillsborough County	235	496	4%	261	111.1%
Merrimack County	309	507	4%	198	64.1%
Rockingham County	4,060	4,254	35%	194	4.8%
Other New Hampshire	108	86	1%	-22	-20.4%
Maine	4,440	4,467	37%	27	0.6%
Massachusetts	455	511	4%	56	12.3%
Other Outside NH	130	219	2%	89	68.5%
Rockingham County					
Residents Working in County	67,438	78,659	61%	11,221	16.6%
Nonresidents Commuting In	33,539	49,402	39%	15,863	47.3%
Total	100,977	128,061	100%	27,084	26.8%
Commuting From:					
Belknap County	372	511	1%	139	37.4%
Carroll County	170	458	1%	288	169.4%
Hillsborough County	6,326	11,259	23%	4,933	78.0%
Merrimack County	1,254	2,496	5%	1,242	99.0%
Strafford County	11,343	15,537	31%	4,194	37.0%
Other New Hampshire	171	190	0%	19	11.1%
Maine	5,844	7,728	16%	1,884	32.2%
Massachusetts	7,575	10,500	21%	2,925	38.6%
Other Outside NH	484	723	1%	239	49.4%

Table 3.3-14 (continued)

Residents Commuting From: Carroll County	1990	2000	% Total	Change	% Change	Commuting to Jobs In: Carroll County	1990	2000	% Total	Change	% Change
Residents Working in County	13,446	15,816	76%	2,370	17.6%	Residents Working in County	13,446	15,816	82%	2,370	17.6%
Residents Commuting Out	3,153	4,969	24%	1,816	57.6%	Nonresidents Commuting In	2,661	3,508	18%	847	31.8%
Total	16,599	20,785	100%	4,186	25.2%	Total	16,107	19,324	100%	3,217	20.0%
Commuting To:						**Commuting From:**					
Belknap County	839	1,239	25%	400	47.7%	Belknap County	414	581	17%	167	40.3%
Coos County	188	172	3%	-16	-8.5%	Coos County	193	303	9%	110	57.0%
Merrimack County	201	240	5%	39	19.4%	Merrimack County	62	99	3%	37	59.7%
Rockingham County	170	458	9%	288	169.4%	Rockingham County	34	155	4%	121	355.9%
Strafford County	581	1,125	23%	544	93.6%	Strafford County	325	376	11%	51	15.7%
Other New Hampshire	226	349	7%	123	54.4%	Other New Hampshire	123	221	6%	98	79.7%
Maine	431	422	8%	-9	-2.1%	Maine	1,340	1,644	47%	304	22.7%
Massachusetts	404	636	13%	232	57.4%	Massachusetts	106	75	2%	-31	-29.2%
Other Outside NH	113	328	7%	215	190.3%	Other Outside NH	64	54	2%	-10	-15.6%

Source: US Census

3.4 Topography, Geology, and Soils

The study area lies geographically in what is referred to as the Seaboard Lowland section of the New England physiographic province, one of the subdivisions of the Appalachian Highlands (Fenneman 1938). Topography within the study area is gently rolling and most of the land lies between sea level and 60 feet above sea level. A small knoll rises to 100 feet in the southern one-third of the study area in Newington, near the Woodbury Avenue on-ramp to the Spaulding Turnpike. The highest point in the Dover portion of the study area lies at about 80 feet and is found at the northern project boundary.

The project lies within the Great Bay Drainage and Coastal Drainage watersheds, which make up the larger Salmon Falls – Piscataqua Rivers drainage basin. The northern one-third of the study area contains portions of Little Bay and the Bellamy River that are tributary to the Piscataqua River which drains to the Atlantic Ocean. Other perennial watercourses that flow into the Piscataqua River in the Newington portion of the study area include, from north to south: Pickering Brook, Railway Brook, and Flagstone Brook in the vicinity of Exit 4, Paul Brook south of Exit 3, and an unnamed stream near the southern extent of the study area.

Much of the present landscape character in the study area is the result of continental glaciation that occurred between 10,000 and 14,000 years ago during the Pleistocene Epoch. As the glacier moved from the northwest to southeast, it scoured and smoothed the underlying bedrock, picking up soil, rock, and other debris. These materials were later deposited as glacial drift when the ice sheet melted. As a result, geologic formations throughout the study area contain exposed bedrock, stratified and unstratified glacial drift, and marine deposits.

Bedrock geology underlying the study area consists of Devonian and Silurian metamorphic rock. The Devonian rock is made up of slate, phyllite, aluminous schist, local calc-silicate granofels, and bimodal metavolcanic rocks. The Silurian rock is aluminous schist, quartzite, calc-silicate granofels, and bimodal metavolcanic rocks.

Soils series, as described in the soil survey maps produced by the Natural Resource Conservation Service (NRCS) for Rockingham County and Strafford County, were each grouped into the categories based on predominant parent material or land-use.

Five major soil categories were identified in the study area (**Figure 3.4-1**). The major parent material or land use categories are:

- Marine/Lacustrine
- Till
- Glaciofluvial
- Anthropogenic
- Organic Material

Soils derived from marine deposits are the most common type identified within the Spaulding Turnpike study area. Marine/lacustrine soils are deep (20 to 50 inches), moderately well drained to very poorly drained fine sand and silt materials deposited in the isostatic depression of the earth's crust as ocean waters inundated upland areas following glaciation. Marine soils are spread uniformly throughout the study area and are interspersed with areas of coarse materials deposited from melt waters during the last glacial retreat. Marine soils comprise approximately 45 percent of the study area.

Till soils generally consist of an unstratified, heterogenous mixture of clay, silt, sand, gravel, and boulders, which were deposited directly by glacial ice with little or no transportation by water. In the study area, till consists of moderately deep (20 to 40 inches), well drained, very fine sandy loam subglacial stream deposits occurring in Newington in the southern portion of the study area. Glacial till soils cover approximately 22 percent of the study area.

Glaciofluvial soils consist of very deep, somewhat excessively drained, gravelly fine sandy loam soils formed in stratified glaciofluvial drift. Glaciofluvial soils are commonly associated with kame terraces, eskers, and deltas deposited from subglacial streams and meltwaters. Glaciofluvial soils occur in small deposits north of Nimble Hill Road, near the western study area boundary and west of the General Sullivan Bridge in Newington. Additionally, Dover Point soil is predominantly glaciofluvial in origin. Glaciofluvial soils cover approximately 13 percent of the study area.

Anthropogenic soil (urban or made land) includes any areas identified in the soil series maps that consist mainly of sandy or gravelly fill material that has been placed on terraces, floodplains, and uplands. The amount of fill that may have been placed varies from 20 inches to 20 feet. Similarly, urban or made land also includes any areas where 85 percent or more of the land area is covered with buildings, asphalt or concrete. Typically, these areas include business districts, industrial parks and shopping centers. Anthropogenic soils make up approximately 20 percent of the study area.

Organic soils are made of material that accumulates in wet places, where it is deposited more rapidly than it decomposes. These deposits are referred to as peat, which is made of varying vegetative materials to 50 inches deep, and can include layers of mineral materials. Within the study area, organic soils are limited to an area comprising less than one percent. The largest of these areas is found adjacent to Pomeroy Cove in Dover. These areas always form wetlands, which are further discussed in Section 3.6.

3.5 Farmlands

3.5.1 Regulatory Overview

The Farmland Protection Policy Act (FPPA) of 1984 [Section 1539-1549, Public Law 97-98, 95 Statute 1341-1344 (7 USC. 4201 et seq.)] provides guidelines to Federal agencies involved in projects that may convert existing or potential farmland areas to non-agricultural uses. The FPPA directs Federal agencies to *"…(a) identify and take into account the adverse effects of their programs on the preservation of farmland, (b) to consider alternative actions, as appropriate, that could lessen adverse effects, and (c) to ensure that their programs, to the extent practicable, are compatible with State and units of local government and private programs and policies to protect farmland…"* (7 CFR 658.1). FHWA's Technical Advisory T6640.8A (October 30, 1987) further directs that impacts on farmlands be assessed as part of the environmental assessment for all transportation projects.

3.5.2 Methodology

The Natural Resource Conservation Service (NRCS) Soil Survey of Strafford County (Vieira and Bond 1973) and Rockingham County (Kelsea and Gove 1994) were used to identify important farmland soils within the study area. The NRCS field offices in Dover and Brentwood provided current lists of Prime, Statewide, and Locally Important Farmland soils for the study area (Table 3.5-1). Based on these lists, the Complex Systems Research Center at the UNH provided an electronic file of digitized soil units within the study area. Since the FPPA excludes farmland soils that are in an urbanized area, the US Census Bureau digital mapping of the Dover-Rochester Urbanized Area (UA) was overlaid onto the farmland soils mapping. Farmland soils within the boundary of the UA were deleted from the subsequent analysis. The resulting data was then merged with the project base map to create the Important Farmland Soils map (**Figure 3.5-1**). A review of aerial photographs and field verification was also conducted to determine the presence of active farmlands within the study area.

3.5.3 Existing Conditions

The four categories of farmland in the Farmland Protection Policy Act (FPPA) of 1984 include Prime Farmland, Unique Farmland,

Table 3.5-1
Important Farmland Soils of Strafford and Rockingham Counties

Map Symbol	Map Unit		Acres
	Prime Farmland		
32A	Boxford Silt Loam, 0-3 percent Slopes		340
BzA	Buxton Silt Loam, 0-3 percent Slopes		3
BzB	Buxton Silt Loam, 3-8 percent Slopes		48
EaA	Elmwood Fine Sandy Loam, 0-3 percent Slopes		15
EaB	Elmwood Fine Sandy Loam, 3-8 percent Slopes		16
460B	Pennichuck Channery Very Fine Sandy Loam, 3-8 percent Slopes		214
WfB	Windsor Loamy Fine Sand, Clay Subsoil Variant, 0-8 percent Slopes		7
		Subtotal	**643**
	Statewide Importance		
32B	Boxford Silt Loam, 3-8 percent Slopes		162
460C	Pennichuck Channery Very Fine Sandy Loam, 8-15 percent Slopes		38
WfC	Windsor Loamy Fine Sand, Clay Subsoil variant, 8-15 percent Slopes		1
		Subtotal	**201**
	Local Importance		
DeA	Deerfield Loamy Sand, 0-3 percent Slopes		24
ScB	Scantic Silt Loam, 3-8 percent Slopes		28
33A	Scitico Silt Loam, 3-8 percent Slopes		90
538A	Squamscott Fine Sandy Loam, 0-5 percent Slopes		91
WdA	Windsor Loamy Sand, 0-3 percent Slopes		20
WdB	Windsor Loamy Sand, 3-8 percent Slopes		12
		Subtotal	**265**

Data: Derived from data from Complex Systems Research Center, University of New Hampshire, 2003.

Farmland of Statewide Importance, and Farmland of Local Importance. In addition, active Farmland or Agriculture Areas are discussed. Each farmland category is described below:

- **Prime Farmland** is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed corps. It has the soil quality, growing season, and moisture supply needed to economically produce a sustained high yield of crops when the land is treated and managed using acceptable farming methods. Prime Farmland produces the highest yields with minimal inputs of energy and economic resources and causes the least damage to the environment. Prime Farmland usually has an adequate and dependable supply of moisture from precipitation or irrigation. Prime Farmland also has a favorable temperature and growing season and acceptable acidity or alkalinity. Prime Farmland has few or no rocks and is permeable to water and air. Prime farmland is not excessively erodible or saturated with water for long periods and either does not flood frequently or is protected from flooding. The slope ranges mainly from 0 to 8 percent. Prime Farmland may now be in crops, pasture, or woodland, but not urban built-up land or water areas. It must either be used for producing food or fiber or be available for these uses. Prime Farmland soils occur throughout the study area, with larger concentrations found within the central portion east and west of the Spaulding Turnpike in Newington. Approximately 643 acres of NRCS mapped Prime Farmland soils occur within the study area.

- **Unique Farmland** is land other than prime farmland that is used for the production of specific high value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to economically produce sustained high quality and/or high yields of a specific crop when treated and managed according to acceptable farming methods. Examples of such crops in New Hampshire are apple orchards, lowbush blueberries, vegetable truck gardens, and maple sugar groves. Soils categorized as Unique Farmland by the NRCS no longer occur within the study area.

- **Farmland of Statewide Importance** is land, in addition to prime and unique farmlands, that is of statewide importance for the production of food, feed, fiber, forage, and oilseed crops. Generally, these farmlands include those areas that are nearly prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods. The largest concentrations of Farmland of Statewide Importance soils within the Spaulding Turnpike study area occur in Newington, east and west of Spaulding Turnpike. Approximately 201 acres of NRCS mapped Farmland of Statewide Importance soils occur within the study area.

- **Farmland of Local Importance** includes certain additional farmlands for the production of food, feed, fiber, forage, and oilseed crops. Farmland of Local Importance soils occur throughout the study area. Approximately 265 acres of NRCS mapped Farmland of Local Importance soils occur within the study area.

- **Active Farmland or Agriculture** consists of lands, which may or may not have been previously categorized, but are currently in active agricultural use. These lands were identified by windshield survey, and include only those lands directly in, or adjacent to, the study area. Included under active agricultural uses are apple orchards, truck gardens, open fields, and pasturelands. Approximately 200 acres of Active Farmland or Agriculture occurs within the study area. Active farmland production within the study area includes hay fields and blueberry stands. In Newington, one area that is currently used for hay production includes a 20-acre field of Prime Farmland soils and an 11-acre field mapped as Farmlands of Statewide Importance soils located south of Patterson Lane. Another area of Prime Farmland in Newington includes large hayfields located to the south and north of Nimble Hill Road. These actively farmed areas are approximately 80 acres and 65 acres, respectively, though the hayfield north of Nimble Hill Road extends outside of the project study area. Active farmland in Dover consists of a 34-acre field east of Dover Point Road, used primarily for haying. In addition, an acre of blueberry production occurs westerly adjacent to the hayfields.

Areas mapped by the NRCS as Prime Farmland, Farmlands of Statewide Importance, and Farmlands of Local Importance soils within the study area are primarily comprised of industrial, retail, and residential development, and forested upland and wetland habitats. Some areas designated by NRCS as farmland based on soil type include waterways and vegetated wetlands, and do not necessarily reflect those areas conducive to agricultural production.

3.6 Freshwater Wetland Resources

This section presents an overview of the regulatory framework governing the protection of wetlands and the methodologies used to identify, describe and assess wetlands. Existing wetlands and vernal pools found within the study area are described in detail.

3.6.1 Regulatory Overview

Federal protection of wetlands is regulated under Section 404 of the Clean Water Act and Section 10 of the Federal Rivers and Harbors Act. The USACOE is charged with the duty of overseeing and regulating activities in wetlands at the federal level. The USEPA also reviews projects that may impact wetlands and has review authority over discharges they find unacceptable.

The state of New Hampshire regulates activities in wetlands under RSA 482-A:1, which grants regulatory authority to the NHDES, Wetlands Bureau (NHWB). Under this statute, all proposals to dredge or fill wetlands must be permitted by the NHWB.

Communities in New Hampshire possess, at minimum, recommendation authority to the NHWB as to whether a permit to dredge or fill wetlands should be issued. The bulk of this recommendation responsibility is placed on the local conservation commissions. Individuals concerned with the protection of wetlands for certain projects, generally express their concerns through the local commissions. Communities also have the ability to enact their own ordinances to regulate activities in wetlands. Both Newington and Dover have provisions within their local ordinances which establish protection of wetlands. Newington recently executed local review of state-designated prime wetlands (pursuant to RSA 482-A) and submitted mapping and data to NHWB, which was approved in 2005. Dover has not opted to establish prime wetlands.

Under Executive Order 11990, federal actions (in which impacts to wetlands are unavoidable) require a "finding" that there are no practical alternatives to the proposed construction in wetlands and that the proposed action included all practical means to reduce harms to wetlands. Such a finding, and the analysis required to support the finding, will be presented in the Final EIS for this project.

3.6.2 Methodology

Identification of Wetland Resources

In New Hampshire, wetlands are identified using the federal definition[50] and are delineated using the USACOE's three parameter approach that considers plants, soils and hydrology in the interpretation of the wetland/upland boundary (1987 USACOE's *Wetland Delineation Manual*).

Wetland resources within the study area were identified through a combination of aerial photo interpretation and field verification. The first phase of wetland identification involved aerial photographic interpretation. The study site was flown in the summer of 2002 to produce 1:200 scale full color aerial photographs. National Wetland Inventory (NWI) wetland layers obtained from New Hampshire's GRANIT Geographic Information System (GIS) were first plotted onto the aerial photographs. A thorough interpretation of the aerial photographs was then conducted to verify the limits of NWI mapping and to identify additional wetland resources previously unmapped that occur within the study area.

During the second phase of wetland identification, environmental scientists conducted extensive field investigations during the months of June, July, and August of 2003. Limits of all wetland resources identified during the Phase I photo interpretation effort were verified for accuracy and photo-mapping was adjusted in the field as appropriate. The limits of any additional wetlands identified in the field were then added to the aerial photo-mapping.

▼

50 Wetlands are "those areas that are inundated or saturated by surface or groundwater (hydrology) at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation (hydrophytes) typically adapted for life in saturated soil conditions (hydric soils). Wetlands generally include swamps, marshes, bogs, and similar areas" [40 CFR 232.2(r)].

The wetland classification type for each wetland identified was field-verified based on *Classification of Wetlands and Deep Water Habitats of the US* (Cowardin *et al.*, 1979). A legend for this system describing each "code" is depicted in **Figure 3.6-1**.

The (Cowardin, *et al*. 1979) classification system uses a hierarchy broken into systems, subsystems, classes, and subclasses to categorize wetlands and deepwater habitats. Systems (marine, estuarine, riverine, lacustrine and palustrine) refer to the type of hydrologic setting in which the wetlands are found (or in relation to) *i.e.*, oceans, estuaries, rivers, lakes and other vegetated non-tidal wetlands. Palustrine, riverine and estuarine systems have been mapped along the Spaulding Turnpike study area. More specifically, the following wetland cover type classifications were identified in the study area: palustrine forested (PFO), palustrine emergent (PEM), palustrine scrub/shrub (PSS), palustrine open water (POW) systems, riverine lower perennial unconsolidated bottom (R2UB), riverine upper perennial unconsolidated bottom (R3UB), riverine intermittent streambed (R4SB), and estuarine, intertidal, emergent (E2EM). Estuarine wetland types are described in Section 3.10.

Palustrine systems include all freshwater, non-tidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens and other wetlands in tidal areas with low salinity. Areas mapped as PFO cover type are forested wetlands containing vegetation that is 20 feet tall or taller in the overstory, and contain an understory of younger trees or shrubs, and an herbaceous layer. The PEM cover type refers to areas dominated by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. The vegetation is present for most of the growing season in most years. Wetlands mapped as PSS include areas dominated by woody vegetation less than 20 feet tall. The species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions. Scrub-shrub wetlands may represent a successional stage leading to forested wetland, or they may be relatively stable communities. POW refers to wetlands that contain small ponds or areas of ponded water that are too deep to support emergent plants. They may be surrounded by other palustrine cover types or may be small depressional areas with steep banks surrounded by upland. In most cases, palustrine forested, shrub and emergent wetlands identified and assessed within the Spaulding Turnpike corridor in Newington are associated with named and unnamed streams or highway drainage. In Dover, most of the palustrine wetlands are isolated or are associated with highway drainage areas.

Riverine systems include wetlands and deepwater habitats contained within a channel, with two exceptions: wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and habitats with water containing ocean-derived salts in excess of 0.5 parts per thousand. Upland islands or palustrine wetlands may occur in the channel, but they are not included in the riverine system. R2UB riverine wetlands consist of slower-moving watercourses found lower in the watershed having stream bottoms consisting of some or all of the following materials: cobble-gravel, sand, mud and organics. Areas designated as R3UB are swifter moving systems located further upstream in the watershed with similar substrate materials. The R4SB designation refers to streams that flow intermittently and have a variety of stream bottom materials, *e.g.,* bedrock, rubble, cobble-gravel, sand, mud, organic, and vegetated. Aside from Railway Brook, riverine systems within the Spaulding Turnpike study area for the most part are bordered by palustrine wetland systems.

E2EM wetlands are tidally-influenced vegetated wetlands commonly associated with a freshwater river channel and flooded twice daily by ocean tides. The upstream limit is where ocean-derived salinity measures less than 0.5 parts per thousand (ppt) during average annual low flow. These resource areas are described in detail in Section 3.10.

Functional assessments were performed using *The Highway Methodology Workbook Supplement* (USACOE, 1995). Additionally, the *Method for the Comparative Evaluation of Nontidal Wetlands in New Hampshire* (Amman and Lindley-Stone, 1991) was used concurrently to supplement understanding of the wetlands within the study corridor by generating a comparative ranking of evaluated wetlands on various functional values. This information was used in the search for, and assessment of, suitable parcels of land to mitigate for lost functions and values from project-related impacts. During the course of the wetland functional assessments, it was noted that some of the wetland areas previously mapped during 2003 had already been impacted by development or otherwise needed revision of mapping prepared to date. Therefore, additional refinement of the wetland boundaries was made at this time. An overview of the resulting wetlands mapping is depicted in **Figure 3.6-2,** while detailed mapping is depicted in **Figure 3.6-3.**

3.6.3 Existing Conditions

Description of Wetland Resources

In general, wetland resources within the study area are habitats fragmented by roadways, railways, and constricted hydrologic flows. Historically, these wetlands have been impacted by extensive residential, commercial, and industrial and military development that characterizes much of the study area.

NWI maps use Cowardin *et al*. (1979) to classify wetlands by “systems” according to plants, soils, and frequency of flooding. The systems are then further subdivided into subsystems, classes, and subclasses based on substrate material, flooding regime, and vegetation type.

For the purposes of this EIS, the wetlands, water bodies, and waterways in the study area have been categorized based on the information contained on NWI and US Geological Survey (USGS) maps, and field verification of these mapped resources. The types or categories of wetlands that occur within the study area include forested wetlands, shrub wetlands, emergent wetlands, water bodies (ponds), and waterways (rivers and streams). These general categories include wetlands throughout the study area in Newington and Dover. Additionally, as presented in Section 3.6.3.2, wetlands (designated by codes) were investigated more closely, and additional descriptions are provided for these areas. Wetlands are shown on **Figure 3.6-3** with corresponding alpha-numeric codes and functional assessment information.

3.6.3.1 Wetland Systems

Study area wetlands are described below by general category (forested, shrub, emergent, and riverine) for the whole study area, and in more detail for those locations that would be potentially impacted by one or more of the proposed Build Alternatives. Detailed descriptions are included for each of these wetlands. In Newington, wetlands are coded as N-1 through N-23, and in Dover, wetlands are designated as D-1 through D-12. Specific impacts to wetlands, and their corresponding functions and values from the various alternatives carried forward are described in detail in Chapter 4.

Forested Wetlands

Freshwater wetlands with at least 30 percent tree areal coverage are classified as PFO. Field verified forested wetlands within the study area consist of deciduous forested swamps, coniferous forested swamps, and mixed deciduous/coniferous forested swamps.

Deciduous forested swamps in the study area are generally seasonally saturated and occur in isolated depressions or along rivers and streams. Dominant vegetation in the deciduous forested swamps consists of red maple *(Acer rubrum)* and white ash *(Fraxinus Americana)* overstory; common winterberry *(Ilex verticillata)*, highbush blueberry *(Vaccinium corymbosum)*, and glossy buckthorn *(Rhamnus frangula)* shrub layer; and cinnamon fern *(Osmunda cinnamomea)*, jewelweed *(Impatiens capensis),* sensitive fern *(Osmunda sensibilis)*, royal fern *(Osmunda regalis),* poison ivy *(Toxicodendron radicans)*, skunk cabbage *(Symplocarpus foetidus)*, and sphagnum moss (*Sphagnum* sp.) providing herbaceous ground cover. Deciduous forested swamps within the study area occur in both Dover and Newington.

Coniferous forested swamps occur in seasonally flooded acidic mineral soils in isolated depressions or along watercourses within the study area. Dominant vegetation in the coniferous forested swamps consists of eastern hemlock *(Tsuga canadensis)* and eastern white pine (*Pinus strobus*) in the overstory; glossy buckthorn and highbush blueberry *(Vaccinium corymbosum)* in the shrub layer; and sphagnum moss, cinnamon fern, poison ivy, and goldthread *(Coptis groenlandica)* as herbaceous ground cover.

Mixed deciduous/coniferous forested swamps occur in seasonally flooded pit-and-mound topography, consisting of saturated loamy/sandy/gravelly soils in isolated depressions, disturbed areas, or along watercourses within the study area. Dominant vegetation in the mixed deciduous/coniferous forested swamps consists of red maple, white pine, eastern hemlock, American elm *(Ulmus Americana)*, white ash *(Fraxinus Americana)*, and yellow birch *(Betula alleghaniensis)* in the tree canopy; glossy buckthorn, northern arrow-wood *(Viburnum recognitum)*, highbush blueberry, and nannyberry *(Viburnum lentago)* in the shrub layer; and cinnamon fern, sensitive fern, skunk cabbage, goldthread, poison ivy, and sphagnum moss in the herbaceous layer.

Newington

The majority of forested swamps in Newington are found west of the Spaulding Turnpike as the area is generally less developed. Relatively expansive forested wetlands are located between Exit 1 and Exit 3, near and within the Pease International Tradeport, and west of Trickys Cove. Smaller remnant forested wetlands also occur east of the highway, in the midst of commercial development off of Gosling Road, Woodbury Avenue, and Shattuck Way. A good example of a mixed deciduous/coniferous forested swamp within the study area occurs in Newington near Exit 1, north of Pease Boulevard. Smaller pockets occur within other larger deciduous swamps in the study area.

Dover

In Dover, larger palustrine forested wetlands occur within the Exit 6 Interchange and to the east of Dover Point Road amongst residential areas. Another large forested system occurs west of the Spaulding Turnpike near Bayview Park north of Spur Road. Portions of this system are dominated by coniferous species.

Shrub Wetlands

Freshwater wetlands with less than 30 percent tree areal coverage and greater than 30 percent shrub aerial coverage are classified as PSS. Shrub wetlands also include wetlands where trees and shrubs, individually, cover less than 30 percent of an area, but in combination provide 30 percent or more areal coverage.

Shrub wetlands within the study area generally occur as seasonally flooded, densely vegetated, fringing habitats bordering forested and emergent wetlands and along the edges of water bodies and waterways. Field verification confirmed that shrub wetlands consist of northern arrow-wood, highbush blueberry, glossy buckthorn, silky dogwood *(Cornus amomum)*, speckled alder *(Alnus rugosa)*, honeysuckle (*Lonicera* spp.), and multiflora rose *(Rosa multiflora)*, with skunk cabbage, sensitive fern, cinnamon fern, and poison ivy in the herbaceous layer.

Newington

Most noteworthy are the extensive scrub-shrub thickets associated with the channelized Railway Brook, including Pickering Brook and Flagstone Brook, extending from the Pease International Tradeport northerly and eventually discharging into Trickys Cove in Newington. Recent maintenance of the channel has removed nearly all of the scrub-shrub community adjacent to Railway Brook, except at the northern end of this area where a remnant remains. The scrub-shrub wetland east of Shattuck Way and south of Sprague Energy has been altered by vegetation clearing activities resulting in patchy areas of glossy buckthorn *(Rhamnus frangula)*, red maple *(Acer rubrum)*, gray birch *(Betula populifolia)*, and speckled alder shrubs; rutted areas with purple loosestrife *(Lythrum salicaria)*, common reed *(Phragmites australis)*, cattail *(Typha* spp.*)*, and sedges *(Carex* spp.*)*; and small upland inclusions vegetated with autumn olive (*Elaeagnus* spp.), bittersweet *(Celastrus* spp.*)*, and gray birch. Other scrub-shrub swamps are located along utility easements located west of the highway between Exits 2 and 4. Additional smaller areas of scrub-shrub swamp collect highway drainage along the right-of-way or are marginal between forested wetlands and areas of emergent wetland.

Dover

Other than along some of the highway drainage features, few substantial areas of scrub-shrub wetlands occur within the Dover portion of the study area.

Emergent Wetlands

Wetlands in the study area identified as PEM and E2EM are grouped into the emergent wetland category. PEM wetlands are freshwater wetlands (marshes and wet meadows) with a tree and shrub coverage less than 30 percent of the area, but where the total cover of emergent vegetation in the wetland is 30 percent or greater. Freshwater marshes are seasonally flooded wetlands commonly saturated at or near the surface when not flooded, and are dominated by grasses or grass-like plants. Freshwater wet meadows are seldom-flooded wetlands that are saturated throughout the growing season, and are dominated by herbaceous vegetation. E2EM wetlands are tidally-influenced vegetated wetlands commonly associated with a freshwater river channel and flooded twice daily by ocean tides. The upstream limit is where ocean-derived salinity measures less than 0.5 parts per thousand during average annual low flow.

In the study area, freshwater emergent marshes are dominated by broad-leaf and narrow leaf cattail (*Typha latifolia* and *T. angustifolia*), wool grass *(Scirpus cyperinus)*, spike rush *(Eleocharis* spp.), shallow and pointed broom sedges *(Carex lurida* and *C. scoparia)*, soft rush *(Juncus effusus)*, three-square sedge *(Scirpus Americanus),* reed-canary grass *(Phalaris arundinacea)*, sphagnum moss, and two exotic invasive species, common reed *(Phragmites australis)* and purple loosestrife *(Lythrum salicaria)*. American elderberry *(Sambucus canadensis)*, swamp milkweed *(Asclepias incarnata)*, and Joe-pye-weed *(Eupatorium* sp.) are found in lesser quantities in some emergent marsh areas.

Emergent wet meadow wetlands are dominated by sensitive fern, fringed sedge *(Carex crinita)*, soft rush, wool grass, blue vervain (*Verbena* sp.), fox sedge *(Carex vulpinoidea),* rough-stemmed goldenrod *(Solidago rugosa)*, redtop grass *(Agrostis solonifera)*, reed canary grass, purple loosestrife, and sphagnum moss.

Estuarine emergent wetlands within the study area consist of fringing salt marsh habitats, some with hydrologic constrictions resulting from roadway and railway fragmentation and under-sized culverts. Estuarine wetlands are typically dominated by salt marsh hay *(Spartina patens)*, smooth cord grass *(Spartina alterniflora)*, sea blite *(Sueda maritima)*, glasswort *(Salicornia europea)*, orach *(Atriplex patula)*, and switch grass *(Panicum virgatum)*.

Newington

Examples of freshwater emergent marsh wetlands located in Newington include those found in numerous roadside drainage areas immediately adjacent to both sides of the Spaulding Turnpike. Larger areas of marsh wetland are also found associated with the circumneutral swamp (forested deciduous swamp)[51] located west of Exit 1, north of Pease Boulevard.

Perhaps the best examples of wet meadow wetlands can be found associated with areas of shrub wetland along the utility easements, and on the former drive-in theatre property west of the highway between Exit 2 and Exit 4.

51 A circumneutral swamp is a variant of a red maple swamp. A key feature is its minerotrophic hydrology, *i.e.*, it receives groundwater from base-rich subsurface strata. It is rare and poorly documented in NH, but occurs elsewhere in southern New England.

Other locations of wet meadow wetlands include areas near Paul Brook to the east of Woodbury Avenue.

Examples of estuarine tidally-influenced wetlands in Newington include those found along portions of the Piscataqua River, especially near the former outlet of Pickering Brook where tidal gates are located on industrial property. (Pickering Brook's flow is now being diverted northward to Trickys Cove *via* Railway Brook and Flagstone Brook where a small area of E2EM wetland is located.) The lower reaches of Paul Brook also contain tidally influenced marshes, as does the terminal section of Unnamed Tributary 2.

Dover

In Dover, freshwater emergent marshes are much smaller in size than in Newington, but are located in similar landscape positions adjacent to the highway. It is likely that many of these areas were created for handling stormwater runoff and highway drainage when the Turnpike was first constructed. Likewise, wet meadows are located in the vicinity of the Exit 6 Interchange.

Estuarine tidally-influenced wetlands include the area around Pomeroy Cove (discussed in Section 3.10), Hilton Park, and near the Scammell Bridge near the northwestern perimeter of the project study area.

Riverine Wetlands

Riverine wetlands include those wetlands identified as Riverine wetlands on the NWI maps and as waterways on the USGS maps. Riverine wetlands are all wetlands and deepwater habitats contained within a channel, except for those wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. The Cowardin classification system further divides Riverine systems into five sub-systems: Tidal, Lower Perennial, Upper Perennial, Intermittent, and Unknown Perennial. Pickering Brook is classified as Riverine, Lower Perennial, Unconsolidated Bottom (R2UB), and the Unnamed Tributary 2 (located near Shattuck Way) is classified as Riverine, Intermittent, Streambed (R4SB). The remaining four streams that occur within the study area are classified as Riverine, Upper Perennial, Unconsolidated Bottom (R3UB). Table 3.6-1 presents the six study area streams and classification. All major rivers and streams in the study area have associated Riverine wetlands (Section 3.9.3.2 and **Figures 3.6-2 and 3.6-3**). Note that these stream systems are described in detail in Section 3.9.

Table 3.6-1
Study Area Waterway Classifications

Waterway	Cowardin Classification
Pickering Brook	R2UB3Hb
Flagstone Brook	R3UB1/2Hh
Railway Brook	R2UB2/1Hbhx and R3UB3H
Paul Brook	R3UB1/2H
Unnamed Tributary 1 (Gosling Road)	R3UB1/2H and R2UB3/2H
Unnamed Tributary 2 (Shattuck Way)	R4SB3/4J

Notes: 3Hb = Mud bottom, permanently flooded, beaver influenced
1/2 Hh = Cobble-gravel and sand bottom, permanently flooded, diked/impounded
2/1 Hbhx = Sand and cobble gravel, permanently flooded, beaver influenced, diked/impounded, excavated
3/2 H = Mud and sand bottom, permanently flooded
3/4 J = Mud and organic bottom, intermittently flooded

3.6.3.2 Individual Wetland Descriptions

Following are descriptions of wetlands that are potentially subject to impacts or lie adjacent to areas impacted by proposed highway improvements. In Newington, wetlands are numbered N-1 through N-23. These wetlands are primarily associated with Pickering Brook, Railway Brook and Flagstone Brook, their tributaries, and Unnamed Tributary 2. A few of the wetlands are isolated. In Dover, wetlands D-1 through D-12 are forested or affiliated with highway drainage. No perennial streams (or associated wetlands) are located in the Dover portion of the study area. Information on each of the wetland systems, including their size, is presented in **Figure 3.6-4**.

Newington

Wetland N-1 consists of two PFO1E wetlands segmented by Arboretum Drive. The portion of the wetland to the west of Arboretum Drive is largely unaltered and drains to the eastern portion *via* a 36-inch culvert into a series of constructed stormwater (and likely flood control) basins. Numerous deer tracks and songbirds were observed in the forested wetland. Nearer the Spaulding Turnpike, the wetland consists of herbaceous emergent (PEM1E) wetland, with pockets of scrub-shrub (PSS1E) wetland. Flow from Wetland N-1 continues beneath the Spaulding Turnpike where it likely joins with other wetlands adjacent to the Fox Run Mall that flow toward the unnamed perennial stream at the southern section of the study area. Principal functions of Wetland N-1 include floodflow alteration, sediment/toxicant retention, nutrient removal and wildlife habitat.

Wetland N-2 is a large, forested wetland (PFO1/4E) scrub-shrub (PSS1E) complex that is located to the east of Railway Brook and includes portions of the Granite State Gas Transmission, Inc. pipeline easement, powerline easement, as well as wetlands that drain a capped landfill on the Pease Development Authority property. Areas of interspersed forested wetland, emergent marsh and wooded uplands provide a variety of wildlife habitat. Portions of this wetland function as a large floodplain for the historic channel of Pickering Brook, most of which is now diverted to Railway Brook. A large active beaver dam has impounded flow from a large shrub swamp located to the south of Arboretum Drive and is segmented by a railway embankment. The dam has effectively expanded the wetland area in recent years, with many dead trees present. The remaining wetland area extends for approximately 2,500 feet mostly along the gas pipeline easement, eventually draining into Railway Brook. Numerous species of birds and mammals were observed throughout the wetland. Deer hunting perches were observed in several places. Although much of the wetland is disturbed and altered, it is situated in a locally remote and undeveloped landscape (compared to areas east of the Turnpike). The principal wetland functions are floodflow alteration, sediment/toxicant retention, nutrient removal, production export, wildlife habitat and uniqueness/heritage.

Wetland N-3a is a small isolated PEM/SS1C wetland located within the powerline easement to the east of Wetland N-2. Approximately 200 feet in length and 30 feet in width, the wetland has probably formed because of the tight compacted fill soils within the easement, which supports a mostly facultative plant community. The wetland provides minimal functions and values due to its small size and location in the landscape. The principal functions include sediment/toxicant retention, nutrient removal and wildlife habitat, with groundwater discharge also present.

Wetland N-3b consists largely of PEM1E wetland located to the west of the Spaulding Turnpike that drains highway runoff from the southbound lanes of the Turnpike for a distance of approximately 1,500 feet and widens, extending into the powerline easement, to a point just before the Exit 3 off-ramp to Woodbury Avenue. Wetland N-3b drains to the east to Wetland N-3c *via* two culverts. Wetland N-3b is vegetated similarly to other emergent wetlands previously described and provides principal functions of sediment/toxicant retention, nutrient uptake and groundwater recharge/discharge.

Wetland N-3c includes sizeable areas of cattail-dominated PEM1E wetlands located between the northbound and southbound lanes of the highway, south of the Exit 4 turnaround. Smaller areas of PFO1E and PSS1E are found marginal to emergent marsh areas. These wetlands primarily provide sediment/toxicant retention, nutrient removal, production export, floodflow alteration and wildlife habitat. As they receive direct drainage from the highway, these wetlands have in part formed because of this hydrologic regime. Drainage from Wetland N-3b flows eastward into Wetland N-3c and then outflows to Wetland N-20b *via* a series of culverts beneath the southbound and northbound lanes, respectively. Although these wetlands are located within the highway median, they provide habitat for deer. Direct evidence includes observed adult animals and scat and indirect evidence includes browsed shrubs and bed-down areas within Wetland N-3c and adjacent highway median grassy areas.

Wetland N-4a is a PFO1E wetland that is located between Arboretum Drive and Pickering Brook to the west of Railway Brook. Shallow forested drainages flow into deeper and narrower intermittent streams that drain to a PEM1E marsh impounded by a beaver dam adjacent to Railway Brook. The marsh drains into Railway Brook further to the north. Areas of scrub-shrub (PSS1E) wetland are interspersed with forested and emergent wetlands. Numerous birds and evidence of deer were observed throughout the wetland complex. In addition to wildlife habitat, principal functions provided by the wetland include floodflow alteration, sediment toxicant, nutrient removal and production export.

Wetland N-4b consists of the upper reaches of Pickering Brook (R2UB3Hb), associated emergent wetlands (PEM1E) and a deadwood swamp (PFO5H) that extends to Railway Brook. Some of the adjacent upland areas are also flooded from the beaver dam that is located to the rear of the Thermo Electron property on Nimble Hill Road. Dead or dying eastern white pine and oak are located at the periphery of the flooded area, which is now acting to control flooding in this portion of the study area. Water depths are three to four feet adjacent to the banks in some areas, indicating the area was an historic depression or has been scoured by floodwaters. A deep layer of organic and silt sediments is currently found behind the dam. In addition to its principal functions of sediment/toxicant retention, floodflow alteration and wildlife habitat, the location is used for recreation by local citizens. Several trails have been cut through adjacent forested upland, and a fire pit and benches have been constructed within a woodland clearing. In addition, the nearby Newington School population on Nimble Hill Road could use the area for educational purposes if access were afforded.

Wetland N-5 consists of the majority of Railway Brook (R2UB2/1Hbhx), and narrow adjacent scrub-shrub (PSS1E) wetlands and forested (PFO1E) wetlands. Approximately 3,000 feet in length and 15 to 20 feet in width, the straightened rip-rapped and impounded stream flows through uplands that have been recently cleared, cut and mowed for much of its length. Railway Brook is a drainage channel that is maintained by the Pease Development Authority. Numerous weirs and flood control structures are located at various intervals along the stream, with the intent to control stream velocity and discharge. Although much of the stream substrate consists of sand and pebbles between the flood-control structures, deep layers of silt and mud have accumulated behind the weirs. Because herbaceous and woody plants have been brush cut or cleared on the banks and in surrounding adjacent areas, shading has been lost contributing to thermal degradation of the water in the stream. The stream and riparian habitat have been severely altered, but are located amidst relatively large expanses of undeveloped land. In addition to the principal functions of floodflow alteration and sediment/shoreline stabilization, the stream and adjacent wetlands provide substantial wildlife habitat as evidenced by deer, raccoon, coyote, raptors, small mammals and numerous songbird species. Additional description of Railway Brook is contained in Section 3.9.

Wetland N-6 includes the lower 1,000-foot reach of Railway Brook (R3UB3H) extending from an active beaver dam located to the rear of the Thermo Electron property on Nimble Hill Road, to the Nimble Hill Road crossing. Extensive, densely vegetated scrub-shrub wetlands (PSS1E) extend on both sides of the 12-foot wide stream along its straightened and rip-rapped banks. As this area of the stream and associated wetlands are nearly flat, sediments, pollutants, and nutrients settle out and are utilized by the thick vegetation growing along the stabilized stream banks. The low-gradient, primarily mud and silt-bottomed stream principally provides floodflow alteration by storing and desynchronizing flows through the channel. Associated wetlands provide sediment/shoreline stabilization as a principal function.

Wetland N-7 consists of a 1,200-foot section of Flagstone Brook (which is a continuation of Railway Brook and is located north of Nimble Hill Road), and its associated PFO1E wetlands. The medium gradient stream is characterized by a cobble and gravel substrate (R3UB1Hh), with sloughing banks that are being undercut in some areas as the highly entrenched down-cutting stream tries to establish equilibrium within its marine clay sediment banks. Active groundwater discharges occur along the banks, particularly along the last 500 feet before the stream discharges to Trickys Cove in an area of salt marsh (E2EM) and tidal mudflat (E2US3). Numerous tracks of deer and raccoon were observed along the flatter sloughed bank areas, and green frogs were observed through the entire length of the stream. Closer to Trickys Cove, several unidentified species of juvenile fish were observed in the tidally-influenced portions of the stream. Principal functions of this riverine system include floodflow alteration, fish and shellfish habitat, groundwater recharge/discharge and sediment/shoreline stabilization.

Wetland N-8 consists of an intermittent stream and an associated narrow area of emergent and forested wetland, part of which is located on a parcel of conserved public land. The stream discharges to Trickys Cove, east of Flagstone Brook. Characterized as PEM1C, the freshwater emergent marsh meets a narrow area of salt marsh (E2EM1) and a much wider area of mudflat that characterizes much of Trickys Cove. An old cobble-lined well is located within the wetland indicating active contact with groundwater. Upgradient portions of the wetland have been recently altered by extension of Shattuck Way, which is being constructed as part of the Interim Improvement project. The only principal function of this small wetland is groundwater recharge/discharge.

Wetland N-8a is an area of remnant PFO1C that is located between the northbound and southbound lanes of the Turnpike, just south of the northbound off-ramp to Shattuck Way and south of the southbound on-ramp from Nimble Hill Road. A review of historic aerial photographs indicates that this shallow depressional wetland was hydrologically connected to Lower Pickering Brook prior to construction of the Spaulding Turnpike. In this regard, it may have functioned as a floodplain area. Connectivity to the stream, however, does not appear to exist present day. Small areas of PEM1E lie adjacent to the forested wetland and have formed as a result of direct highway drainage to these areas. Because this wetland has been effectively segmented from its primary source of hydrology due to the original construction of the Turnpike and diversion of stream flow from Pickering Brook to Railway Brook over the last several decades, this wetland area appears to be transitioning to upland as evidenced by a facultative dominant plant community. Principal functions and values include groundwater recharge/discharge, floodflow alteration, wildlife habitat and sediment/toxicant retention.

Wetland N-9a includes the portion of Pickering Brook (R2UB3Hb) and associated forested wetlands located between Railway Brook and the southbound lanes of the Spaulding Turnpike. A berm extends from the beaver dam (described in Wetland N-4) running parallel to Railway Brook essentially blocking the historic overland flow of Pickering Brook, which is largely diverted to Railway Brook. A thick organic and silt substrate characterizes much of the floodplain wetland and stream bottom. Fish were observed swimming in the stream to the rear of the Thermo Electron building. Base flow of Pickering Brook at the western edge of the wetland is provided by groundwater. The stream in this area is a low-gradient low flow watercourse split between several channels as it flows through the PFO1E wetland. Approximately 500 feet from its western edge, the flow is impounded within a shallow marsh that has a well-established aquatic bed plant community consisting of arrow arum (*Peltandra virginica*), bur-reed (*Sparganium* sp.), rattlesnake grass (*Glyceria canadensis*), and duckweed (*Lemna* sp.). Areas adjacent to the aquatic bed consist of shallow marsh with a plant community typical of other PEM1E wetlands. Closer to the Turnpike, Pickering Brook is confined to a single channel approximately 8 feet wide. Pickering Brook flows under the highway to the east in a 6-foot culvert. Principal functions provided by Wetland N-9a include groundwater recharge/discharge and floodflow alteration. Additional description of Pickering Brook can be found in Section 3.9.

Wetland N-9b includes the portion of Pickering Brook (R2UB3Hb) located between the northbound and southbound lanes of Spaulding Turnpike and wetlands that drain to the brook. Pickering Brook in this area is a low flow and low-gradient stream, with a very mucky and silt-laden substrate that flows through a forested wetland (PFO1E). The wetland is bisected by the old railroad bed, but is hydrologically connected *via* a culvert to the wooded wetland to the south of the rail line. Although the wetland is located within the median of the highway, it apparently provides wildlife habitat as deer were observed in the wetland, and a bedding area was observed in a grassy area along the western edge of the wetland near the southbound lanes. PEM1E wetlands collect highway drainage and direct it alongside the former Exit 4N median turnaround and drain toward the connected forested wetlands. Principal functions and values include floodflow alteration, sediment/toxicant retention, nutrient removal and wildlife habitat.

Wetland N-10 consists of an isolated toe-of-slope depressional area of PFO1C located approximately 1,300 feet south of the southbound Turnpike on-ramp from Nimble Hill Road. Wetland N-10 is located just south of Wetland N-9a and principally provides a limited amount of groundwater recharge/discharge, sediment/toxicant retention and wildlife habitat (numerous deer tracks were observed.)

Wetland N-11 is a toe-of-slope PFO/EM1E wetland located approximately 200 feet south of Wetland N-10. Principal functions in this small narrow wetland include sediment/toxicant removal and floodflow alteration and wildlife habitat. Wetland N-11 does not appear to be hydrologically linked to any other wetlands.

Wetland N-12 consists of a small isolated PEM1E wet meadow located within a depressional area at the former southbound Exit from the old drive-in property. Similar to other areas of emergent wetland in the study area, Wetland N-12 provides limited functions such as sediment/toxicant retention and nutrient removal.

Wetland N-13 is a wetland that is largely influenced by impervious surface stormwater discharge from Shattuck Way and Fox Run Mall on Woodbury Avenue. The system drains to and includes Paul Brook (R2UB1H) and its associated riparian wetland (see Section 3.9.3.2 for a detailed description of the brook). Wetland 13 is located to the south and east of the Allard Park property on Shattuck Way approximately 300 feet south of any proposed project impacts along Woodbury Avenue. A shallow drainage ditch (PEM1E) collects drainage and directs it southward along Shattuck Way to an area of forested wetland (PFO1E). Notable vegetation at the edge of the forested wetland includes a number of planted spruce (*Picea* sp.) trees with buttressed roots. This wetland receives additional stormwater and roof runoff from the Allard building *via* a 24-inch culvert. Further to the west an area of shrub wetland (PSS1E) and PEM1E collect drainage from 36-inch culvert that connects to a detention basin located at Fox Run Mall. Although small in size, a principal function of the wetland is habitat for a number of bird species, woodchuck and fox. Additional principal functions and values include sediment/toxicant retention, nutrient removal and floodflow alteration.

Wetland N-14 is located to the east of Shattuck Way, south of the Newington Energy facility. The wetland consists of an area of created or enhanced PEM1C wetland (evidenced by recently-planted shrubs) that drains eastward to a narrow forested (PFO1C) wetland to the east. A deeper basin is located in the western portion of the wetland and contains the planted vegetation. The basin wetland principally provides sediment/toxicant retention and nutrient uptake. Most of the planted shrubs appear to be very drought stressed or are dead, although a healthy herbaceous plant community is found on the periphery of the depression. No point sources of direct flow to the wetland were observed, although the wetland does appear to provide some storage and slow release thereby providing sediment/toxicant retention, nutrient removal and floodflow alteration.

Wetland N-15a is located on the Newington Energy property and consists of a recently-constructed basin (PEM1C) that is vegetated with common herbaceous plants, such as cattail and sedges. In addition to stormwater runoff from the Newington Energy property, this basin receives flow from Wetland N-15b. Hydric soils are beginning to form in some places within the basin, and the nascent plant community provides a principal function of sediment/toxicant retention.

Wetland N-15b is a small isolated forested wetland (PFO1E) on the west side of Shattuck Way located opposite Wetland N-15a. Although this wetland is drained by a culvert beneath Shattuck Way to Wetland N-15a, the culvert invert is set quite high in comparison with the wetland substrate. For this reason the wetland likely functions principally to recharge groundwater and provide flood storage.

Wetland N-16 is located in the vicinity of Patterson Lane to the east of Shattuck Way. This PEM1E wetland consists of a recently constructed cattail-dominated drainage basin and roadway ditches along Patterson Lane and Shattuck Way that drain northward *via* a culvert through the gas pipeline easement to the north of Patterson Lane and toward Wetland N-18 (which is associated with Unnamed Tributary 2). Principal functions and values of Wetland N-16 relate to sediment/toxicant retention, floodflow alteration and nutrient removal.

Wetland N-17 is a narrow forested wetland (PFO1C) located to the west of Shattuck Way and east of River Road. This narrow isolated wetland may have been more extensive and drained east toward Unnamed Tributary 2 before being bisected from it by Shattuck Way. Due to its limited size, Wetland N-17 functions in a minimal way by providing primarily groundwater recharge and wildlife habitat.

Wetland N-18 is located to the east of Shattuck Way and north of Patterson Lane. Consisting primarily of PFO1E wetland associated with an Unnamed Intermittent Tributary 2 (see Section 3.9.3.2 for a detailed description of this stream). Wetland N-18 begins at an area of PEM1E located near the discharge point of the culvert that drains Wetland N-16. As this area is at the base of a steep slope which drops about 15 feet in elevation, the western-most portion of this wetland also receives groundwater discharge at the base. Several shallow drainage channels flow eastward from this area then merge into a single channel within mostly well-defined banks. The intermittent stream has narrow (several feet) to wide (20 to 30 times bank width) depositional floodplain wetland areas in some locations. In other areas, the stream cuts deeply through upland forest, where heavy erosion, bank undercutting and fallen trees indicate a high energy area of the stream. Ample evidence of deer and raccoon were observed throughout the wetland and upland areas. An additional tributary stream joins the main channel from the south, approximately 400 feet west of an area of saltwater marsh (E2EM1) that is located to the west of the rail bed that runs parallel to the Piscataqua River. This area is a tidally-influenced marsh, which flushes incompletely due to an undersized 4-foot granite block culvert that is largely filled with sediment and debris. Adjacent successional wooded uplands near the stream bank are largely undisturbed, although a sizeable dump of discarded farm implements (rusted equipment, sap buckets and bottles) was observed near the northern bank of the stream approximately 800 feet from the saltwater marsh. In addition to groundwater recharge/discharge, fish and shellfish habitat, and floodflow alteration, Wetland N-18 (including the watercourse) also provides a good example for the study of active stream processes (*i.e.*, educational/scientific value). Other principal functions include sediment/toxicant retention, nutrient removal, and wildlife habitat. Other functions present are production export and shoreline stabilization.

Wetland N-19a and **Wetland N-19b** are two small PFO1C and PEM1E wetlands located to the east and west of Shattuck Way, respectively, and to the north of Wetland N-18. These isolated wetlands were likely bisected by the construction of Shattuck Way. Both areas provide a minimal amount of sediment/toxicant retention, nutrient removal and wildlife habitat functions.

Wetland N-19c consists of a series of PEM1E wetlands located along the east side of the Turnpike from Woodbury Avenue to River Road. These wetlands primarily receive and treat roadway drainage and provide principal functions such as sediment/toxicant retention, nutrient removal, and floodflow alteration.

Wetland N-20a and **Wetland N-20b** (PSS/EM1E) are located to the east and west of Shattuck Way, respectively, and east of the Spaulding Turnpike. A substantial portion of Wetland N-20a eventually drains into the Piscataqua River *via* Lower Pickering Brook although portions closest to the Piscataqua River drain directly. Wetland N-20b wraps around the parking lot of the Asia Restaurant, providing stormwater retention and treatment. Much of the wetland in front of the Asia Restaurant is vegetated with mature trees and saplings and is therefore designated as PFO1E. Runoff from the Sprague property also flows into these wetlands. A large salt and sand pile is present on the industrial facility property. Near the Turnpike, portions of the wetland have been brush cut. Both wetlands provide sediment/toxicant retention, floodflow alteration, and nutrient uptake as principal functions. Wetland N-20a also provides wildlife habitat.

Wetland N-21 is east of the Turnpike and lies adjacent to and includes the lower portion of Lower Pickering Brook (R2UB3Hb), which discharges into the Piscataqua River. Lower Pickering Brook begins on the east side of the beaver impounded confluence of Upper Pickering and Railway Brook and crosses under the Spaulding Turnpike to the east. Small beaver ponds are located along the channel in several places. The surrounding PEM1E wetland varies between 100 and 200 feet in width. Principal functions of Wetland N-21 include: floodflow alteration, sediment/toxicant retention and nutrient removal.

Wetland N-22 is located east of Shattuck Way and just north of Wetland N-21. It is composed of a series of marsh and shrub swamps, similar to Wetland N-20 and Wetland N-21, and also contains a small area of forested (PFO1E) wetland. Wetland N-22 mainly supports PEM1E vegetation, and provides the principal functions of floodflow alteration, sediment/toxicant retention and nutrient removal.

Wetland N-23 is a narrow PFO1C wetland which begins north of Shattuck Way in the northernmost part of Newington, east of the Little Bay Bridges. Within this wooded wetland is a small marshy area, which receives stormwater runoff *via* a culvert and swales off of Shattuck Way. Wetland N-23 functions minimally by providing groundwater recharge/discharge, flood storage and sediment/toxicant retention.

Dover

Wetland D-1 consists of a series of shallow highway drainage swales and ditches located to the east of the Spaulding Turnpike in the vicinity of the existing Exit 5 to Hilton Park. Portions of these wetlands are regularly mowed, with deep ruts occurring from maintenance equipment or vehicles that have traveled off paved surfaces. These emergent wetlands (PEM1E) are interconnected *via* culverts, and ultimately drain northward and discharge to Pomeroy Cove *via* a 36-inch culvert. A deep sump catch basin is located between the Turnpike northbound on-ramp from Hilton Park and Dover Point Road, providing sediment and pollutant retention before stormwater is discharged to the section of marsh that is upgradient of Pomeroy Cove. Most of the culverts are partially restricted by sand and sediments. Two small areas of forested wetland (PFO1E) are located to the east of the Exit ramp to the park and receive some overflow from the emergent wetlands and surface stormwater runoff from surrounding areas. Principal functions of this wetland include groundwater recharge/discharge, floodflow alteration, sediment/toxicant retention and nutrient removal.

Wetland D-1a is located along both sides of Hilton Drive's southeastern extent (east of the Spaulding Turnpike). The wetland drains to the southeast into Little Bay, just east of the Little Bay bridges. The wetland consists of roadway influenced vegetated swales that are regularly mowed. These emergent wetlands (PEM1A) receive runoff from Hilton Drive, Hilton Park, and the adjacent Spaulding Turnpike. The wetlands are primarily ditches, which do not detain any appreciable amount of runoff. Wetland D-1a's principal functions and values are sediment and toxicant retention.

Wetland D-2 consists of a forested (PFO1E), shrub (PSS1E), and persistent emergent (PEM1E) wetland complex north of Pomeroy Cove, to the east of the Exit 6 off-ramp to Dover Point Road. A portion of the Granite State Gas Transmission, Inc. pipeline extends through the western periphery of the wetland. In this location, emergent and shrub wetlands have formed on top of the pipeline easement and in a parallel drainage ditch which was likely constructed in previously forested wetland. Portions of the ditch contained up to 8 inches of water. The forested wetland continues along the ramp shoulder for several hundred feet north of Hilton Road, which dead-ends at the wetland. Highway drainage flows to the ditch from several stormwater drainage culverts along the ramp. Several old man-made ditches drain the wetland, running roughly perpendicular to the highway and connecting to the larger drainage ditch that parallels the highway. Other areas of the PFO wetland are wetter, having several inches of water and a pit and mound microtopography supporting a diverse shrub community including highbush blueberry, nannyberry, chokeberry (*Aronia* sp.), American elderberry, and withe-rod (*Viburnum cassinoides*). As evidenced by numerous tracks, browsing and scat, this portion of the wetland is frequented by white-tailed deer and raccoon. Principal functions of Wetland D-2 include groundwater recharge/discharge, floodflow alteration, sediment/toxicant retention, nutrient removal and wildlife habitat.

Wetland D-3 consists of a PEM1E marsh located in a stormwater detention basin at the junction of the Exit 6N off-ramp and Dover Point Road. This cattail-dominated basin receives stormwater runoff from the Turnpike *via* two culverts and discharges to a small area of wetland to the east of Dover Point Road *via* a 24-inch culvert. Primary functions of this wetland include floodflow alteration, sediment/toxicant retention and nutrient removal. The narrow receiving wetland is primarily forested and drains between residences eastward to the Piscataqua River.

Wetland D-4 is a narrow toe-of-slope PFO1E wetland with a PEM1E fringe located along the northbound lanes of the Turnpike, approximately 1,000 feet south of the Dover Toll Plaza. The wetland was previously disturbed by installation of the gas pipeline. An active ATV trail is located in adjacent wooded upland areas. Principal functions in the wetland include sediment/toxicant retention and nutrient removal. Additionally, the wetland provides limited wildlife habitat, evidenced by white-tailed deer and raccoon tracks.

Wetland D-5 is a small isolated wetland located in a shallow depression atop a small hill between the Exit 6W northbound off-ramp to US 4 and Dover Point Road. Classified as PFO1B, this wetland has a red maple, eastern white pine and quaking aspen overstory, with a dense tangle of northern arrow-wood, bittersweet, and poison ivy in the understory. Principal functions include groundwater recharge/discharge and wildlife habitat.

Wetland D-6 is a constructed detention basin located opposite Bayview Park between US 4 and Spur Road. Because this basin appears to have been constructed in a former wetland area, it is classified as a jurisdictional wetland. The PEM1E rip-rapped basin receives stormwater runoff from several culverts along both roads and drains *via* a 24-inch culvert to the Bellamy River near its confluence with Little Bay north of the Scammell Bridge. The stormwater treatment area provides comparable functions and values to other emergent marshes (*i.e.* sediment/toxicant retention and floodflow alteration) previously described, although it is largely vegetated with common reed (*Phragmites* sp,).

Wetland D-7 is a narrow isolated remnant PFO1B wetland located between the Dover Point Road connector to US 4 and Spur Road to the northeast of Wetland D-6. This wetland was likely connected to a larger mixed deciduous and coniferous wetland (Wetland D-7a) located to the north of Spur Road. A series of catch basins drains the roadside area adjacent to the wetland, with the likely effect of drying the forested wetland over time. Due to its limited size and the fact that it is drained by catch basins, the wetland provides minimal groundwater recharge and wildlife habitat.

Wetland D-7a is a large PFO1/4E wetland located to the north of Spur Road and comprising portions of Bayview Park. Shallow ditches are located in the wetland, which drain towards the Bellamy River. The edge of the wetland along Spur Road is mowed and brush cut with some frequency. Principal functions in this wetland include sediment/toxicant retention (largely limited to the southern edge), nutrient uptake, groundwater recharge, wildlife habitat, and recreation.

Wetland D-8 is a narrow strip of PFO1/4E wetland located south of the connector on-ramp from US 4 to the southbound lanes of the Turnpike. A four to six-foot wide constructed ditch holds stormwater from several culverts along the on-ramp within the red maple and eastern hemlock dominated wetland. The forested wetland functions principally in the aspects of groundwater recharge/discharge, floodflow alteration and wildlife habitat. North of the on-ramp within the median, a wooded upland area supports an active woodchuck (*Marmota monax*) population as evidenced by numerous burrow entrances.

Wetland D-9 consists of a forested and emergent wetland located to the south of Wetland D-8 along the on-ramp to the Turnpike from US 4. A shallow ditch is located at the highway toe-of-slope in a narrow strip of PFO1E, to the rear of residences along Boston Harbor Road and drains to a man-made stormwater infiltration basin, which supports an herbaceous (wet meadow) plant community. The PEM1E stormwater basin drains southward to an area of PFO1E wetland located south of a short connector road from Boston Harbor Road to the southbound lanes of the Spaulding Turnpike. This wetland then drains beneath the Turnpike to Pomeroy Cove. As with most of the other wetlands adjacent to the highway, Wetland D-9 functions principally to ameliorate the effects of stormwater runoff by providing sediment/toxicant retention, nutrient removal and floodflow alteration.

Wetland D-10 is a large NWI-mapped PFO1E wetland exhibiting a pit and mound microtopography. Wetland D-10 is located to the west of the Turnpike between the southbound on-ramp to the Turnpike at Exit 6, and the Dover Point Road overpass. A constructed berm separates the forested wetland from a shallow PEM1E drainage ditch that collects highway runoff. Wetland D-10 drains to the south, joining with the pipe from Wetland D-9 that drains to Pomeroy Cove. Wetland D-10 functions principally in the areas of sediment and toxicant retention, floodflow alteration, groundwater recharge/discharge, nutrient uptake and wildlife habitat.

Wetland D-11 consists of a several PEM1E drainage ditches located to the south of the Division of Motor Vehicles facility on Boston Harbor Road. Two ditches are oriented perpendicular to a larger ditch that runs parallel for about 600 feet along the southbound lanes of the Turnpike. The ditches are similar in characteristics and functions to the PEM1E portions of Wetland D-1 and provides sediment retention, nutrient removal and floodflow alteration. Wetland D-11 drains eastward beneath the Turnpike and drains into Pomeroy Cove.

Wetland D-12 consists of a toe-of-slope highway drainage ditch to the west of the Turnpike that runs for about 1,100 feet north of Hilton Park. Areas of forested (PFO1E) wetland drain properties to the east of Dover Point Road to drainage ditches. The ditches are similar in attributes and functions to the PEM1E portions of Wetlands D-1 and D-11 and provides the principal functions of sediment/toxicant retention, nutrient removal and floodflow alteration.

3.6.3.3 Wetland Functions and Values

Wetlands function as habitat for numerous aquatic plant and animal species, and are critical for the protection of many water resources. Wetlands help to filter and purify water by trapping soil particles along with the pollutants they carry before these pollutants enter watercourses. Wetlands have an ability to absorb nutrients, such as nitrogen and phosphorus, and later release these nutrients when they are less likely to degrade water quality. Wetlands act to regulate the release of stormwater by acting as temporary storage basins, which can lower flood crests and reduce the destructive potential of severe storms. Wetlands stabilize the shores along rivers and lakes, as well, and further buffer the destructive forces of storms by absorbing the impact of waves. These actions alone can protect vast areas of shoreline property. Some wetlands also augment groundwater supplies by passing surface water and direct precipitation through the wetland soil into the underlying aquifers. The realization that wetlands provide certain functions and values, from which the general public may benefit, has led to the passage of federal, state and local wetland laws and ordinances.

Study area wetlands provide a variety of habitats with unique functions and values. Coastal wetlands provide sediment and shoreline stabilization, floodflow alteration, and fish and shellfish habitat; scrub-shrub wetlands along watercourses provide nutrient uptake, production export, and sediment and shoreline stabilization; forested and scrub shrub floodplain wetlands provide nutrient, toxicant, and sediment retention, production export, and floodflow alteration; and emergent wetlands provide floodflow alteration, nutrient and sediment retention, and groundwater discharge/recharge functions. In addition, most wetland habitats within the study area provide wildlife habitat functions and values.

Using the Highway Methodology (USACOE, 1993; USACOE, 1995), functional assessments were performed at locations along the study area where any of the alternatives carried forward (Newington Alternatives 10A, 12A, 13 and Dover Alternatives 2 and 3) might impact wetlands. As previously described above in the individual wetland descriptions, most of the functions and values of the wetlands that were assessed relate to water quality, water quantity, hydraulic control, or wildlife. **Figure 3.6-4** provides a summary of the wetland functional assessments that were performed. The complete assessment, including field data sheets, species lists and photographs is contained in the separately-bound document, *USACOE Highway Methodology Wetland Functions and Values Assessment* (NHDOT, August 2006).

3.6.3.4 Vernal Pool Habitats

During the summer and fall of 2003, study area wetland inventories were conducted to determine the presence of vernal pools. Eight areas were identified during the field studies as potential vernal pool (PVP) habitat. PVP habitat was generally noted as small open water areas and depressions, and wetlands with evidence of seasonal flooding and/or areas of open water.

The NHF&GD defines a vernal pool as "a temporary body of water providing essential breeding habitat for certain amphibians and invertebrates and [that] does not support fish." In New Hampshire, it must specifically be demonstrated that:

- The pool occupies a confined depression without a permanently flowing outlet,
- The pool contains water for at least two months in the spring/summer,
- The pool dries up and does not contain fish,
- Indicator species are present, *i.e.* there is evidence of amphibian breeding or the presence of certain amphibians or invertebrates in a flooded pool.

Amphibian vernal pool indicator species (animal species which breed only in vernal pools) are specifically identified in New Hampshire by NHF&GD and include: spotted salamander (*Ambystoma maculatum*), blue-spotted salamander (*Ambystoma laterale*), Jefferson salamander (*Ambystoma jeffersonianum*), marbled salamander (*Ambystoma opacum*), and wood frog (*Rana sylvatica*). Collectively, the *Abystoma* spp. salamanders are known as mole salamanders because of their use of the tunnels of moles and other burrowing small animals during the non-breeding portions of their life cycles. Invertebrate indicator species including fairy shrimp (Order Anostraca), or the common fairy shrimp (*Eubranchipus vernalis*), are identified as the most observed species.

Vernal pools also provide habitat for a variety of other non-indicator species. amphibian and reptilian non-indicator species (animal species which utilize vernal pools but are not entirely dependent on them for survival) include:

four-toed salamander (*Hemidactylium scutatum*), eastern newt (*Notophthalmus viridescens*), spring peeper (*Pseudacris crucifer*), American toad (*Bufo Americanus*), grey treefrog (*Hyla versicolor*), green frog (*Rana clamitans*), spotted turtle (*Clemmys guttata*), and Blanding's turtle (*Emydoidea blandingii*). Non-indicator invertebrates include numerous species of crustaceans, mollusks, and insects.

Using the NHF&GD criteria, the areas previously identified as potential vernal pools in 2003 were investigated in the spring of 2004 for use by indicator and non-indicator amphibian and reptile species by using the following observation techniques:

- Making visual observations for amphibians by wading within the flooded pools,
- Investigating potential wetland and upland habitat locations by lifting fallen branches, stones, *etc.*,
- Assessing the invertebrate community by dragging a small net through the water column,
- Listening for and identifying audible mating calls,
- Assessing the pool's physical and biological characteristics, and
- Photographing representative biological and physical evidence.

The results of the spring 2004 survey reveal that only two areas previously identified as having PVPs, are confirmed as vernal pools. All potential and verified vernal pools are located in Newington (Table 3.6-2). The locations of the potential and confirmed vernal pools are indicated on **Figure 3.6-3**, and a description and discussion of each area follow.

Potential Vernal Pool 1 is located southeast of Fox Run Mall, adjacent to Woodbury Avenue. Classified as PEM1E, this man-made stormwater detention basin receives direct runoff from paved surfaces associated with the mall. The basin is surrounded by asphalt and mowed grass on all sides. Water quality in the basin is poor with very high turbidity. The basin provides no upland habitat for vernal pool species. Vegetation present includes primarily broad leaf cattail within the basin; and autumn olive (*Elaeagnus umbellate*), staghorn sumac (*Rhus hirta*), arrow-wood, and common buckthorn (*Rhamnus cathartica*) found at the periphery of the stormwater management area.

PVP 1 *does not* meet the NHF&GD vernal pool criteria because no indicator species or evidence of indicator species (*i.e.,* egg masses, calls) were observed. It is unlikely that the detention basin completely dries up; however, it is also unlikely that the detention basin supports fish either, because of its highly degraded water quality.

Table 3.6-2
Potential Vernal Pools in the Study Area

Potential Pool	Location	Description	Meets NHF&GD Criteria
PVP 1	Southeast of Fox Run Mall at Woodbury Avenue	Stormwater detention basin with open water	No
PVP 2	East of Fox Run Mall at Woodbury Avenue	Stormwater detention basin with open water	No
PVP 3	Industrial Area, Avery Drive	Depressional drainage swale	No
PVP 4	Newington Branch Rail Corridor	Complex of pools adjacent to railbed and within adjoining forested wetland	Yes
PVP 5	In Exit 4 area between northbound and southbound lanes	Excavated pit functioning as stormwater treatment area	No
PVP 6	East of Arboretum Drive and west of southbound lanes	Two-stage stormwater detention basin	No
PVP 7	East of Arboretum Drive and north of PVP 6	Forested wetland depressional areas	No
PVP 8	West of Arboretum Drive and PVP 7	Complex of pools with forested wetland with pronounced pit and mound	Yes

Potential Vernal Pool 2 consists of a stormwater detention basin (PEMIE) located to the east of Fox Run Mall, adjacent to Woodbury Avenue. Very similar in to PVP 1 in dimensions and characteristics, additional dominant vegetation in this basin includes multiflora rose (*Rosa multiflora*), black cherry (*Prunus serotina*), paper birch (*Betula papyrifera*), and red raspberry (*Rubus idaeus*) found along the edges of the created stormwater treatment pond.

PVP 2 *does not* meet the NHF&GD vernal pool criteria for the same reason as PVP 1.

Potential Vernal Pool 3 is a PEM1E drainage swale located amidst the industrial area adjacent to Avery Road. This cattail-dominated stormwater discharge area is adjacent to mowed grass and located on a low-gradient slope with no available forested upland habitat.

PVP 3 *does not* meet NHF&GD vernal pool criteria because no indicator species or evidence of indicator species were observed. PVP3 is more of a hillside drainage swale than a depression, and it is unlikely to support open water for at least two months in the spring/summer.

Vernal Pool 4 is a complex of individual (and in some locations connected) pools located approximately 1,600 feet north of Patterson Lane along the Pan Am Railways (Newington Branch) corridor. Classified as PUBFx per Cowardin, *et al.* (1979), two narrow pools extend alongside the railroad grade for a total distance of approximately 60 feet. The pools are contained within what appears to be excavated drainage ditches or old borrow areas. Two additional pools classified as PUB4E are 20 to 40 feet west of the railroad bed in a red maple swamp[52]. Other plant species present include speckled alder, black willow (*Salix nigra*), green ash (*Fraxinus pensylvanica*), gray birch, cinnamon fern, sweet fern (*Comptonia peregrine*), horsetail (*Equisetum* sp.), purple loosestrife, species of *Spiraea*, wool grass, arrow-wood, sensitive fern, jewelweed, marsh fern (*Thelypteris palustris*), poison ivy, and barberry (*Berberis* sp.).

All of the pools in the PVP 4 area meet NHF&GD vernal pool criteria. More specifically, they all occupy confined depressions without a permanently flowing outlet, each pool contained open water during our site visit, and the pools do not support fish and are likely to dry up. Wood frog (*Rana sylvatica*) tadpoles were present in all of the pools, and the pools located within the swamp were also noted as having adequate shrub stems, which could be used for egg attachment sites by mole salamanders. No salamanders or salamander egg masses were observed; however, an adult pickerel frog (*Rana palustris*) was observed at this site.

PVP 4 is outside of proposed highway improvements, but would be of concern if the railroad corridor is to be developed at a later time.

Potential Vernal Pool 5 is a small deep area of ponded water between the north and southbound lanes of the Turnpike approximately 500 feet northeast of the Exit 4N median ramp. Characterized as a small open water area with very high turbidity, it is likely an excavated basin (although no inlet/outlet pipes were observed) or a remnant borrow pit from Turnpike construction. PVP 5 is surrounded by honey locust (*Gleditsia triacanthos*), arrow-wood, poison ivy, and sweet vernal grass (*Anthoxanthum odoratum*). Much of the surrounding area is mowed regularly.

PVP 5 *does not* meet the NHF&GD vernal pool criteria because no indicator species or evidence of indicator species (*i.e.*, egg masses, calls) were observed. This is probably because of the pool's close proximity to the Turnpike, its highly degraded water quality, and the mowed upland areas surrounding the pool.

▼

52 See Figure 3.6-1 for a legend describing the (Cowardin *et al.* 1979) classification system.

Potential Vernal Pool 6 consists of a two-stage detention basin system, classified as PUB4xh, located between the Spaulding Turnpike and Arboretum Drive. An adult bullfrog (*Rana catesbeiana*), and green frog tadpoles were observed at this location. The detention basins are located in a red maple swamp with skunk cabbage (*Symplocarpus foetidus*), sensitive fern, poison ivy, spicebush (*Lindera benzoin*), marsh fern, royal fern, and multiflora rose.

PVP 6 *does not* meet the NHF&GD vernal pool criteria because no indicator species or evidence of indicator species (*i.e.*, egg masses, calls) was observed. The detention basin is also unlikely to completely dry up and has been observed to contain flowing water at various times during the year.

Potential Vernal Pool 7, classified as PEM1E, is located approximately 800 feet north of PVP 6, to the east of Arboretum Drive. Conditions and vegetation are very similar to PVP 6, with the addition of American elm (*Ulmus Americana*), cattail, and duckweed (*Lemna* sp.). One adult green frog was observed. Very turbid water conditions are present, likely the result of untreated stormwater flowing to the area.

PVP7 *does not* meet the NHF&GD vernal pool criteria for the same reasons as PVP6.

Vernal Pool 8 is located to the west of Arboretum Drive and PVP 7, more than 500 feet away and upgradient of the Spaulding Turnpike. Numerous wood frog tadpoles, an adult green frog, and a dead snapping turtle (*Chelydra serpentine*) were observed in this red maple pit and mound swamp. Classified as PUB4E, several vernal pool areas are present in pits dispersed throughout the swamp. The swamp is surrounded by a largely undisturbed eastern white pine (*Pinus strobus*) and red oak (*Quercus rubra*) dominated upland, which provides adequate habitat for the adult stages of vernal pool species and also provides shade for the pools. Additional vegetation present includes yellow birch, American elm, skunk cabbage, poison ivy, jewelweed, sensitive fern, highbush blueberry, arrow-wood, *Sphagnum* mosses, royal fern, winterberry holly, and spicebush. As with Vernal Pool 4, numerous shrub stems are present in many of the pooled-water pit areas, although evidence of mole salamanders was not observed.

PVP 8 meets all of the NHF&GD vernal pool criteria. More specifically, vernal pool habitat is located within confined depressions without permanently flowing outlets; and each pool contained open water to several inches in depth during our site visit. Hundreds of wood frog tadpoles were present in all of the observed pools.

3.7 Wildlife Resources

3.7.1 Regulatory Overview

The NHF&GD is responsible for managing and protecting resident wildlife species. NHF&GD has promulgated rules (FIS Chapter 1000) for the protection and management of these species. These rules pertain almost entirely to the exploitation of the species and not to the habitats. The rules set seasons, bag limits, and legal means for the taking of game, fish, and furbearing species.

The US Fish and Wildlife Service (USFWS) is responsible for managing and protecting migratory wildlife species. Except for threatened and endangered species and their associated "critical habitats," federal protection of wildlife on private property is confined to regulations regarding the exploitation of species and is not extended to wildlife habitat. Both wildlife species and wildlife habitats are generally protected on Federal lands, including National Wildlife Refuges, National Parks and Monuments, and National Forests, none of which are present in the study area.

3.7.2 Methodology and Existing Wildlife Resources and Habitat Use

The occurrence of wildlife species and habitat use in the study area are heavily influenced by the geographic location of the habitats and surrounding land uses. The study area is located in coastal New Hampshire with the large Great Bay estuary to the west and the Piscataqua River to the east. Extensive commercial and industrial land uses in the Newington part of the study area, and residential development, as well as the Turnpike itself, in the Dover Point area, have fragmented and isolated most of the natural habitats in the study area.

Relative to bird species, the position of the study area between the Great Bay Estuary and the Piscataqua River increases the seasonal variability in both species diversity and numbers. During the spring and fall migration periods, habitats in the area serve as resting or stopover areas for neotropical migrants as they move north or south. During the breeding season (spring and early summer), bird species' diversity and numbers are more directly related to the specific types of habitat present as well as their size and carrying capacity (*i.e.*, quality). Species diversity during the winter, although influenced by anthropomorphic factors like bird feeders, is uniquely affected by the climatic characteristics of the coastal location of the study area. Temperatures tend to be more moderate along the coast in the winter, and the presence of open water adjacent to the shore attracts a wide variety of overwintering waterfowl species and top predators, like the bald eagle (*Haliaeetus leucocephalus*).

Relative to mammalian species, the high density of commercial development in Newington and the peninsular nature of Dover Point limit movement of large, highly mobile mammalian species through the study area. In contrast, the presence of small and medium-sized mammalian species having smaller home ranges is predictable from the types and sizes of habitats present. Since much of the study area is highly developed or residential, many small and medium-sized mammalian species characteristic of these urban-like habitats are present.

The relative scarcity of freshwater habitats largely influences the relative abundance of amphibian species. Pickering Brook is a perennial stream draining a freshwater marsh and a brackish pond as it flows northeastward into the Piscataqua River in Newington. Vernal pools are scarce and limited to undisturbed wooded habitat patches. Except for their upland edge, the brackish tidal marshes (salt marshes) have no resident amphibian species and only an occasional reptile, such as the northern water snake or snapping turtle.

Typical habitats found in the study area are described below and shown on **Figure 3.7-1**. Lists of species, which could potentially utilize these habitats, were compiled from the NEWILD Computer Program (Thomasma *et al.* 1998). NEWILD is software developed by the US Department of Agriculture that can be used to determine which of the 338 vertebrate species in New England may be found in a particular type of habitat. See Appendix D for a listing of the habitats in the study area.

Upland Types

Natural upland habitats in the study area include three forested communities (hardwood dominated, softwood dominated, and mixed); shrublands; grasslands including pastures and hayfields; and orchards. Although residential yards and other suburban/urban areas provide some habitat value for wildlife, their value is typically low compared to natural, undisturbed areas.

Hardwood Forest

The mature hardwood forests in the study area are typically dominated by red oak and northern hardwoods (American beech, yellow birch, and sugar maple) often with a large component of softwoods (white pine, *Pinus strobus*, and hemlock, *Tsuga canadensis*). There are usually four layers of vegetation, but only the overstory is dense. Common shrub species include witch hazel (*Hamamelis virginiana*) , beaked hazelnut (*Corylus cornuta*), northern wild raisin (*Viburnum cassinoides*) and seedlings of red maple (*Acer* *rubrum*), American beech (*Fagus grandifolia*), white pine, hemlock, and red oak (*Quercus rubra*). The herbaceous layer is typically sparse consisting of Canada mayflower (*Maianthemum canadense*) and several species of ferns. A litter layer comprised of leaves and dead twigs covers the ground.

Young hardwood stands, as typically found in recently cutover areas, are dominated by pioneer species like gray birch (*Betula populifolia)*, quaking aspen (*Populus tremuloides*) and pin cherry (*Prunus pensylvanica*), as well as sprouts of red oak. With the reduced canopy layer (*i.e.*, shade) in these young stands, the herbaceous and shrub layer is usually dense.

In general, the greater the number of vegetation layers and the density of each (called structural diversity), the greater is the diversity of bird species. The mature hardwood stands have a moderate level of structural diversity while the young stands are slightly higher in diversity. The mature stands are characterized by bird species preferring a closed canopy (*e.g.*, sharp-shinned hawk (*Accipiter striatus)*, barred owl (S*trix varia)*, red-eyed vireo (*Vireo olivaceus)*, black and white warbler (*Mniotita varia)*, scarlet tanager (*Piranga olivacea*)), moderate size tree boles (*e.g.*, downy woodpecker (*Dendrocopus pubescens)*, brown creeper (*Certhia familiaris)*, white-breasted nuthatch (*Sitta carolinensis*)) or a forest floor with a thick litter layer including logs and scattered patches of herbaceous cover (*e.g.* redback salamander (*Plethodon cinereus)*, wood thrush (*Hylocichla mustelina)*, ovenbird (*Seiurus aurocapillus*)). Mammals include gray fox (*Urocyon cinereoargenteus*), gray squirrel (*Sciurus carolinensis)*, southern flying squirrel (*Glaucomys volans),* eastern chipmunk (T*amias striatus)*, and white-footed mouse (*Peromyscus leucopus)*. In comparison, the young stands are characterized by species more commonly associated with early successional stages like shrublands (*e.g.*, ruffed grouse (*Bonasa umbellus)*, American redstart (*Septophaga ruticilla)*, chestnut-sided warbler (*Dendroica pensylvanica)*, willow flycatcher (*Empidonax traillii)*, eastern cottontail (*Sylvilagus floridanus)*, white-footed mouse, short-tailed shrew (*Blarina brevicauda*)). White-tailed deer (*Odocoileus virginianus*) browse in both mature and young hardwood stands, primarily in those stands west of the Turnpike in Newington. Wild turkeys (*Meleagris gallopavo*) also utilize these hardwood stands as they are commonly observed on the Great Bay National Wildlife Refuge property, located just west of the study area.

Softwood Forest

Areas of softwood forest are dominated by either white pine or hemlock. Structural diversity is typically low to moderate. The dense shading results in an undeveloped shrub and herbaceous layer. The litter layer is characterized by needles and dead branches, leading to a highly acidic environment that also inhibits herbaceous growth.

Although softwood stands typically serve as deer wintering areas (because of the protection they afford from winds and low temperatures) in this study area, their proximity to human development and isolation from other undeveloped areas preclude them from serving this function. In the study area, other species typically associated with softwood forests include red squirrel (*Tamiasciurus hudsonicus*), porcupine (*Erethizon dorsatum*), black-capped chickadee (*Parus atricapillus*), veery (*Catharus fuscescens*), and blackburnian warbler (*Dendroica fusca*).

Mixed Forest

The most common forest stands in the study area are typically mixed forest and composed of species found in both hardwood and softwood types. Their small size, however, limits species diversity. Vegetative structural diversity varies from moderately low to moderately high. Structurally these mixed stands are similar to hardwood stands and contain many of the same wildlife species (veery, rose-breasted grosbeak (*Pheucticus ludvicianus)*, red-backed salamander, eastern chipmunk, and gray squirrel).

Shrubland

Shrubland in the study area includes primarily "old fields" reverting to young forest. Old fields are classified as shrubland when they contain a shrub layer of at least 30 percent coverage with the remainder dominated by dense grasses and forbs.

Bird species typically associated with shrublands include chestnut-sided warbler, common yellowthroat (*Geothlypis trichas)*, rufous-sided towhee *(Pipilo erythrophthalmus)*, prairie warbler (*Dendroica discolor)*, American goldfinch (*Spinus tristis)*, field sparrow (*Spizella pusilla)*, and song sparrow (*Melospiza melodia*). Common mammal species include white-footed mouse, short-tailed shrew, red fox (*Vulpes fulva*), and eastern cottontail.

Grassland/Agricultural Field

This habitat type includes both pastures and mowed fields, as well as the mowed right-of-way edge of the highway. There are several agricultural fields in the western portion of the study area in Newington. Structural diversity is characteristically low in this habitat with the mowing diminishing both the cover and wildlife food value. Nonetheless, the edge created between this and other habitats, particularly forested areas, is very valuable. Species typical of this habitat and its edge include red-tailed hawk (*Buteo jamaicensis*), eastern meadowlark (*Sturnella magna*), American robin (*Turdus migratorius*), American goldfinch, song sparrow, yellow warbler (*Dendroica petechia*), woodchuck (*Marmota monax*), meadow vole (*Microtus pennsylvanicus*), eastern cottontail, and red fox. White-tailed deer may also be observed feeding in the open fields during warm summer evenings.

Orchard

Orchards are a habitat type closely related to grasslands because of their evenly spaced trees and the mowed herbaceous layer. The one orchard in the study area is located west of the Turnpike in Newington. Species representative of this type are typically a mix of those found in grasslands and young forests (*e.g.*, American kestrel (*Falco sparverius)*, rose-breasted grosbeak (*Pheuticus ludovicianus)*, Baltimore oriole (*Icterus galbula)*, eastern kingbird (*Tyrannus tyrannus)*, woodchuck, meadow vole, short-tailed shrew, and red fox).

Wetland Types

Wetlands are a particularly important habitat for wildlife (see Section 3.6). All amphibians require freshwater or wet areas for breeding so their occurrence is dependent on wetlands. Vernal pools provide essential breeding habitat for mole salamanders (Genus *ambystoma*) as well as wood frogs (*Rana sylvatica*). Many reptile species also depend on wetlands.

Described below are the major wetland types found in the study area along with representative species of each.

Forested Wetlands (Forested Swamps)

Forested wetlands in the study area are typically dominated by red maples with varying amounts of hemlock, and white pine intermixed. The typical interspersion of water and trees creates high structural diversity that enhances this habitat's value for wildlife. Common species include a variety of amphibians (spring peeper (*Pseudacris crucifer),* gray treefrog (*Hyla versicolor)*, wood frog, bullfrog (*Rana catesbeiana)*, green frog (*Rana clamitans)*, mole salamanders) and reptiles (eastern ribbon snake (*Thamnophis sauritus)*, ringneck snake (*Diadophis punctatus)*, painted turtle (*Chrysemys picta)*, snapping turtle (*Chelydra serpentina*).

The avian community found in red maple swamps is typically composed of facultative species, those which are found in upland forests as well, *e.g.*, black-capped chicadee, gray catbird (*Dumetella carolinensis*), ovenbird (*Seiurus aurocapillus*), wood thrush (*Hylocichla mustelina*), American robin (*Turdus migratorius*) and blue jay (*Cyanocitta stelleri*); (Golet *et al*. 1993). Other bird species appear to be attracted to this habitat because of the presence of water, *e.g.*, wood duck (*Aix sponsa*), American black duck (*Anas rubripes*), and mallard (*Anas platyrhynchos*). Bird species perhaps most characteristic of forested wetlands of the northeast include northern waterthrush (*Seiurus noveboracensis*), Canada warbler (*Wilsonia pusilla*), and veery (Golet *et al*. 1993). among raptors, red-shouldered hawks are probably most characteristic of forested wetlands where they both nest and hunt. Characteristic mammalian species include beaver (*Castor canadensis*), raccoon

(*Procyon lotor*), mink (*Mustela vison*), woodland jumping mouse (*Napaeozapus insignis*), and white-footed mouse.

Scrub-Shrub Swamp

Scrub-shrub swamps in the study area are dominated by species such as highbush blueberry (*Vaccinium australe*) , willow (*Salix* spp.), alder (*Alnus* spp.), dogwood (*Cornus* spp.), and northern arrowwood, (*Vibernum dentatum*). Structural diversity is low because of the lack of multiple vegetation layers. Nonetheless there is typically dense shrub growth, along with dense herbaceous growth in spots. Seasonally this habitat (like forested wetlands) is frequently flooded by an adjacent stream or runoff from surrounding uplands.

Amphibians and reptiles commonly found in shrub swamps include spring peepers and wood frogs, while the presence of open water enhances the attraction for snapping turtles and painted turtles. Bird species commonly found in this habitat include American woodcock (*Philohela minor*), song sparrow, alder flycatcher (*Empidonax aluorum*), and tree swallow (*Iridoprocne bicolor*). Mammalian species include white-footed mouse, meadow jumping mouse (*Zapus hudsonius*), and raccoon.

Emergent Marsh

There are generally two types of emergent marshes in the study area: The first type are shallow marshes with water depths up to 1.5 feet characterized by persistent vegetation such as cattails (*Typha* spp.), various sedges, and two common invasive species, purple loosestrife (*Lythrum salicaria*) and phragmites (*Phragmites australis*). A second type of emergent wetland, the wet meadow or sedge meadow are in fact shallow marshes. These meadows will have up to 6 inches of water in winter or early spring, but with an exposed, saturated soil surface in summer (Thomasma *et al*. 1998).

Typical species found in marshes include mallard, sora rail (*Porzana carolina*), American bittern (*Botarus lentiginosus*), great blue heron (*Ardea herodias*), red-winged blackbird (*Agelaius phoeniceus*), muskrat (*Ondatra zibethica*), foraging white-tailed deer, and common snapping turtle. During the dry summer months, meadow vole, meadow jumping mouse and American kestrel will be observed in shallow freshwater marshes and sedge meadows.

Open Water (Ponds)

There are only two "ponds" in the study area, both on the Newington side. Both are associated with Pickering Brook. The smallest one is freshwater and is now essentially an emergent marsh. The larger one is tidally influenced with a tide-gate at its mouth with the Piscataqua River.

Wildlife use of these waterbodies is largely a reflection of the surrounding or bordering habitats and whether they are brackish. Shallow marsh or aquatic beds line the margins of these "ponds." Wildlife representative of freshwater ponds include bull frog (*Rana catesbeiana*), pickerel frog (*Rana palustris*), painted turtle, hooded merganser (*Lophodytes cucullatus*), common merganser (*Mergus merganser*), mallard, Canada goose (*Branta canadensis*), beaver, otter (*Lutra canadensis*), and mink.

Salt Marsh

Although the tidal marshes in the study area are very valuable habitat for birds and mammals, their brackish nature limits species diversity for amphibians and reptiles. There are no resident amphibian species and only an occasional water snake (*Nerodia sipedon*) or snapping turtle will be seen in them. In contrast, the salt marsh is ideal habitat for meadow voles, which adapt to the tidal cycle of inundation, and raccoons, which scavenge food at the water's edge. Norway rats (*Rattus norvegicus*), an urban species, are also a common resident in salt marshes because of their semi-aquatic nature and ability to adapt to fluctuations in water levels. The marsh is occupied by a wide variety of bird species with various sandpipers and plovers foraging the exposed shorelines at low tides (*e.g.*, greater (*Tringa melaleuca*), and lesser yellowlegs (*T. flavipes*); killdeer (*Charadrius vociferous*); and spotted (*Actitis macularia*), least (*Calidris minutilla*), and semipalmated (*Calidris pusilus*) sandpipers) and a variety of song birds occupying the marsh interior (*e.g.*, song and sharp-tailed sparrows (*Ammospiza caudacuta*), red-winged blackbird, and common yellowthroat). Barn swallows (*Hirundo rustica*) are also a common aerial feeder above the marshes, while herons and egrets (*e.g.*, black crowned night heron (*Nycticorax nycticorax*), and snowy egret (*Egretta thula*)) forage within the marsh and along tidal creeks. A variety of waterfowl, including mallards, mute swans (*Cygnus olor*), and Canada geese, will also nest in this habitat or at its edge.

3.7.3 Wildlife Refuges

There are no refuges in the study area. However, the Great Bay National Estuarine Research Reserve is located approximately three miles west of the study area. This 5,280-acre reserve is managed by the NHF&GD, under the guidance of the National Oceanographic and Atmospheric Administration (NOAA).

The Great Bay National Wildlife Refuge, managed by the USFWS, lies just beyond the study area in the Hoyt Hill area of Newington, west of the Pease International Tradeport on Great Bay. The refuge contains a mix of both upland and wetland habitats and is a little over 1,000 acres (J. Reynolds, USFWS, personal communication).

3.8 Threatened and Endangered Species

3.8.1 State Threatened and Endangered Species

3.8.1.1 State Regulatory Protection

In the state of New Hampshire, the Endangered Species Conservation Act (RSA 212-A) delegates authority and responsibility for the listing and protection of threatened and endangered species of wildlife to the NHF&GD. NHF&GD has in turn promulgated the rules for the protection of these species in Fish and Game Rules, Conservation of Endangered Species. These regulations restrict the transportation and killing or taking of listed species, but do not describe or protect the species' habitats. Species eligible for listing under these rules include invertebrate and vertebrate species of fish and wildlife (protection of plant species is described below). Protected animal species are placed in one of two categories, threatened or endangered, depending on their rarity.

NHF&GD manages threatened and endangered species cooperatively with the New Hampshire Natural Heritage Bureau (NHNHB). The NHNHB has compiled information on the distribution and abundance of these species from the literature, from files of area scientists, and from various field surveys, into computerized databases. These databases provide information on the present, past, or probable existence of such species for improved land use planning and environmental impact assessment.

The New Hampshire Native Plant Protection Act (RSA 217), enacted by the New Hampshire Legislature in 1987, established the authority for the state to develop a list of rare plant species. The NHNHB was empowered with this authority and developed the list in NH Administrative Rules Res 1100, *et seq*. Plants deemed as rare in the state and in need of protection were listed as endangered, threatened, or special concern plant species in descending order of rarity.

Unlike federally-listed species (see Section 3.8.2), plant or wildlife species need only be rare within the state of New Hampshire to be state-listed, not rare over the entire range of the species. Therefore, many state-listed species are rare because New Hampshire is at the edge of their range, or because there is a limited amount of habitat for the species within the state. Besides the prohibitions on the taking or killing of state-listed wildlife species, protection of state-listed plants or animals is largely restricted to recommendations by the aforementioned state agencies for the approval or disapproval of projects which might impact the environment. All projects initiated or funded by the state, or requiring such state permits as Wetlands Permits, or Site Specific Permits, are forwarded to NHF&GD and NHNHB, which have the opportunity to recommend approval or denial.

3.8.1.2 Study Area Occurrences

The NHNHB database contains specific or general location reports of six occurrences of state-listed (threatened or endangered) species or species of special concern within or near the study area as listed in Table 3.8-1. In addition, the NHNHB identified two exemplary natural communities that occur within the study area: a Southern New England Acidic Seepage Swamp that occurs west of the Spaulding Turnpike and south of Arboretum Drive in Newington; and a Southern New England Calcareous Seepage Swamp that occurs north of Pease Boulevard and west of the Spaulding Turnpike in Newington (see Appendix E). Information on the documented occurrences of listed-species in the study area is provided in Table 3.8-1 and **Figure 3.8-1.**

As many as four species of wildlife may occur in the study area, all of which are avian species and which are officially tracked by the state (state-listed or species of concern) per the Endangered Species Conservation Act (RSA 212-A).

Two of these species, the bald eagle and the common tern, are listed as endangered under state law. A third species, the grasshopper sparrow is listed as Threatened, while the fourth species (Henslow's sparrow) is listed as a species of special concern.

In addition to the exemplary natural communities listed above, the study area includes three known plant populations listed as endangered or threatened per the New Hampshire Native Plant Protection Act (1987 RSA 217) and its Administrative Rules (Res 1100). Both the prolific knotweed and the small spike rush are state-threatened, while the bulbous bitter-cress is listed as endangered in the State of New Hampshire.

As shown on **Figure 3.8-1**, the location of the prolific knotweed population is within an area that would potentially be impacted by all alternatives, *i.e.*, along the shore under the existing Little Bay Bridges. For this reason, field survey was initiated in hopes of clarifying the status of this population. In August 2004, botanists visited the area to survey all plants. No prolific knotweed was found during this inspection. This finding, when taken in consideration with the fact that the population was last observed in 1955, strongly indicates that the prolific knotweed has been extirpated from this location.

Table 3.8-1
Documented Occurrences of State-Listed Species[1]

Common Name	Scientific Name	State Rank	Status	Location	Last Observed
Animal Species					
Henslow's sparrow	*Ammodramus henslowii*	Extirpated	Special Concern	Newington, Fox Point Road	1983
Common tern[2]	*Sterna hirundo*	Not Ranked	Endangered	Newington, Hen Island	1995[3]
Grasshopper sparrow[2]	*Ammodramus savannarum*	Not Ranked	Threatened	Newington, Pease Runway/ Short Road	2002
Bald eagle[4]	*Haliaeetus leucocophalus*		Endangered		
Plant Species					
Bulbous bitter-cress	*Cardamine bulbosa*	Excellent Quality	Endangered	Newington, Paul Brook Swamp	1990
Prolific knotweed	*Polygonum prolificum*	Historical/Current Condition Unknown	Threatened	Dover, Hilton State Park	1955
Small spike-rush	*Eleocharis parvula*	Fair Quality	Threatened	Dover, off Bay View Road	1996

Notes:
1 Data from Cairns, Sara. New Hampshire Natural Heritage Bureau (NHNHB), Letter dated July 10, 2003 and Personal Communication, June 2, 2006.
2 The common tern and the grasshopper sparrow are found within the area, but are not recorded within the study area boundary.
3 The NHF&GD reports that the common tern is now annually present in the Lower Little Bay during their breeding season. The Hen Island site has supported about 12 breeding pairs as of 2004. (See Appendix A, letter from John I. Nelson, dated April 2, 2004). However, these new observations have apparently not been recorded in the NHNHB database.
4 The NHNHB did not identify the bald eagle as occurring in the study area, but it was identified by the USFWS, and so is included in this table.

3.8.2 Federal Threatened and Endangered Species

3.8.2.1 Federal Regulatory Protection

The Endangered Species Act of 1973 (ESA) (P.L. 93-205), as amended in 1973 and 1978, recognizes the need, and provides the means to protect rare plants, and invertebrate and vertebrate species of fish and wildlife, and provides for the protection and/or acquisition of critical habitats and the management of endangered species. Per the 1978 amendments to the ESA, separate (geographically or genetically isolated) but rare populations of fish and wildlife (but not plants or invertebrates) may be protected as well as entire species. Listed species are categorized as either endangered species, which are in danger of extinction throughout all or a substantial portion of its ranges, or threatened species, which are likely to become endangered throughout all or a substantial portion of its range.

Section 7 of the ESA dictates that all Federal agencies must consult the US Department of the Interior (USDOI) to ensure that actions taken under federal funding, federal assistance, or federal permits (*e.g.* Section 404 Wetland Fill Permits) do not jeopardize the existence of threatened or endangered species. Jurisdiction is given to the USDOI to recommend changes to the project to avoid such jeopardy (including impacts to the habitat as well as to the plants or animals themselves).

3.8.2.2 Study Area Occurrences

The USFWS has determined (letter dated July 23, 2003, Appendix E) that one federally-listed species, the bald eagle, uses the Great Bay estuary as wintering habitat (see Table 3.8-2). In addition to this species, the USFWS recommends that a suitable habitat evaluation be conducted within the study area for the New England cottontail (*Sylvilagus transitionalis*), a species currently under petition for endangered species evaluation. A habitat survey was therefore completed in May 2006, which determined that New England Cottontail distribution is limited to Dover. The habitat in the study area was determined to be of marginal quality.

Table 3.8-2
Federally-Listed Threatened and Endangered Wildlife Species that May Occur within the Study Area

Common Name	Scientific Name	Federal Status	State Status
Bald eagle	*Haliaeetus leucophalus*	Threatened	Endangered
New England cottontail	*Sylvilagus transitionalis*	Under Study	Not Listed

Source: Amaral, Michael, Endangered Species Specialist. USFWS, New England Field Office. Letter dated July 23, 2003 and Personal Communication, May 23, 2006; Cairns, Sara. New Hampshire Natural Heritage Bureau. Letter dated July 10, 2003 and Personal Communication, June 2, 2006.

3.9 Surface Water Resources

The following sections describe surface water resources located within the study area. The major water bodies include the Little Bay, the Great Bay Estuary, and the Piscataqua River. The Great Bay Estuary is a large tidal embayment that covers over 17 square miles and contains 144 miles of shoreline. The Piscataqua River is a major tidally-influenced river system that forms part of the border between Maine and New Hampshire and drains approximately 1,400 square miles of watershed. The Little Bay represents the lower part of the Great Bay and includes the narrow section between Dover and Newington where it joins the Piscataqua River. The tidal exchange between the Great Bay and Piscataqua River, involves enormous volumes of water and is known to have unusually strong tidal currents (see Section 3.10, Marine Environment). Portions of the Dover side of the study area drain to various tidal coves of the Little Bay and Piscataqua River, as well as the tidal portion of the Bellamy River at the northern most section of the study area. With regard to freshwater resources, the Newington portion of study area contains six streams (Pickering Brook, Paul Brook, Flagstone Brook, Railway Brook, and two unnamed tributaries draining to the Piscataqua River), and two small unnamed ponds. There are no freshwater streams or rivers on the Dover side of the study area. A more detailed discussion of each of these resources and an assessment of the existing water quality conditions is provided below.

3.9.1 Regulatory Overview

Surface water quality regulations are administered by the NHDES Watershed Management Bureau. Any discharge to a surface water resource is subject to NHDES Surface Water Quality Regulations (Env-Ws 1700). These regulations established water quality standards for various physical, biological and chemical parameters for the protection of aquatic life and human health that vary depending on their designated use classification. Class A is the highest classification and designates water quality that is uniformly excellent and potentially acceptable for water supply uses, after adequate treatment. Discharge of sewage or waste into Class A waters is prohibited. Class B waters are considered acceptable for swimming, fishing, and water supplies after adequate treatment. According to the NHDES, all surface waters within the study area are considered Class B waters (K. Edwardson, NHDES, personal communication). Discharges to Class B waters are allowed provided that such discharges do not violate the established water quality standards. Under Section 401 of the Federal Clean Water Act, NHDES must certify that Federal actions (*i.e.*, FHWA funding or USACOE permitting) comply with the state water quality standards. In addition, as discussed below, Federal and State law can provide additional regulatory protection through the National Wild and Scenic River Program or the NH Rivers Management and Protection Program (Section 3.9.3.7), and under the Magnuson Stevens Act, concerning essential fish habitat (Section 3.9.3.8).

3.9.2 Methodology

To identify existing surface waters within the study area, NH GRANIT surface water data layers for the Newington and Dover area were obtained from Complex Systems Research Center at UNH. Information contained in the GRANIT data layer is based on USGS 1:24,000 Digital Line Graphs. **Figure 3.9-1** illustrates the USGS mapped surface waters within the study area, which are discussed in more detail below. Additionally, the 2004 303(d) list of impaired waters prepared by the NHDES was used to identify impaired water bodies within the study area. These published data were supplemented by field work conducted as part of this study in 2003, 2004, and 2005.

3.9.3 Existing Conditions

The study area's surface water resources include the Piscataqua River, the Bellamy River, and the Little Bay, as well as five smaller perennial streams and one intermittent stream. While there are two small ponds in the Newington portion of the study area, there are no lakes or great ponds. **Figure 3.9-1** provides an inventory of USGS mapped surface waters within the project area.

3.9.3.1 Watersheds

As shown on **Figure 3.9-1**, the study area includes three principal watershed areas associated with the Bellamy River, Piscataqua River, and Little Bay. All three systems are part of the larger Piscataqua River Basin which empties into the Atlantic Ocean. The eastern portion and bulk of the southern portion of the study area are contained within the Piscataqua River watershed, whereas the northwestern portion is within the Bellamy River watershed and the west central portion of the study area is within the Great Bay watershed. Smaller drainage basins associated with Pickering Brook, Railway Brook, Flagstone Brook, Paul Brook, and two, unnamed tributary streams that are located in Newington and lie within the Piscataqua River watershed. The following sections provide a detailed description of the individual resources.

3.9.3.2 Rivers and Streams

In addition to the Piscataqua and Bellamy Rivers (see Section 3.9.3.4), five perennial streams and one intermittent stream are located within the study area in Newington. These streams, characterized below, discharge to Little Bay and the Piscataqua River. Little Bay and the Piscataqua River are tidally influenced and are capable of supporting fish species such as striped bass (*Morone saxatilis*), bluefish (*Pomatomus saltatrix*), winter flounder (*Pleuronecties Americanus*), herring (*Clupea* spp.) and river herring (*Alosa* spp.). Also supported are several diadromous fishes such as white perch (*Morone Americana*), American eel (*Anguilla rostrata*), mummichog (*Fundulus heteroclitus),* and ninespine stickleback (*Pungitius punitius*), which move from estuarine environments into the freshwater tributaries to spawn. These tributaries also provide important habitat for their freshwater residents including golden shiner and pumpkinseed. These freshwater species are particularly tolerant to degraded water quality conditions and are generally quite common in surface waters that are currently affected by pollutant sources.

There were no perennial or seasonal streams identified within the Dover portion of the study area (**Figure 3.9-1**).

Railway Brook

Railway Brook is a man-made, rip-rap lined, channel that runs from the northeastern end of the Pease International Tradeport tarmac towards the Little Bay. Railway Brook flows northeasterly adjacent to the abandoned Pease Spur railway bed and then joins Flagstone Brook just south of Nimble Hill Road. Flagstone Brook flows for about another 0.5 mile before it empties into Trickys Cove, which is part of the Little Bay. The total watershed area of Railway Brook is estimated to be about 420 acres with about 25 percent of the area consisting of impervious surfaces. Nearly all the impervious surfaces are associated with the Pease International Tradeport.

The Railway Brook channel is approximately 8 to 10 feet wide with several flood control weir structures along its length that create deeper, pool areas and stagnant flow conditions. Much of the stream bed along its length is composed of sand deposits with pockets of silt/muck deposits, while other swifter-moving stretches consist of cobble/gravel substrate. The banks appear to be moderately stable with the rip-rap in place and scrub-shrub vegetation along much of its length. The mature vegetation, however, has been cut on both sides allowing for an open canopy and minimal shading.

The construction of Railway Brook channel has altered the natural drainage pattern within its own watershed and that of the Pickering Brook watershed as well. The original Railway Brook stream once flowed easterly through forested wetland areas on the east side of the Pease Spur tracks. The original stream bed is still evident in these wetland areas. Previously, Railway Brook was a tributary to Pickering Brook. Currently, the manmade Railway Brook flows along the west side of the tracks, intersects Pickering Brook approximately 600 feet south of Nimble Hill Road and then redirects flow northward to Flagstone Brook and eventually into Trickys Cove. Railway Brook is deeply entrenched where the two streams intersect with a large berm on the northern embankment. This water diversion was evidently established to provide a more direct and shorter flow path to estuarine tidal waters and to serve as a spill control catchment in the event of a crash at the former Pease Air Force Base (AFB) (Leon Kenison, Pease Development Authority, Personal Communication). Some ground water seepage appears to Exit from the base of the diversion berm, and thus, providing some limited base flow to what remains as the lower Pickering Brook channel.

As discussed in more detail below, the redirection of flow has altered the flow and habitat conditions in the lower Pickering Brook watershed. The stream channel through much of the study area in the lower half of the watershed is not well-defined, and it appears to support minimal flow, remaining more or less as a seasonal hydrologic connection to a series of wetland areas during high flow periods.

According to the NHDES 305(b)/303(d) Surface Water Quality Assessment (2006), Railway Brook (Assessment Unit ID [AUID]: NHRIV600031001-08) is listed as an impaired waterbody and is considered to not fully support its aquatic life use designation due to previously observed elevated iron concentrations. As shown in Table 3.9-1, NHDES lists an unspecified, industrial point source discharge as the suspected cause for the elevated concentrations. As with all surface water bodies in the state, this stream is also listed as impaired due to elevated mercury levels found in fish tissue, which means it does not support its designated use for fish consumption. Recent aquatic biota sampling revealed that several fish species do exist in Railway Brook including the golden shiner (*Notemigonus crysoleucas*), American eel (*Anguilla rostrata*), pumpkinseed (*Lepomis gibbosus*), and ninespine stickleback (*Pungitius pungitius*). (See complete biota sampling results in Appendix F.)

According to a published report (Weston 1989), there are several major contamination sources within the upper headwaters of the Railway Brook watershed that are remnant of the former Pease AFB, which include as many as six (6) former landfills, a paint can disposal area and the use of herbicides to control unwanted vegetation along the railway tracks. Presumably, DDD may have been used at one time for vegetation control. The report also indicates that previous surface water and sediment sampling efforts showed that copper, lead, mercury, nickel, and zinc concentrations often exceeded the established aquatic life criteria in Railway Brook and many of other streams that flow to the Little Bay or Piscataqua River. Various organic compounds such as DDD, DDT and petroleum aromatic hydrocarbons (PAHs) were also detected in both surface water and sediment samples at concentrations shown to be toxic in other studies (Weston, 1989).

Recent sampling and analysis of the benthic community in late September 2005, showed results consistent with the previous NHDES findings, that the benthic community is composed mostly of tolerant families, and has low

Table 3.9-1
Classified Surface Waters[1]

Surface Water Name	AU Category [2]	Assessment Unit ID[3]	Impairment	Cause	Suspected Source
Railway Brook	5	NHRIV600031001-08	Aquatic Life	Aluminum, Iron	Industrial Point Source Discharge
			Fish Consumption	Mercury	Atmospheric Deposition
Pickering Brook	5	NHRIV600030904-06	Aquatic Life	Copper, Iron, pH, Dissolved Oxygen	Industrial Point Source Discharge; Source Unknown
			Primary Contact Recreation	*Escherichia coli*	Source Unknown
			Fish Consumption	Mercury	Atmospheric Deposition
Flagstone Brook	5	NHRIV600031001-01	Aquatic Life	Aluminum, Iron	Landfills
			Fish Consumption	Mercury	Atmospheric Deposition
Pauls Brook	5	NHRIV600031001-07	Aquatic Life	DDD Chloride Benthic Macro-invertebrate Bioassessments	Industrial Point Source Discharge Commercial/Highway/Road Runoff Municipal (Urbanized High Density Area)
			Fish Consumption	Mercury	Atmospheric Deposition
Upper Piscataqua River	5	NHEST600031001-01	Fish Consumption	Mercury Polychlorinated biphenyls	Atmospheric Deposition Source Unknown
			Shellfishing	Dioxin (including 2,3,7,8-TCDD) Mercury Polychlorinated biphenyls	Source Unknown Atmospheric Deposition Source Unknown

Table 3.9-1 (Continued)

Surface Water Name	AU Category 1	Assessment Unit ID2	Impairment	Cause	Suspected Source
Lower Piscataqua River	5	NHEST600031001-02	Aquatic Life	Other Flow Regime Alterations	Littoral/shore area modifications (non-riverine)
			Fish Consumption	Mercury	Atmospheric Deposition
				Polychlorinated biphenyls	Source Unknown
			Primary Contact Recreation	*Enterococcus*	Combined Sewer Overflows (CSO)
			Shellfishing	Dioxin (including 2,3,7,8-TCDD)	Source Unknown
				Mercury	Atmospheric Dep., Source Unknown
				Polychlorinated biphenyls	Source Unknown
Bellamy River	5	NHEST600030903-01	Fish Consumption	Mercury	Atmospheric Deposition
				PCBs	Source Unknown
			Primary Contact Recreation	*Enterococcus*	Sanitary Sewer Overflows (SSO)
					Source Unknown
					Wet Weather Discharges (point source and combination of stormwater, SSO, CSO)
			Shellfishing	Dioxin (including 2,3,7,8-TCDD)	Source Unknown
				Fecal Coliform	Source Unknown
				Mercury	Atmospheric Dep., Source Unknown
				Polychlorinated biphenyls	Source Unknown
Little Bay	5	NHEST600030904-06-09 NHEST600030904-06-12 NHEST600030904-06-13 NHEST600030904-06-14	Fish Consumption	Mercury	Atmospheric Deposition
				Polychlorinated biphenyls	Source Unknown
			Shellfish	Dioxin (including 2,3,7,8-TCDD)	Source Unknown
				Fecal Coliform	Sourcce Unknown
				Mercury	Atmospheric Dep., Source Unknown
				Polychlorinated biphenyls	Source Unknown

1 This table lists only streams contained in the NHDES 305(b)/303(d) Surface Water Quality Assessment (2004)
2 AV Category is a descriptor of the level of water quality impairment and action needed. Category 5 waters have at least one use impaired and require a TMDL, *i.e.*, a study to determine clean up needs.
3 Assessment Unit ID is a unique identifier used by NHDES and USEPA to track water quality data.

diversity, which is indicative of poor water quality (Table 3.9-2 and Appendix F). Field measurements of several water quality parameters collected on three separate occasions during September and October 2005, indicated that turbidity levels ranged from 3.6 to 12.5 NTUs during dry weather conditions and the specific conductance levels ranged from 91.5 to 237.6 microseimens per centimeter (µS/cm). Both turbidity levels and specific conductance are slightly elevated but appear to be well below levels of concern. [53]

Pickering Brook

The upper watershed of Pickering Brook is bisected by the large berm associated with Railway Brook, creating an upper and a lower segment. Upper Pickering Brook drains into Railway Brook, south of Nimble Hill Road, and eventually into Flagstone Brook. Upper Pickering Brook drains approximately 270 acres with roughly 4 percent impervious surfaces. Seepage and flooding, due to nearby beaver damming, allow some periodic flow to the lower part of the watershed, but there is no longer continuous flow.

Lower Pickering Brook continues on the eastern side of the railway tracks, flowing east as an intermittent stream under the southbound and northbound lanes of the Spaulding Turnpike via 6-foot diameter culverts (the brook daylights within the median). Once east of the Turnpike, lower Pickering Brook narrows in places to a width of 4 feet or less, is not well-defined and is interspersed amongst numerous wetland areas. It continues through the Sprague Energy property into two unnamed ponds before discharging into the Piscataqua River. The lower-most portion of the channel, approximately 500 feet of channel from the point it crosses beneath Shattuck Way, is tidally-influenced. The watershed of the lower Pickering Brook is estimated to be about 240 acres with approximately 20 percent of the area consisting of impervious surfaces.

According to the NHDES (2006), Upper Pickering Brook (AUID: NHRIV600030904-06 [above Railway Brook]), is listed as an impaired waterbody due to elevated copper and iron concentrations as well as low pH and dissolved oxygen levels. Table 3.9-1 shows that NHDES lists the potential sources as either unknown or due to industrial point sources presumably related to the contamination sites associated with the former Pease AFB that are located in the headwater areas of both Pickering Brook and Railway Brook watersheds.

53 NHDES considers a specific conductance level of 850 µS/cm to be roughly equivalent to the chronic aquatic life standard of 230 mg/L for chloride based on extensive sampling in other streams in recent years (NHDES 2003).

Field measurements in Upper Pickering Brook on September 16, 2005 showed a turbidity level of 5.9 NTU s and a specific conductance level of 212.0 µS/cm. Both parameter levels appear slightly elevated, but well below levels of concern. Benthic sampling in Pickering Brook was not possible due to an absence of favorable substrate and the lack of stream flow during the sampling period, especially in the lower reaches.

Table 3.9-2
Benthic Macroinvertebrate Sampling and Water Quality Data[1]

Location	Final Biotic Score[2]	Water Quality Rating[2]	EPT Richness[3]	Shannon Diversity Index[4]
Railway Brook	6.74	Poor	3	1.95
Flagstone Brook	7.25	Poor	2	1.17
Paul Brook	5.75	Fair	2	1.16
Unnamed Tributary 1	7.02	Poor	0	0.87

Notes:

1 All data is from Vanasse Hangen Brustlin, Inc.; based on kick net sampling conducted in October 2005. See Appendix F.

2 Final Biotic Score and Water Quality Rating are directly related and are based on the following scale: 0-3.75=Excellent; 3.76-4.25=Very Good; 4.26-5.00=Good; 5.01-5.75=Fair; 5.76-6.0=Fairly Poor; 6.51-7.25=Poor; >7.26=Very Poor.

3 EPT Richness is a count of the total number of Ephemeroptera, Plecoptera, and Trichoptera families present in each sample. These major families generally represent the more sensitive or less tolerant species to pollution effects. On a general scale of 0 to 10, higher values represent better water quality conditions.

4 The Shannon Diversity Index is another relative measurement of the range or variety of the benthic species present. Values closer to zero indicate low diversity and is usually indicative of poor water quality conditions (Ludwig and Reynolds, 1988).

Flagstone Brook

Railway Brook transitions into Flagstone Brook just south of the Nimble Hill Road culvert, where Flagstone Brook continues to drain north into Trickys Cove. In comparison to Railway Brook, Flagstone Brook has a more sinuous channel, has a rockier substrate, and has dense vegetative cover due to the overhanging, scrub-shrub under-story and a mature tree canopy. Dominant substrate consists of cobble and gravel, embedded approximately with 10 percent sand and silt. The stream banks appear to be somewhat unstable with evidence of bank slumping along the stream channel. This may be due to the presence of underlying marine clay layers rather than erosive flow forces. The shallow groundwater seepage that flows above these clay layers can create an unstable condition that tends to cause the overlying sand and gravel to slough off into the stream channel. The downstream portion of Flagstone Brook is tidally influenced and provides estuarine emergent vegetated habitats.

According to the NHDES (2006), the Pickering Brook – Flagstone Brook assessment unit (AUID: NHRIV600031001-01) is also listed as an impaired waterbody due to elevated concentrations of aluminum and iron. Again, the elevated levels of iron and aluminum are presumably linked to possible groundwater leaching from the former Pease AFB landfills upstream in the Railway Brook watershed. Although Flagstone Brook does support several fish species including the mummichog, white perch (*Morone Americana*), American eel, pumpkinseed, and ninespine stickleback (Appendix F), they are not fit for consumption due to elevated mercury levels.

Similar to Railway Brook, benthic sampling at Flagstone Brook showed results consistent with the previous NHDES findings, that the benthic community is composed mostly of tolerant families, has low diversity, and indicates impaired water quality.

Turbidity levels measured in the field on three separate occasions in September and October 2005 ranged from 9.7 to 14.8 NTUs, which were relatively higher that that measured in the other streams. Specific Conductance levels ranged from 175.0 to 243.0 µS/cm, which is similar to that measured in the other streams, previously discussed.

Paul Brook

Paul Brook is a small, perennial stream that originates just east of Woodbury Avenue in Newington. The stream receives stormwater runoff from a large portion of the Fox Run Mall parking lot *via* a detention basin on the easterly end of its main parking lot. The stream flows easterly for about 0.5 mile before empties into the Piscataqua River. Its drainage area is estimated to be less than 250 acres with as much as 42 percent of the area consisting of impervious surfaces, which is the highest of the six streams in the study area. The dominant substrate consists of platy cobble with approximately 10 percent of the stream bottom appears to be embedded with silt and fine sediment. Banks appear to be mostly stable with some areas of erosion. The lower end of Paul Brook is tidally influenced providing estuarine emergent vegetated habitats. The western portion of Paul Brook supports palustrine scrub-shrub and emergent vegetation communities along its riparian zone.

According to the NHDES (2006), Paul Brook (AUID: NHRIV600031001-07) is listed as an impaired waterbody due to poor benthic community composition, elevated chloride and DDD concentrations and low dissolved oxygen levels. NHDES lists the sources for the elevated chloride concentrations as being runoff from commercial, highway and other road surfaces as well as from high density urbanized areas. The source of DDD, a byproduct of the now banned herbicide DDT, may relate to previous historic herbicide applications that were done on the Pease AFB for vegetation control.

Benthic sampling at Paul Brook showed results consistent with the previous NHDES findings, that the benthic community is composed mostly of tolerant families, has low diversity, and indicates poor water quality. Fish species observed in Paul Brook include mummichog, American eel, and ninespine stickleback.

Turbidity levels measured in the field on three occasions in September and October 2005, ranged from 0.83 to 4.9 NTUs, which are relatively low in comparison to the other streams The specific conductance levels, however, were comparatively higher than measured in the other five streams with levels ranging from 854.0 to 1758.0 μS/cm. NHDES considers a specific conductance level of approximately 850 μS/cm to be a surrogate water quality standard that is equivalent to the chronic aquatic life standard of 230 mg/L for chloride based on extensive sampling in other streams in recent years (NHDES 2003). Thus, the observed specific conductance levels in Paul Brook might suggest that the chloride concentrations in Paul Brook are above the established chronic water quality standard of 230 mg/L for chloride.

Unnamed Tributary 1

An unnamed perennial tributary to the Piscataqua River originates from a series of large wetland areas located on the south side of the Spaulding Turnpike/Gosling Road interchange near the main entrance to the Pease International Tradeport at the east end of the study area. The stream has two branches, one that flows from the south along Gosling Road and then under Woodbury Avenue, and a second branch that flows northeast under Gosling Road, east of Woodbury Avenue. The confluence of these two branches is located just north of the Gosling Road/Woodbury Avenue intersection. The stream then flows northeast to its confluence with the Piscataqua River within the industrial area of Newington. The drainage area is estimated to be around 465 acres with about 34 percent of the area consisting of impervious surfaces.

Dominant substrate includes boulders and cobble entrenched with silt and fine sediment. However, downstream the substrate becomes nearly 100 percent embedded with fine sediment as the gradient flattens and woody debris obstructs stream flow and causes sediment deposition. This lowland area was observed to have virtually no flow and water trickles between muck bottom pools. Marine clays appear to be prevalent in this area. A full canopy overstory exists along most of the stream channel, until it crosses under power lines and flows into the Piscataqua River. Dense shrub and herbacious vegetation along the stream banks is also quite prevalent. However, very little favorable habitat exists for fish or macroinvertebrates within this stream given extensive sedimentation and the abundance of various debris and trash such as bottles, cans, and paper. Although they are relatively scarce, the American eel, pumpkinseed, and ninespine stickleback can be found in this unnamed tributary.

Again, recent field sampling and analysis of the benthic communities in September 2005 showed low species diversity and an abundance of highly tolerant species, which is indicative of poor water quality and/or habitat conditions. Specific Conductance levels measured in the field on three separate occasions ranged from 638 to 1166 uS/cm, which are considered elevated in comparison to the surrogate water quality standard of 850 µS/cm, which is equivalent to the chronic water quality standard of 230 mg/L for chloride.

Unnamed Tributary 2

Another small unnamed tributary originates from the eastern side of Shattuck Way, flows north and discharges into the Piscataqua River. The stream is less than 0.5 mile long has a watershed area of approximately 72 acres and is considered to support only seasonal flow.[54] The upper reaches of this stream flow through a forested, freshwater wetland and the lower portion is tidally influenced, supporting estuarine emergent vegetated habitats. Dominant substrate consists of cobble and gravel that is heavily embedded with sand. Marine clays are present in the lower section. Although the stream had no flow during site visits in mid-September and early October, it is likely to convey a fair amount of seasonal flow as evidenced by the 4-6 feet wide channel and a variable depth of 0.5 to 2 feet. The channel follows a normal meandering pattern with some undercutting of the bank areas suggesting some flashiness with a wide range of flow levels. Some areas show evidence of heavy erosion, and sediment deposition ahead of snags and downed trees. The watershed area is estimated to be comprised of about 10 percent impervious surfaces.

While attempts were made to conduct a biotic inventory, benthic sampling and electro-fishing were not possible due to lack of flow in the channel at the time of sampling.

3.9.3.3 Ponds

There are two, unnamed, ponds located along the lower reaches of Pickering Brook, southeast of Exit 4 and east of Shattuck Way. Pickering Brook flows eastward beneath the Spaulding Turnpike, connecting the two ponds under

54 According to the method of Bent and Archfield (2002), the Unnamed Tributary to Piscataqua River near Shattuck Way is intermittent.

the existing railway. The two ponds have a combined surface area of approximately 3.13 acres, with the easterly pond mapped as tidally influenced in the National Wetlands Inventory (NWI). Over recent years the westerly pond has succeeded towards a palustrine emergent wetland (see discussion in Wetlands Section 3.6). Approximately 3,000 feet of the northbound and southbound lanes of the Spaulding Turnpike and Shattuck Way lie within the watershed of these ponds. Much of the roadway runoff flows to adjacent upland areas or into Pickering Brook prior to entering the ponds. The two ponds are classified as Class B waters with some aquatic and terrestrial wildlife habitat value.

3.9.3.4 Estuaries and Tidal Rivers

Piscataqua River

The Piscataqua River is part of the larger Salmon Falls/Piscataqua River Basin which includes approximately 1,400 square miles in New Hampshire and Maine. The Piscataqua River is formed by the confluence of the Cocheco and Salmon Falls Rivers approximately 12 miles north of the study area. Within the study area, the Piscataqua River is a tidally-influenced channel, that is typically 2,000 to 3,500 feet wide and has a substrate composition of sand and mud throughout. Various small tributaries discharge cool oxygenated water into the Piscataqua River from the surrounding uplands. Adjacent land use consists of residential/commercial development, forested upland, and vegetated wetland habitats. Within the study area, the Piscataqua River supports striped bass (*Morone saxatilis*), bluefish (*Pomatus saltatrix*), winter flounder (*Pleuronectes Americanus*), and herring (*Clupea* spp.).

According to the NHDES 305(b)/303(d) Surface Water Quality Assessment Report (2006), there is an upper and lower assessment unit for the Piscataqua River within the project area. The upper Piscataqua River (AUID: NHEST600031001-01-03) is listed as an impaired waterbody for not fully supporting its designated uses for fish consumption and shellfishing. The fish consumption impairment is due to mercury from atmospheric deposition and polychlorinated biphenyls from an unknown source. The shellfishing impairment is due to dioxin (including 2,3,7,8-TCDD) from an unknown source, mercury from atmospheric deposition and an unknown source of polychlorinated biphenyls. The lower Piscataqua River (AUID: NHEST600031001-02) is listed as an impaired waterbody because it does not support its designated uses for aquatic life, fish consumption, primary contact recreation, and shellfishing. The cause for the aquatic life impairment is due to flow regime alterations associated with littoral/shore area modifications (non-riverine). The fish consumption and shellfishing impairments are linked to the same causes and sources as the upper

Piscataqua River AUID. The primary contact recreation impairment is linked to the occasional detections of *Enterococcus* bacteria, that is suspected to be contributed from combined sewer overflows.

Bellamy River

The Bellamy River flows south through Dover along the west side of the study area and is the second largest river within the study area having a total length of approximately 8 miles (from the Bellamy Reservoir) and an estimated watershed area of 34 square miles. The Bellamy River is classified as a Class B waterway below the Bellamy Park dam in Dover. Within the study area, the Bellamy River is tidally influenced and is typically 1,000 to 1,200 feet wide with a substrate composition of sand and mud throughout. Various small tributaries discharge cool oxygenated water into the Bellamy River from the surrounding uplands. Adjacent land use consists of residential/commercial development, forested upland, and vegetated wetland habitats.

The Bellamy River watershed spans across the towns of Barrington (46 percent), Lee (1 percent), Madbury (21 percent), Durham (1 percent), and Dover (31 percent), NH. Approximately 7 square miles (20 percent) of the watershed drains directly to the estuarine portion of the Bellamy River. Swains Pond in Barrington and the Bellamy Reservoir in Madbury are the two most substantial water bodies within the watershed.

According to the NHDES 305(b)/303(d) Surface Water Quality Assessment (2006), the Bellamy River (AUID: NHEST600030903-01-02) is listed as an impaired waterbody for not fully supporting its designated uses for fish consumption, primary contact recreation, and shellfishing. The fish consumption impairment is linked to mercury levels in fish tissue from atmospheric deposition and an unknown source of polychlorinated biphenyls. The primary contact recreation impairment due to occasional detections of *Enterococcus* bacteria, suspected from sanitary sewer overflows (collection system failures), unknown sources, and wet weather discharges (point source and combination of stormwater, SSO, or CSO). The shellfishing impairment is linked to detections of dioxin (including 2,3,7,8-TCDD) from an unknown source, mercury from atmospheric deposition and an unknown source of polychlorinated biphenyls.

Little Bay

Little Bay is a tidally influenced waterway west of the study area that receives flow from the Piscataqua River to the east; the Bellamy River to the north; the Oyster River to the west; and Great Bay to the south. Little Bay is within the Great Bay watershed which has a total watershed area of approximately 112 square miles. Little Bay is approximately 3 square miles in size upstream of its confluence with the Piscataqua River. The substrate composition is sand and mud throughout.

According to the NHDES (2006), there are several Lower Little Bay assessment units and a Little Bay CA2 assessment unit within the project area. Each of the Little Bay assessment units (AUIDs: NHEST600030904-06-09, NHEST600030904-06-12, NHEST600030904-06-13, NHEST600030904-06-14) are listed as impaired for fish consumption and shellfishing. The fish consumption impairment is caused by mercury levels in fish tissue contributed from atmospheric deposition and polychlorinated biphenyls from an unknown source. The shellfishing impairment is caused by dioxin (including 2,3,7,8-TCDD) from an unknown source, mercury from atmospheric deposition and an unknown of polychlorinated biphenyls.

3.9.3.5 Highway Stormwater System

A preliminary survey was conducted to understand the existing stormwater conveyance system along the Spaulding Turnpike within the project area. The system descriptions are based on the aerial plans and some as-built plans from the area of the Exit 4N ramps on the Spaulding Turnpike just south of Pickering Brook. Stormwater is conveyed into closed drainage systems (catch basins and culverts) or allowed to sheetflow overland to the roadway's toe of slope. At the toe of slope, stormwater will infiltrate if soil conditions are suitable, remain perched if soil conditions are not suitable, or will flow to adjacent wetlands. The actual discharge points were not located for the preliminary investigation of the existing system.

The Newington side of the Spaulding Turnpike has a closed drainage system from Gosling Road to the Woodbury Ave northbound on-ramp. North of the Woodbury Avenue on-ramp, stormwater is allowed to sheet flow over the roadway to collect at the toe of slope. Some of these toe of slope areas infiltrate rapidly, others occur within small and isolated depressional wetlands, while the remainder drain to wetlands that connect to Pickering Brook.

The Dover side of the Spaulding Turnpike has mostly closed drainage systems, with some pockets of sheet flow that deposit at the roadway's toe of slope. Once detained, the majority of the stormwater south of the US 4 overpass drains to wetlands along the corridor that eventually drain into Pomeroy Cove. The drainage north from the US 4 overpass to the toll plaza drains to the west making its way to the Bellamy River.

3.9.3.6 Aquatic Resources

Within the study area, the Piscataqua River and Little Bay are tidally influenced and capable of supporting salt water fish species such as striped bass *(Morone saxatilis)*, bluefish *(Pomatomus saltatrix),* winter flounder *(Pleuronectes Americanus),* and herring (*Clupea* spp.). These waterways also support crustacean (crab, lobster), shellfish (clams), and macroinvertebrates (marine worms *Nereis* sp.). Essential Fish Habitat, as designated by the National Marine Fisheries Service, is present in the study area as presented in Sections 3.9.3.8 and 3.10.3.4 with a detailed description of marine habitats.

Based on an informal assessment of habitat types associated with the freshwater resources described earlier in this section, it is expected that only common warm water species would be found within the perennial streams and ponds in the study area. Appendix F contains data that shows that streams in the study area support species such as American eel, ninespine stickleback, mummichog, golden shiner, and pumpkinseed. This habitat type on New Hampshire's seacoast could also support species, such as pumpkinseed, brown bullhead (*Ictalurus nebulosus*), white sucker (*Catostomus commersoni*), and black crappie (*Pomoxis nigromaculatus*). (Bruce Smith, NHF&GD, personal communication.)

3.9.3.7 Wild and Scenic, and NH Designated Rivers

There are no rivers, brooks, or streams in the study area either under study or currently listed with the National Park Service's Wild and Scenic Rivers Program. None of the rivers, brooks or streams in the study area are under study for protection, or are currently designated as natural, rural, or community rivers within the New Hampshire Rivers Management and Protection Program under RSA 483.

3.9.3.8 Freshwater Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) established a requirement to describe and identify "essential fish habitat" (EFH) in each federal fishery management plan. EFH is defined as "those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity." "Waters" include aquatic areas and their associated physical, chemical and biological properties.

In the northeast, managed fish species predominantly include species which spend their entire life cycle in marine or estuarine environments. However, Atlantic salmon (*Salmo salar*) is a diadromous species, *i.e.*, it migrates deep into interior freshwater rivers and streams where the adults spawn. Therefore, in addition to the marine EFH described in Section 3.10.3.4, field work in preparation for this Final EIS included an assessment of whether freshwater EFH is present.

In New Hampshire, both the Merrimack River and the Connecticut River and their tributaries supported large populations of Atlantic salmon until the 1800s, and tributaries to these systems are considered EFH. The appropriate spawning and nursery habitat includes beds of stones measuring one-half to four inches in diameter. These gravel beds promote the movement of clean, well-oxygenated water through the redd (*i.e.*, a spawning nest made by the adult salmon), which is critical since salmon eggs may be deposited as deep as 12 inches. Salmon nursery habitat typically is composed of shallow riffle areas interspersed with deeper riffles and pools. The substrate pebbles, ranging from one-half to greater than nine inches in diameter, afford adequate cover for the juvenile salmon. Clean, well-oxygenated water is a necessity and the most valuable salmon habitat tends to be located in headwaters (Page and Burr, 1991).

As reported earlier in this section, habitat surveys were conducted in all freshwater streams in the study area in the summer and fall of 2005. Based on the results of these stream surveys, no managed fish species, including the Atlantic salmon, were observed to use the freshwater stream resources. Furthermore, while it is still possible that Atlantic salmon may feed in the Piscataqua and/or Bellamy Rivers as well as Little Bay, no adequate freshwater tributary habitat was identified that would support the spawning, breeding, feeding or growth to maturity of the Atlantic salmon or other managed fish species.

Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act, as amended through October 11, 1996, requires Federal agencies to consult with NOAA's National Marine Fisheries Service (NMFS) on all actions or proposed actions authorized, funded, or undertaken that may adversely affect EFH.

A formal EFH Assessment was prepared (NHDOT, August 2006) which supports the findings of the EIS and provides a record of the interagency coordination between NMFS and the USACOE relative to the application for a Section 404 permit.

3.10 Marine Environment

The Little Bay and General Sullivan Bridges span an area in Little Bay that can be described as a tidal rapid. All tidal waters entering and leaving Great Bay, Little Bay, and their associated tributaries pass through the constriction between Dover Point and Newington, resulting in unusually strong currents. This is a major environmental factor affecting the ecology of the area, as well as the design of the bridge structure within the channel. The distributions of plants and animals in this area probably are determined in large measure by the tidal current patterns in combination with water depth and substrate type.

In addition to the intertidal and subtidal zones, the upland area directly adjacent to the tidal Piscataqua River, Bellamy River, and the Little Bay is also recognized as a distinct environmental resource. Specifically, the NHDES Wetlands Bureau has jurisdiction over upland areas adjacent to all tidal submerged lands, salt marsh, sand dunes, and tidal flats. The Tidal Buffer Zone (TBZ) is an upland tidal buffer that extends 100 feet from the highest observable tide line. The tide line is the furthest limit of tidal flow, and may be defined by a strand line of flotsam and debris, the landward margin of salt tolerant vegetation, or a physical barrier blocking the flow of the tide. Within the TBZ, wetlands, transitional areas, and both natural and developed uplands may be included as a regulated resource.

3.10.1 Existing Studies

The Great Bay/Piscataqua River estuarine system has been the subject of a wide range of studies by scientists from the University of New Hampshire (UNH) and other institutions. Recent technical reports that review this research include Short (1992), Jones (2000), and NH Estuaries Program (NHEP 2000). Information directly relevant to the present project, however, is not extensive because few studies have been conducted at the bridges.

The most extensive information on the general ecology of the area under and near the bridges is the result of a series of field studies conducted during the 1970s by Arthur Mathieson, a phycologist at UNH and senior scientist at Jackson Estuarine Laboratory (JEL), and colleagues. These studies focused on the plants and animals attached to the bridge piers, but included data on environmental conditions in other areas. The following discussion is based largely on Mathieson *et al*. (1983), the published synthesis of these studies, as well as information from earlier research (Reynolds 1971; Reynolds and Mathieson 1975; Mathieson *et al.* 1981).

Based on field measurements at multiple locations and depths over several tidal cycles, maximum speeds of about 6 knots (9 feet per second) occurred on the ebb tide with fastest flows in the deeper waters along the south (Newington) side. Speeds up to about 4 knots (6 feet per second) were recorded during flooding tides in the shallow subtidal areas along the north (Dover Point) side. Current flows in the area were complex and had a wide range of directional components and speeds during a tidal cycle.

The dominant invertebrate and plant taxa on hard substrate (bridge piers and rocky bottom) in the intertidal zone included: northern acorn barnacle (*Semibalanus balanoides*), blue mussel (*Mytilus edulis*), sea laver (*Porphyra umbilicus*), a green alga (*Blidingia minima*), and rockweeds (*Fucus vesiculus* and *Ascophyllum nodosum*). Several species distribution patterns were related to current regime and/or interspecific interactions such as competition. For example, *Porphyra* and *Blidingia* were found in high-current flow areas, whereas rockweeds mainly occurred in areas with intermediate to low current speeds and were stunted in high-speed areas. In some areas, *Mytilus* displaced *Chondrus crispus* (Irish moss) over several months, but *Mytilus* was apparently removed by predators in other areas. *Laminaria digitata* (kelp), a species that typically occurs in open coastal waters, was noted in some shallow subtidal areas.

These studies by Mathieson and colleagues represent most of the published research in the immediate area of the bridges. Other published papers, as well as technical reports and unpublished data, exist on eelgrass (*Zostera marina*), salt marsh (*Spartina* spp.), sediments, and water quality (see below) conditions in the study area or nearby (*e.g.,* Short *et al*. 1993; Ward *et al*. 1993; Jones *et al.* 2001). However, no data collected recently or covering the study area for this project in any detail exist. Hence, it was determined that a new mapping effort would be required.

Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act, as amended through October 11, 1996, requires Federal agencies to consult with NOAA's National Marine Fisheries Service (NMFS) on all actions or proposed actions authorized, funded, or undertaken that may adversely affect EFH.

A formal EFH Assessment was prepared (NHDOT, August 2006) which supports the findings of the EIS and provides a record of the interagency coordination between NMFS and the USACOE relative to the application for a Section 404 permit.

3.10.2 Methodology

A study of marine intertidal and subtidal bottom types was conducted during the summer of 2003 in an effort to better understand the key marine habitat elements in the vicinity of the project. These investigations were limited to areas of potential direct impacts, and included a corridor 600 feet wide centered on the existing Little Bay Bridges, as well as Pomeroy Cove.

Habitats were preliminarily mapped directly from the 2002 aerial imagery and color infrared imagery taken at low tide during 1990 and 1991.

Preliminary maps were ground-truthed by field inspection on three different days with differential GPS (DGPS). Subtidal maps were constructed based on a composite, geo-referenced bathymetric map consisting of 1953 data from the entire study area under and near the bridges combined with high resolution multibeam sonar data collected in 2001 from the 18-foot contour line (below sea level) and deeper. Subtidal bottom types and habitat types were based on underwater videography along pre-determined transect lines using a towed video system with recording DGPS.

The intertidal bottom types and habitat types map (**Figure 3.10-1)** is based on geo-referenced, low-altitude aerial imagery with sub-meter resolution and accuracy. The boundaries between most bottom types and habitat types were readily discernable from the imagery and both study areas were inspected with nearly 100 percent coverage on three separate field trips.

The subtidal bottom type map and habitat type map were mainly derived from underwater videography. In some cases, the bathymetric data were used to estimate boundaries between bottom and/or habitat types.

The tidal buffer zone in the vicinity of the project area was identified and mapped using ArcGIS software. Highest observable tide elevations were determined from the NOAA 2005 Tide Predictions at Hilton Park in Dover (4.1 feet NAVD 88).

After identifying the elevation contour of the highest observable tide, the 100-foot buffer was offset landward. Impacts to the TBZ could then be calculated on the Newington and Dover sides of Little Bay as well as for the Bellamy River by overlaying the proposed construction footprint. ArcGIS software was used to perform these impact calculations, as well.

3.10.3 Existing Conditions

3.10.3.1 Habitat at Pomeroy Cove

Pomeroy Cove is a soft-sediment environment consisting of a large intertidal mudflat surrounded by peaty deposits with associated salt marsh habitat.

Intertidal habitats in Pomeroy Cove were grouped and mapped by two major types: salt marsh and unvegetated mudflat. Salt marsh habitat is dominated by cord grass (*Spartina* spp.) and includes other plants such as sedges (*Carex* and *Scirpus* spp.), spike grass (*Distichlis spicata*), spike-rushes (*Eleocharis* spp.), rush (*Juncus* spp.), and glasswort (*Salicornia* spp.). Invertebrates such as common periwinkle (*Littorina littorea*), Atlantic ribbed mussel, green crab, and amphipods (*Gammarus* spp.) are present. Fish species such as mummichog (*Fundulus heteroclitus*), silverside (*Menidia menidia*), four-spine stickleback *(Apeltes quadracus)*, nine-spine stickleback *(Pungitius pungitius)* and the three-spine stickleback (*Gasterosteus aculeatus*) are also present in areas of salt marsh. Intertidal mudflats in many areas of the Great Bay/Piscataqua River estuarine system are "potential habitat" for soft shell clams (*Mya arenaria*).[55] For the present study, a map based on information in Banner and Hayes (1996), as well as input from NHF&GD and Jackson Estuarine Lab at UNH was provided by the NHDES. It should be noted that no shellfish (oysters or clams) were observed in Pomeroy Cove, but more extensive surveys than were conducted would be needed to adequately assess their distribution.

The Tidal Buffer Zone at Pomeroy Cove consists mainly of previously developed upland. The residential neighborhood of Cote Drive is located on the northern portion of this area, while several year-round and seasonal homes are located on Wentworth Terrace to the south. The dominant feature of this TBZ, however, is the existing Spaulding Turnpike.

3.10.3.2 Habitat and Substrate at the Little Bay and General Sullivan Bridges Area

The study area near the bridges has a wide diversity of bottom types and habitat types, and includes intertidal and subtidal areas. For the overall area, nine different bottom types were mapped: intertidal hard bottom with rockweed; intertidal mudflat, intertidal rock/algal/abundant mussel; intertidal rock/algal/soft sparse mussel; intertidal salt marsh; intertidal scattered rock/algal/soft sediment; subtidal kelp bed; subtidal macroalgal (non-kelp) bed; and subtidal mussel reef (**Figure 3.10-1**).

Intertidal areas near the bridges consist of peaty deposits in several areas, expansive unvegetated mudflats, and rocky bottoms with scattered patches of soft sediments.

Subtidal areas consist mainly of rocky bottom types ranging from small gravel to large boulders interspersed with widely scattered patches of soft sediments. Discussion of these bottom types is incorporated into the discussion of habitat types below.

Intertidal habitats near the bridges were grouped and mapped by six major types: hard bottom with rockweed; mudflat; rock/algal/abundant mussel; rock/algal/soft sparse mussel; salt marsh; and scattered rock/algal/soft

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55 Comment from the NHF&GD indicates that the staff of this agency believes that there are clams in the soft sediments of Pomeroy Cove.

sediment. Salt marsh is restricted to the intertidal zone, forming a narrow fringe along Trickys Cove. Field inspection of the areas under and on both sides of the existing bridges indicates that there is some narrow fringe salt marsh in some places, although this fringe is in some places only a few feet wide in the immediate vicinity of the bridges.

Salt marsh habitat is dominated by cord grass and includes similar species of plants, invertebrates and fish indicated for salt marsh areas in Pomeroy Cove (discussed in Section 3.10.3.1). Intertidal mudflats are relatively narrow and only occur in two areas east of the bridges on the Dover Point (north) side. In contrast, there are expansive mudflats on both sides of the bridges on the Newington (south) side. All intertidal mudflat habitat is at least potential clam habitat. With the exception of a few scattered patches of soft-sediment deposits, the remaining intertidal habitats near the bridges are all on rocky bottoms, and vary mainly by the presence or absence of rockweeds and mussels. These habitats grade into similar habitat types subtidally.

Subtidal habitats near the bridges are all predominantly hard bottom, ranging from gravel to boulders. This area is a tidal rapid which regularly experiences tidal currents up to approximately 9 to 10 feet per second on spring tides. Hence, the organisms must be adapted for high-flow conditions, or live in micro-environments (*e.g.*, patches of soft sediment in a few areas) protected from the currents. All four of the mapped habitat types are ecologically quite diverse and apparently (based on numbers of epibenthic organisms observed) very productive. Of particular note in this respect are the kelp beds (dominated by *Laminaria* spp.) and mussel beds. Even areas with the highest tidal velocities support a community of hydroids, seastars, sponges, crabs and lobsters, depicted as “other habitat” on **Figure 3.10-1**.

Upland TBZ associated with the bridges is located on both the Newington and Dover shores. In both cases, the TBZ has been previously developed to support the Spaulding Turnpike infrastructure. In Newington, the TBZ is associated primarily with the peninsula on which the General Sullivan and Little Bay Bridges abutments are located. On the Dover side of the Bay, the TBZ is dominated by the landscaped areas associated with Hilton Park and the bridges.

3.10.3.3 Marine Mammals

The only marine mammal known to be resident in the study area is the harbor seal (*Phoca vitulina*) (NH Estuaries Project 2000). Harbor seals are frequently observed in the open waters of Great and Little Bays, as well as the Piscataqua River. This species is more common downstream along the rocky coastline of Portsmouth. Harbor seals feed on a variety of fish and shellfish, some of commercial value. The NHF&GD reports evidence of some transient occurrence of seals other than harbor seals in Lower Little Bay. A large seal observed basking on a dock at a local marina was probably a gray seal *(Halichoerus grypus)* (John Nelson, NHF&GD, personal communication, April 2, 2004).

Another marine mammal species, the Atlantic bottlenose dolphin (*Tursiops truncatus*), may occasionally enter the Piscataqua River estuary and may pass under the Spaulding Turnpike bridges to Great Bay. This latter species is more common south of Cape Cod (MA) and prefers pelagic (deep water) habitats, although it is also frequently found in harbors, bays, estuaries, and gulfs. The NHF&GD has observed occasional Atlantic whitesided dolphin *(Lagenorhynchus acutus)* in the Piscataqua River as far up as Hilton Park (John Nelson, NHF&GD, personal communication, April 2, 2004).

Both seal and dolphin species are protected under the Marine Mammal Protection Act of 1972, as administered by the National Marine Fisheries Service.

3.10.3.4 Marine Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) established a requirement to describe and identify "essential fish habitat" (EFH) in each federal fishery management plan. EFH is defined as "those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity." "Waters" include aquatic areas and their associated physical, chemical, and biological properties.

Fishery Management Councils determine which areas will be designated as EFH. The MSA requires all federal agencies to consult with the National Marine Fisheries Service (NMFS) on all proposed federal actions that may adversely affect EFH.

The Great Bay estuary in the vicinity of the Spaulding Turnpike Improvement project has been identified as EFH for 17 species of fish. Temperature, salinity, dissolved oxygen, water depth, substrate composition, and bathymetry are factors comprising EFH and influence the presence or absence of individual fish species. Since these parameters vary greatly within the EFH mapping units, some of the 17 species listed in Table 3.10-1 may not actually be present within the study area. A discussion of potential impacts to EFH is contained in Section 4.10, and a detailed assessment of potential EFH impacts and mitigation is provided in a separate report (NHDOT, August 2006).

Table 3.10-1
Great Bay Estuary EFH Species and Stages

Species	Eggs	Larvae	Juveniles	Adults
American plaice *(Hippoglossoides platessoides)*				X
Atlantic cod *(Gadus morhua)*	X	X	X	X
Atlantic halibut *(Hippoglossus hippoglossus)*	X	X	X	X
Atlantic mackerel *(Scomber scombrus)*	X	X	X	
Atlantic salmon *(Salmo salar)*			X	X
Atlantic sea scallop *(Placopecten magellanicus)*	X	X	X	X
Atlantic sea herring *(Clupea harengus)*		X	X	X
Bluefin tuna *(Thunnus thynnus)*				X
Bluefish *(Pomatomus saltatrix)*			X	X
Haddock *(Melanogrammus aeglefinus)*	X	X		
Pollock *(Pollachius virens)*	X	X	X	X
Red hake *(Urophycis chuss)*	X	X	X	X
Yellowtail flounder *(Pleuronectes ferruginea)*		X		X
Whiting *(Merluccius bilinearis)*			X	X
White hake *(Urophycis tenuis)*	X	X	X	X
Windowpane flounder *(Scopthalmus aquosus)*	X	X	X	X
Winter flounder *(Pleuronectes Americanus)*	X	X	X	X

Source: National Marine Fisheries Service. "Summary of Essential Fish Habitat (EFH) Designation" posted on the internet at http://www.nero.noaa.gov/ro/STATES4/Gulf_of_Maine_3_western_part/43007040.html

3.10.3.5 Hydrodynamics and Navigation

Navigation

The Piscataqua River channel provides important navigational access to Great Bay from the open ocean. A portion of the Piscataqua River federally-maintained navigation project is located within the study area. The federal project is a 35-foot deep, 400-foot wide channel which extends from deep water in Portsmouth Harbor to about 1,700 feet upstream of the Sprague Energy Terminal Corporation wharf in Newington. An 850-foot wide, 35-foot deep turning basin is situated at the head of the project. A project to dredge the channel is currently being studied by the USACOE. The center line of the navigation project defines a portion of the New Hampshire/Maine state boundary.

While the federal project accommodates larger vessels, navigation is limited largely to smaller recreational craft beyond the upstream limit of the channel, *i.e.*, beneath the General Sullivan and Little Bay Bridges and toward Little Bay. In this vicinity, where the Piscataqua River meets Little Bay, the waters are characterized as tidal rapids. As discussed in Section 3.10.1, current velocities increase to as much as 9 to 10 feet per second due to flow constrictions caused by Dover Point and Bloody Point. Potential continued deterioration of General Sullivan Bridge is a threat to safe navigation beneath the bridge and is a concern of the USCG. (USCG, Appendix A, June 4 and August 20, 2003). Note that the effect of the project on navigation is subject to the review of the USCG under their authority pursuant to Section 9 of the Rivers and Harbors Act of 1899 and the General Bridge Act of 1946.

Hydrodynamic Modeling

The UNH Ocean Engineering Laboratory developed a hydrodynamic model of the Great Bay/Piscataqua River Estuarine System to predict currents in the area of the Little Bay and General Sullivan Bridges and to show what effects changes to the bridge pier system would have on currents in the area. Physical measurement of currents in the vicinity of the bridges was conducted by UNH in the summer of 1975 in cooperation with the National Ocean Survey (NOS) and reported in a paper by Swift and Brown (1983). They reported that river currents appear to be nearly uniform with depth and have magnitudes that are sensitive to the local channel cross-section area. Data published in their paper show that the currents in the area of the Little Bay Bridges are on the order of 10 feet per second at maximum values during both the ebb and flood tides, with the ebb values slightly greater than the flood values.

3.11 Floodplains

3.11.1 Regulatory Overview

All federal projects potentially impacting floodplains require an evaluation under Executive Order 11988, *Floodplain Management* (May 24, 1977). The regulation that sets forth the policy and procedures of this order is entitled *Floodplain Management and Protection of Wetlands* (44 CFR §9), which is under the authority of the Federal Emergency Management Agency (FEMA). FHWA policies and procedures also cover the impact of projects on floodplains and floodways, and are found in *Location and Design of Encroachments on Floodplains* (23 CFR 650A).

A 100-year floodplain is defined as having a one percent annual chance of flooding and typically is the minimum level of flooding used in floodplain management regulations. Floodplain refers to “the lowland and relatively flat areas adjoining inland and coastal waters including, at a minimum, that area subject to a one percent or greater chance of flooding in any given year” (44 CFR §9). Factors that cause or contribute to flooding include drainage area characteristics (*i.e.*, topography), storm patterns, antecedent moisture conditions, time of year, and channel obstructions.

The Regulatory Floodway is generally defined as the channel of a river or other watercourse and the adjacent land areas that must be reserved to discharge the base flood without cumulatively increasing the water surface elevation more than one foot at any point. Along watercourses that do not have a designated Regulatory Floodway, no encroachment is permitted within specified zones on each community's Flood Insurance Rate Map (FIRM), unless the applicant demonstrates that the cumulative effect of the proposed development, when combined with all existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point in the community.

The City of Dover Code for Floodplain Development (Chapter 113-3) recognizes floodplain elevations as those delineated in the FEMA "Flood Insurance Study (FIS) for the County of Strafford, NH," dated May 17, 2005, with the accompanying series of Flood Insurance Rate Maps (FIRMs). The Code prohibits building, encroachment, or other development within the floodplain along watercourses that have been designated as Regulatory Floodways. For watercourses not designated as Regulatory Floodways, the City of Dover permits development if it is demonstrated that such development will not increase the base flood elevation more than one foot at any point within the community.

Newington does not have a specific town ordinance regulating development within floodplains and floodways. The town does, as a matter of policy, prohibit building within the floodplain according to the floodplain elevations calculated during preparation of the FIS for the Town of Exeter (Town of Newington Website and Tom Morgan, Town Planner, personal communication, December 3, 2003). More information is provided below on how Newington interprets floodplain elevations within its municipal boundaries.

3.11.2 Methodology

To determine floodplain elevations within the study area, Flood Insurance Studies for Strafford County, New Hampshire (All Jurisdictions, May 17, 2005), and Rockingham County, New Hampshire (All Jurisdictions, May 17, 2005) were obtained from NH GRANIT. Digital data from the Flood Insurance Rate Maps for both counties were also obtained from NH GRANIT. **Figure 3.11-1** shows the FEMA defined limits of the 100-year floodplain within the study area, which are based on the flood elevations specified in the Strafford County and Rockingham County FISs, The FISs specify 100-year flood elevations for flood insurance rate zone that were determined by detailed methods (zone AE). The study area includes five separate flood zones, three of which are zone AE. The two remaining study area zones (both zone A) were determined in the Strafford FIS by approximate methods, which do not define flood elevations. To determine the 100-year flood elevations within the two zone A areas, the digital FIRM data was compared to existing elevation data obtained for the study area. Elevations of the 100-year floodplain were interpreted based on the study area elevations that the FIRM data corresponds to, with a focus on low lying areas where design alternatives were most likely to encroach on 100-year floodplains. Interpreted 100-year flood limits for the two zone A areas are incorporated into **Figure 3.11-1**. Flood elevation data will be discussed in more detail in the following sections.

3.11.2.1 Newington

In Newington, the Rockingham County FIS (May, 2005) was relied upon to identify 100-year flood elevations. Prior to this FIS, no FIS was conducted specifically for the Town of Newington. To date, Newington has relied upon 100-year flood information contained in a FIS produced for the Towns of Exeter and Dover by Stone & Webster Engineering Corporation (SWEC), issued November 17, 1981 (Tom Morgan, Newington Town Planner, personal communication).

For the purpose of assessing 100-year floodplain impacts for this study, the 2005 FEMA FIS data was used because it was determined by detailed methods resulting in base flood elevations, and it is the only FIS that has identified flood elevations specifically for the Newington shoreline. Elevations of the 100-year floodplain in the Newington portion of the project area range from 7.2 to 9.0 feet (NGVD29). Specific floodplain information is discussed in Section 3.11.3.

3.11.2.2 Dover

In Dover, the Strafford County FIS (May 2005) was relied upon to identify 100-year flood elevations. Elevations of the 100-year floodplain in the Dover portion of the project area range from 7 to 10 feet (NGVD29). Specific floodplain information is discussed in Section 3.11.3.

3.11.3 Existing Conditions

Town-specific floodplain elevation data as it relates to various locations within the study area is provided in the following sections.

3.11.3.1 Newington

Based on the 2005 FEMA FIS for Rockingham County, there are two flood zones (both AE) in Newington. Because the flood zones were determined by detailed methods, 100-year flood elevations were determined in the FIS. The Piscataqua River's 100-year flood zone along the entire Newington Shoreline has an elevation of 9 feet (NGVD29). This flood zone extends from the City of Portsmouth boundary to just east of the Little Bay bridges. The remaining portion of the Newington shoreline, including Little Bay and Great Bay, has a 100-year flood elevation of 7.2 feet (NGVD29). These elevations were used to assess 100-year floodplain impacts in the Town of Newington.

3.11.3.2 Dover

Based on the 2005 FEMA FIS for Strafford County, there are three flood zones (one zone AE, two zone A) in Dover. Only one of the Dover flood zones was determined by detailed methods (Zone AE), therefore, the two Zone A flood area elevations were interpreted based on FIRM mapping and existing elevations.

The three flood zones within the Dover portion of the project area include the shoreline of the Piscataqua River, the shoreline of Little Bay and Great Bay, and the shoreline of the Bellamy River north of the US 4 bridge. The Piscataqua River flood zone in Dover was determined by approximate methods; therefore no base flood elevations were determined in the FIS. Along the Piscataqua River, Pomeroy Cove is the only area where the 100-year floodplain is likely to be encroached upon by design alternatives based on FIRM mapping. In the vicinity of Pomeroy Cove, the FIRM 100-year flood limit corresponds with the 9-foot NGVD29 elevation based on known existing elevations. This 100-year flood elevation is consistent with the flood elevation of the Piscataqua River in Newington (also 9 feet NGVD29). Therefore, a 9-foot NGVD29 100-year flood elevation was used to assess floodplain impacts along the Piscataqua River in Dover.

The shoreline of Little Bay and Great Bay in Dover has a 100-year flood elevation of 7.0 feet NGVD29, as determined by detailed methods of the Strafford County FIS. Finally, the Bellamy River flood zone in Dover was determined by approximate methods yielding no base flood elevations. Along the Bellamy River, the eastern end of the US 4 bridge is the only area where design alternatives are likely to encroach upon the 100-year floodplain based on FIRM mapping. In the vicinity of the eastern end of the US 4 bridge, the FIRM 100-year flood is somewhat inconsistent, but it corresponds best with 9 to 10-foot NGVD29 elevations based on known existing elevations. These elevations are expected to be higher than the 7-foot NGVD29 elevations in Great Bay because of the US 4 bridge (Scammell Bridge) and the Bellamy River confluence with Great Bay. Therefore, a 10-foot NGVD29 100-year flood elevation (to be conservative) was used to assess floodplain impacts along the Bellamy River in Dover.

3.12 Groundwater Resources

3.12.1 Regulatory Overview

Groundwater resources within the study area consist of stratified-drift aquifers, and the municipal, community, and private supply wells that pump water from them. These groundwater resources are regulated under the New Hampshire Groundwater Protection Act, 1991, which empowers local municipalities to regulate land uses in certain cases.

3.12.2 Methodology

A review of NH GRANIT layers was conducted to determine the location of aquifers, water wells, and wellhead protection areas (WHPA) within the study area. These electronic files were merged with the project base map to create the water resources map **(Figure 3.12-1)**.

3.12.3 Existing Conditions

The most productive aquifers in the study area are composed of stratified-drift deposits as depicted in **Figure 3.12-1**. The potential yields of groundwater from areas within each aquifer are mapped by NH GRANIT according to transmissivity values. Transmissivity is measured in square feet per day and quantifies the ability of an aquifer to transmit water. Aquifer transmissivity is broken down into four categories: 4,000–8,000 sq ft/day; 2,000-4,000 sq ft/day; 1,000–2,000 sq ft/day; and 1–1,000 sq ft/day. Groundwater within the study area is currently classified as GA2, the default classification for areas of known stratified-drift deposits.[56]

Notable within the study area is a large glacial stratified-drift aquifer that occurs under the entire northern portion of the study area in Dover. The majority of this aquifer is mapped with a transmissivity value of 1,000 to 2,000 sq ft/day, relatively low for a stratified-drift formation. Smaller portions of this aquifer directly north of Pomeroy Cove have higher

56 Per NH RSA 485-C:5, Class GA2 shall be assigned to groundwater within aquifers identified as highly productive for potential use as public water supply.

transmissivity values, with potentials of 2,000 to 4,000 and 4,000 to 8,000 sq ft/per day. A stratified-drift aquifer also occurs along the western side of the Newington portion of the study area and is mapped by NH GRANIT with a relatively low transmissivity value of 1 to 1,000 sq ft/day.

Bedrock aquifers contain water available to wells only in fractures in the otherwise crystalline rock. Although bedrock aquifers currently serve as private and public water supplies, variation in the density and location of water-bearing fractures make methodical prospecting for large production wells difficult. According to a review of existing geological mapping and consultations with the NHDES, no high yield bedrock aquifers occur within the study area.

Two private water wells occur in Dover within the northeast portion of the study area as depicted on **Figure 3.12-1.** Data on private wells are supplied to NH GRANIT by the NHDES and were supplemented by field observations.[57] NHDES requires all private wells to maintain a 75-foot radius sanitary protection zone. Private wells must be located at least 75 feet from property boundaries and 75 feet from septic systems and leach fields.

Community wells are operated either by a municipal entity or a group of private citizens who share the cost of installing and operating the wells and treating and delivering the water. No community wells are known to occur within the study area.

WHPAs are created to prevent contamination of groundwater used for drinking water and encompass the surface and subsurface areas that are likely to contribute to underlying groundwater resources. WHPA delineations are based on a standard 4,000-foot radius or a fixed radius based on volume and existing site information. One Phase I wellhead protection area (*i.e.,* a wellhead delineated on the basis of existing information rather than a site-specific hydrogeological investigation) associated with the Pease International Tradeport occurs in the southwestern portion of the study area in Newington.

3.13 Air Quality

3.13.1 Introduction

The Clean Air Act, as amended (CAAA), protects the quality of the nation's air resources at both the federal and state level. It established National Ambient Air Quality Standards (NAAQS) for various criteria pollutants in order to protect the health and welfare of the general public. From a

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57 The NHDES private well database is not a complete record of all private wells. Therefore, although not observed during field work, additional private wells may occur within the study area.

transportation perspective, the primary pollutants of concern are carbon monoxide (CO), volatile organic compounds (VOC's) and oxides of nitrogen (NOx), which are emitted from gasoline and diesel engines. Highway agencies are required to consider the impacts of their projects on a local and a regional level.

CO is a colorless gas that is absorbed through the lungs into the bloodstream, where it interferes with the transport of oxygen from the lungs to other parts of the body. Carbon monoxide concentrations are highest in the immediate vicinity of roadways and intersections and can vary widely over a very short distance. Highest concentrations are generally produced by traffic idling in queues while stopped at signalized intersections. Therefore, CO pollution is assessed at the local level by measuring concentrations in the immediate vicinity of the project area, especially at congested intersections.

Ozone is a highly reactive form of oxygen that irritates mucous membranes and pulmonary tissue. It is a secondary pollutant that is formed by reactions between its precursors, VOC's and NOx, and strong sunlight. Ozone formation also occurs over a period of hours, during which time the precursors can be transported hundreds of miles from the source. Consequently, ozone formation is a regional phenomenon and changes in total VOC and NOx emissions in a given geographical area are the primary concern. Therefore, ozone is analyzed at the regional level through an evaluation of the Transportation Improvement Program (TIP).

The CAAA divided the State into attainment and non-attainment areas with classifications based upon the severity of the air quality problems. The entire project lies within the boundary of the 8-Hour Moderate Ozone Nonattainment Area, as designated by the USEPA in June 2004. The project area is designated as "unclassifiable" attainment for carbon monoxide.

The CAAA also identified 188 air toxics, also known as hazardous air pollutants. The USEPA has assessed this list of toxics and identified a group of 21 as mobile source air toxics (MSATs). The USEPA has also extracted a subset of this list of 21 that it now labels as the six priority MSATs. These are benzene, formaldehyde, acetaldehyde, diesel particulate matter/diesel exhaust organic gases, acrolein, and 1,3-butadiene. Section 4.13.6 contains a discussion of air toxics. Because there is currently a lack of analytical tools to assess these potential impacts, the discussion is qualitative in nature.

3.13.2 Regional Analysis

In order to satisfy the conformity requirements established under the Clean Air Act Amendments of 1990, this project was analyzed, along with other non-exempt projects and regionally significant projects, in a total burden analysis conducted as part of the "FY 2007-2010 Conformity Determinations for Transportation Improvement Programs, Transportation Plans, and Regional Emissions Analysis of Transportation Projects in New Hampshire's Non-Attainment Areas" (January 10, 2007). The conformity determinations were reviewed by the USEPA and approved by the US Department of Transportation (USDOT) in February 2007. Therefore, a separate mesoscale analysis of the project was not conducted for this study.

3.13.3 Project-Specific Analysis

A microscale or site-specific air quality analysis was conducted to determine if the proposed project complies with the CAAA and the State Implementation Plan (SIP)[58] criteria. This analysis focused primarily on existing and future intersection locations where carbon monoxide concentrations would be highest. Intersections were selected through a screening process based on traffic volumes and level of service. Existing (2003) conditions were modeled using the MOBILE 6.2 program[59] to generate emission factors and the CAL3QHC (Version 2.0) program[60] to predict carbon monoxide concentrations at selected receptor locations. The intent was to provide a baseline for comparison to future "Build" and No-Build" scenarios at specific locations in the years 2013 and 2025.

The NAAQS for CO is 35 parts per million (ppm) concentration for a 1-hour period and 9 ppm for an 8-hour period, each not to be exceeded more than once per year. These levels were set to protect the public health. The microscale analysis was conducted using a "Worst Case" modeling protocol since site-specific, long-range meteorological data for the study area were not available. The "Worst Case" scenario results in conservative estimates of predicted concentrations at the selected receptor locations.

3.13.3.1 Dispersion Model

The microscale analysis calculates maximum 1-hour and 8-hour CO concentrations in the project area. The microscale analysis was conducted utilizing the CAL3QHC Version 2 model for free flow and intersection roadway links (USEPA, 1992). CAL3QHC is recommended by the USEPA and is required by USEPA Region I for the air quality analysis of major congested intersections. The CAL3QHC pollution dispersion model calculates the air quality impacts from vehicles in both free-flow and idle operation by creating a three-dimensional model that represents the roadway and receptor geometry. The effect and extent of vehicle queuing on CO levels at each

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58 See 63 Federal Register 67405, December 7, 1998 for the EPA final rulemaking that approved the NH SIP.
59 USEPA, Office of Mobile Sources (2004)
60 USEPA, Office of Air Quality Planning and Standards (1992)

intersection is determined by CAL3QHC at the intersection of analysis by evaluating the following input; the MOBILE6.2 idle emission rates, exhaust emission factors, total signal cycle time, effective red time, volumes, roadway geometry, and capacity of the intersection (USEPA, 2004).

3.13.3.2 Analysis Sites

The objective of the microscale analysis was to evaluate the CO concentrations at congested intersections in the study area during the peak CO season (winter). Alternatives 10A, 12A, 13, 2, and 3 will create new signalized intersections in the study area, which are identified below. The microscale analysis calculated existing CO concentrations at the new intersection locations to provide a basis for comparison to the future build CO concentrations. The existing and new intersections in the study area were ranked based on traffic volumes and level of service under the various Build Alternatives. The following intersections (depicted in **Figures 3.13-1 and 3.13-2**) were selected for analysis because they represent the most congested intersections that are most likely to be affected by project-related traffic in the study area:

Newington

1. Spaulding Turnpike Exit 3 Northbound Ramps at Woodbury Avenue Extension (Alternatives 10A, 12A, and 13, New Signalized Intersection)
2. Spaulding Turnpike Exit 3 Southbound Ramps at Woodbury Avenue Extension (Alternatives 10A and 12A, New Signalized Intersection)
3. Local Connector at Woodbury Avenue Extension (Alternatives 10A and 12A, New Signalized Intersection)
4. Spaulding Turnpike Exit 3 Southbound Ramps at Woodbury Avenue Extension (Alternative 13, New Signalized Intersection)

Dover

1. Dover Point Road at US 4 (Alternatives 2 and 3)
2. Spaulding Turnpike Exit 6 Northbound Ramps at US 4 (Alternatives 2 and 3, New Signalized Intersection)
3. Spaulding Turnpike Exit 6 Southbound On-Ramp at US 4 (Alternatives 2 and 3, New Signalized Intersection)

An additional receptor location in both Newington and Dover, representing the highway right-of-way, was also included in the analysis. Receptor locations were located along the right-of-way, where the highest traffic volumes on the Spaulding Turnpike mainline occur.

The receptor locations were placed in areas where the public is likely to be present. Typically, the receptor locations were placed at the edge of the roadway, but not closer than 10 feet from the nearest travel lane, so that they were not within the roadway mixing cell.[61]

The USEPA guidelines call for locating up to five receptor sites for each intersection quadrant, starting at the intersection and locating additional receptor sites at approximately 75-foot increments. This ensures that the worst-case CO values at an intersection will be modeled. In addition to the required receptor sites, another receptor site (location 15) was added at the highway right-of-way line on the west side of NH 16 in Newington. This receptor location provides a CO value that is representative of the worst-case CO concentrations all along the right-of-way in the study area.

The microscale analysis evaluated over 100 receptor sites near the intersections. Of these, 24 receptor locations were selected in the study area to represent the receptor sites. These receptor locations are shown on **Figures 3.13-3 and 3.13-4**. These values represent the highest concentrations for each quadrant of each intersection. Receptor locations located farther away from the intersections will have lower concentrations because of the CO dispersion characteristics. Receptors that are along major roadways (Spaulding Turnpike, Woodbury Avenue, Shattuck Way, Dover Point Road, and US 4) are also expected to have lower CO concentrations, because the emission factors for vehicles traveling along these roadways are much lower than the emission rates for vehicles queuing at intersections.

The 1-hour CO concentrations were calculated directly from the USEPA computer model, using peak hour traffic and emission data. The 8-hour CO concentrations were derived by applying a persistence factor of 0.7 to the 1-hour CO concentrations. USEPA recommends the use of a 0.7 persistence factor when monitoring data for a local area are not available.

3.13.3.3 Emission Factors

The vehicle emission factors used in the microscale analysis were obtained using the USEPA MOBILE6.2 computer model. MOBILE6.2 calculates CO emission factors for motor vehicles in grams per vehicle-mile. The emission factors calculated in this study were adjusted to reflect New Hampshire- specific conditions such as temperatures representative of the winter CO season (30° F). The detailed MOBILE6.2 input and output data are available upon request.

61 The roadway mixing cell is considered to be an area of uniform emissions and turbulence that includes the travel lanes and ten feet on each side.

3.13.3.4 Worst Case Meteorological Conditions

The worst case meteorological conditions, including wind speed, stability class, ambient temperature, and persistence factor were selected and utilized for the microscale analysis peak one-hour period as follows:

- Wind Speed: 3.3 feet per second
- Wind Direction: Worst Case wind angle search
- Wind Angles: 10-degree increments from 0 to 360 degrees
- Stability Class: D
- Temperature: 30 degrees Fahrenheit
- Mixing Height: 3,280 feet

CO Background Values

The CO concentrations presented in the results include background CO concentrations. The background concentrations are the constant and diffuse levels of CO that is typically present due to numerous sources throughout the area. A background CO concentration of 2.0 ppm was used for both the 1-hour and 8-hour analysis.

3.13.4 Model Predictions

Table 3.13-1 presents the Newington maximum predicted 1-hour and 8-hour CO concentrations for the 2003 Existing condition. Table 3.13-2 presents the Dover maximum predicted 1-hour and 8-hour CO concentrations for the 2003 Existing condition at the various intersections.[62] The air quality study in Chapter 4 evaluates the existing conditions, the estimated year of project opening, and the design year. The CO concentrations for the future years included No-Build and Build Alternatives. The maximum one-hour and eight-hour concentrations were estimated at each analysis site. The microscale analysis demonstrated that the CO results meet the National Ambient Air Quality Standards.

62 The CO concentrations for existing conditions were calculated at some intersections that currently do not exist to provide a basis for comparison to the future build CO concentrations.

Table 3.13-1
Newington Predicted Maximum Existing CO Concentrations (Parts per Million)[1]

Receptor No. and Location[2, 3]	1-Hour Existing	8-Hour Existing
Spaulding Turnpike Exit 3 Northbound Off Ramp at Woodbury Avenue Extension		
1. Southeast Corner	5.5	4.5
2. Northeast Corner	4.2	3.5
3. Northwest Corner	4.8	4.0
4. Southwest Corner	7.8	6.1
Spaulding Turnpike Exit 3 Southbound Ramps at Woodbury Avenue Extension		
5. Northeast Corner	2.7	2.5
6. Northwest Corner	2.6	2.4
7. South Corner	2.7	2.5
Local Connector at Woodbury Avenue Extension		
8. Southeast Corner	2.6	2.4
9. Northeast Corner	2.6	2.4
10. West Corner	2.5	2.4
Spaulding Turnpike Exit 3 Southbound Ramps at Woodbury Avenue Extension		
11. Northeast Corner	2.5	2.4
12. Northwest Corner	2.5	2.4
13. Southwest Corner	2.5	2.4
14. Southeast Corner	2.6	2.4
Spaulding Turnpike		
15. Right of Way	3.0	2.7

Notes:
1 The concentrations are expressed in parts per million (ppm) and include a background concentration of 2.0 ppm. The 1-hour NAAQS for CO is 35 ppm and the 8-hour NAAQS for CO is 9 ppm.
2 The air quality study assumes that if these intersections meet the NAAQS, then all other intersections, regardless of alternative, which will have lower volumes and better levels of service, can be assumed to also meet the NAAQS.
3 See **Figure 3.13-3** for locations.

Table 3.13-2
Dover Predicted Maximum Existing CO Concentrations (Parts per Million)[1]

Receptor No. and Location[2, 3]	1-Hour Existing	8-Hour Existing
Dover Point Road at US 4		
1. Southeast Corner	3.8	3.3
2. North Corner	3.9	3.3
3. Southwest Corner	3.8	3.3
Spaulding Turnpike Exit 6 Northbound Off Ramp at US 4		
4. Southeast Corner	4.2	3.5
5. Northeast Corner	4.9	4.0
6. Northwest Corner	5.5	4.5
7. Southwest Corner	6.8	5.4
Spaulding Turnpike Exit 6 Southbound On Ramp at US 4		
8. Southeast Corner	3.7	3.2
9. North Corner	4.7	3.9
10. Southwest Corner	3.6	3.1
Spaulding Turnpike		
11. Right of Way	3.0	2.7

Notes:
1 The concentrations are expressed in parts per million (ppm) and include a background concentration of 2.0 ppm. The 1-hour NAAQS for CO is 35 ppm and the 8-hour NAAQS for CO is 9 ppm.
2 The air quality study assumes that if these intersections meet the NAAQS, then all other intersections, regardless of alternative, which will have lower volumes and better levels of service, can be assumed to also meet the NAAQS.
3 See **Figure 3.13-4** for locations.

3.14 Noise Environment

3.14.1 Introduction

NHDOT[63] and FHWA[64] noise impact assessment procedures for Type I projects were used to identify receptor locations, to predict existing and future highway noise levels, to determine project noise impacts, and to evaluate noise mitigation measures in the Spaulding Turnpike (Newington to Dover) improvement project area. A Type I project is a highway project that results in the construction of a new highway or the physical alteration of an existing highway that substantially changes either the horizontal or vertical alignment or increases the number of through travel lanes.

63 *Policy and Procedural Guidelines for the Assessment and Abatement of Highway Traffic Noise for Type I Highway Projects*, New Hampshire Department of Transportation, July 1996.
64 *Procedures for Abatement of Highway Traffic Noise and Construction Noise*, Federal Highway Administration's 23 CFR, 772.

While the complete results of this modeling effort are reported in Chapter 4, the information below provides a characterization of the existing noise environment in the study area.

3.14.2 Methodology

3.14.2.1 Background

Noise is defined as unwanted or excessive sound. Sound becomes unwanted when it interferes with normal activities such as sleep, work, or recreation. The individual human response to noise is subject to considerable variability since there are many emotional and physical factors that contribute to the differences in reaction to noise.

Sound (noise) is described in terms of loudness, frequency, and duration. Loudness is the sound pressure level measured on a logarithmic scale in units of decibels (dB). For community noise impact assessment, sound level frequency characteristics are based upon human hearing, using an A-weighted (dBA) frequency filter. The A-weighted filter is used because it approximates the way humans hear sound. Table 3.14-1 presents a list of common indoor and outdoor sound levels. The duration characteristics of sound account for the time-varying nature of sound sources.

The most common way to account for the time-varying nature of sound (duration) is through the equivalent sound level measurement, referred to as L_{eq}. The L_{eq} averages the background sound levels with short-term transient sound levels and provides a uniform method for comparing sound levels that vary over time. The time period used for highway noise analysis is typically one hour. The peak hour L_{eq} represents the noisiest hour of the day/night and usually occurs during the peak periods of automobile and truck traffic. The FHWA guidelines and criteria require the use of the one-hour L_{eq} for assessing highway noise impacts on different land uses.

The following general relationships exist between hourly traffic noise levels and human perception:

- A 1 or 2 dBA increase/decrease is not perceptible to the average person.
- A 3 dBA increase/decrease is a doubling/halving of acoustic energy, but is just barely perceptible to the human ear.
- A 10 dBA increase/decrease is a tenfold increase/decrease in acoustic energy, but is perceived as a doubling/halving in loudness to the average person.

Table 3.14-1
Indoor and Outdoor Sound Levels[1]

Outdoor Sound Levels	Sound Pressure (μPa)[2]		Sound Level (dBA)[3]	Indoor Sound Levels
	6,324,555	-	110	Rock Band at 15 ft.
Jet Over-Flight at 1000 ft.		-	105	
	2,000,000	-	100	Inside New York Subway Train
Gas Lawn Mower at 3 ft.		-	95	
	632,456	-	90	Food Blender at 3 ft.
Diesel Truck at 50 ft.		-	85	
Noisy Urban Area—Daytime	200,000	-	80	Garbage Disposal at 3 ft.
		-	75	Shouting at 3 ft.
Gas Lawn Mower at 100 ft.	63,246	-	70	Vacuum Cleaner at 10 ft.
Suburban Commercial Area		-	65	Normal Speech at 3 ft.
	20,000	-	60	
Quiet Urban Area—Daytime		-	55	Quiet Conversation at 1 m
	6,325	-	50	Dishwasher Next Room
Quiet Urban Area—Nighttime		-	45	
	2,000	-	40	Empty Theater or Library
Quiet Suburb—Nighttime		-	35	
	632	-	30	Quiet Bedroom at Night
Quiet Rural Area—Nighttime		-	25	Empty Concert Hall
Rustling Leaves	200	-	20	
		-	15	Broadcast and Recording Studios
	63	-	10	
		-	5	
Reference Pressure Level	20	-	0	Threshold of Hearing

Notes:
1 Highway Noise Fundamentals, Federal Highway Administration, September 1980.
2 μPA -- MicroPascals describe pressure. The pressure level is what sound level monitors measure.
3 dBA -- A-weighted decibels describe pressure logarithmically with respect to 20 μPa (the reference pressure level).

The FHWA-established noise abatement criteria protects the public health and welfare from excessive vehicle traffic noise. Traffic noise can adversely affect human activities such as communication. Recognizing that different areas are sensitive to noise in different ways, the FHWA has established Noise Abatement Criteria (NAC) according to land use. The NAC are described in Table 3.14-2. The NHDOT and FHWA consider a receptor location to be impacted by noise when existing or future sound levels approach (within 1 dBA), are at, or exceed the NAC, or when future sound levels exceed existing sound levels by 15 dBA or more. It is generally considered that a 0-5 dBA increase/ decrease represents a slight change in noise levels, a 6-14 dBA increase/decrease represents a moderate change in noise levels, and a 15 dBA or greater increase/decrease represents a substantial change in noise level. The feasibility of noise mitigation is evaluated when noise impacts are identified at receptor locations.

Table 3.14-2
Noise Abatement Criteria — One-Hour, A-Weighted Sound Levels in Decibels (dBA)[1]

Activity Category	$L_{eq}(h)$[2]	Description of Activity Category
A	57 (Exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purposes.
B	67 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (Exterior)	Developed lands, properties, or activities not included in Categories A or B above.
D	--	Undeveloped lands
E	52 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

Notes:
1 23 CFR 772 - *Procedures for Abatement of Highway Traffic Noise and Construction Noise.*
2 $L_{eq}(h)$ is a energy-averaged, one-hour, A-weighted sound level in decibels (dBA).

3.14.2.2 Study Methodology

The study area was evaluated to identify receptor locations that have outdoor activities that might be sensitive to highway noise. In evaluating the Spaulding Turnpike corridor, the study area was subdivided into approximately fourteen (14) areas containing receptor locations that are sensitive to highway noise.

Within the 14 areas, approximately 299 receptor locations were identified along the existing Spaulding Turnpike corridor from Newington to Dover. Table 3.14-3 presents the areas and the numbers of receptor locations. The areas, which predominately included outdoor ground level areas between the roadways and the buildings, are shown in **Figure 3.14-1.** Most of the receptor locations (residences) fall into the FHWA's "Activity Category B", which has a noise abatement criterion of 67 dBA. Other land uses, such as commercial buildings, (*i.e.,* those that do not involve temporary overnight residence), are in FHWA "Activity Category C" which has a noise abatement criterion of 72 dBA.

A sound level program was conducted to obtain a sampling of the existing sound levels in the Spaulding Turnpike corridor and to provide a database for calibrating the noise model. The noise monitoring was conducted at eight receptor locations, typically residences, in October of 2003 and June of 2005. These noise measurements were collected in conformance with the

FHWA noise monitoring guidelines[65]. Traffic data (except for the June 2005 measurement) were obtained at the same time as the sound level data. This traffic data included traffic volumes, vehicle mix (automobiles, medium trucks, and heavy trucks), and operating speeds. Noise sources in the study area included vehicles on the Spaulding Turnpike and vehicles on local roadways. **Figure 3.14-1** presents the location of the noise monitoring sites.

Table 3.14-3
Areas and Receptor Locations

Area Number	Areas	Number of Receptor Locations Represented
Area 1	Fox Run Road – Newington	2
Area 2	Old Dover Road – Newington	5
Area 3	Patterson Lane – Newington	10
Area 4	Nimble Hill Road – Newington	25
Area 5	Shattuck Way – Newington	5
Area 6	Bloody Point – Newington	5
Area 7	Hilton Park – Dover	1
Area 8	Wentworth Terrace – Dover	20
Area 9	Dover Point Road – Dover	60
Area 10	Boston Harbor Road – Dover	25
Area 11	Cote Drive – Dover	60
Area 12	Bayview Park – Dover	1
Area 13	Clearwater Drive – Dover	55
Area 14	Homestead Lane – Dover	25
	Totals	299

3.14.2.3 Existing Conditions

Sound Level Measurements

Table 3.14-4 presents the results of the noise monitoring program and the predicted results from the Traffic Noise Model (TNM). Little to no difference between the monitored results and the predicted results confirms that the Traffic Noise Model has been calibrated properly.

The existing sound levels for the study area were calculated using the TNM that was calibrated based upon the noise monitoring data. The results presented in Table 3.14-5 represent the range of sound levels in the study area that have been calculated using the existing peak hour traffic data. The highest sound levels will occur at receptor locations adjacent to the Spaulding Turnpike. The sound levels at the lower end of the range will occur at receptor locations further away. The study area includes a diversity

65 *Measurement of Highway-Related Noise*, US Department of Transportation, Federal Highway Administration, FHWA-PD-96-046, May 1996.

of building types, such as, residential, commercial, and public buildings. The results of the noise analysis demonstrate that a majority of the non-commercial receptor locations currently experience sound levels that approach, are at, or exceed the NAC.

Table 3.14-4
Noise Model Calibration Data

Monitoring Location Number	Monitoring Site[1]	Monitored	Predicted	Difference[3]
M1	Nimble Hill Road – Newington	64	65	+1
M2	Old Dover Road – Newington	62	64	+2
M3	Wentworth Terrace – Dover	68[2]	69[2]	+1
M4	Dover Point Road – Dover	72[2]	71[2]	-1
M5	Homestead Lane – Dover	55	57	+2
M6	Spur Road – Dover	63	64	+1
M7	Boston Harbor Road – Dover	76[2]	75[2]	-1
M8	Trickys Cove – Newington	54	—[4]	—

Notes:
1 The monitoring sites are depicted in **Figure 3.14-1** .
2 The sound level approaches, is at, or exceeds the FHWA noise abatement criterion.
3 Predicted minus Monitored.
4 Measurement site only, no predicted values calculated.

Table 3.14-5
Existing Sound Levels (dBA)

Area Number[1]	Receptor Type	Areas	Range of Existing Sound Levels
Area 1	Commercial/Church	Fox Run Road – Newington	58-67[2]
Area 2	Residential/Commercial	Old Dover Road – Newington	51-59
Area 3	Residential/Commercial	Patterson Lane – Newington	39-47
Area 4	Residential	Nimble Hill Road – Newington	52-54
Area 5	Residential/Commercial	Shattuck Way – Newington	50-68[2]
Area 6	Residential	Bloody Point – Newington	53-57
Area 7	Park	Hilton Park – Dover	57-67[2]
Area 8	Residential	Wentworth Terrace – Dover	59-71[2]
Area 9	Residential	Dover Point Road – Dover	55-70[2]
Area 10	Residential	Boston Harbor Road – Dover	54-63
Area 11	Residential	Cote Drive – Dover	49-71[2]
Area 12	Park	Bayview Park – Dover	40-56
Area 13	Residential	Clearwater Drive – Dover	44-66[2]
Area 14	Residential	Homestead Lane – Dover	54-68[2]

Notes:
1 Areas Presented in **Figure 3.14-1**
2 The sound level approaches, is at, or exceeds the FHWA noise abatement criterion.

3.15 Community Resources

3.15.1 Regulatory Overview

Potential impacts of USDOT-funded projects on publicly owned parks and recreation areas, waterfowl and wildlife refuges and privately or publicly-owned historic resources must be addressed under the Section 4(f) provision of the National Transportation Act of 1966. Under Section 4(f) of the Department of Transportation Act as amended by the Federal-Aid Highway Act of 1968 (Public Law 90-495, 49 USC 1653), the Secretary of Transportation shall not approve any program or project which "requires the use of any publicly owned land from a public park, recreation area, or wildlife and waterfowl refuge of national, state, or local significance as so determined by federal, state, or officials having jurisdiction thereof, or any land from a historic site of national, state or local significance as so determined by such officials unless (1) there is no feasible and prudent alternative to the use of such land, and (2) such program includes all possible planning to minimize harm to such park, recreation area, wildlife and waterfowl refuge, or historic site resulting from such use."

In addition, properties which have received funding under the Land and Water Conservation Act (LWCF), as administered by the United States Department of Interior (USDOI), require special evaluation including specific requirements for mitigation under Section 6(f) of the LWCF. 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. The US Department of the Interior, National Park Service has jurisdiction over these lands. Section 6(f) lands cannot be converted to another use without replacement by land that is of comparable value and use. The NH Department of Resources and Economic Development (NHDRED), Division of Parks and Recreation, maintains a list of lands acquired or improved with Land and Water Conservation Funds in New Hampshire.

NH RSA 4:30-a requires that impacted municipally-owned recreation or conservation lands be replaced. The RSA states that when the state of New Hampshire acquires any municipal conservation or recreation land, it shall transfer to the affected municipality other comparable land and facilities to the extent feasible, or shall grant to the municipality sufficient funds to acquire comparable lands.

In addition, the New Hampshire Land Conservation Investment Program (LCIP), under NH RSA 162-C:6 is responsible for monitoring the condition and status of 80 state held conservation easements (approximately 25,880 acres) acquired through the LCIP during the late 1980's and early

1990's. Coordination with the NHOEP and the Council on Resources and Development (CORD) is necessary if NHDOT needs to acquire any such properties for highway purposes.

3.15.2 Methodology

Information on public parks, recreation areas, and conservation lands was obtained through field reconnaissance, interviews with City of Dover and Town of Newington officials, NHDRED, and the NHOEP. See Section 3.17 for a detailed description of the historic resources, all of which are potentially 4(f) resources. **Figure 3.15-1** shows the locations of the resources discussed in this section.

3.15.3 Existing Conditions

3.15.3.1 Municipal/Public Facilities

Newington

The only public building in Newington within the study area is the Newington School, located on Nimble Hill Road just west of the Coleman Drive intersection. This is an elementary school with an enrollment of approximately 60 students in Kindergarten through Grade Six. Three other facilities, the Newington Town Hall, including the fire and police stations, Langdon Public Library, and a cemetery, are all located just west of the study area along Nimble Hill Road. There is also a Town-owned boat landing located at the end of Patterson Lane on the Piscataqua River.

In addition to the Pease International Tradeport, another state facility in Newington within the study area is the NH Air National Guard Station, located at the Tradeport along Arboretum Drive. A portion of the grounds of the Veterans Affairs Portsmouth Outpatient Clinic, a federal facility, is also located within the Tradeport, immediately adjacent to the study area on Newmarket Street.

Dover

There are three publicly owned facilities in Dover within the study area: the NHF&GD's Bayview Park, between Spur Road and the Bellamy River, the state's Hilton Park at Dover Point (see below for description of these two parks), and a NH Motor Vehicle Registry Office on Boston Harbor Road.

3.15.3.2 Parks, Recreation, and Conservation Lands

Review of the study area by NHOEP and NHDRED staff indicates that no LCIP or LWCF [Section 6(f)] properties are present within the study area. There are, however, several recreational resources in the study area as described below.

Newington

The only known public recreational resource in Newington within the study area is the Town Boat Landing at the end of Patterson Lane, a publicly-owned recreational site maintained by the Town of Newington. The Patterson Lane boat ramp is located on the Piscataqua River at the eastern extent of Patterson Lane. At the boat ramp, Patterson Lane ends at a turnaround that accommodates vehicles with trailers. A small grassy park area with a flagpole is adjacent (east) of the boat ramp, which faces the northwest. The boat ramp and turnaround area is well posted notifying users that the ramp is restricted to residents, and that parking is by resident permit only per the Board of Selectmen. The boat ramp's surface is fairly steep, consisting of asphalt construction. A trash barrel is located adjacent to the ramp, which appears to be emptied regularly.

The Murray Easement, a 0.6-acre parcel protected by a conservation easement, is located on the southeast shore of Trickys Cove. A portion of this property was recently transferred to NHDOT to allow for construction of the Interim Improvement Project (see Section 2.4). West of Trickys Cove is a 14-acre (±) parcel known as the Beane Tract, which was recently acquired by fee ownership by the Great Bay Partnership, a coalition of State and Federal agencies and private organizations. The parcel is now primarily managed by the NHF&GD as conservation land.

Dover

There are two public parks in the Dover portion of the study area: Hilton Park (owned by NHDOT) located on Dover Point and Bayview Park (owned by NHF&GD) located between Spur Road and the Bellamy River.

Hilton Park was created in 1938 following the General Sullivan Bridge construction. It contains a public fishing pier and boat launch, mowed lawns and picnic area, playground, parking lot, and a one-way interior road that wraps around the Point from west to east.

Bayview Park is a popular spot for fishermen to gain access to the shoreline of the Bellamy River adjacent to the Scammell Bridge.

Other than Hilton Park and Bayview Park, there are no known recreation or conservation lands within the Dover portion of the study area.

3.16 Aesthetic and Visual Resources

During the public scoping process, comments were received that described the Spaulding Turnpike through the study area as the veritable "gateway" to New Hampshire's north country. Starting at the south end of the study area in Newington and traveling northward, the view from the highway to the east includes a highly commercialized landscape, including several shopping plazas and malls. Blocks of natural vegetation and highway landscaping provide some screening. However, just south of the Little Bay Bridge, one gets a very picturesque and panoramic view of mountains in the distance and the arched General Sullivan Bridge and Little Bay Bridges in the foreground. Approaching and then crossing over the northbound Little Bay Bridge, one has an exceptional view of the broad waters of the Piscataqua River and Hilton Park. In the summer months, the manicured lawns of Hilton Park and its pier, as well as boats in the river, provide a very scenic viewscape.

Crossing over the northbound Little Bay Bridge, the two-lanes of traffic of the southbound bridge and superstructure of the General Sullivan Bridge partially block the view of Little Bay to the west. Reaching Dover Point, the natural vegetation in the highway median dominates the viewshed. Also visible are homes lining both shorelines of Dover Point to the west and east. Continuing northward, the multiple lanes of highway, including the Exit 6 ramps for US 4 and Dover Point Road, begin to dominate the view from the roadway; small blocks of forested areas are visible within the interchange and immediately adjacent to the highway. Continuing on to the toll plazas, a line of trees provides an effective screen on both sides of the highway.

In the southbound direction, the views are as described above with the exception that the extensive shoreline and waters of Little Bay are more readily visible in the distance as one approaches and then crosses the southbound Little Bay Bridge. On the bridge itself, one's view is again partially obstructed by the superstructure of the General Sullivan Bridge. Continuing southward into Newington, the view along the west side of the Turnpike is once again dominated by natural vegetation, including mowed highway areas. Other features include the convenience/service station at Nimble Hill Road, a field in the center of the median area, an abandoned drive-in theatre site now grown over into a shrubland and young forest; and a practically uninterrupted block of forest all the way to Exit 1. This view is in stark contrast to the views on the east side of the highway, previously described.

Relative to views of the highway from residential neighborhoods, homes along streets on the eastern side of Dover Point are today largely screened by natural vegetation. On the western side of Dover Point, views from homes on Boston Harbor Road are either screened by blocks of forest or mature trees in their front yards. On the Newington end, residential neighborhoods are far removed from the highway. East of the Turnpike, they are separated from it by commercial/industrial developments located along the highway. West of the Turnpike, views from the Nimble Hill Road neighborhood are screened by natural vegetation and the commercial establishments near its intersection with the Turnpike.

3.17 Cultural Resources

3.17.1 Regulatory Overview

3.17.1.1 Federal Requirements

Historic properties and archaeological resources, that are listed in or are eligible for listing in the National Register of Historic Places, are afforded protection by Section 106 of the National Historic Preservation Act (NHPA) and Section 4(f) of the Department of Transportation Act of 1966.

National Historic Preservation Act

Congress enacted the NHPA in 1966 to ensure that the effects of federal, federally-funded, or federally-permitted projects on historic and archaeological resources, structures, and districts are considered. Through the NHPA, amended in 1976, 1980, and 1992, Congress sought to involve the federal government as an active participant in the nation's preservation efforts.

Section 106 of the NHPA requires Federal agencies to take into account the effects of their activities and programs on any historic district, site, building, structure, or object that is included, or eligible for inclusion, in the National Register of Historic Places. The resources and the effects on those resources are evaluated by the State Historic Preservation Officer (SHPO) and the Federal agencies having jurisdiction, in this case the FHWA, the lead agency. In New Hampshire, the SHPO is the director of the New Hampshire Division of Historical Resources (NHDHR). Prior to the approval of the undertaking, the agency must afford the Advisory Council on Historic Preservation (ACHP), established under Title II of the NHPA, a reasonable opportunity to comment on the undertaking.

The procedures followed in the Section 106 review are referred to as the "Section 106 process" and are set forth in regulations issued by the ACHP. The ACHP's regulations, *Protection of Historic Properties* (36 CFR 800) govern the Section 106 process. The ACHP does not have the authority to halt or terminate projects that will affect historic properties; rather, its regulations emphasize consultation among the responsible Federal agencies, the SHPO, and other interested, consulting parties, to identify, evaluate eligibility, determine the potential effect of the project on historic properties, and if possible, to agree upon ways to protect the affected properties through avoidance and/or through minimization or mitigation of the effects.

Opportunities for Public Participation Under Section 106

In addition to the participation of Federal and State agencies in the Section 106 review process, the 1999 regulations of 36 CFR 800 require that the Federal agencies consult with the public about the projects and their effects on historic properties. The segment of the public specifically involved in the consultation process under these regulations generally includes immediately affected property owners; local and statewide historical, archaeological, preservation, heritage, and planning organizations; and the Native American community. It is the responsibility of the lead Federal agency to seek out and notify interested parties and to provide adequate opportunity for these groups to receive information on the project and share their views. Typically, those individuals and organizations request consulting party status in writing from FHWA, and receive notification of their consulting party status. Consulting parties are notified of public meetings involving the project and meetings held to specifically discuss historical issues related to the project. The comments from consulting parties involving historical properties are taken into account during the design stage.

In addition, with the exception of precise archaeological sites, the information on historical properties developed by State and Federal agencies for this project is available to the community, citizens, and local officials, should they elect to enact ordinances protecting historic properties. The material can also be incorporated into the community master plan to identify historical resources and preserve them for future enrichment of the community.

Section 4(f) of the Department of Transportation Act

Section 4(f) of the Department of Transportation Act of 1966 (49 USC 303) states that "…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." Regulations governing 4(f) implementation specify that there can be no taking of public-park or recreation lands or impairment of wildlife and waterfowl refuges or historic sites without a thorough investigation of all prudent and feasible alternatives. Such alternatives may range from project modifications to "No-Build." If it is determined that no prudent and feasible alternative exists and that public park or recreational lands, wildlife and waterfowl refuges, or historic sites must be acquired or impaired, the FHWA must demonstrate that implementation of other alternatives would result in extraordinary costs, and/or social, economic, or environmental impacts. In addition, the proposed project or program must include all possible planning to minimize harm to these historic properties and other resources.

3.17.1.2 State Requirements

The NHDHR is charged under RSA 227-C:9, Directive for Cooperation in the Protection of Historic Resources, to coordinate the identification and evaluation of cultural resources in the state of New Hampshire.

NHDHR, in cooperation with NHDOT and FHWA, has established a method of identification and evaluation to meet the requirements of historic preservation review, a responsibility established under RSA 227-C:9. The purposes of this process are to (1) locate and identify historical, architectural, archaeological, and historical archaeological resources within the project's impact area; (2) apply the criteria for evaluation of significance to a resource to determine possible eligibility to the National Register of Historic Places (National Register), if not previously determined eligible or listed; (3) assess the probable effects of a project on resources listed on or eligible for, the National Register; and (4) avoid historic properties and/or develop appropriate mitigation or minimization methods to lessen the project's impact on affected historic properties.

NHDHR prepared "Procedures for Identifying Cultural Resources That May Be Affected by State or Federal Transportation Projects in New Hampshire" in November 1992. These procedures were updated in 2001 and 2003. This document offers specific guidance for cultural resource survey efforts undertaken as a component of transportation improvement projects.

3.17.2 Historic Architectural Resources

3.17.2.1 Methods and Procedures

Survey

All work was done in accordance with the methodology created to identify historical and architectural resources, adopted by the NHDOT, the NHDHR, and the FHWA in October 1991. The methodology used to identify archaeological resources is addressed separately in Section 3.17.3.

Initial study addressed through a Project Area Form was done to form a large-scale overview for understanding contexts in which to identify and review individual historic resources. A "windshield survey" was conducted in the fall of 2002. Every property believed to be over fifty years old within the study area was photographed and located on the base map. A historic context was created to enable the interpretation of the significance of these properties.

The second phase of study involved in-depth survey of all properties built before ca. 1955 located within potential impact areas of the project. Individual properties were documented on NHDHR Individual Inventory Forms. Most properties were surveyed at the intensive level; those which completely lacked integrity were recorded on reconnaissance-level forms. Several small groups of related structures were recorded on NHDHR Area Forms.

To provide context and comparative information for the review of individual resources in the town of Newington, a Newington Townwide Area Form was completed according to NHDHR methodology. A Dover Townwide Area Form was completed in 1999 as part of the Dover-Rochester-Somersworth Exit 10 Project. Identification of properties in Newington was aided by the town-wide survey conducted in 1981 by the Strafford Rockingham Regional Council.

A total of ninety-four (94) properties were surveyed individually and five area forms were prepared for groups of properties and the railroad spur. Of these, sixteen individual properties and two small historic districts were determined eligible for the National Register of Historic Places by a Determination of Eligibility Committee as discussed below. All are listed in Table 3.17-1 and depicted in **Figure 3.17-1**.

Determination of National Register Eligibility

The intensive level survey information was deemed sufficient to determine significance and eligibility for the National Register of Historic Places. The Determination of Eligibility (DOE) Committee, comprised of representatives from NHDOT, NHDHR, and FHWA, met on numerous occasions (see Section 8.2). All final determinations of National Register eligibility were made by consensus. The resulting DOE forms for each eligible property within the project area are on file with each agency and included in Appendix G.

The criteria (36 CFR Part 60) by which National Register eligibility is determined are:

Criterion A: Resources that are associated with events or trends that have made a substantial contribution to the broad patterns of our history.

Criterion B: Resources that are associated with the lives of persons substantial in our past.

Criterion C: Resources that embody the distinctive characteristics of a type, period or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a substantial and distinguished entity whose components may lack individual distinction.

Criterion D: Resources that have yielded, or may be likely to yield, information important in prehistory or history.

To be eligible for inclusion, resources must also retain integrity, defined as the quality of location, setting, design, materials, workmanship, feeling and association sufficient to clearly convey a property's history and significance.

In addition, there are Criteria Exceptions for properties that are generally not eligible for the National Register. There are exception circumstances under which these properties may be found eligible. Several properties were evaluated under these criteria exceptions (F & G).

Criterion Exception F for commemorative properties states that a property can be eligible if design, age, tradition or symbolic value has invested it with its own significance. Criterion Exception G states that properties less than fifty years old may be eligible if of exceptional significance.

Sixteen individual properties and two small historic districts were determined eligible for listing on the National Register of Historic Places.

3.17.2.2 Historic Context of Study Area

The following narrative is taken from the Project Area Form completed in 2004. Additional text on the significance of the architectural development of the area is available from NHDOT and NHDHR.

Table 3.17-1
List of Surveyed Potentially Historic Properties and Districts

DHR #	Tax # Map/ Parcel	Street #	Street Name	Date (circa)	Description: Name, type	Eligibility/ NR Criteria	Eligible acreage
NWN0008	13/9		Off Patterson Lane	ca. 1800	Rollins family cemetery	No	
NWN0009	19/13		Old Dover Road	ca. 1841	Dow family cemetery	No	
NWN0010	26/5		Off Woodbury Avenue	ca. 1842	Smith family tomb	No	
NWN0011	12/13		Off Spaulding Turnpike	ca. 1845	Downing family cemetery	No	
NWN0148	12/10	97-105	Nimble Hill Road	1887	Benjamin S. Hoyt House and barn, Italianate	Yes / A + C	19.6
NWN0149	12/5	84	Nimble Hill Road	mid 20th	Altered bungalow	No	
NWN0152	12/3	62	Nimble Hill Road	1940	Ranch	No	
NWN0159	7/3		Off Nimble Hill Road	mid 20th	Cape, vacant	No	
NWN0161	7/2		Off Spaulding Turnpike	mid 20th	Ranch, vacant	No	
NWN0162	7/5	1223	Spaulding Turnpike	mid 20th	Cottage, vacant, remodeled	No	
NWN0163	7/4		Off Spaulding Turnpike	1945	Cottage, enlarged, vacant	No	
NWN0168	-	-	Bloody Point Road, former railroad ROW	1873	Newington Railroad Depot/ Toll House	Yes / A + C	5.8
NWN0172	7/12	196	Shattuck Way	1940	Former filling station	No	
NWN0176	7/13	170	Shattuck Way	1940	Cavaness House	No	
NWN0177	7/16	147	Shattuck Way	1940	Kershaw/Johnson House, cape	No	
NWN0181	13/3	115	Shattuck Way	1940	Cape	No	
NWN0183	19/5	21	Shattuck Way	1955	Commercial	No	

Table 3.17-1 (continued)

DHR #	Tax # Map/ Parcel	Street #	Street Name	Date (circa)	Description: Name, type	Eligibility	Eligible acreage
NWN0199	13/9	58	Patterson Lane	1940 / 1970s	Wall Cottage, altered	No	
NWN0201	13/11	48	Patterson Lane	1738	John Downing House and Barn	Yes / A + C	3.0
NWN0204	19/9	2299	Woodbury Avenue	1903	Beane Farm	Yes / C	8.22
NWN0205	19/1A	2204	Woodbury Avenue	1820/ 1880s	Isaac Dow House, Federal/Italianate	Yes / C	0.57
NWN0207	19/16	148	Old Dover Road	1872	Richard P. Hoyt House I-house, altered	No	
NWN0208	19/17	144	Old Dover Road	1900	Cottage	No	
NWN0209	19/18	140	Old Dover Road	late 19th	Sidehall, altered	No	
NWN0210	19/15	138	Old Dover Road	mid 20th	Ranch	No	
NWN0214	19/14	-	Off Old Dover Road	1892	George W. Pickering House, now offices	No	
NWN0228	19/22	-	Off Arboretum Drive, Pease International Tradeport	1955	City of Portsmouth Water Department, auxiliary pumping station	Yes / A + C	2.82
Area NWN-PR	----	-	-------	ca. 1955	Pease Rail Spur	No	
Area NWN-CPL	Multiple		Off Patterson Lane	1910s-1950s	Group of cottages, most lack integrity	No	
Area NWN-SP	Multiple		Off Shattuck Way	1917, ca. 1919, 1930s	Industrial Complex	No (Holden House more info)[1]	

Table 3.17-1 (continued)

DHR #	Tax # Map/ Parcel	Street #	Street Name	Date (circa)	Description: Name, type	Eligibility	Eligible acreage
DOV0086	8/8-31	1	Wentworth Terrace	1878/2004	Former John Hanson House, completely remodeled	No	
DOV0087	8/ 8-34	8	Wentworth Terrace	1935	Stringfield-Ehl House, altered cottage	No	
DOV0089	8/ 8-45	31	Wentworth Terrace	1940	Crocker House	No	
DOV0090	8/8-24	441	Dover Point Road	1900	Dame House/ Linwood Lodge, now apartments	No	
DOV0091	8/8-25	439	Dover Point Road	1865	John E. Pinkham House	No	
DOV0092	8/8-25A	435	Dover Point Road	1945	Belanger House	No	
DOV0093	8/8-29	430	Dover Point Road	1853	Ira Pinkham House, Wentworth summer residence	Yes / A + C	0.80
DOV0094	8/8-38B	428	Dover Point Road	1945	Bartlett House, cape	No	
DOV0095	8/8-38C	424-426	Dover Point Road	1945	Wentworth Duplex	No	
DOV0096	8/8-12	425	Dover Point Road	1878	George Card House, undergoing renovation	No	
DOV0097	8/8-38A	422	Dover Point Road	1945	Graves House, cape	No	
DOV0098	8/8-8	419	Dover Point Road	1878	Charles Morang House and barn, possible brickyard site	Yes / A + C	0.81
DOV0099	8/8-39	416	Dover Point Road	1840	Card-Coleman-Cousens House, brick cape	Yes / C	0.23
DOV0100	8/8-7	415	Dover Point Road	1840	William Card House, brick cape altered	No	
DOV0101	8/8-6	413	Dover Point Road	1930	Bradley Fleming House, 2½-story sidehall	No	
DOV0102	8/8-44A	412	Dover Point Road	1918	Chapman-Mackey House with additions	No	

Table 3.17-1 (continued)

DHR #	Tax # Map/ Parcel	Street #	Street Name	Date (circa)	Description: Name, type	Eligibility	Eligible acreage
DOV0103	8/8-44	410	Dover Point Road	1935	Brown House, with addition	No	
DOV0104	8/8-4	405	Dover Point Road	1928	Crocker-Fleming House & garage	Yes / C	1.48
DOV0105	7/7-20	391	Dover Point Road	1920/1995	Parle House, with large addition	No	
DOV0106	7/7-18	49	Boston Harbor Road	1935	Casey cottage	No	
DOV0113	7/7-7	13	Boston Harbor Road	1935	Varney cabin & boathouse	No, More info boat house[2]	
DOV0114	7/7-6	13.5	Boston Harbor Road	1945	Bowen Cabin	No	
DOV0115	7/7-5	9 & 9.5	Boston Harbor Road	1940	Baron Cabins	No	
DOV0116	L-1/L-57	354	Dover Point Road	1933	Stephens House, Colonial Revival	No	
DOV0117	L-1/L-56	346	Dover Point Road	1950	Huston House, cape, no integrity	No	
DOV0118	L-1/L-55	343	Dover Point Road	1830	Ford-Weymouth House, heavily remodeled in 1990s	No	
DOV0119	L-1/L-60	339	Dover Point Road	1937	Mackey House and barn	No	
DOV0120	L-1/L-59B	6	Hilton Road	1890, moved ca. 1955	West Pierson House, 1½-story sidehall	No	
DOV0121	L-1/L-59A	4	Hilton Road	1890, moved ca. 1955	East Pierson House, 1½-story sidehall	No	
DOV0122	L-1/L-48A	283	Dover Point Road	1945	Dubois House	No	
DOV0123	L-2/L-47	281	Dover Point Road	1938	Tuttle House and shop	No	

Table 3.17-1 (continued)

DHR #	Tax # Map/ Parcel	Street #	Street Name	Date (circa)	Description: Name, type	Eligibility	Eligible acreage
DOV0124	7/7-3	5	Boston Harbor Road	1939/1988	Cottage, gambrel roof added	No	
DOV0125	7/7-4	7	Boston Harbor Road	1936	Wiggin-Miksenas House and garage	Yes / C	0.16
DOV0126	7/7-26	16	Boston Harbor Road	1950	Ranch	No	
DOV0127	7/7-10	17	Boston Harbor Road	1950	1½-story residence	No	
DOV0128	7/7-11A	19	Boston Harbor Road	1950	Ranch	No	
DOV0129	7/7-12	27	Boston Harbor Road	1940/1982	Older garage with modular home	No	
DOV0130	L-2/L-65	271	Dover Point Road	1890	Belanger-Pomeroy House, moved	No	
DOV0131	L-2/L-103	274	Dover Point Road	1920	Hurd – Demo House	No	
DOV0132	L-2/L-104	278	Dover Point Road	1953	Palmer-Elkerton House	No	
DOV0133	L-2/L-106A	280.5	Dover Point Road	1930	Ranch	No	
DOV0134	L-2/L-105C	284	Dover Point Road	1790	Thomas Henderson House	Yes / C	0.80
DOV0135	L-2/L-48E	293	Dover Point Road	1810	Daniel Pinkham House, now two family	No	
DOV0136	L-2/L-110	294	Dover Point Road	1885	Lower Neck School House	Yes / A	0.28
DOV0137	L-1/L-63	301	Dover Point Road	1750/1930s	Cape, moved, porch and dormers added 1930s, A. Pinkham House	No	
DOV0138	L-1/L-111C	304	Dover Point Road	1850	former barn; now commercial use	No	

Table 3.17-1 (continued)

DHR #	Tax # Map/ Parcel	Street #	Street Name	Date (circa)	Description: Name, type	Eligibility	Eligible acreage
DOV0138	L-1/L-111	306	Dover Point Road	1800	Federal, remodeled in early 20th century	No	
DOV0138	L-1/L-111B	306C	Dover Point Road	1973	Ranch	No	
DOV0139	L-1/L-113A	320	Dover Point Road	1850	Altered cape	No	
DOV0140	L-1/L-58	322	Dover Point Road	1930	Altered bungalow	No	
DOV0141	l-1/L-55A	338	Dover Point Road	1840	Federal cape, moved 1960s (James H. Card House)	No	
DOV0142	L-1/L-111A	304	Dover Point Road	1900/1952	Riverview Hall - Mayrand's Highway Furniture	No	
DOV0143	L-1/L-58M	340	Dover Point Road	1950/1974	Garage with mobile home	No	
DOV0144	8/8-38D	418	Dover Point Road	1950??	Modern style house	No	
DOV0145	8/8-13A	431	Dover Point Road	1900 / 1983	Newick's Seafood Restaurant and camp	No	
DOV0146	L-1/L-112	308	Dover Point Road	1840/1940	Henry Coleman House, cottages and store	No	
DOV0147	L-1/L-113	316	Dover Point Road	1925	Former marine repair shop, now condos	No	
DOV0148	L-1/L-59C	321	Dover Point Road	1950	House and concrete block garage	No	
DOV0149	L-2/L-46	275	Dover Point Road	1890	Clements-McLaughlin House	No	
DOV0150	8/26	N/A	Hilton Park	1938	State Park	No[3]	

Table 3.17-1 (continued)

DHR #	Tax # Map/ Parcel	Street #	Street Name	Date (circa)	Description: Name, type	Eligibility	Eligible acreage
DOV0151	L-2/L-110	292	Dover Point Road	1910	Dover Point Chemical Company #1 (former fire station)	Yes / A + C	0.149
DOV0152	8/8-32	3	Wentworth Terrace	1928	Whitehouse-Gearin Cottage, altered	No	
DOV0154	8/ 8-43	15	Wentworth Terrace	1940	Cottage, currently being renovated	No	
DOV0155	8/ 8-42	16	Wentworth Terrace	1920	Garage	No	
DOV0156	8/ 8-40B	24	Wentworth Terrace	1940	Cottage	No	
DOV0157	8/ 8-39A	25	Wentworth Terrace	1940	Cottage	No	
DOV0158	N/A	N/A	General Sullivan Bridge	1935	Bridge	Yes / A + C	The Bridge Structure & approx. 2.5 acres of bridge approach
Area DOV-CB	7/7-17 and -17A	39 + 45	Boston Harbor Road	1930	Cullen Cabin, 1-story with additions (DOV0107) and Cullen-Bruyere House (DOV0108)	Yes/ A + C	0.327
Area DOV-CH	7/7-13, 13A, 13B and 13C	29, 33, 33A and 33B	Boston Harbor Road	1930	Chapman Cabins and Store, Chapman-Bishop Cabin and Chapman-Lumsden Cabin DOV0109 thru DOV0112	Yes / A + C	8.27

1 Holden House located within the Industrial Complex requires more information to determine its individual eligibility. However, no impacts to the Holden House are anticipated with the Build Alternatives.
2 The boathouse requires more information to determine its individual eligibility. However, no impacts to the boathouse are anticipated with the Build Alternatives.
3 The picnic pavilion located within Hilton Park requires more information to determine its individual eligibility. However, no impacts to the picnic shelter are anticipated with the Build Alternatives.
4 In addition to the properties listed, the deRochemont property had previously been identified as eligible for the National Register (NWN0224).

Definition of Study Area

The Spaulding Turnpike (NH 16) is the primary route north from the New Hampshire seacoast to the White Mountains and Lakes Region. Constructed beginning in 1953, the Turnpike superseded older transportation routes. The Turnpike runs southeast to northwest, beginning at I-95 and the Portsmouth Traffic Circle. The Project Area corridor begins at the Newington/Portsmouth municipal line (Gosling Road). The Turnpike passes through the northeastern part of Newington, parallel to the historic road, now Woodbury Avenue and Shattuck Way, which also parallel the shore of the Piscataqua River. The center of the Project Area is at the General Sullivan Bridge, which crosses the confluence of Little Bay and the river between Bloody Point in Newington and Dover Point. The water is the boundary between Newington and Dover and Rockingham and Strafford Counties. This area, and the two points of land, were important to the earliest history of New Hampshire settlement and to the transportation network of the region. The Spaulding Turnpike runs northwest the length of Dover Point and continues, curving around the west side of downtown Dover. The northern end of the Project Area is located at the Dover Tollbooth.

The Spaulding Turnpike is a limited access highway. Historic resources are located on either side of the Turnpike, primarily on intersecting and parallel roads. Interchanges within the Project Area provide access to local roads. At the southern end of the project area, Exit 1 is the intersection of Gosling Road which connects to Woodbury Avenue and the adjacent commercial properties, and Pease Boulevard into Pease International Tradeport. Exit 2 (northbound only) at Fox Run Road connects to the Fox Run Mall and Woodbury Avenue beyond. Exit 3 is an interchange with Woodbury Avenue. Exit 4, south of the General Sullivan Bridge, connects to Shattuck Way on the east from the northbound lanes and to Nimble Hill Road on the west from the southbound lanes. After crossing the river, Exit 5 in Dover provides local access to Hilton Park and Wentworth Terrace. The Exit 6 interchange at the northern end of the project area is the junction of US 4, which crosses the Scammell Bridge and travels west toward Concord. Exit 6 also provides local access to Dover Point Road which runs north toward downtown Dover, as well as to Boston Harbor and Spur Roads.

The historical development of the region was directly linked to its accessibility to the seacoast and inland waterways. Five tributaries flow together to create Great Bay, Little Bay and the Piscataqua River, which flows through Portsmouth Harbor to the Atlantic Ocean. It is the more than 100 miles of tidal shore, which reaches 15-25 miles inland, that transformed New Hampshire's fourteen-mile coastline into a historically substantial maritime transportation system (Monroe 1998).

Great Bay is formed by three tributary rivers (the Lamprey, Squamscott, and Winnicut rivers) flowing into it from the west. The bay extends southeast between Greenland and Newington, its northeast shore defining the western edge of the latter town. Great Bay empties to the north into the narrower channel of Little Bay along Newington's northwestern edge. The Oyster River flows into Little Bay from the northwest and the Bellamy River flows from the north along Dover Point. Little Bay waters pass around the tip of Fox Point in Newington and flow southeast into the Piscataqua River between Newington and Dover Point. The Piscataqua (also known as the Fore River) defines the eastern side of Dover Point. The Piscataqua extends upstream to the confluence of the Salmon Falls River and Cocheco River. Across the Piscataqua (east) from the Project Area is Eliot, Maine. The Piscataqua flows southeast along Newington's northeast edge, to Portsmouth and the ocean.

Newington occupies the large point of land between Great Bay and the Piscataqua. It is bounded on the southeast and south by Portsmouth and on the south by Greenland. Within the town limits the land is gently rolling with scenic vistas of the surrounding waterways visible from some small hills, none of which are over 100 feet in elevation. The northern edge of Newington has two major points of land, Fox Point which projects into Little Bay, and Bloody Point which projects into the Piscataqua, directly across from Dover Point. The shoreline of the Piscataqua is now the site of industrial activity. Newington has the largest deep-water port in the state, and industries include New Hampshire's third and fourth-largest electrical power plants. In the southeastern corner of town, just over the line from Portsmouth is the third largest retail market in the state, the Fox Run Mall, surrounded by other large-scale commercial properties.

Dover Point, the southernmost part of the irregular shaped city of Dover, was the site of the first settlement in the region, and was later important as the site of wharves, shipyards and brickyards. Traditionally Dover Point was defined as south of Pomeroy Cove, and to the north, Dover Neck was divided into the Lower and Upper Necks (Smith 1973:51). The long, narrow peninsula runs north-south between the Salmon Falls and Piscataqua Rivers on the east and the Bellamy on the west. Tidal flats line the shores. The tip of the point, sometimes called Hilton's Point, curves to the southeast into the confluence of Little Bay and the Piscataqua. The narrowest section of the point is formed by Pomeroy Cove on the east and Boston Harbor on the west. Pomeroy Cove was the site of early landings. Boston Harbor was so-named for an early twentieth century summer homeowner. North of Pomeroy Cove are small projections known at one time as Sandy Point and Nute's Point.

The narrow stretch of water between Dover Point and Bloody Point has long been an important water crossing, the site of one of the earliest crossings in the region. Ferry service was established shortly after the first European settlement. Starting in 1640, the Bloody Point Ferry served as the only early connection between Portsmouth, Dover and the up-country settlements. Another early ferry crossed to Eliot, Maine for east-west travelers (Monroe 1998). From the end of the eighteenth through the middle of the nineteenth century, the major crossing was over the Piscataqua Bridge from Fox Point in Newington to Cedar Point in Durham. Then in 1873, a new bridge was built between Bloody Point and Dover Point, to carry the new Portsmouth and Dover Railroad as well as road traffic. This bridge was replaced by the General Sullivan Bridge in 1934 and the latter was superseded by the current Little Bay Bridges.

The Spaulding Turnpike parallels early overland routes. Dover Point Road (formerly Route 16) was always a north-south road in and out of the center of Dover. Early on, Woodbury Avenue, Old Dover Road and Shattuck Way formed the route from Portsmouth to the Bloody Point Ferry. When the Piscataqua Bridge was built from Fox Point, traffic shifted, following what is now Woodbury Avenue and then turning up Fox Point Road, which continued across the present Pease International Tradeport property. Shattuck Way continued to the old ferry site at Bloody Point, and again became an important through route when the railroad/highway bridge was built in 1873. From the early 1900s, this bridge carried the East Side Trunk line road, from the Seacoast to the Mountains, known as the White Mountain Highway, later as Route 16. The highway shifted slightly when the new bridge was erected in 1934. In the 1950s, the Spaulding Turnpike bypassed the older sections of road. The Newington section was built ca. 1950 as a Spur Road between the new Portsmouth Traffic Circle and the General Sullivan Bridge. From Dover Point north, the Turnpike was built in 1954-55 as a bypass around the cities of Dover and Rochester.

At the southern edge of the Project Area, Gosling Road was laid out along the dividing line between Portsmouth and Newington when it was established in the mid-1600s. Historically Gosling Road continued across Pease to South Newington. Newington’s village center near the geographical center of the town was connected to the crossing at Bloody Point by Nimble Hill Road (once known as Bloody Point Road). In the seventeenth and eighteenth centuries, this was part of an early post road from Hampton, through Greenland towards inland points.

The southern end of Dover Point is now dominated by Exit 6 connecting the Spaulding Turnpike and US 4, which leads west over the Scammell Bridge through Durham toward Concord. Cedar Point was the northern terminus of the Piscataqua Bridge and US 4 originated there as the First New Hampshire Turnpike. Downtown Dover was connected to the Piscataqua Bridge and the Turnpike by Back Shattuck Way, also known as Piscataqua Road. The crossing at the Scammell Bridge was established in 1934 with improvements to the State Highways, including Routes 4 and 16.

The Portsmouth and Dover Railroad, later Boston and Maine, was built in 1873 and operated until 1934. It ran parallel to and northeast of the Spaulding Turnpike, along the shore of the Piscataqua. The right-of-way remains evident and the rails were in use through the late twentieth century in Newington, connecting to waterfront industries and a spur rail built into Pease sometime after 1955. The line is now Pan Am Railways' Newington Branch. The Newington Railroad Depot and tollhouse survives just south of the former bridge site. The railroad passed through the eastern part of Hilton Park and crossed Dover Point Road in the vicinity of Exit 6, continuing toward downtown Dover up the northwest side of Dover Point along the Bellamy River.

Historical Background

Dover Point, the northern portion of the Project Area, was site of one of the first European landings and settlements in the region. Due to its pivotal location on the Piscataqua, and natural resources including lumber and clay, Dover Point was substantial throughout the region's historical development. It was a maritime transportation and ship-building center, the site of farming and extensive brick manufacturing, and a land and rail transportation corridor between the state's only seaport and the interior. In the early twentieth century, it was the site of a summer cabin and hotel community, a state park, and finally the location of the Spaulding Turnpike, the highway that links Route I-95 with the recreational opportunities of the White Mountain and Lakes Regions. Each successive layer of history has partially erased the historical significance of earlier periods, and today the evidence of each layer is scattered (Monroe 1998).

Newington was also an early community, and remained a prosperous agricultural town on the outskirts of Portsmouth into the twentieth century. During the First World War, the eastern shore of town became the site of industrial activity, which transformed the Piscataqua into a heavy industrial zone and seaport, with deep water just upriver from the ocean. Pease Air Force Base consumed a large area of the town in 1952. Since that time, the corner of town near the Newington/Portsmouth line has become the site of extensive, large-scale commercial development along Woodbury Avenue.

Settlement, Lumber Industry and Agriculture, Water and Land Transportation (1623-1794)

During the seventeenth century, Dover was one of New Hampshire's four original great "towns" or plantations, along with Portsmouth, Exeter and Hampton. Newington was originally included within Dover. Dover Point was the second site of European settlement in the region. In 1623, a group of English investors, the Laconia Company, sent London fishmongers Edward and William Hilton with a small group of men to establish a fishing colony

(Clark 1970:17). The first landing was at Pomeroy Cove, which became the location of wharves and Edward Hilton's salmon and cod fishing and drying operations. The group constructed houses, planted corn, and initiated trade with Native Americans (Monroe 1990). Located at the confluence of the five tributaries of the navigable Piscataqua River, Dover Point became a natural hub of activity as points inland were settled. An early village developed just north of Pomeroy Cove, supporting itself primarily by fishing, lumbering and farming.

Hilton's business interests were acquired by Captain Thomas Wiggin, who after scouting in the area in 1631, came to Dover in 1633 with a group of settlers from Salem, Massachusetts. Some of these families were entrepreneurs like those already at Dover Point. Others were Puritans. The new group formed the First Parish Church of Dover in 1638 and built a meetinghouse near the site of the present tollbooth on the Spaulding Turnpike (Monroe, Laprey and Hill 1999).

Land in Newington was originally included in Hilton's Grant. The earliest settlement ca. 1630 was at Bloody Point. The origin of that name, by which the whole settlement came to be known, is uncertain. It apparently referred to a bitter dispute which nearly elevated to a duel, between the two agents, Captain Wiggin who claimed the land as part of Hilton's patent (Dover), and Captain Neal who claimed it was part of Strawbery Banke (Portsmouth). Alternately Bloody Point is said to refer to an Indian attack on the area in 1690 (Hurd 1882:392; Rowe 1987:10).

Throughout the first hundred years of settlement, lumber was a lucrative business, as Boston was expanding and London rebuilding. Newington was originally covered with white pine, making it a prime source of masts and shipbuilding material. There were several water-powered mills. The earliest was built by Mr. Swanden in 1623, on a tidal stream known today as Mill Brook near the Greenland town line. Logs were hauled down to the Piscataqua along some of Newington's earliest roads, including Patterson Lane, the first road of record (1656). An early resident of Patterson Point was Jeffrey Ragg. Joseph "Pattison" had a wharf on the landing in the 1700s. Gosling Road (1659) was the route to Boiling Rock landing.

Early, prominent Dover families were granted land and water privileges on the falls of inland rivers. Lumber mills were established and the lumber from these mills was shipped to Dover Point for transport for building in Boston, Portsmouth and Britain (Monroe 1990 and Bunker 1991). Shipbuilding was a natural outgrowth of the lumber industry. The first known ship was a frigate built in Dover Point prior to 1650 (Scales 1923). A ship was built north of Pomeroy Cove in 1652. Newington and Dover Point were cleared for farming early on, but remained a natural center for lumbering operations due to their locations along the water transportation routes to Portsmouth.

Nothing remains of the early settlement and roads laid out on Dover Point in the 1630s. Dover Point Road was High Street, running up the middle of the point. Low Street was parallel, about where the Turnpike is now. Fore River Lane ran along the water off the main road in the vicinity of DOV0138. The second meetinghouse was built in 1654 on the historic site now marked, north of the Project Area on the west side of Dover Point Road. Most of the first homes were replaced early on and the oldest structures on Dover Point now date from the mid- to late-eighteenth century.

Newington residents protested the difficulty of traveling to the Dover meetinghouse, and in 1712, the separate parish known as Bloody Point was set off. In that year the Newington Meetinghouse, now said to be the oldest meetinghouse in continuous use in the state, was erected. Shortly thereafter, the first Town meeting was held. In 1714 incorporation status was granted, and the name was changed to Newington (Strafford Rockingham Regional Council 1981). The meetinghouse became the focus of Newington's town center.

Dover's town center shifted inland to its current location around the falls on the Cocheco River, which were an important sawmill site. In 1713, a new, more centrally located meetinghouse was built on Pine Hill on the south side of what is now the downtown.

The Piscataqua and Great Bay offered some maritime transportation advantages, but as settlers moved inland (north and westward), these bodies of water also served to isolate the interior from the developed coastal cities. Little Bay interrupted travel between Portsmouth and Dover. Early on, the only method of crossing the inland tributaries of the Piscataqua was by ferry or small pile bridges erected far enough upstream to permit construction with available technology (Chesley 1984:22). Travelers inland from Portsmouth could take the long overland route around the southern side of Great Bay, or one of three toll ferries across the Piscataqua (Chesley 1984:23).

The Project Area is centered on one of the earliest water crossings in the state, with ferry service between Bloody Point in Newington and the southern tip of Dover Point begun in 1640 and continuing until the late arrival of the railroad in 1873. The first ferry was operated by Thomas Trickey from 1640 to 1676, then by his son Zachariah Trickey who lived on the nearby farm until 1705. Trickey sold his property, which included the ferry, farm and a tavern, to John Knight. Knight's Ferry operated until 1725. Later, the ferry was based on the north side of the crossing, run by Captain Howard Henderson, Howard Henderson Jr. and Thomas Henderson (Chesley 1984:23).

Early roads leading to this crossing included Dover Point Road, running north-south along the point in and out of Dover's developing center on the Cocheco. Farms were spread along both sides of the road with rectangular lots extending down to the water on either side. Bloody Point Road or Greenland Road, now Nimble Hill Road, connected Newington's town center with the ferry as early as 1660. Early on, this was part of the south-north road from Hampton through Greenland and Newington to the ferry. Woodbury Avenue and Shattuck Way connected Portsmouth and the crossing.

Piscataqua Bridge, Turnpikes, Agrarian Economy, First Brickyards (1794-1820)

Transportation patterns in the state shifted during the late eighteenth century as inland settlement, particularly along the Merrimack River, rapidly developed. Inland commerce and trade was drawn to Newburyport, Massachusetts at the mouth of the Merrimack, away from Portsmouth, which was accessible from the interior only by poor overland routes and ferries over Great and Little Bays.

In 1794, a group of private investors hoping to alleviate transportation problems within the state and bring traffic into Portsmouth, funded the construction of the Piscataqua Bridge. The bridge between Fox Point in Newington and Cedar Point in Durham, was the largest bridge in the country at the time (Chesley 1984). The site was chosen because of the central location of Goat Island and the lesser currents. The bridge was integral to construction in the early 1800s of the First New Hampshire Turnpike from Portsmouth to Concord.

For Newington, the bridge was an important impetus for growth and the increased mobility. Fox Point became a focus of activity and the location of the Bridge tavern and inn. Fox Point Road built in 1795, now truncated by Pease, crossed through Newington from Woodbury Avenue at Fox Run Road, to Fox Point. It became the main route out of Portsmouth to the Piscataqua Bridge. A ferry continued to cross from Bloody Point across the Piscataqua to Maine (Monroe 1998). The ferry from Dover Point operated on a reduced scale.

Agriculture was the dominant occupation during this period in Newington. Agricultural prosperity is indicated by the construction and remodeling of numerous farmhouses in the Federal style. There was little industrial development in the town due to lack of waterpower and insufficient demand because larger industrial centers were located nearby.

Dover Point became a center for brick-making, utilizing extensive deposits of natural marine clay (blue clay) found near the surface in continuous beds along the banks of the Piscataqua and its tributaries. The clay was found to fire into strong, high quality bricks. Dover Point also offered the open land for processing the clay and making the bricks. Settlers made bricks early on for chimney construction (Scales 1923). The first recorded brickyard in the Project Area was that of Thomas Henderson on the southeast side of Dover Point. He sold it to Capt. Thomas Card in 1812 and moved further north on the Neck (Scales 1923:58) to DOV0135 where he had a brickyard on the river. During this period, the method for brick-making was to dig the clay with shovels or by horse drawn cutter in the fall or early spring. The clay was either turned frequently or spread thinly on hard dry ground to dry in the sun and rain. In the summer, the clay was slaked in soak pits and "tempered by the feet of men or oxen" or in a pug mill (Scales 1923:59). The clay was then molded into bricks by hand, struck off with a straight edge, left in the yard to dry, and burned in a kiln.

Brick-making, Farming, Growth of Nearby Cities, Loss of Piscataqua Bridge (1820-1873)

Dover as a whole prospered as downtown Dover developed as an industrial center with large textile mills, including the Dover Cotton Factory, later Cocheco Manufacturing Company, first established in the 1820s, as well as Sawyer Woolen Mills on the banks of the Bellamy River.

On Dover Point, brick-making was a dominant part of the economy. The success of Dover Point brick-makers was based on the availability of high quality raw materials, a ready market and transportation mechanisms to carry the finished brick to that market, seasonally available labor and firewood to burn the kilns (Bunker 1991). The demand for brick was great in the early 1800s. Brick was needed for fireproof construction in Portsmouth where brick was mandated following a series of fires, and for the large textile factories being built in Dover and elsewhere. Dover River brick became highly regarded in Boston markets (Scales 1923:56). Bricks were transported on the water by gundalows and other craft.

Brick-making, farming and associated maritime trades were often a family business and the Dover Point families were inter-related. Many properties were owned by generations of one family and relatives lived nearby (Walling 1851; Hurd 1892). Brick-making was closely tied to farming, a seasonal industry that could be integrated with other occupations. Most of the families on the Point had riverfront brickyards, which they worked in conjunction with their farms.

The original Henderson brickyard near the end of the point was owned by the Card family during the 1810s-20s. Capt. Thomas Card lived on the north side of Pomeroy Cove until his death in 1875 (Chace 1856; Sanford and Everts 1871). About 1830 Enoch Pinkham (1796-1875) acquired the brickyard and land on Hilton Point (Scales 1923:58). The Pinkham family dominated brick manufacturing on the end of Dover Point for several generations.

Historic maps show Enoch Pinkham's house (later the Piscataqua House) was located west of the southern end of Dover Point Road in the path of the Turnpike. The end of Dover Point Road bent toward Pinkham's wharf, now in Hilton Park. Pinkham's brickyards were located on either side of the point, on the current sites of Newick's Restaurant and Hilton Park (Whitehouse 1984). Enoch Pinkham was the sixth generation of the family living in the area. The early Pinkham homestead was north of the meetinghouse up Dover Neck. Enoch Pinkham's father (one of twelve children) Joseph (1772-1842) moved to Tuftonboro, New Hampshire. Enoch returned to Dover Point and married his cousin, Hannah Davis Pinkham (1802-1882), and the couple had nine children (Sinnett 1908:35-36). Hannah Pinkham's brother Daniel Pinkham (1797-1885) lived at DOV0135.

The Card family retained land on Dover Point. Thomas and Phebe Card's seven children settled in the area. Their homes included two 1½-story, brick houses built ca. 1840 (DOV0100 and DOV0099). Thomas Card sold one of these homes (DOV0099) in 1847 to William Coleman, a farmer, who lived there through the 1850s. Henry Card lived at DOV0100. He was a brick-maker and a mariner. As of 1850 Henry and his nineteen-year-old son were mariners as was their relative James H. Card who lived across the road (house moved to DOV0141) (Bureau of the Census 1850b). William Card, brother of Henry, lived on Hilton's Point in an old house later replaced by John Hanson's hotel (site now in Hilton Park). He then moved into DOV0100 which he occupied for many years. He was a brick-maker and probably had a brickyard on this property, though it is not shown on historic maps. Sister Dorothy Card married Joseph Coleman a mariner (house not extant). She was widowed early on. Phebe married Calvin Coleman and they lived in the vicinity of DOV0138. Edwin Coleman married Enoch Pinkham's daughter Caroline and they lived at his homestead (not extant). DOV0146 was home to Henry Coleman, then James Coleman (Walling 1851; Sanford and Everts 1871; Hurd 1892).

On the west side of Dover Point Road, north of Pomeroy Cove was the property of Benjamin Ford who lived in the vicinity of DOV0118. Ford's brickyard was located to the west along Redding Point. Another early nineteenth century brickyard was located on the northeast side of Dover Point (east of Exit 6, vicinity of DOV0139-0140). Farther up Dover Neck early brickyards were located at Varney's and Young's wharves (Whitehouse 1834).

As of 1850, the brickyards were considered part of farm operations; they were not listed in the industrial census of that year and no one gave brick-making as their occupation. Area residents on Dover Point included nine farmers plus their sons who worked as farm laborers, a blacksmith, a shoemaker and four mariners (Bureau of the Census 1850b).

Dover Point and Newington were both sites of numerous productive farms, benefiting from their proximity to growing cities in Dover and Portsmouth.

Following regional trends, Newington's economic base shifted from subsistence farming to a market economy. Newington emerged as a major supplier to the dairy market in Portsmouth (Strafford Rockingham Regional Council 1981). South Newington had access to the railroad at the Concord and Portsmouth depot just to the south in Greenland (Chace 1857). The Project Area in Newington consisted of large farms that extended between the road and the Piscataqua shore. Mid-nineteenth century farms were mostly improved land, generally 50-100 acres. Crops were hay, corn, smaller amounts of barley, rye and oats. Farmers owned a horse, two to four milk cows, and a pair or more of oxen (Bureau of the Census 1850).

Dover Point children attended the Lower Neck schoolhouse. In the early nineteenth century, the schoolhouse was located north of the Project Area in the vicinity of the old meetinghouse site. In the 1850s a new schoolhouse was built farther south on the east side of the road in the vicinity of DOV0136 (Whitehouse 1834; Walling 1851; Chace 1857). The surviving schoolhouse (DOV0136) was built in the 1880s.

The area was dramatically impacted by the loss in 1855 of the Piscataqua Bridge between Fox Point in Newington and Cedar Point, which was irreparably damaged by ice flows and was not rebuilt. For nearly twenty years there was no bridge across the Bay. Commerce was again dependent on ferry and gundalow traffic in the region. A direct route from Portsmouth to Concord was not replaced until the construction of the Portsmouth-Dover Railroad Bridge over Little Bay in 1873 and the Scammell Bridge over the Bellamy River in 1935 (Monroe 1990; Rowe 1987:124). In the interim, travelers from Portsmouth going west had to travel around the south side of Great Bay. From Portsmouth to Dover, one could travel through Kittery and Eliot, crossing upstream over the Salmon Falls River. The brick industry, which relied on river transportation, continued to prosper on Dover Point.

Brick-making was a predominant part of the area's economy by 1860. In June of that year the census recorded eleven farmers, and eight brick-makers living on Dover Point, four seamen and a hotelkeeper (Bureau of the Census 1860b). The first summer hotel on Dover Point was John P. Hanson's hotel, later Hilton Hall, built in 1854 on the site of an older house (site now in Hilton Park) (Scales 1923:64). Some brickyards were still owned by men who were primarily farmers. The 1860 industrial census listed nine brickyards. Most employed one or two men part of the year. Each made 150,000-300,000 bricks a year and burned between 72 and 250 cords of wood.

Three of Enoch Pinkham's sons established brickyards and built houses near their father's. Ira F. Pinkham (1833-1907), a brick-maker, built DOV0093 ca. 1853. As of 1860, Richard Augustus Pinkham (1831-1888) and John Elbridge Pinkham (1835-1906) both brick-makers were living with their father. Also boarding in the household were four young men (ages 19-20) who were working in the brickyard. One was French Canadian, one Irish, one from Maine and the other from New Hampshire. John E. Pinkham built DOV0091 in the 1860s and had his own brickyard in the vicinity. Richard Pinkham's house was located where Newick's is now (DOV0145) and his brickyard was on the site. Later Richard acquired his father's brickyards towards the end of the point. The youngest Pinkham brothers Ezra Oscar and DeOrville L. also worked as brick-makers. At the turn-of-the-century, they were in charge of the Fiske Brick Company.

Sons of Daniel Pinkham of DOV0135, Aaron (1825-1900) and Alonzo (1829-1900) Pinkham, were also brick-makers just to the north on Dover Point. Aaron Pinkham's brickyard was located on the east side of Dover Point Road, north of Hilton Road. He had a house nearby and later owned his father's homestead. Alonzo lived south of his father at DOV0137. The Pinkham's were also farmers. In 1860, Thomas Parle a brick-maker who later lived on the site of DOV0105 boarded with Aaron Pinkham. Benjamin Ford (DOV0118) had a brickyard on Redding Point. A young brick-maker boarded with him also (Bureau of the Census 1860). Other mid-nineteenth century brickyards were farther north on Dover Neck, including the large yards of Moses Gage where five men were employed, and Furber and Peirce who employed seven (Bureau of the Census 1860b).

Brick-making operations expanded in the 1860s, with annual production doubling. The 1870 population censuses listed seven Dover Point men as brick-makers, seven as farmers. Sons and unrelated boarders lived with them and assisted as laborers. Increasingly, brickyard workers were French Canadian young men who migrated south each summer to work in the yards. Farm families had three or four young men board with them and work in the brickyards during the spring and summer months (Adams 1976:114; Bureau of the Census 1870b). Three French Canadian laborers were boarding in Hanson's hotel when the census was taken. John E. Pinkham's (DOV0091) brickyard employed four men and produced 350,000 bricks in a year. Five men worked in Richard Pinkham's yard (site of DOV0145). Ira (DOV0093) and Albert Pinkham's yard employed one man and produced 300,000 bricks. Aaron Pinkham's yard in the vicinity of DOV0139-0149 employed three and produced 500,000 bricks a year. Two men worked in George W. Ford's (DOV0118) brickyard. It is difficult to directly correlate property owner names and brickyards shown on historic maps. Sometimes the brickyards were associated with the residence, others were located elsewhere. North of the Project Area on Dover Neck were the yards of Moses Gage, Isaac Lucas and Andrew Roberts, which employed three to four men. David H. Gage manufactured brick machines (Bureau of the Census 1870a).

Railroad, Brick Industry and River Freighting, Dairy Farming, and Orchards (1873-ca. 1910)

In the mid-nineteenth century there were railroad lines through both Dover and Portsmouth, but there was no direct connection between the two cities until 1873. The Portsmouth and Dover Railroad was financed in part by businessman Frank Jones who needed to transport grain from inland farms to his Portsmouth breweries. The railroad ran northwest out of Portsmouth along the shore of the Piscataqua in Newington and crossed the water between Bloody and Dover Points, continuing north up Dover Point. The bridge crossed parallel to and east of the later bridges from the northeast tip of Bloody Point, to the southeast edge of Dover Point, now in Hilton Park. The bridge carried the railroad and a roadway, which was subject to a toll. The railroad portion was a steel Howe truss purchased from Chicago; the highway portion was of traditional pile and trestle construction (Chesley 1984).

Passenger and freight depots were located north and south of the bridge. The Dover Point depot is no longer extant. It stood in the path of the Turnpike east of DOV0091. A second stop was located to the north at the end of Hilton Drive, where the Turnpike is now. Newington's Railroad Depot and Tollhouse remains extant on Bloody Point (NWN0168). Nearby is the stone abutment of the old bridge. The "Rollins Farm" station was a flag stop at Patterson Lane. The building was later moved and made into an outbuilding on a nearby property. During this period, Bloody Point Road (Nimble Hill) and Woodbury Avenue were again important routes from the surrounding area to Newington Station on Bloody Point. The Newington Depot contained a residence for the station-master who also collected the tolls for the vehicular bridge. The bridge was closed for the first of many repairs in 1888. The draw section was opened with a hand-operated windlass. During the month of December 1892, the draw was opened 21 times for 29 vessels – 13 gundalows, 12 steamers, two schooners and two barges (Adams 1976:137). Dover Point residents James H. Card and his sons, formerly mariners, went to work for the railroad (Bureau of the Census 1880b). John B. Hanson built a house next to his hotel (DOV0086) ca. 1878, and became the railroad station agent. Hanson was later an owner of the Dover Packet Company, which had a wharf near his home.

The railroad allowed for the growth of the brick industry. During the same period, brick-making technology improved, particularly with the use of horsepower. Brick-making involved extraction and manufacturing on the same site. A 2-inch layer was planed daily from the clay bank with a horse-drawn clay cutter. The clay was left to soak in water in a pit overnight. The following day the clay was mixed with varying amounts of sand to prevent shrinkage and shoveled into a brick machine. At the top of the horse-drawn machine, a funnel fitted with knives pulverized the clay. The clay was then forced down into a press box, fitted with a six-brick mold. The mold was filled, drawn out and wheeled away on a cart to the drying ground. The molds were tipped, and the bricks left to dry until strong enough to be handled. Bricks were particularly vulnerable to rain at this stage, and some yards built well-ventilated sheds for drying bricks. Kilns were built of brick, in arches of 20-25,000 bricks, into which wood was placed (Monroe 1998). Poorer quality bricks formed the exterior of the kiln, which was then plastered with mud. Kilns were burned as long as a week, usually in August or September (Scales 1923:60, Adams 1976:109-110). Skilled burners were needed to constantly tend the kilns. Brick-makers such as George W. Ford, John, Alonzo, and Aaron Pinkham were hired as burners at brickyards other than their own (Whitehouse, n.d.).

Firing the kilns took tremendous amounts of hardwood. In the 1890s, brickyards along the Piscataqua burned 20-30,000 cords of wood a year (Winslow 1982:61). Gundalows brought firewood to the site and transported bricks away. The Piscataqua region brickyards were at their height in the 1880s and 1890s. Captain Adams, a gundalow captain from Durham, recalled from memory 43 brickyards operating during his youth (Winslow 1983:61). Bricks were transported to Dover and Portsmouth by gundalow, or on to Boston or Portland by schooner. During the 1890s, the Dover Navigation Company operated a fleet of six to eight schooners, known as “brickers,” which averaged 20-30 trips a season. One schooner could carry 50-60,000 bricks, worth about $150 (Beaudoin and Whitehouse 1988:170, 188).

Brickyards were first listed in Dover’s business directory ca. 1890, though they had been in operation for decades. In that year, there were twelve brick manufacturers, seven in the vicinity of the Project Area. Richard Pinkham of DOV0145 ran his father’s brickyard from the 1870s to the turn-of-the-century. John E. Pinkham (DOV0091) shipped bricks by rail to Portsmouth for the Jones Brewery in 1892. George W. Ford learned brick-making from his father, Benjamin Ford, and inherited his yard and home (DOV0118). He operated the yard for about sixty years. He was also a farmer and had a brickyard worker living with him (1880). Later in life he worked logging, rafting logs and sailing gundalows (Whitehouse n.d.). William Card’s (DOV0100) brickyard was taken over by his son-in-law George Roberts who lived with him. George Card, who worked as a carpenter, built DOV0096 on land divided from his father’s. Charles Morang purchased land from the Card family and built a house DOV0098 ca. 1880. His original brickyard was probably located on that property. About 1890, his yard was producing loads of 10,000 bricks that were shipped by rail to Boston (Whitehouse n.d.). Thomas Parl (or Pearl) lived in the vicinity of DOV0105. In 1888 he shipped 8,000 bricks to the Isles of Shoals for additions to the hotel there (Whitehouse n.d.). Later he had a brickyard farther north on Back River[66] (Hayes 1912).

66 The “Back River” is an archaic name for the Bellamy River.

During the 1890s, Elbridge Gage ran the brickyard east of DOV0134. He lived on the west side of Dover Point Road north of the Project Area. J.W. Clement and J.H. Henderson acquired a brickyard near their homes at the north end of the Project Area (see DOV0130 and DOV0149) in 1889. They expanded the operation; a mammoth kiln of brick was burned and sold to a Boston firm, carried there by schooner (Whitehouse n.d.).

The railroad fueled a small summer tourist business on Dover Point during the late nineteenth century. Hilton Hall, formerly Hanson's, near the station on the site of Hilton Park, was popular with visitors into the 1920s. The late nineteenth century hotel-keeper was D. Wiggin. Near Pinkham's Grove was the site of large clambakes, to which residents of Dover and Portsmouth traveled by special train (Smith 1973:52). About 1910, the old Enoch Pinkham House became a hotel, known as the Piscataqua House (not extant) (Scales 1923:59).

Farmers in Newington continued to prosper. Dairy products were the major marketable entity. Butter made on the farm was the most convenient method to preserve and transport to market. The railroad brought changes in dairy farming. After 1873, local farmers sold their milk in bulk and shipped it to creameries by rail (Strafford Rockingham Regional Council 1981). The opportunity for farmers to reach national and international markets, accessible by the new railroad, demanded the cultivation of a non-perishable crop. Orchards soon became a part of almost all farm operations, large or small, and helped establish Newington as a center for apple production (Strafford Rockingham Regional Council 1981).

Most of the residents of the Project Area in Newington were farmers, some with large farms and several boarding laborers living with the family. Other residents of the area were a sailor (Capt. Frank Coleman), a coaster, a mason, a butcher, house carpenter and farmer Isaac Dow, and tavern keeper Nancy Drew (Bureau of the Census 1880 a and b). As of 1900 farming was still the primary occupation. Residents of the Project Area in Newington also included a teamster, a retired physician, and the railroad station agent. Several members of the Whidden, Downing, Hoyt and Coleman families lived in the vicinity (Bureau of the Census 1900; Hurd 1892).

The brick industry declined on Dover Point during the early 1900s, due to the depletion of clay and the mechanization of the industry. One of the last was the Fiske yard, established in 1902 by Boston investors, north of Pomeroy Cove on the east side of Dover Point Road. The plant was large and modern. Raw materials entered the plant on a railway at the south end of the large plant and were mechanically transported through the manufacturing process, replacing the labor-intensive nineteenth century method. An operator and assistant could produce the same number of bricks as 15-20 men previously (Scales 1923:60-610). Most of the clay was cut from beds farther up Back River. Clay and sand were brought to the plant by rail from as far away as Madbury. Bricks were used in the construction of Dover's High School and Public Library. Although successful, when the plant was destroyed by fire in 1906, it was not rebuilt (Scales 1923:62).

The Seavey & Loughlin yard on the point, west of the railroad bridge (the original Enoch Pinkham yard), and John E. Pinkham's yard, located a short distance north, were still in operation in 1908. Loughlin was the boss of the brickyard and also the proprietor of the Piscataqua House hotel (Scales 1923:59). About 1910 E.P. Kennard purchased the Loughlin property making the old hotel into a residence and the brickyard site into an extensive lawn. Farther north on Dover Neck, brickyards remained in operation into the 1920s (Scales 1923:57). One was owned by C.H. Morang who lived at DOV0098. Elbridge Gage worked a yard on the river east of DOV0135 (Hayes 1912; Anonymous 1917).

Automobile Era, End of Railroad, State Highways, Shattuck Shipyard, Sullivan Bridge, Summer Cottages (ca. 1910-1952)

The 1910s-20s were transitional periods in the Project Area, as Dover Point brickyards closed and a community of summer cabins developed in their place. Newington's Piscataqua shore had a number of summer cottages in the early 1900s, and then became increasingly industrial.

During the first decades of the twentieth century the railroad was replaced by automobile and highway travel. The Portsmouth and Dover was operated as part of the Boston and Maine network from 1900. The station agent at Dover Point was Herbert Dame, who married the daughter of Richard A. Pinkham. They built a house DOV0090 and later a store next to it. During the early twentieth century, residents of the Bloody Point area of Newington south of the bridge got their mail *via* the Dover Point post office (the rest of Newington being RFD 1 from Portsmouth). In Newington the toll taker and station agent occupied a residence in the railroad station building NWN0168. Rollins Station operated as a flag stop.

The toll and railroad bridge between Newington and Dover Point was often damaged by currents and ice jams, including a serious failure in the spring of 1918, after which repairs were completed in three months. At the same time, automobile traffic over the bridge increased. Woodbury Avenue, Shattuck Way and Dover Point Road became one of the first state highways, the East Side State Road (later NH 16), after the Trunk Line system was established in 1905 as a system of three roads running from the Massachusetts border into the White Mountains. During this period, US 4 followed Dover Point Road into Dover and went west through Barrington toward Concord on what is now NH 9 (USGS 1918, 1941). Railroad traffic, mainly passenger cars, continued between Portsmouth and Dover carrying Newington students to high school in Portsmouth and workers to the Portsmouth Naval Shipyard and elsewhere.

Both Newington and Dover with their extensive waterfronts became the locations of summer residences. Camps and cabins were established on Dover Point, by families who were primarily year-round residents of downtown Dover. Dover Point offered inexpensive land within easy driving distance of the city as the automobile came into use. DOV0086 was a summer home after 1906. The Ira Pinkham House (DOV0093) became summer residence of Annie C. and Frank Wentworth of Dover in 1912. Wentworth, owner of a Dover bicycle and later auto dealership, was among Dover's first automobile owners. The Wentworths subdivided and sold off much of the land formerly associated with DOV0093 along what became Wentworth Terrace. They built a camp there themselves and moved several more structures to the site in the 1920s (none extant) (Bartlett 1992). In 1928, Clyde Whitehouse, a Dover optometrist, built a camp (not extant) between Wentworth's property and Hilton Point (Whitehouse 1992).

Groups of vacation cottages were built along the Piscataqua in Newington, off of Shattuck Way. Land formerly part of the Rollins Farm was sold and groups of summer cottages built. By 1914 there were more than sixteen summer residents in the vicinity. Some of these cottages remain, including groups off the end of Patterson Lane (Area CPL) and off Avery Lane, but most lack integrity.

Businesses catering to travelers, especially summer tourists opened on Dover Point. In the 1920s, Wentworth built a gas station (not extant) just south of DOV0093. Next door was the Mackey store and tearoom (not extant, opposite DOV0092). The Ida M. Dame House became the Linwood Lodge (DOV0090) in 1925, when it was purchased by Alexander and Mary Blake of Lynn, Massachusetts. The Dover Point House (site now in Hilton Park), which had long catered to summer boarders, closed ca. 1921 and later burned down. North of Pomeroy Cove was another tearoom operated by the Stevens'.

Farming continued on some properties in the area in the early twentieth century. Fannie King had a poultry farm on the former Piscataqua House/Enoch Pinkham property until the land was taken for construction of the Bridge and Hilton Park in the 1930s. There were also chicken coops associated with DOV0086 owned by Earl Priestly. Early twentieth century residents of the Project Area in Newington included seven farmers, four carpenters, three laborers, the railroad agent, and two retirees (Anonymous 1914). The Beane Farm (NWN0204) was a large dairy farm through the first half of the twentieth century. Other farms remained in operation along Woodbury Avenue where commercial buildings are now located.

The first industrial development on the Piscataqua River in Newington was the Shattuck Shipyard on Bloody Point. L.H. Shattuck of Manchester began negotiating with property owners of several large farms in the area soon after the outbreak of the First World War. L.H. Shattuck Inc. received a Navy contract to build 3,500-ton, wooden-hulled cargo steamships for the US Shipping Board with funds from the Emergency Fleet Corporation. The ships' frames were built in Newington and then towed to another location to be outfitted with engines. Wooden ships though less desirable than steel ones, could be built quickly and easily based on standardized Navy plans. The Shattuck Shipyard was rapidly constructed including shipways along the shore for building four ships at a time, a sawmill with a daily capacity of 300,000 board feet of timber, warehouses, workshops, offices and drafting rooms. Also on the site were a restaurant, hospital and fire department (Rowe 1987:275). Between July 4, 1918 and August 14, 1919, fifteen ships were launched in Newington, the government honoring outstanding contracts after the War ended. Wages at the shipyard were high for the time; unskilled laborers started at three dollars a day. Businesses in nearby Dover and Portsmouth had difficulty retaining their employees. Without any prior experience, laborers were hired and there was a sudden and overwhelming influx of people arriving to learn ship-building. Quickly, all kinds of housing went up in the area around the shipyard to accommodate its personnel, much of it temporary or shoddy (Monroe 1998; Rowe 1987:223-224).

Services were established nearby. Fred Prescott opened a restaurant to feed the single men working in the yard. Joseph Cavaretta built a hotel, with a dining and pool room, beside the railroad tracks. His son ran a bus service between Newington and Portsmouth. Francis "Mary" Davis opened Mary's Place, a store and restaurant on the west side of present Shattuck Way near the train depot (Anonymous 1976). Within months of launching the last ship in August 1919 the yard closed and was liquidated. Mary's Place stayed open for a few years beyond the closing of the shipyard and the bus continued to run into the 1920s (Rowe 1987:230). Although the shipyard was short-lived, it paved the way for the development of a heavy industrial zone along the river (Bolster 2002:105).

The 1920 directory of Newington listed more than ten shipyard employees (probably recently unemployed), four laborers, seven carpenters, one ship carpenter, a blacksmith, a teamster, and the railroad station agent. Residents of the area were from Massachusetts, New York, Vermont and other states, the Maritime Provinces, and from Quebec. There were only about three farmers. At least one resident of the area worked in Portsmouth and three more at the Portsmouth Navy Yard (Bureau of the Census 1920).

During the 1920s, the former Shattuck Shipyard was owned by American Dye and Chemical Company, makers of coal tar dye (Rowe 1987:227). They built a new plant on the site, which consisted of six utilitarian brick buildings with saw-tooth roofs, three of which remain. Some shipyard buildings were reused; others were taken down. The dye company, which depended heavily on the railroad for raw material and transport of finished goods, closed down in the 1930s. In 1930 area residents in Newington included the toll-taker, about five farmers and seven farm laborers, and two house carpenters. There were two gas station owners, one auto body mechanic and a trucker. Five men worked at the dye plant, several at other industries, one at the Navy Yard (Bureau of the Census 1930).

The dye company plant was purchased ca. 1931 by Newington resident John E. Holden for an oil storage facility of the Atlantic Terminal Sales Corporation (ATSC). Holden reused existing buildings and the wharf, and built a number of new structures, including eleven oil tanks. He cleared a forested site west of the wharf and tanks for his residence. The house and barn were later moved on the property.

More summer cottages were built on Dover Point as automobile ownership became widespread. Families could move out to the waterfront for the summer months and drive back and forth into the city for work and business. The first camps on the west side of the point on Boston Harbor Road were built by Dover residents Joe Boston and Pete Stone. Boston, who delivered for the J.E. Lothrop Piano Company, was noted for his entertaining. Visitors reported that “When you went to a party at Joe Boston’s camp, you had a great desire to go again,” and so the name ‘Boston Harbor’ was coined (Smith 1973:52). The earliest camps were built as temporary structures, without running water or electricity. Later they were replaced or enlarged. Other early campers were the Chapman and Cullen families of Dover. Charles Chapman, a carpenter, built a camp at DOV0112 ca. 1928 and moved there year-round a few years later. He had a store (DOV0109) and boat rentals on the property. Chapman erected several more cottages in the vicinity (DOV0110-0112) ca. 1930 which were later inherited by his sister Sarah Cullen. She and William Cullen built a cabin DOV0107 as a summer home, followed by DOV0108 for his parents. The grouping of cabins is known as the “Chapman Cabins Historic District”.

The last brickyard in Dover was operated by Charles Belanger during the 1930s, on the Back River, at the north end of the Project Area. Belanger’s homestead was on the west side of Dover Point Road just in the vicinity of Belanger Drive. When the land was subdivided for development, the house was moved to its current location.

In 1933-34, as part of improvements to the state highway network, the General Sullivan Bridge (DOV0158), a toll bridge, was built between Newington and Dover. There was discussion about the location of the crossing for several years. In 1927, Durham legislator Oren Henderson sponsored a bill to build a bridge between Fox and Cedar Points on the site of the old 1794 Piscataqua Bridge, and restore Durham's place on the route from Portsmouth to Concord. Governor Spaulding called for further study and the Bloody/Dover Point crossing, favored by engineers, was included in the bill passed in January of 1933. Work on the foundation of the new bridge began in July. The General Sullivan Bridge opened in September 1934. In the same year, the Scammell Bridge was erected between Dover Point and Durham, reopening the First New Hampshire Turnpike and creating what is now US 4 through Durham, initially known as Alt. US 4 or 4A. The 1873 bridge immediately east of the new bridge was demolished in February 1935 bringing an end to railroad traffic between Portsmouth and Dover. The state took over the railroad right-of-way on Dover Point and it later became the basis for the layout of the Spaulding Turnpike Corridor. The Boston and Maine Railroad Newington Branch continued freight service along the riverfront in Newington, serving the industries there. In 1937 the State Legislature authorized acquisition of land for the improvement to the approaches of the General Sullivan and Scammell Bridges. This park and recreation land was to be managed by the New Hampshire Toll Commission. In Newington the purchase included the former Newington Railroad Depot (NWN0168) and adjacent railroad corridor on Bloody Point. From the 1930s to the 1970s the former depot was the residence of Elmer Brooks who leased it from the state. On Dover Point, the state created Hilton Park (DOV0150) as the northwestern approach to the Sullivan Bridge, to preserve the bridge approaches for the public good. Originally the park encompassed land on the western side of the bridge approach. There was concern about unattractive properties in the vicinity, particularly the chicken farm of Fannie King located on both sides of the road. The General Sullivan Bridge was a toll bridge until 1949. The western part of Hilton Park was essentially the same design that remains now. The section of Hilton Park east of the approach (now east of the Spaulding Turnpike) was created ad-hoc. The former Piscataqua House and the Mackey house and tearoom were among those removed during this period.

During the 1930s small houses were built in the Project Area. The Wentworth's sold off additional lots and properties DOV0087, DOV00154, 0156 and 0157 were built. Originally summer cottages, these were later turned into year-round homes, as residents commuted to work by car. On Boston Harbor Road the Varney (DOV0113), Baron (DOV0115) and Bowen (DOV0114) cabins were built in the 1940s. By the mid-1940s homes were being built for year-round use. The first year-round home on Boston Harbor Road was DOV0106. Frank Wentworth developed additional land during the post-war building boom including DOV0094, 0095, 0097 on land north of his home DOV0093. Area residents included Portsmouth Naval Shipyard workers James Loughlin of DOV0091 and John Knight of DOV0101. Howard Wakefield who occupied half of DOV0095 worked for General Electric in Somersworth. Maurice Tuttle of DOV0123 worked at Clarostat in Dover.

Automobile traffic, by travelers and commuters increased. Roadside businesses flourished. Tourist cabins were built on the water at DOV0146. In the 1950s, a lobster take-out stand operated on the property. Newick's Restaurant, previously Newick's Lobsterland originated ca. 1948 as a roadside stand on the Newick's property on the east side of Dover Point Road (removed for Turnpike construction). Up Dover Point Road, the Tuttle family had a small flower shop and greenhouse at their home (DOV0123). In Newington, while River Road was part of the main highway, NWN0172 was built as a filling station ca. 1940. The Portsmouth Traffic Circle opened in 1950, followed by the opening of I-95 in 1960. A new section of highway was also built through Newington parallel to Woodbury Avenue to the Sullivan Bridge. This became the southern end of Spaulding Turnpike constructed a few years later. Auto related businesses were located along it. The Newington Drive-in opened in the early 1950s.

Pease Air Force Base, Spaulding Turnpike, Commercial and Industrial Development (1952-present)

The second half of the twentieth century brought substantial changes to the project area. The US Air Force began acquiring land in both Newington and Portsmouth in 1952 for the construction of a Strategic Air Command base in the Northeast United States, believed to be crucial to the Cold War effort. The base was named Pease Air Force Base in 1957, in honor of Harl Pease, Jr., a New Hampshire World War II veteran posthumously honored with a Congressional Medal of Honor. Portsmouth Airport, which had been used by the military during World War II, was acquired along with other acreage in Portsmouth and over the line in Newington. Ultimately, nearly sixty percent of the base's land area was in Newington. Construction of the base entailed the acquisition of historic farmsteads and other buildings. By 1953 fifty families had been dispossessed and thirty dwellings, most of which were large farm complexes, were demolished with only a few relocated elsewhere in town (Rowe 1987:262, 265-66). The large restricted Base area severed Newington into two distinct sections. The southern portion near the Portsmouth and Greenland borders was completely isolated from the town center, because the network of roads running through the air base was closed to civilian traffic.

The residential section of the Air Base was located in the southeast corner of the property, adjacent to the Spaulding Turnpike. In 1955, the Manchester firm of Koehler & Issak designed a 1,005-family housing project and did a site plan for an additional 1,000 units (Anonymous 1958:6-9). The design was suburban in character with curvilinear streets, equal setbacks, cluster arrangements and ample open space. Site preparation began in 1956 and was undertaken by the H.W. Hinmann Company of Westbrook, Maine. Davison Construction Company of Manchester built the houses (Anonymous 1958:15-19). Two years later, the first base housing was made available to personnel, and by September 1958 nearly 700 units were available (Anonymous 1958:23-24). Within a few years housing included 1,200 dwelling units broken down into ten single family detached units, sixty-three duplexes, two hundred and sixty quadra-plexes, and six six-plexes (Bechtel Corporation 1990).

For construction of Pease, the federal government acquired the land that was the site of Portsmouth's principal water sources, Peverly Pond and the Haven and Smith wells. As mitigation a new reservoir was created in Madbury by damming the Bellamy River. Pipes were laid from the reservoir to the new filtration plant, then under ground and beneath Little Bay to a water tower and booster pumping station (NWN0228) at the edge of the air base in Newington.

During the same period, the Highway Department undertook the expansion of state highways and initial construction of the Interstate system. In 1954-55 the Spaulding Turnpike, a toll-road, was built as a bypass around the cities of Dover and Rochester on the route north. From the General Sullivan Bridge, the Turnpike paralleled Dover Point Road, roughly along the old Portsmouth and Dover Railroad bed.

The expanded Turnpike separated Newington's rural residential areas from the industrial section along the riverfront. A series of interchanges provided access to Woodbury Avenue and to Newington's town center. The limited access road split Dover Point down the middle and severed the historic through road, Dover Point Road. Several properties were demolished for construction of the Turnpike; they included the Newick property, Wentworth's gas station (south of DOV0093) and the Ayerport Inn (Mackey 1992). Properties that had stretched from one side of the Point to the other were split and sold to different owners (Dubois 1992). Changes were made in access to Hilton Park (NHDOT Plans 1954-55). Existing properties were given access to the highway, but not those built afterward. The Exit 6 Interchange, including overpass and Exit ramps, was built to connect the Turnpike with the Scammell Bridge and the older bypassed sections of Dover Point Road.

There were pre-existing automobile related businesses along the Spaulding Turnpike on the older highway in Dover and Newington. Some were reoriented toward the new Turnpike. These included two filling stations (not extant) in the median between the Turnpike and Old Dover Road and Woodbury Avenue. A Shell Oil station and Flagstone's Restaurant (not extant) were located south of the Sullivan Bridge. Filling stations included an Exxon at the corner of Nimble Hill Road (site of modern gas station), and another in the median (NHDOT plans 1954-55). On Dover Point Road near Exit 6 was the filling station of John Keefe. A motel was built on the corner of Nimble Hill Road, west of the Turnpike ca. 1960.

Local businessman, John E. Holden, owner of ATSC oil tank facility, was an advocate of locating Pease Air Force Base in Newington, as he considered it beneficial to the town and also to his oil business (Rowe 1987:260). Holden owned and operated ATSC until 1959 when he sold it to C.H. Sprague and Son. The facility became Sprague's New Hampshire headquarters. A new 400-foot dock and a 217,000-barrel tank were added. The remaining Shattuck shipyard buildings were taken down. An oil refinery was established and expanded in the 1960 and operated into the 1980s.

The proximity of the highway made Dover Point an ideal place for residential subdivisions. Cote Drive between Dover Point Road and the Piscataqua River was established in the 1950s and continued to develop throughout the second half of the twentieth century. Several year-round homes were built on small in-fill lots along Dover Point and Boston Harbor Roads, on Leighton Way and Wentworth Terrace. In the second half of the twentieth century, Homestead Road, Pineview and Pearson Drives, were built as cul-de-sacs off the west side of Dover Point Road north of the Exit 6. By this time, most of the summer cottages on the Piscataqua in Newington and on Dover Point were converted to year-round use. In 1966, a new bridge (Little Bay Bridge) was built parallel to the General Sullivan Bridge. For eighteen years, the new bridge carried only northbound traffic, while the General Sullivan Bridge carried southbound lanes. In the 1980s, the new bridge was widened to four lanes and the General Sullivan Bridge closed to motor vehicles. Hilton Park, not actually a part of the state park system, is owned and maintained by the NHDOT Bureau of Turnpikes.

Pease Air Force Base expanded in the 1960s-70s. An additional one hundred dwelling units were constructed in 1977 (Bechtel Corporation 1990).

During the last quarter of the twentieth century, the eastern part of Newington became a regional commercial and industrial market. The Woodbury Avenue corridor developed into the third largest retail area in the state supported by the Fox Run Mall and other large retail chains. The riverfront supports some of the state's largest industrial employers, such as Tyco, Georgia-Pacific, Westinghouse, and Sprague. The former B&M Newington Branch railroad was purchased by Pan Am Railways in 1983. Elsewhere, Newington and Dover's outlying areas became bedroom communities, whose residents commuted to work elsewhere in the Seacoast region and as far away as Boston.

In the late 1980's, Newington faced another dramatic change. Pease Air Force Base was one of five Air Force bases identified by the US Department of Defense as non-essential for national security, and slated for closure by the early 1990s. Plans were made to redevelop the former base. Ultimately, in 1991 the Pease International Tradeport opened as a commercial airport and industrial/business park (Pease Development Authority 1993). The

Tradeport has expanded considerably since then with many large modern commercial/office buildings and manufacturing plants. Most of the base housing has been demolished.

3.17.2.3 National Register Eligible Properties and Districts

A total of ninety-four (94) properties and five historic areas were surveyed as part of this undertaking. The material developed for this study is available at NHDHR, NHDOT and FHWA, along with documentation and discussion of eligibility.

The following is a description of those properties that have been determined eligible for the National Register of Historic Places, based on the NHDHR Determination of Eligibility Forms (see **Figure 3.17-1**).

Newington

The Benjamin S. Hoyt House (NWN0148) is located west of the Spaulding Turnpike on the southeast side of Nimble Hill Road. The property contains 19.6 acres, extending south toward the northern edge of Pease and southeast nearly to the Turnpike. The Benjamin S. Hoyt House is eligible for the National Register under Criteria A and C, for its historical associations with agriculture in Newington and for its architectural significance as an intact farmstead. The date, plan and style of the house is of particular interest; it stands as a tribute to the unending popularity of this house type in the Seacoast region and may serve as an early example of the popularity of the Colonial Revival. Built ca. 1887, the traditional two-story, hip-roofed, 5 x 2 bay form and center hallway twin chimney plan give it the appearance of an early 19th century, Federal period house. The property includes a large New England barn, wagon shed, and surrounding open fields.

The Newington Railroad Depot/Tollhouse (NWN0168) is located at the end of Bloody Point Road on Bloody Point east of the Spaulding Turnpike and the bridge over Little Bay. The property includes the combination railroad station and residence for station-master/toll-taker. Bloody Point Road passes on one side of the building, the railroad bed on the other, coming together on the point, where the southern abutment of the combination road and railroad bridge stood. Newington Depot is individually eligible for the National Register under Criterion A for its historical associations with railroads and transportation at this pivotal point of land in the Seacoast area. The building was erected in 1873 on the Portsmouth and Dover Railroad, which was built in that year, crossing a new railroad and toll highway bridge between Newington and Dover Point. The property is also eligible under Criterion C for its architectural significance as an intact railroad station that combined living quarters with railroad and highway functions (only a handful of these stations remain today in the state). The boundary of the eligible property (5.8 acres) encompasses the building, road and rail beds on both sides, as well as, the adjacent abutment site.

The John Downing Farm (NWN0201) is located on Patterson Lane, an early road that runs from the Woodbury Avenue/Turnpike Interchange northeast to the Piscataqua shore. The John Downing Farm is dated ca. 1738, the oldest surviving Newington farm on the east side of the Spaulding Turnpike, and has been continuously owned by members of the Downing family to the present time. The house, a center chimney cape, has a heavy timber frame and a rectangular form without additions; the south façade (facing away from the road) is divided into five bays and has the dwelling's only exterior door; the north (rear) elevation, facing the road, has three bays and no entrance. The Downing house is the last surviving example of a once common house type in Newington (the 1 ½ story center chimney cape). Beside the house is an 18th century English barn, also south-facing. The house and barn are eligible for the National Register under Criterion C as intact examples of these eighteenth-century vernacular building types. The John Downing Farm is eligible under Criterion A as a rare survivor of the earliest days of farming in the town. The small house and barn and adjacent open fields document the early agricultural associations of Newington's Piscataqua shore. The parcel presently associated with the buildings contains three acres. The boundary of the eligible property is defined by the tree line surrounding the open field on which the buildings sit. This encompasses adjacent parcels on either side subdivided from the historic farm, but previously associated and visually substantial to defining the domestic space and historic associations of the buildings.

The Beane Farm (NWN0204) is located at 2299 Woodbury Avenue on the crest of Beane's Hill. This property and the Isaac Dow House directly across the road form a strong visual anchor, conveying the last remnant of the area's nineteenth and early twentieth century agricultural associations. The Beane Farm, built ca. 1905, is eligible for listing on the National Register under Criterion C for its architectural significance as a connected farm complex constructed in response to expanding dairy farming in Newington. The property consists of a large 2½- story farmhouse with hip roof and wraparound porch, a series of ells and connected gambrel roofed dairy barn. The connected farm has been remodeled for commercial use in the second half of the 20th century, but the defining elements are intact to make this the best example of its type in Newington. The eligible property (8.22 acres) excludes adjacent driveways and parking lots. It includes the building's footprint and ten feet around it on all sides, plus land sloping towards the junction of Woodbury Avenue and Patterson Lane, which is associated with the property's once rural setting

The Isaac Dow House (NWN0205) stands atop Beane's Hill at 2204 Woodbury Avenue. The Isaac Dow House is eligible for the National Register under Criterion C for its architectural significance as an example of the federal style and form (built ca. 1820), updated in the later 19th century (ca. 1890) as tastes and technologies changed. Carpenter Isaac Dow who moved from Rye and established a large farm here, built the house on the highest point in the seacoast region. The house has the common federal period form, two stories with a hip roof. Isaac Dow Jr. worked as a carpenter and inherited the farm. He remodeled the house with Victorian porch, window hoods and window sash, bringing it up to date to reflect his prosperity and status. The boundary of the eligible property (0.57 acres) includes a portion of the parcel now associated with the house excluding the parking lot.

The Louis C. deRochemont Mansion (NWN0224) is located at 2111 Woodbury Avenue at the end of a maple lined drive that was bisected by the new bypass road, which reduced the eligible parcel by over half. The deRochemont Mansion is eligible for the National Register under Criterion B as the property most associated with the life of film maker Louis C. deRochemont. His contribution to social history is best exemplified by the film, Lost Boundaries; to entertainment/recreation by his efforts in Cinerama; and to communication by his reinvention of the newsreel, best shown in his series The March of Time. The deRochemont Mansion is eligible under Criterion C as a locally significant example of a Greek Revival dwelling, expanded and modified in the twentieth century with Colonial Revival elements.

The Portsmouth Water Department Booster Station (NWN0228) stands on the west side of the Spaulding Turnpike on Arboretum Drive which runs around the perimeter of Pease International Tradeport. The facility was built in 1956 during the construction of Pease Air Force Base as compensation for the federal government's taking of the principal sources of Portsmouth's water supply, Peverly Pond and the Haven and Smith wells. Built for the City of Portsmouth at the edge of the air base, this pumping station was part of a larger waterworks system designed by the Army Corps of Engineers including a reservoir and filtration plant in the town of Madbury. The purpose of this station is to boost the water pressure of the water piped from the reservoir to the level of the city's water pressure. The property includes a one-story red brick building, with modern style influence. Behind it is a round 1.5 million gallon metal storage tank with a domed cap. The property is eligible for the National Register under Criterion A for its historical associations with two locally important historic contexts – the construction and effects of Pease Air Force Base and 20th century improvements to municipal water distribution. The property is also eligible under Criterion C for its architectural and engineering significance as an unaltered example of a modern waterworks structure. The parcel contains 2.82 acres. It is visible on the west side of the Turnpike at the northern entrance to Pease.

Dover

The Ira F. Pinkham House/Wentworth Summer Home (DOV0093) is located at 430 Dover Point Road. The property, on the northeast side of Dover Point Road, abuts the Spaulding Turnpike, near the southern end of Dover Point. It is eligible for the National Register of Historic Places under Criteria A and C. The house and barn built ca. 1853 and 1886 respectively and renovated ca. 1912, have architectural significance as a mid-19th century farm complex altered to serve the needs of early 20th century summer residents. The property reflects associations with several historic important historical contexts on Dover Point – brick-making, agriculture and summer home tourism. Like many area residents, Ira Pinkham combined farming and brick-making to make a living. After his death in the early 1900s, Dover automobile dealer and developer Frank Wentworth and his wife Annie acquired the house for use as a summer home. They added the porch, replaced windows and applied asbestos shingle siding. The eligible property is defined as the 0.8 acre parcel associated with the buildings. The barn sits back from the road, near the southbound lane of the Turnpike.

The Charles Morang House (DOV0098) was built ca. 1878 at 419 Dover Point Road. Located on the southwest side of the road, the 0.81-acre property extends to the shore of Little Bay. The Charles Morang House is eligible for the National Register (Criterion A) for its strong historical associations with brick-making and agriculture on Dover Point, an important local context, as well as for its architectural significance (Criterion C) as a relatively unaltered connected farm complex. The 1½ story, side hall plan house, ell and connected small barn, retain more integrity than most 19th century properties on Dover Point. The waterfront setting and surviving outbuildings add to the property's integrity. Charles Morang settled on Dover Point to work as a farmer and brick-maker, the laborers in the brickyard boarding with the family in-season. The property remained in the Morang family through the 1920s.

The Card-Coleman-Cousens House (DOV0099) (416 Dover Point Road) is eligible for the National Register under Criterion C as the best-surviving example of rural brick house construction in Dover (an important locally-produced building material). The property extends from Dover Point Road northeast toward the Spaulding Turnpike. The Card-Coleman-Cousens House, built ca. 1840, is the more intact of two small adjacent brick houses on Dover Point. It was occupied by members of the Card family who owned brickyards in the area. The house retains its original 1 ½ story, 5 x 2 bay form, twin end chimneys, splayed window lintels and entry framed by recessed blind panels. The eligible parcel contains 0.23 acre. A small tract between this and the Turnpike has been subdivided, but is not developed and affords a view of the rear of this property from the highway.

The Crocker-Fleming House (DOV0104) at 405 Dover Point Road is located on the southwest side of the road extending toward the shore of Little Bay. The Crocker-Fleming House, built ca. 1928, is eligible for the National Register under Criterion C for its architecture, as a well-preserved example of the types of camps and houses built in the early 20th century on Little and Great Bays. These small waterfront residences were once common along the shore and part of a substantial development trend, but are now being rapidly replaced by new or completely rebuilt structures. The Crocker-Fleming House displays many of the distinctive characteristics of the type and period, including a waterfront location, nearly square plan, small-scale one-story massing, pyramidal hip roof, overhanging eaves, multi-pane double-hung sash (some with original storms), a concrete foundation, wood framing, plain trim and a lack of stylistic ornamentation. The parcel contains 1.48 acres.

The Wiggins-Miksenas Cottage (DOV0125) is located on the shore of Little Bay, at 7 Boston Harbor Road, just south of the Scammell Bridge/US 4 interchange. The property is eligible for the National Register under Criterion C as a well-preserved example of the types of camps and houses built in the early 20th century on Little and Great Bays. These small waterfront residences were once common and part of a substantial development trend, but are now being rapidly replaced by new or completely rebuilt structures. The Wiggins-Miksenas property displays many of the distinctive characteristics of the type and period, including a waterfront orientation, a small main block and shallow gable roof augmented by shed additions, multi-pane double-hung sash, porches, a concrete foundation, wood framing, plain trim, a lack of stylistic ornamentation, and the garage's hip roof and square plan. The house's interior integrity adds to its significance. The small parcel contains 0.16 acre.

The Thomas Henderson House (DOV0134) at 284 Dover Point Road is located on the east side of the road at the northern end of the Project Area, due east of the Dover Toll Booth. The Henderson House, built ca. 1790 and 0.8 acres of surrounding property are eligible for the National Register under Criterion C for their association with late Georgian style architecture in Dover. The house is among the oldest buildings to survive in the project area. Although it lacks integrity as an agricultural property, its massing, south facing orientation, entry, 9/6-window sash, cornice, center chimney and known interior features remain to clearly illustrate its architectural significance.

The Lower Neck Schoolhouse (DOV0136) at 294 Dover Point Road was built as a district schoolhouse ca. 1885. The Lower Neck School House and the 0.28 acre which it occupies is eligible for the National Register under Criterion A for its associations with education and community life in Dover, and more specifically in the Lower Neck neighborhood. Although its architectural integrity has been slightly lessened by the changes to the side elevation windows and the rear addition, both could be reversed in the future. The building retains characteristic 1 ½ story gable front from with double entries, and Victorian door and window trim. This un-graded schoolhouse remained in use into the 1920s and is now the last known surviving one-room schoolhouse in Dover.

The Dover Point Chemical Company #1 Firehouse (DOV0151) is located at 292 Dover Point Road immediately north of the former Lower Neck Schoolhouse. This property (approximately 0.149 acres) is eligible for the National Register both for its historical associations with fire fighting, local government and community life in Dover (Criterion A) and for its architectural significance as a well-preserved single-engine firehouse (Criterion C). It appears unaltered from its construction ca. 1910 during the days of horse-drawn engines. The Dover Point Chemical Company #1 was a volunteer organization formed by residents of the surrounding neighborhood. The building displays characteristic elements of the property type and has been "mothballed" since last used in the 1950s.

The General Sullivan Bridge (DOV0158) was built in 1933-1935 across the outlet of Little Bay, between Newington's Bloody Point and Dover Point. The bridge was the keystone of a project that was then regarded as "the most unique and outstanding along the line of bridge and highway construction that has ever been proposed in the history of the state" (Foster's Daily Democrat, September 5, 1935). The bridge was built under difficult weather and tidal conditions, including rapid tide currents, extreme cold and ice floes. Design and construction of the bridge were noteworthy achievements, described in articles and engineering journals of the time. The General Sullivan Bridge is eligible for the National Register under Criterion C for national significance in engineering, and also under Criterion A in the area of transportation.

The General Sullivan Bridge was the first span in New Hampshire to be designed as a continuous arched truss, without structural breaks at the supporting piers. Its design and construction contributed substantially to the advancement of twentieth century American bridge technology. This design employed newly developed sophistication in analyzing stresses in continuous structures. Fay, Spofford and Thorndike, bridge design specialists from Boston, designed the bridge. Founded in 1914, this partnership was one of the most prolific American bridge engineering firms of the 1920s and 1930s. Charles M. Spofford was an authority in structural analysis, whose textbook *The Theory of Structures* (1911, 1915, 1928) outlined some of the methods of analysis for statically indeterminate structures that were employed in the design of the General Sullivan bridge, specifically the "method of least work."

The Sullivan Bridge was one of four major US bridges of its type and style, designed by Fay, Spofford and Thorndike in this time period. In 1929, they designed the direct prototype for the Sullivan Bridge – the Lake Champlain Bridge. The Sullivan Bridge was an important step in the evolution of the continuous truss highway bridge for three reasons: it incorporated special features of the Lake Champlain bridge that had proved economically sound; it demonstrated the practical application of a new technology for weighing bridge reactions; and it helped establish a reduced economical span length for the continuous truss. The thru-arch continuous truss design was copied for years to come for major and minor highway bridges throughout the country where aesthetics and cantilever construction were necessary factors. When New Hampshire's bridges were evaluated for historical and engineering significance in 1982, the General Sullivan Bridge attained a numerical score of 28, the second highest ranking of any bridge in the state.

The General Sullivan Bridge had a major impact on regional transportation patterns. Previously all traffic from Portsmouth to Concord traveled first to Dover, then through Barrington on NH 9 to join the First New Hampshire Turnpike (US 4) in Northwood. The General Sullivan Bridge and a companion structure, the Scammell Bridge, provided a new connection with the eastern end of the old Turnpike at Cedar Point in Durham. Conveying traffic along the old route through Durham, Lee and Nottingham, the bridge restored usefulness to the full length of the Turnpike. At the same time, the Sullivan Bridge, replacing the former road and railroad bridge between Newington and Dover Point, became part of the East Side Road trunk line highway, from the seacoast through Dover to points north. The Sullivan Bridge carried the Spaulding Turnpike when it was first created in the 1950s.

The eligible property encompasses the bridge footprint including the abutments and the approach road on both sides. The total acreage of the eligible property is approximately 8 acres.

The Chapman Cottages Historic District (DOV-CH) was determined eligible for the National Register under Criteria A and C. The four cottages (29 and 33, 33A and 33B Boston Harbor Road) are located on 8.27 acres on a private drive leading to the shore of Little Bay off of Boston Harbor Road south of Exit 6 of the Spaulding Turnpike. The Chapman Cabins Historic District is substantial for its strong historic associations with the early to mid-20th century development of seasonal camps not only on Dover Point, but all along the Little and Great Bay estuaries. This group of cabins is among the last intact clusters of what was once a substantial pattern of development in the area. The cabins are also important as examples of an architectural type. The four seasonal cabins and small store were built in the 1930s-40s by Dover resident and carpenter Charles L. Chapman. He and wife Emma summered in one cabin and rented the others out. From the store they rented boats and fishing equipment. The buildings retain low gable roofs, masonry pier foundations, novelty siding, and overhanging eaves with exposed rafters. Some of the original window sash and doors are intact.

The Cullen-Bruyere Historic District (DOV-CB) includes 39 and 45 Boston Harbor Road, the Cullen–Bruyere House and the Cullen Camp. Surveyed individually as DOV0107 and 0108, these properties were determined eligible together as a small historic district, under Criteria A and C. The two small cabins are sufficiently intact to convey their historic associations with the early to mid-20th century development of seasonal camps on Dover Point and all along the Little and Great Bay estuaries. Few intact cabin clusters remain from what was once a substantial pattern of development. Much of the waterfront development was united through family ties. William Cullen of Dover built a camp for his family ca. 1930, followed by a second cabin for his parents a few years later. The two properties together contain a total of 0.327 acre.

3.17.3 Archaeological Resources

To fulfill requirements of Section 106 of the National Historic Preservation Act and its accompanying regulations, a preliminary archaeological reconnaissance level survey (Phase I-A) was conducted for the proposed study area. Research was initiated in May 2003, and included background research, visual inspection of the study area, interpretation of data and preparation of this report. The purpose of this study was to develop a cultural context for the study area and to identify known archaeological resources and locations of archaeological resource sensitivity within the study area that would constitute constraints to project design. This was accomplished through a strategy of research and field inspection addressing both terrestrial and underwater resources.

Definitions

Archaeological resources include cultural and culturally associated remains below the surface of the ground as well as ruins above it. The latter resources may include standing buildings, structures, objects, and landscapes when these resources are examined primarily for the data they may contain and relate to associated archaeological deposits.

Native American archaeological resources are those locations and resources once occupied by Native American or Indian peoples. They pre- and post-date the initial period of European settlement of the Americas, known as the contact period.

For the purposes of this project, historical archaeological resources are those sites and associated resources that usually date to, and after, the period of initial European contact with Native Americans. They not only include below-ground resources and foundations or ruins, but also the culturally associated landscapes and standing buildings. The data associated with these sites include not only the archaeological records but also the written, oral, and pictorial documents. While these resources are examined primarily for the data they may contain, associated standing resources may also gain significance for their architecture.

Methods

Background research and documentary review was conducted to identify previously recorded archaeological resources and to complete a chronology of past human activity within the study area. This was intended to provide a research baseline for addressing sites, features or remains and their contexts. Data accumulated from archival sources were used to identify particular sites, features, or past land use patterns. Background research also permitted development of contexts to develop expectations for resource presence in the study area.

Research was completed using a variety of primary and secondary sources. Research was conducted at a number of institutions including Strawbery Banke Museum, the Portsmouth and Newington libraries, the New Hampshire Historical Society, the NHDHR, the NHDOT, and the UNH.

Documents reviewed included the following: statewide site inventory files maintained by the NHDHR; published and unpublished archaeological site reports, including previously conducted cultural resources management studies in the project vicinity, filed with the Consultant or at the NHDHR; local and regional histories, available at the New Hampshire Historical Society, Strawbery Banke Museum, the Portsmouth Library and the Newington Library; historic and topographic maps, in files at the NHDHR, the Newington Library, Strawbery Banke Museum, and in secondary sources; historic photographs and aerial photographs, available at the Newington Library, Strawbery Banke Museum, the NHDOT, and in secondary sources. Research was completed in collaboration with other scientists at the UNH Jackson Estuarine Laboratory and the Center for Coastal and Oceanic Mapping who provided assistance in collecting underwater data. These sources provided information on known and potential cultural resources within the study area.

Research was augmented through interviews with property owners, NHDOT personnel, NHDHR personnel, Strawbery Banke Museum historians, archeologists and marine specialists.

Field inspection involved several steps and components. Inspection was completed to assess resource presence and sensitivity in the field. This was accomplished for both terrestrial and underwater resources.

For terrestrial resources, the study area was viewed using a strategy combining drive-over and walk-over survey. All roadways within the study area were driven and notation made on general conditions. A selected number of areas were walked. These included accessible shorelines, public property (*e.g.*, Hilton Park and Bloody Point), undeveloped or wooded sectors of the study area and the margins of historic roadways. In addition, all previously recorded archaeological sites within the study area were inspected by walkover survey in all accessible areas. No subsurface investigations of any type have been conducted to date.

During visual inspection notation was made on terrain, surface waters, disturbance or intrusions. All previously recorded sites were inspected to confirm their existence, location and status. When new sites, features or resources were discovered, preliminary field sketches were made, photographs taken and information collected to compile a minimum-level, site NHDHR inventory form. Sketches were drawn using compass and tape to record overall dimensions of visible features or remains. Observations on the likely occurrence of archaeological resource presence were also made during visual inspection, based on such environmental qualities as visually intact landscape surfaces, topography, drainage, surface water, soils, and overall setting.

Field survey further included complete walkover of all areas that would become impacted by the preliminary alternatives (Alternatives 1, 2 and 3 in Dover and 6-Revised, 7, 9, 10, 11, 12 and 13 in Newington). In this effort, all proposed routes were inspected to make refined observations on condition and archaeological resource sensitivity. Mapping, compass bearings and landmarks were utilized to guide the walkover, as the corridors were not flagged in the field at the time of survey. Information gathered during this effort was combined with research data and observations made in the first stage of field inspection to assign sensitivity zones for the occurrence of archaeological resources along individual alternatives. During the field inspection efforts, the occurrence of cultural features was recorded, photographs and field notes were made, and data were accumulated to combine with archival research to delineate areas of resource sensitivity and create the constraints map.

For nautical or underwater resources, several approaches were used. The search for locations of maritime archaeological resources was initiated by a search through the Encyclopedia of American Shipwrecks (Berman 1973). To obtain a sense of the presence of any partially submerged features reflecting human activity, aerial photographs of the area were also reviewed. These primary sources did not indicate the presence of any shipwrecks or partially submerged features in the study area.

Field survey was then undertaken to recognize the presence of any nautical resources visible during a full moon low tide. This involved walkover along drained cove margins for nautical resource assessment. The occurrence of cultural features was recorded during this effort. Because of the severe current, no diving was conducted within the channel.

Survey of deeper waters in the vicinity of the Little Bay Bridges was completed using data produced during underwater mapping efforts. A map was produced by remote sensing, using a 8125 Multi-beam Echo Sounder, a Marine Magnetics Gradiometer, and a NOAA Shallow Water Survey Set. Resulting data were made available by the Jackson Estuarine Laboratory and the Center for Coastal and Oceanic Mapping at the University of New Hampshire. This map provided an underwater topographic view of the study area. Other underwater data were produced by remote sensing systems that provided coverage of the submerged sector of the study area. This included completion of five video tracks using a custom-made Aqua-Vu black and white camera (Model IR) with a Sony digital video camera (Model DCR-TRV-103) with real time locations plotted along tracks. Video camera tracks were produced by towing this underwater camera system. Coverage of the study area was insured by interlacing the camera tracks. Coverage in waters shallower than 18 feet was limited due to potential camera damage. All underwater images were then assessed to define anomalies and determine the presence of any cultural occurrences within the river bed.

Archaeological resources sensitivity rankings were assigned to all portions of the study area. The rankings were developed specifically for this project, based on the nature and quality of information available as well as discoveries made in the field. Rankings were uniformly applied to both pre-contact and proto-historic Native American and historic period Euro-American occurrences. Resource sensitivity was defined as: no sensitivity; probably sensitivity; sensitive for resource occurrence; and verified sites. No resource sensitivity for sites of any age was assigned to those areas which were positively confirmed as having no likelihood of resource preservation due to extensive disturbance and landscape modification. Probable sensitivity for sites of any age was assigned to those areas where a veneer of surface disturbance was believed to cover areas, which would otherwise be considered sensitive. Areas were assigned sensitivity for the occurrence of archaeological resources of any age on the basis of a variety of criteria including historic map data, topography, setting (*e.g.* soils, drainage and proximity to surface water features), or analogy to other recorded sites in the locale. Actual sites, features or resources of any age or cultural affinity, were also defined and included both known and previously recorded sites as well as newly discovered sites found during this survey.

Based on archival research and field surveys, areas within the study area were classified according to their archaeological sensitivity as depicted in

Figures 3.17-2 and 3.17-3. Additionally, detailed information on each of the areas mapped is presented in Tables 3.17-2, 3.17-3 and 3.17-4.

3.17.3.1 Native American Archaeological Context

While only one Native American archaeological site has been previously recorded within the project are, the overall Piscataqua region has a rich and varied archaeological record that reflects over 11,000 years of occupation by Native American peoples. Sites with artifacts and components from all major time periods and cultures are present within the wider region. They are found in a variety of environmental settings that reflect the changing economic and adaptive strategies of Native people and changes in the local environment since the end of the Pleistocene. Habitation site locations are generally correlated with a number of specific environmental variables, notably including well-drained soils and proximity to fresh water, but artifacts reflecting more specialized activities (*e.g.,* hunting, gathering, or fishing) may be found in many settings in the Piscataqua region. The Native American archaeological record has become intermingled with that of Euro-Americans, and Native artifacts many thousands of years old occur in association with European sites of the 17th, 18th and 19th centuries. This requires archeologists to address the archaeological records of both cultures even when undertaking research projects that are strictly "historic" or "prehistoric" in nature.

The Piscataqua region of New Hampshire and southern Maine was inhabited by Native Americans for 11,000 years before the arrival of the first European. This long and complex history is reflected today in the many Indian place-names of the seacoast region (Ogunquit, Kennebunkport, Piscataqua, *etc.*), by the ongoing presence of Native people, and in the work of archeologists.

In the coastal areas of New England, European contact began shortly after 1500 AD with the arrival of the first European explorers, traders, missionaries, and colonists, who left a small number of written accounts. Within 150 years, diseases of European origin and the violent effects of colonialism had produced astounding mortality rates among Native populations (Snow 1980:32-35; Day 1978; Cook 1976). Few of the survivors would remain in the seacoast area, as refugee communities formed in other areas and "praying Indian" settlements were established by European missionaries. The severity of the disruption of Native life limits the extent to which historical knowledge can be derived from oral histories, and places a greater burden on archeology.

Table 3.17-2
Archaeological Phase 1A Sites, with Determination of Sensitivity[1]

Area	Sensitivity	Description	NHDHR Site No.
1	No Sensitivity	Dover, residential subdivisions	
2	Sensitive	Dover, Dover Point Road, first settlement and historic period land use, area of original meetinghouse and garrison	
3	Sensitive	Dover, wooded area on Dover Point Road, historic period land use	
4	Probable Sensitivity	Dover, Exit 6 of Spaulding Turnpike, historic land use with veneer of highway modification	
5	Sensitive	Dover, remaining wooded area, historic	
6	Sensitive	Dover, remaining wooded area, historic and Native American	
7	Verified Site	Brickyard, Dover	27-ST-51
8	Verified Site	Brickyard, Dover	27-ST-52
9	Verified Site	Hall's Spring, Dover	27-ST-53
10	No Sensitivity	Dover, residential subdivision	
11	Probable Sensitivity	Dover, Spur Road, residential subdivision with sensitivity for Native American, first settlement, historic period land use with veneer of recent development	
12	Sensitive	Dover, wooded yards in residential area, first settlement and historic period land use	
13	Verified Site	Dover, wooded yards and shoreline, Native American and first settlement, historic period land use, brickyards and industry	27-ST-54
14	Sensitive	Dover, Dover Point Road, brickyard	
15	No Sensitivity	Dover, Spur Road, C.H. Morang &Son brickyard,	
16	Sensitive	Dover, Spur Road, Hall's Spring, Dover, Hilton Park, wooded sections and residential development, Native American and historic period land use Dover, residential subdivision	
17	Verified Site	Dover, Hilton Park, brickyard	27-ST-55 & 27-ST-56
18	Probable Sensitivity	Dover, wooded area along Back River[2] to Redding Point, Native American and historic period land use, Hilton settlement	
19	Sensitive	Dover, Redding Point, brickyard, Dover, Wentworth Terrace and shoreline, residential yards and wooded sections, Native American, first settlement, historic period land use Dover, Boston Harbor Road, commercial and residential area with veneer of disturbance from development and road modifications	
20	Sensitive	Dover, Boston Harbor Road, commercial parcels and trailer park Dover, US 4 interchange, wooded section, historic period land use	
21	Verified Site	Dover, Dover Point, brickyard	27-ST-57
22	Sensitive	Newington & Dover, historic railroad bed and piling	

Table 3.17-2
Archaeological Phase 1A Sites, with Determination of Sensitivity[1] (Continued)

Area	Sensitivity	Description	NHDHR Site No.
23	Verified Sites	Newington, Bloody Point, foundation sites	27-RK-147, 27-RK-158, 27-RK-385
24	Probable Sensitivity	Newington, Bloody Point, historic period land use	
25	Sensitive	Newington, Bloody Point and shoreline, Native American & historic period land use	RK-153
26	No Sensitivity	Newington, northeastern shoreline, oil tanks	
27	Sensitive	Newington, Pickering Brook, Native American	
28	No Sensitivity	Newington, River Road	
29	Sensitivity	Newington, historic period land use	
30	Probable Sensitivity	Newington, Spaulding median, historic period land use with veneer of highway modification	
31	No Sensitivity	Newington, commercial development	
32	Sensitive	Newington, historic period land use	
33	Sensitive	Newington, upper reaches of Pickering Brook and Dirty Gut, Native American and historic land use	
34	No Sensitivity	Newington, commercial development	
35	No Sensitivity	Newington, west of Spaulding Turnpike & median, highway modification and logging	
36	Sensitive	Newington, open & wooded land with stream, Native American and historic period land use	
37	Probable Sensitivity	Newington, height of land, historic period land use with veneer of highway modification and development	
38	Sensitive	Newington, wooded lot, historic period land use	
39	Verified Site	Newington, Dow family burying ground/Dow-Padman Cem	NWN0009
40	No Sensitivity	Newington, industrial development	
41	Probable Sensitivity	Newington, historic period land use along historic roadway with veneer of road expansion	
42	Sensitive	Newington, wooded section along Paul Brook, Native American and historic period land use	
43	No Sensitivity	Newington, commercial	
44	No Sensitivity	Newington, commercial	
45	Probable Sensitivity	Newington, wooded zones, historic period land use with veneer of commercial expansion	
46	Verified Site	Newington, historic foundation site	27-RK-386
47	Verified Site	Newington, foundation site	27-RK-154
48	Sensitive	Newington, wooded wetland, Native American and historic period landscape use	
49	No Sensitivity	Newington, military development	
49a	Probable Sensitivity	Newington, wooded areas of historic period land use with veneer of logging and air base development	
50	No Sensitivity	Newington, military development including runway, detention pond, canal and railroad grade	

Table 3.17-2
Archaeological Phase 1A Sites, with Determination of Sensitivity[1] (Continued)

Area	Sensitivity	Description	NHDHR Site No.
51	No Sensitivity	Newington, ruins of drive-in theater	
52	Verified Site	Newington, foundation site	27-RK-283 (Not Eligible)
53	Verified Sites	Newington, two dump sites	27-RK-284 and 287 (Not Eligible)
54	Verified Site	Newington, foundation site	27-RK-282 (Not Eligible)
55	Verified Site	Newington, Native American	27-RK-275 (Not Eligible)
56	Verified Site	Newington, spring	27-RK-286 (Not Eligible)
57	Verified Site	Newington, road & culvert	27-RK-285 (Not Eligible)
58	Sensitive	Newington, shoreline and stream, Native American and historic period land use	27-RK-302 27-RK-410 (Not Eligible)
59	No Sensitivity	Newington, commercial	
60	No Sensitivity	Newington & Dover, Spaulding Turnpike and US 4 with extensions, bridges and interchanges	
61	No Sensitivity	Newington, Road to Bloody Point	
62	No Sensitivity	Newington, Nimble Hill Road	
63	No Sensitivity	Newington, Road to the Piscataqua Bridge	
64	No Sensitivity	Newington, Road to Boiling Rock	
65	No Sensitivity	Dover, Dover Point Road (formerly High Street).	
66	Verified Site	Newington, 2 wells	27-RK-388 (Not Eligible)
67	Verified Site[3]	Newington, Shattuck Shipyard	
68	Verified Site	Newington, Downing family cemetery	NWN0011
69	Verified Site[3]	Newington, cemetery	
70	Verified Site[3]	Newington, Valentine Pickering grave was moved in 1991	
71	Verified Site[3]	Newington, Lydia R. Downing gravesite	
72	Verified Site	Newington, Rollins family cemetery	NWN0008
73	Verified Site[3]	Newington, Joseph Patterson gravesite, precise location unknown	
74	Verified Site	Newington, Smith family tomb site	NWN0010
75	Verified Site[3]	Dover, Tuttle Cemetery	

1 See Figures 3.17-2 and 3.17-3 for locations of each sensitivity area.
2 The “Back River” is now known as the Bellamy River.
3 Not all verified sites have been assigned NHDHR Site Numbers.

Table 3.17-3
Previously Recorded Archaeological Sites in the Project Area

DHR Site No.	Site Name	City/Town	Cultural Period	Site Detail	Location
27-RK-147	None	Newington	Euro – American, 19th century	A stone marker indicating the location of Trickey's Ferry. Recorded in NHDHR site files, although the age, extent and components have not been established and detailed data on the site have not been collected. The site may be pertinent to transportation related themes, particularly ferrying operations.	Bloody Point
27-RK-153	None	Newington	Euro – American	Location of 2 foundations, recorded in the NHDHR site files, although age, affinity, extent and precise location or cultural components and artifacts have not been established and detailed data on the site have not been collected. The site may be pertinent to domestic related themes.	East of Bloody Point
27-RK-154	None	Newington	Euro – American	A foundation of a residence of unknown age, with evidence of extreme landscape modifications. Recorded in the NHDHR site files, although age, affinity, extent and precise location or cultural components and artifacts have not been established and detailed data on the site have not been collected. The site may be pertinent to domestic related themes.	East of Spaulding Turnpike
27-RK-158	None	Newington	Euro – American, 19th Century	The vicinity of the Bloody Point railroad station recorded in the NHDHR site files, although age, affinity, extent and precise location of subsurface and cultural components as well as artifacts have not been established and detailed data on the site have not been collected. The site may be pertinent to transportation related themes, particularly the establishment of rail service in Newington and the crossing of the Piscataqua River.	Bloody Point
27-RK-275	PAFB3P	Newington	Native American - unknown period	Non diagnostic quartz flakes and cores found on terrace. Phase II survey determined site lacked quality for National Register eligibility (Hartgen Archeological Associates 1997)	Pease Air Force Base east of Pickering Brook and west of Spaulding Turnpike
27-RK-282	PAFB9H J.Boss/ Norman Beane House	Newington	Euro – American, mid 19th – 20th century	A residential foundation, composed of fieldstone, concrete block, brick and poured concrete, determined to be partly demolished and filled following house removal and relocation. Site also included drainage ditch, dump, domestic plantings, Hartgen (1991) determined that the site did not meeting eligibility criteria for National Register due to lack of integrity.	Pease Air Force Base west of Spaulding Turnpike

Table 3.17-3
Previously Recorded Archaeological Sites in the Project Area (Continued)

DHR Site No.	Site Name	City/Town	Cultural Period	Site Detail	Location
27-RK-283	PAFB 10HA/10HB Pauline Karlo house and garage	Newington	Euro – American, 19th century	A residential foundation composed of fieldstone, concrete, block and brick, with remains of a garage. Site also included boulder fence line, trash deposits, and domestic plantings. Hartgen (1991) determined that the house site did not meet eligibility criteria for National Register due to lack of integrity .	Pease Air Force Base west of Spaulding Turnpike
27-RK-284	PAFB11H	Newington	Euro – American, 19th – 20th century	A dump, containing household trash reflecting rural domestic patterns, but does not meet eligibility criteria for National Register listing due to lack of context and that it can not be positively associated with any adjacent specific structure (Hartgen 1991).	Pease Air Force Base west of Spaulding Turnpike
27-RK-285	PAFB12H	Newington	Euro – American, 20th century	A stone bridge road grade and ceramic culvert, which does not meet eligibility criteria for National Register listing due to partial destruction and lack of integrity (Hartgen 1991).	Pease Air Force Base on old Fox Point Road west of Spaulding Turnpike
27-RK-286	PAFB13H	Newington	Euro – American, Post 1890	A stone-lined well or spring head, possibly used for watering livestock, considered as part of the rural agricultural landscape but does not meet eligibility criteria for National Register listing due to lack of context and isolated location (Hartgen 1991).	Pease Air Force Base east of wetland and west of Spaulding Turnpike
27-RK-287	PAFB14H	Newington	Euro – American, 19th – 20th century	A refuse dump, containing household trash, reflecting nineteenth and twentieth century rural domestic patterns, but does not meet eligibility criteria for National Register listing due to lack of context (Hartgen 1991).	Pease Air Force Base west of Spaulding Turnpike
27-RK-302	None	Newington	Native American	Recognized by the presence of a Squibnocket Triangle type biface, dateable to ca. 4000 years before present.	West of Knight Brook and south of Broad Cove
27-RK-410	None	Newington	Native American, unknown period	Artifacts, including a green quartzite gouge, quartz flake, and cobble tool, were recovered from a sloping terrain overlooking an unnamed stream which flows into Little Bay. (Determined Not Eligible)	West of Spaulding Turnpike at south end of General Sullivan Bridge
None	Shattuck Shipyard	Newington	Euro-American, 20th century	The Shattuck Shipyard operated from 1918 to 1919, building wooden freighters to replace merchant ships lost to German submarines during World War I. The remains of several unfinished wooden freighters and pilings for a former wharf were detected No designated NHDHR site number, although recorded by Switzer (1998).	Shoreline of the Piscataqua River
NH-40-72	Hilton's Point	Dover	Native American/ Euro-American	Site of the Hilton Brothers fishery in the 1620s. Designated only as a lead in the NHDHR files. Detailed archaeological data have not been collected. The site nature, extent, integrity, resources are not known.	Dover Point

Table 3.17-4
Newly Discovered Archaeological Sites in the Project Area[1]

DHR Site No.	Temporary Site No.[2]	Site Name	City/Town	Cultural Period	Dates	Site Detail
27-ST-51	Area 7	Brickyard	Dover (Point)	Historic Euro-Am.	c.1860-1920	Site consists of a large scatter of common red brick along the banks of the Piscataqua River, both in and out of the water for about 500 meters. Brickyards are depicted in the vicinity on the 1856, 1871 and 1892 maps. The 1912 map identifies the Gages Brickyard. Further investigation is recommended to address questions on 19th/20th century regional and local brick manufacture and its archaeological correlates.
27-ST-52	Area 8	C.H. Morang & Son Brickyard	Dover (Point)	Historic Euro-Am.	c.1912+	A 1912 map depicts C.H. Morang & Son Brickyard in this location. A large quantity of common red brick is visible along the bank of the Bellamy River, both in and out of the water. Further investigation is recommended to aid in understanding 20th century regional and local brick manufacture and its archaeological correlates.
27-ST-53	Area 9	John Hall Spring	Dover (Point)	Historic Euro-Am.	c.1633+	A granite monument marks the location of the Deacon John Hall Spring on the east side of 197 Spur Road. The inscription indicates nearby was the Hall home, Old Log Meeting House, stocks, whipping post, and Hall Slip – 1648. Further investigation is recommended to address questions of early historic European American settlement and its archaeological correlates.
27-ST-54	Area 13	Brickyard	Dover (Point)	Historic Euro-Am.	c.1900-1920	The brickyard is located on the southeast side of Scammel Bridge on the east bank of the Bellamy (Back) River where the river empties into Little Bay. Structural elements, brick scatter, terra cotta sewer pipe, granite blocks, and a cement wall foundation are visible. A 1912 map depicts an "Old Brickyard" in the location. Further research is recommended to address questions of 20th century regional and local brick making and its archaeological correlates.
27-ST-55	Area 17	Brickyard	Dover (Point)	Historic Euro-Am.	c.1830-1890	The brickyard is located on the southwest side of Little Bay Bridge in the western portion of Hilton Park along the shoreline. Eroding from the banks for about 150 meters is a dense scatter of bricks, glass and ceramics. The 1834 Whitehouse map depicts a brickyard in this location. Brickyards are also noted in the vicinity on the 1856 and 1871 maps. Further research is recommended, as intact subsurface archaeological contexts may be present.

Table 3.17-4
Newly Discovered Archaeological Sites in the Project Area[1] (Continued)

DHR Site No.	Temporary Site No.[2]	Site Name	City/Town	Cultural Period	Dates	Site Detail
27-ST-56	Area 18	Brickyard	Dover (Point)	Historic Euro-Am.	c.1830-1890	The brickyard is located on the shoreline within Hilton Park between the docking wharf and boat launch area along the southeast tip of Dover Point. A scatter of common red brick and glass fragments are evident for approximately 100 meters. The 1834, 1856, and 1871 maps indicate brickyards in the vicinity. Further research is recommended, as intact subsurface archaeological contexts may be present.
27-ST-57	Area 21	Brickyard	Dover (Point)	Historic Euro-Am.	c.1830-1890	The brickyard is located beneath the Gen. Sullivan and Little Bay Bridges at the tip of Dover Point. A scatter of bricks is evident on the site surface. The 1834, 1856, and 1871 maps depict a brickyard in this location. Further investigation is recommended to address questions of 19th century regional and local brick making and its archaeological correlates.
27-RK-385	Area 23	Historic house foundation/ neighborhood features	Newington	Historic Euro-Am.	c.1850-1950	A stone house foundation, artifact scatter, and 8 meter in diameter depression denoting an outbuilding foundation or other feature are located on the terrace edge overlooking Little Bay on Bloody Point between two previously recorded historic sites – the Newington Railroad Station and Trickey's Ferry Landing. 19th century maps depict residences in the area. Further investigation is recommended to identify possible intact deposits.
27-RK-386	Area 46	Historic house foundation	Newington	Historic Euro-Am.	c.1890-1990	This historic house and outbuilding foundation and dense artifact scatter is located on the north side of the intersection of Fox Run Road and Woodbury Avenue. USGS maps of 1893 and the 20th century depict a former structure in this location. Further investigation is recommended as good archaeological context is present.
27-RK-388	Area 66	Two wells	Newington	Historic Euro-Am.	Indeter.	Two dry laid stone wells are in a wooded zone on the west side of the Spaulding Turnpike, west of Shattuck Way. Sampling in the vicinity revealed the 19th through 20th century household cultural materials in mixed contexts. The eastern well is filled with domestic trash; the western well is filled with stagnant brackish water. The context of these wells is disturbed and does not exhibit integrity.

1 See Figures 3.17-2 and 3.17-3 for locations of each site.
2 "Temporary Site Number" refers to codes used during the Phase 1A, referenced in Table 3.17-2 and Figures 3.17-2 and 3.17-3.

The archaeological record of the Piscataqua region is simultaneously rich and fragile, and beset by inherent limitations. Foremost among these is the acidic soil of New England, which ensures that most organic remains (wood, leather, textile, *etc.*) will quickly decay. Thus, the archaeological record is dominated by the less perishable items of every day life, particularly stone tools and, after 3000 B.P., ceramics. Consequently, archeologists are left with a partial and unrepresentative sample of what was undoubtedly a rich material culture. Some of the few exceptions to this rule are found on coastal sites, where shell middens neutralize the acidity and organic remains may be preserved. Examples of this are seen in the relatively rich bone tool assemblages from the Rock's Road and Hunt's Island sites in Seabrook (Robinson and Bolian 1987; Greenly 1998, 1999).

A second limitation on the early archaeological record comes from the extensive destruction brought about by the activities of the historic period. Plowing, road building, and the growth of cities and towns since the 17th century have disturbed or destroyed countless pre-contact sites, and has left archeologists with, again, a partial and unrepresentative sample of what was the total range of site locations and types. This process has been particularly pronounced in urban areas, which often arose in the same locations most attractive to Native people. In coastal and estuarine settings, extensive filling of inlets and marshy areas introduced soils from other locations, and with this, artifacts were removed from their primary context and redeposited sometimes miles from their original location. In such a situation, it is crucial to correlate artifacts with soil strata and to understand the nature and origin of each stratum.

The study area is situated in what would have been an attractive setting for Native Americans over time (Brummer and Chesley 1980; Harrington and Kenyon 1987). The abundant resources of the coast were only a few miles to the east. Estuaries, some of the most productive environments in northeastern North America (Thorbahn and Cox 1988), abounded. The Great Bay estuary, formed where the major tributaries of the Piscataqua River join before flowing to the ocean, is one of the largest estuarine system on the Gulf of Maine (Potter *et al.* 1992:6). Here numerous species of shellfish, fish, and birds were to be found. Finally, the resources of the interior woodlands were also close at hand, including such staples as white-tail deer, nuts, and the abundant resources of fresh-water wetlands (McBride 1992).

This rich environment, however, developed over time. The formation of Great Bay and its associated drainages was substantially influenced by glacial activity at the end of the Pleistocene. The retreat of the glacial ice sheets at the end of the Pleistocene (*ca.* 13,000-10,000 B.P.) resulted in "...an invasion of sea water that rose approximately 180-200 feet above the present sea level. During this period, low-lying areas and interior stream valleys as far inland as present-day Kingston, Lee, and Rochester were inundated. The extent of this invasion is delineated by deposits of marine clays and outwash deltas...As the ice continued to retreat and the coastline began to rise, these features were exposed and reworked by wave action. The resulting complex pattern of surficial deposits include remnants of kame terraces, outwash deltas, former beaches, and interbedded marine sand, silt, and clay" (Potter 1994:13).

Soils in this area were formed in the remains of glacial till, with coarse glacial till predominating in the uplands and glacio-fluvial deposits on the outwash plains and terraces (Potter 1994).

The position of the shoreline at the end of the last period of glaciation underwent a complex series of changes (see Hart 1994:12-33), where the period of initial marine transgression was followed by a period of rapid crustal rebound and corresponding regression, with sea levels being "tens of meters" lower than present during the early Holocene. Continuing glacial melting and a slowing of crustal rebound then raised sea levels to their present levels by several thousand years before present (Oldale 1986:90). Thus, prior to 10,000 years ago, miles of now-submerged shoreline were available for human occupation, but by 3,000 years ago this reach had become submerged. Today, we may discover coastal sites reflecting habitation between ca. 10,000 or 11,000 years ago to 3,000 years ago in submerged settings anywhere within the coastal zone.

For most of the pre-contact period, the Piscataqua region was an attractive one from the standpoint of Native American inhabitants. Easy proximity to three major environmental zones (interior forest, estuarine, and coastal) provided a wide variety of potential food and other resources.

The choice of specific site locations by Native people, however, was shaped considerably by a number of environmental variables. Slope, drainage, and proximity to fresh water have long been recognized as important factors in site location, with native people selecting level ground with well-drained soils near surface water features (Bunker 1994). In the vicinity of Great Bay, Native people recognized and discriminated among different soil types in choosing settlement locations:

In coastal areas, where soils of good and poor drainage are inter-fingered, sites are positioned on soils of better drainage even when poorly drained soils occur only a few meters away (Bunker 1994:25-26).

A review of site locations in the Great Bay/Piscataqua drainage indicated that 90 percent of known sites are located in areas of dry sandy outwash or till soils, either on stream banks to as much as 500 to 750 feet from water (Anonymous 1991). Native people were apparently selecting for small "islands" of dryer soils in proximity to stream rapids and tidal marshes (Potter et. al. 1992:8-9). The potential for archaeological sites within the

Piscataqua region is tied to the area's geological history. Human habitation was not possible until the retreat of the glacial ice sheets approximately 13,500 years before present and the archaeological record for northeastern North America conclusively dates the arrival of people some 2,000 years after this time (Gramly and Funk 1990).

The Paleoindian Period (11,500-10,000 B.P.)

This period marks the first human habitation of New England. Ethnographic analogies and archaeological evidence suggest these Paleoindian people, ancestral to later Native American populations, lived in small bands, practiced an economy in which hunting of large mammals was important, and were highly mobile. They entered New England from the south and west at the end of the Pleistocene period (Spiess and Wilson 1987:130), following by only a few thousand years the retreat of the glacial ice sheets. New England at this time was a challenging environment for human beings, as a major climatic transition created instability in the landscape and floral and faunal communities.

Large-bodied Pleistocene mammals, such as mammoths and mastadons, were rapidly dying off, while caribou and other modern species were increasing in number (Curran and Grimes 1989: 57-58). The common focus on large game and the presumed rapid spread of the Paleoindians across North America left a relatively homogeneous set of artifacts in the archaeological record of this time period. Foremost among these are variations of the fluted point, the most diagnostic artifact of the Paleoindians. Other artifacts include a variety of stone knives and scrapers, pieces esquilles or wedges, awls, drills, and hammerstones (Gramly and Funk 1990; Wilson and Spiess 1990). While no tools of organic material (bone, antler, wood, leather, *etc.*) have been recovered from New England Paleoindian sites, this is undoubtedly due to problems with preservation. Many of the stone tools from these sites were used in an extensive industry based on non-lithic technology.

Further evidence of the complexity of Paleoindian life comes from the stone often used in the manufacturing of tools. While local stone tool materials were used (Boisvert 1999; Bouras and Bock 1997), the Paleoindians of New England also relied on high quality cryptocrystalline stones such as chert or jasper, often obtained from great distances (Petersen 1995:212-213; Spiess and Wilson 1989). At the Bull Brook site in Ipswich, Massachusetts (25 miles south of the Piscataqua), so called "Pennsylvania" jasper (c.f. King *et al*. 1997), and cherts from Maine and the Champlain Valley dominated the lithic assemblage (Grimes 1979). While this pattern may reflect the high mobility of Paleoindian peoples, the extent of their social networks, or both, it is a signature pattern for sites of this time period.

Paleoindian site location is strongly correlated with particular environmental variables, most notably the presence of sandy, well-drained soils, particularly when adjacent to swampy areas (Bunker and Potter 1999; Spiess and Wilson 1987:130-131). Other environmental variables thought attractive to Paleoindians include prominent outlooks for observing the movements of game, and narrow valleys where herds of animals could be more easily hunted (Boisvert 1999; Bouras and Bock 1997; Gramly 1982). Because the Paleoindians were living in an environment markedly different from later Native Americans, their choices about settlement were likewise quite different. As a result, Paleoindian sites tend to be "single component" sites, free of admixture from more recent occupations. This results in an archaeological clarity that permits the identification of discrete activity loci or living areas, and a greater potential for studying intra-site dynamics such as cooperative hunting and meat-sharing (Gramly 1982).

Paleoindian sites have been located in the modern seaboard lowland area of northeastern Massachusetts and southern Maine, and illustrate the diversity and complexity of the Paleoindian archaeological record in this region.

In sum, there is clear archaeological evidence for the presence of Paleoindian sites in the Piscataqua region. Like contemporaneous sites in other parts of New England, these sites contain a variety of diagnostic stone tools, and the lithic raw materials reflect travel to, or connections with, Paleoindian bands throughout the northeast. Paleoindian sites are found in specific geologic and topographic settings, and an understanding of site location and settlements for this dynamic period is dependant on adequate information on deglaciation, sea level rise, the formation of river drainages, and crustal rebound.

The Archaic Period (10,000-3,000 B.P.)

The Archaic period in the prehistory of eastern North America extends for some 7,000 years, beginning at approximately 10,000 B.P. The Archaic is conceived of as a time during which the broadly similar big-game hunting cultural systems of the Paleoindian peoples gave way to more regionally and locally distinct cultures, each shaped by the resources and conditions present in their domain. Increasing climatic and environmental stability, the development of river drainage systems and estuarine environments, and a growing familiarity with local environments and resources contributed to the emergence of regionally distinct cultures that were the precursors of the enormous cultural and linguistic diversity present among Native American peoples at the time of European contact.

A number of cultural trends characterize the Archaic period in New England. The theme of "settling in" to local environments is reflected in a general decrease in the quantity of exotic lithic materials, as people relied increasingly on lithic resources closer to home. A variety of ground-stone tools appear in the archaeological record, including axes, gouges, adzes, chisels, plummets, and net sinkers. Many of these are believed to have been used in woodworking, boat-building or fishing. The Paleoindian emphasis on the hunting of large-bodied, gregarious mammals gave way to a broader, more varied diet that included increasing amounts of plant foods, fish, and smaller-bodied birds, mammals, and reptiles. The first evidence of cultures specially adapted to coastal and marine environments dates to this period. Long-distance travel in pursuit of migratory herds gave way to patterns of seasonal movement within more restricted areas and the repeated occupation of favored sites. The consistency in settlement patterns also lead to the establishment of actual cemeteries, where the dead were interred in increasingly complex ways and that continued to be used, in some cases, for centuries or even millenia.

The regional diversification typical of the Archaic period contributed to an increasingly heterogeneous archaeological record. Unlike the broad similarities in the artifacts of the Paleoindians, archeologists recognize materially distinct "cultures" in the Archaic period of New England. In some instances, these different "cultures" correspond to distinct environmental zones, but in others they seem to cut across them. These cultural differences are reflected in the raw materials used for stone tool production, in the styles of the tools themselves, in the choice of site locations and the resources utilized, and in mortuary rituals. Throughout this period, people continued to live as hunter-gatherers, presumably in relatively small social groups or "bands". These bands, based on analogies to band societies studied by cultural anthropologists in the 20th century, are assumed to have been relatively egalitarian, lacking formal leaders or any formalized hierarchy or social divisions except those based on gender and age. Both the archaeological record and the work of cultural anthropologists suggest hunter-gatherer bands were stable, self-sufficient societies that provided adequately for the biological and social needs of their members and that existed in a sustainable relationship with the natural world.

The Early Archaic (10,000-8,000 B.P.)

The Early Archaic period in New England was initially thought to be a period of very low population or even a population hiatus, corresponding to what was believed to be the dominance of a low-resource boreal forest environment of the early Holocene (Ritchie 1980; Fitting 1968). Recent paleo-environmental reconstructions and archaeological research have shown both of these assumptions to be erroneous, and populations of the Early Archaic are now regarded to have been comparable in number to the more recent Archaic periods (Dincauze and Mulholland 1977; Robinson and Petersen 1992; Robinson 1992).

Prior to the recent research of Brian Robinson (1992), the best known Early Archaic manifestation in New England was characterized by distinctive projectile points with bifurcated bases, comparable to contemporaneous points found throughout much of the Atlantic seaboard region (Dincauze and Mulholland 1977; Snow 1980:160). The greatest concentration of these points have been recovered in southeastern New England, but rarely as part of larger components that would shed light on the overall nature of Early Archaic cultures. Other locally distinctive Early Archaic bifaces are known from northwestern Vermont (Thomas and Robinson 1980). At least one isolated find of a bifurcate base point has been reported from the Piscataqua region, from Shaw's Hill in the Exeter River drainage (Potter, *et al.* 1992:9).

The understanding of the Early Archaic period in New Hampshire and the Gulf of Maine has been transformed by recent research (Bunker 1992; Robinson 1992; Robinson and Petersen 1992). Drawing on data from sites ranging from the mouth of the Merrimack River to central Maine, Robinson defined a Gulf of Maine Archaic Tradition that spanned a 4,000-year period from 10,000 to 6,000 B.P. Situated in an environment that Robinson depicted as rich and well-watered, the peoples of this tradition made extensive use of freshwater fish, produced a wide variety of beautifully made ground-stone tools, and, unlike later Archaic cultures, produced a flaked stone tool assemblage that included cores, flakes, and unifaces but lacked diagnostic bifacial projectile points.

Associated with this tradition was the Morill Point mortuary complex, named after a site at the mouth of the Merrimack River. This complex included cremation and non-cremation burials and the inclusion of red ocher, full-channeled gouges, ground-stone rods, and occasional non-diagnostic bifaces (Robinson 1992:94).

The Gulf of Maine Archaic tradition is arguably the best defined Early Archaic tradition in the Piscataqua region, although relatively few sites are known. In the Great Bay drainage, a Gulf of Maine Archaic component was identified at the Wadleigh Falls site on the Lamprey River in Lee, New Hampshire, radiocarbon-dated to 8630+/-150 years before present (Maymon and Bolian 1992:123). In sum, the Early Archaic period in the Piscataqua/Great Bay drainage is most likely represented by artifacts attributable to the Gulf of Maine Archaic tradition, although bifurcate base points may be found here as well.

The Middle Archaic Period (8,000-5,000 B.P.)

The Middle Archaic period is well represented in the archaeological record of the Piscataqua region, mirroring its high visibility across much of New England. In the northern Gulf of Maine region, the Gulf of Maine Archaic continues through much of this period, and is believed to be ancestral to the later Maritime Archaic tradition distributed along the coastal areas from central Maine to the Canadian Maritimes. To the south and west in New England, a series of distinct archaeological complexes are recognized. First defined at the Neville site in Manchester, NH (Dincauze 1976), they include the Neville Complex (*ca.* 7500 B.P.), Stark Complex (*ca.* 7000 B.P.), and Merrimack Complex (*ca.* 6500 B.P.) the first two of which have related analogs along the Atlantic seaboard as far south as Florida (Dincauze 1976:140-142). Neville and Stark complex sites have often been associated with inland riverine fishing stations, with anadramous fish being a critical economic resource although one recent study has questioned this interpretation (Carlson 1988). During this period the first evidence of shell fishing appears in coastal areas, and nuts become an increasingly important resource in interior forests.

At the mouth of the Merrimack River, the Morrill Point Mound site was used by Robinson (1992) to define the Morrill Point Mortuary Complex, the mortuary component of the Gulf of Maine Archaic. At this site, cremation burials, including red ocher, gouges, adzes, celts, and stone rods were radiocarbon dated between 6325 and 7245 B.P. The presence of this site to the south of the Piscataqua region, and the presence of related sites to the north in Maine (Robinson 1992:79-86) indicates that people of this tradition were also present along the New Hampshire seacoast during the Middle Archaic Period.

At the same time, sites with Neville and Stark complex components are well-documented in the Piscataqua region, although the relationship between these sites and those of the Gulf of Maine Archaic is not clear. At the Wadleigh Falls site in Lee, NH a well-defined Neville complex component was recognized in a stratigraphic layer overlying a Gulf of Maine Archaic component, an associated faunal assemblage dominated by reptiles (snake and turtles) but also including shad, deer, beaver, and muskrat. (Maymon and Bolian 1992: 122-131). Elsewhere in the Piscataqua region, numerous Middle Archaic bifaces have been recovered at the Hayden Farm site in Newfields (White and Finch 1959, 1975: Plate 3). Middle Archaic bifaces were recovered from the Alexander site on the Exeter River in Raymond (Finch 1962), a Stark/Neville drill was found at the White Site on the Exeter River (Potter, *et al.* 1992:9), and a Merrimack-like point was recovered during excavations at the Deer Street site (DS 2.8B) by archeologists from the Strawbery Banke Museum.

In sum, Middle Archaic sites associated with either the Gulf of Maine Archaic or the Neville, Stark, and Merrimack complexes may be expected in the Piscataqua region.

The Late Archaic Period (5,000-3,000 B.P.)

The Late Archaic period is one of the most complex and dynamic in the prehistory of northeastern North America. Temporal and spatial variability in the archaeological record has suggested to some archeologists the existence of as many as four distinct archaeological traditions in New England, the overlapping settlement of peoples "belonging" to these traditions, and the possibility of a major episode of migration at the end of this period. One of the four traditions, the Maritime Archaic, is generally located well north of the Piscataqua region, and will not be considered here. Artifacts from the remaining three traditions, the Laurentian, Small Stem, and Susquehanna are all encountered at sites in the Piscataqua region.

The Laurentian tradition is the oldest of the Late Archaic traditions, beginning as early as 6000 B.P. and continuing to 4000 B.P. (Ritchie 1980:79; Funk 1988; Snow 1980:216-222). When first defined by William Ritchie, it was described as an interior, lake-forest cultural tradition extending from northern New England and New York to southern Quebec and Ontario. In much of New England, however, the Laurentian is recognized in a scattering of diagnostic projectile points, with very few intact components, so that its true nature remains unknown (Dincauze 1975; c.f. Funk 1988). The lack of fit between the original definition of the Laurentian "culture" and the distribution of diagnostic Laurentian artifacts is clearly seen in the Piscataqua region. While true Laurentian components would not be expected in a coastal/estuarine environment, Laurentian points have been recovered from the Hunt's Island and Rock's Road sites in Seabrook (Greenly 1998:Plate 3; Robinson and Bolian 1987:38), the Hayden's Farm site in Newfields (White and Finch 1975:Plate 4), on Pettee Brook in Durham (Goodby 1998:5), and the Nelson Island site in northeastern Massachusetts (Robinson 1985:11-12). At none of these sites, however, are there defined Laurentian components--merely low numbers of points not clearly associated with other cultural material.

The Small Stem Tradition is well-represented in the archaeological record of the New Hampshire seacoast region, as it is elsewhere in New England. A series of narrow stemmed, and triangular projectile points, most often manufactured from quartz, are the most widely recognized diagnostic artifacts of this tradition, and actually continue in use through much of the following Early Woodland period (*e.g.* Goodby 1996:10-11). Small Stem sites are found in a variety of environments, including coastal, estuarine, and interior riverine settings, indicating a great deal of economic diversity within this tradition. Small Stem components have been found in the Cocheco River drainage (Dubois n.d.), at the Hunt's Island and Seabrook Marsh sites in Seabrook, NH (Greenly 1998; Robinson 1985) and the Hayden Farm site in Newfields (White and Finch 1975: Plate 2; Skinas 1980). Small Stem points have also been recovered from the Rock's Road site in Seabrook (Robinson and Bolian 1987: 38-39) , at two sites in Maine on the Salmon Falls River

(Bunker, *et al.* 1990), at the Newmarket Town Farm site (Skinas 1980:3), and in the excavation of site SB20.157 at Strawbery Banke.

Important data on the Small Stem Tradition came from the Seabrook Marsh site, where evidence for a specialized marine-oriented economy was recovered (Robinson 1985). The remains of swordfish and other deep-water marine species provided indirect evidence of considerable skill in boat-building and fishing, and the existence of a well-developed maritime culture generally. Other faunal remains were from estuarine and terrestrial species, including a variety of birds and mammals. Finally, human burials from the site provided a glimpse into the developed and complex spiritual lives of this society. The Seabrook Marsh site provided convincing evidence that a marine focus was not limited to the Maritime Archaic, but could be found among other Late Archaic cultures further south along the New England coast.

The Susquehanna Tradition represents the most recent, or "terminal" tradition of the Late Archaic period. Its diagnostic attributes include a variety of broad-bladed bifaces, carved steatite bowls, and cremation sites, where burned human remains were deposited with ritually broken or "killed" artifacts (Dincauze 1968, 1975; Snow 1980:235-259). The artifact styles and burial practices of the Susquehanna tradition were so distinct from earlier cultures in New England that many archeologists have argued for a migration of Susquehanna populations into New England from the southwest shortly after 4000 B.P. (Dincauze 1972; Ritchie 1980; Borque 1995:245-247). In New England, the Susquehanna Tradition lasts for a maximum of 800 years before giving way to the cultures of the early Woodland period. Susquehanna period sites are found from southern Connecticut north to the central Maine coast (Borque 1995:7-10), and the tradition itself is divided into a number of distinct phases marked primarily by changes in projectile point morphology (Dincauze 1968, 1972, 1975).

In the Piscataqua region, Susquehanna Tradition materials have been recovered from a number of sites, including the Rock's Road site, where an intact Atlantic Phase component was identified (Robinson and Bolian 1987: 38), at the Hayden Farm site in Newfields (White and Finch 1975), at the Seabrook Marsh site (Robinson 1985:42), and the Stanley site in Exeter (Foster 1982: 41).

In sum, sites attributable to three Late Archaic traditions are expected to occur in the Piscataqua region. These sites may occur in a variety of environmental zones, and include habitation sites, specialized food procurement sites, or cemeteries.

The Woodland Period (3,000-450 B.P.)

In eastern North America, the Woodland period of prehistory begins approximately 3000 years before present. The Woodland period in the Northeast is characterized by major cultural changes that take place over a broad area and by an increase in cultural and societal complexity. There are substantial changes in material culture, the most notable of which is the advent of ceramics. It is believed that Woodland societies generally grew to be larger, more densely populated, and more prone to hierarchical social structures than the generally egalitarian societies of the Archaic period. The second change is the appearance and spread of a number of mortuary "cults" or traditions, notably those of the Adena, Hopewell, and Mississippian moundbuilder cultures, most characteristic of Midwest late Woodland culture. Another change is the advent of farming, or horticulture, notably of the Mesoamerican cultigens maize (corn), beans, and squash. The final major change during the Woodland period is an increase in sedentary settlements and the beginnings of village life.

The Woodland concept as defined above, however, does not accurately describe the situation for New England. There is considerable continuity between the Archaic and Early Woodland periods in material culture, settlement patterns, economy, and mortuary ritual (Heckenberger, *et al.* 1990; Filios 1989). There is little evidence for an increase in sedentarism at the onset of this period. Evidence for agriculture in the form of carbonized remains of cultigens are almost entirely limited to the period after 1200 B.P., indicating that cultivation began in New England considerably later than in other parts of eastern North America. Even when cultivation does begin, it appears to have been as a supplement to the traditional broad-based hunter-gatherer economy. Actual village sites dating to the Late Woodland have proven notoriously elusive to archeologists (*e.g.* Kerber 1988; Leudtke 1988). In fact, the only real change in New England at 3000 B.P. that is in keeping with the Woodland concept is the appearance of pottery.

The Early Woodland Period (3,000-2,000 B.P.)

The Early Woodland period in New England is marked by the appearance of some new projectile point styles (notably the Meadowood and Rossville point types), pendants, gorgets and "birdstones" made of ground slate, copper beads and tubular blocked-end stone pipes for the smoking of tobacco. Widely scattered cemeteries contain complex burials laden with exotic artifacts and raw materials from across much of eastern North America (*e.g.* Heckenberger, *et al.* 1990). One of the most distinctive and commonly encountered artifacts of the Early Woodland is the Vinette I ceramic vessel, which are typically undecorated conical pots made with thick coils of clay tempered with large pieces of crushed quartz or feldspar. Both the exterior and interior surfaces of these vessels bear the impressions of the fabric-covered paddles used to paddle the vessel walls and bond the coils together. Vinette I vessels appear in New England as early as anywhere else in the northeast, with some of the earliest dated examples coming from the central Merrimack River valley of New Hampshire (Bunker 2002, 1992:138; Howe 1988).

In the New Hampshire seacoast region, Early Woodland components, including Vinette I ceramics and Meadowood points, are present at the Rock's Road and Hunt's Island sites in Seabrook (Robinson and Bolian 1987:39; Goodby 1995:47-48; Greenly 1998:62). The component at Rock's Road also included a Rossville point, a large pit feature containing Vinette I ceramics radio-carbon dated to 2130+/-115 B.P., and a lithic workshop where "well-thinned bifaces reminiscent of Meadowood cache blades" (Robinson and Bolian 1987:39) were manufactured from blue-grey felsite. Early Woodland components are also present along Great Bay. A single Meadowood point was recovered at the Hayden Farm site (White and Finch 1975: Plate 4n), an interior/exterior fabric impressed ceramic sherd was recovered from the Great Bay site at Brackett's Point in Greenland (Finch 1969: Plate 6, 15), and Meadowood and Rossville points and Vinette I ceramics were recovered from the Stanley site in Exeter (Foster 1982:41; Finch 1967:Plate 2). Additionally, at least some of the sites where Small Stem tradition bifaces have been recovered may be of Early Woodland age.

The Middle Woodland Period (2,000-1,150 B.P.)

The Middle Woodland is one of the most visible periods for the Piscataqua region. The period is often subdivided into "early" and "late" stages, with pseudo-scallop shell impressed ceramics and Fox Creek points being key diagnostics of the former, and dentate-stamped ceramics and Jack's Reef pentagonal and corner-notched points of the latter.

While the archaeological record for the Middle Woodland period in New England shows little indication of direct influence from the midwestern mound-builder cultures, this is also a time of considerable dynamism in New England, seen most notably in evidence for long distance interaction in the form of exotic lithic materials. In the Piscataqua region, this takes the form of an exotic yellow-brown jasper that appears on sites dating to the late Middle Woodland (Barber 1982; Goodby 1988; Leudtke 1987; Strauss 1992). Often referred to as "Pennsylvania" jasper because of its presumed origin in a series of quarries in southeastern Pennsylvania (Leudtke 1987), recent studies have called this into question (Hatch 1993; King, *et al.* 1997). Regardless, it is clearly exotic to the Piscataqua region (Goodby 1988), and reflects the existence of long distance interaction between the Native peoples of the northeast during this period. Jasper was used in the manufacture of many different tools, including Jack's Reef corner-notched points, unifacial scrapers, perforators, knives, and wedges for the splitting of bone, wood, or antler (Goodby 1988).

Important Middle Woodland sites in the Piscataqua region include the Rock's Road and Hunt's Island sites in Seabrook. At Rock's Road, an early Middle Woodland component is represented by pseudo-scallop shell impressed ceramics (Goodby 1995:48-49) and a single Fox Creek point, while a substantial late Middle Woodland occupation left behind dozens of jasper tools, thousands of jasper flakes, numerous features, and the remains of at least 14 ceramic vessels (Robinson and Bolian 1987; Goodby 1988, 1995). At nearby Hunt's Island , a comparable though less intensive Middle Woodland occupational sequence was present (Greenly 1998:62). In the interior of Great Bay, sites on Adam's Point in Durham yielded early Middle Woodland pseudo-scallop shell impressed ceramic sherds, and jasper Jack's Reef points, debitage, a shattered core and dentate-stamped ceramics from the late Middle Woodland (Hecker 1995). Other Middle Woodland components are present at the mouth of the Merrimack River (Barber 1982; Bullen 1949), in the interior Lamprey River drainage (Goodby and Ritchie 1989), and at the Great Bay site on Brackett's Point in Greenland (Finch 1962).

The transition between the Middle and Late Woodland periods at about 1100 B.P. is a time of considerable change in New England. Corner-notched projectile points disappeared and were replaced by triangular Levanna points. Dentate stamped ceramics were replaced by cord-wrapped stick impressed and other ceramic decorative types (Petersen and Sanger 1991). Most dramatically, exotic lithics all but disappear from the archaeological record, to be replaced by locally or regionally available lithics reflecting what appears to be a rather sudden end to the intensive exchange or interaction of the Middle Woodland. Finally, Native societies begin to cultivate maize and other exotic domesticates. The relationship among these events has not yet been clearly explained by archeologists.

The Late Woodland Period (1,150-450 B.P.)

The Late Woodland period in much of New England is characterized by the incremental addition of horticulture to local economies, a continuation of many traditional hunting, gathering and fishing patterns, the manufacture of increasingly sophisticated and elaborately decorated ceramics, and a reliance on locally available lithic materials. Triangular Levanna projectile points are a common diagnostic artifact. Ceramics undergo considerable change during the Late Woodland period, beginning with so-called "cord-wrapped stick" impressed ceramics that, by 500 B.P., are being replaced by finely made vessels decorated with ornate zones of incising and punctuation. Shell temper replaces grit temper in many ceramic vessels from coastal areas. Vessel form changes as well, with conical or ovoid vessel forms being replaced by vessels with constricted necks and clearly defined collars with castellated peaks, elaborate incised decoration, and occasional appliqued effigy figures (Petersen and Sanger 1991; Goodby 1994).

The Late Woodland period is rather poorly represented in the Piscataqua region, possibly in part because these relatively recent sites have undergone more historic disturbance than more deeply buried older sites. There are no sites that have revealed direct evidence of horticulture, although its occurrence is likely due to the small number of intact components excavated to date. A Late Woodland component was present at the Rock's Road site in Seabrook, but was apparently of lesser intensity or shorter duration than the preceding Middle Woodland occupation, based on the number of diagnostic bifaces and ceramic vessels recovered (Robinson and Bolian 1987: 40-41; Goodby 1995:53-54). Levanna points and shell-tempered ceramics marked a Late Woodland occupation at Hunt's Island (Greenly 1998), and a single Levanna point was recovered from the Adam's Point site on Great Bay in Durham (Hecker 1995:70). Incised ceramics from the Great Bay site in Greenland (Finch 1969:Plates 3-6) may date to the Late Woodland, as may two bifaces from the Hayden Farm site in Newfields (White and Finch 1975:Plate 4, a and e). A single sherd of incised ceramic was recovered in association with historic architectural remains recovered by archeologists from the Strawbery Banke Museum during excavations at the historic Warner House in Portsmouth.

The Contact and Proto-Historic Periods (450-300 B.P.)

The beginnings of European contact in northeastern North America are shrouded in mystery, although it is known to have begun in the early decades of the 16th century with the voyages of Basque and Breton fishermen to the rich fishing grounds off the northern New England coast (Brasser 1978). Little information was recorded by these fishermen about their contact with Native people. Nothing specific is known about early contacts in the Piscataqua region, although they are likely to have occurred, given that the Isles of Shoals was an early European fishing site (Robinson and Bolian 1987:46). Possible early 17th century contact may have occurred in connection with the 1604 voyages of Samuel Champlain and the English captain George Weymouth, the latter of whom kidnapped a number of Indians from the coast of Maine (Brasser 1978).

By the time of the earliest recorded European settlements in the Piscataqua region in 1623 at Odiorne's Point in Rye and Dover Point in Dover, Native societies had already been transformed by the effects of European contact. Two English fish merchants, Edward and William Hilton, settled at Dover Point (first called Hilton's Point) in 1623, traded with local Indians, and are credited with the first Euro-American settlement in what would become Dover. Their activities were focused on the drying of fish for shipment to England, but by 1631 only three houses had been built here, and subsequent settlement focused on areas to the west around Cocheco Falls (Stevens 1833; Colby 1975). Members of the aristocratic "Fishmonger's Guild", which dominated the fishing industry from Newfoundland to New England, established fishing stations for the drying of cod and other fish at Dover Point. They used the same traditional European technology employed at Isle of Shoals and other locations in the region (Rowe 1987; Scales 1923; Thompson 1965; Wadleigh 1913). Further, the 1634 map of William Wood suggests considerable contact with and knowledge of the Native population as indicated by the depiction of many village locations throughout coastal and interior locations as well as important place names.

European trade goods had been circulating among Native people before the settlement at Dover Point, bringing about changes in traditional technology and lifeways. A devastating epidemic in the years 1616-1619 produced rates of mortality estimated at 90 percent or more among many Native communities, particularly those on the coast (Snow 1980:38-40; Cook 1976). Survivors of the epidemic sought refuge in neighboring communities or coalesced to form new communities. At the same time, intensifying trade with Europeans and trade-induced warfare among Native peoples contributed to additional disruption of traditional culture and dislocation of traditional communities. One result was that the "tribal" groups and names recorded by Europeans during the 17th century are drawn from a rapidly changing cultural situation and are not reliable indicators of pre-contact social organization.

Anthropologists and ethnohistorians have offered many answers to the question of, “who were the Native people of the Piscataqua region?” They have incorporated the people of the Piscataqua into one or another larger cultural grouping all of which are groups within the Penacook “sphere of influence”, including the Massachusetts (Snow 1980:26), Pawtucket (Salwen 1978:161), and Pennacook (Stewart-Smith 1984:70). If the Piscataqua people were indeed Pennacook, they would likely speak a dialect of Western Abenaki as opposed to Massachusetts (*c.f.* Day 1978:148). Three "tribal" territories are said to have existed in the Piscataqua region: the Newichewannock, in the upper Piscataqua drainage; the Piscataqua, on the east bank of the Piscataqua River (Stewart-Smith 1994:71), and the Winnacunnet, in the Hampton/Seabrook area (Stewart-Smith 1994:71; Robinson and Bolian 1987:41). Following the epidemic of 1616-1619, many of the surviving members of these groups gathered at Dover, where they were known as the Cocheco Indians (Colby 1975:70). A smallpox epidemic in 1633 killed many of the remaining Native people in this area (Robinson and Bolian 1987:33).

The archaeological record of this period shows the rapid cultural change within the Native populations in the face of disease and European encroachment, showing ongoing resistance to this process. Archaeological sites from this period contain a wide variety of European trade goods, including iron axes and knives, brass and copper kettles, glass beads, metal buttons, and kaolin pipes. Native ceramics from this period are made with a high degree of decorative elaboration and technological sophistication that intensifies during the early decades of European contact (Goodby 1994). Artifacts from contact period sites clearly show that European goods were incorporated into Native cultural contexts: Brass and copper kettles, for instance, were routinely cut into triangular arrow points that were clear copies of the stone triangular Levanna points being used on the eve of contact (Foster *et al.* 1981; Robinson and Bolian 1987:42).

In the Piscataqua region, contact period components are present at two sites in Seabrook, Hunt's Island and Rock's Road. At Hunt's Island, a wampum bead and early kaolin pipe were recovered (Robinson and Bolian 1987:46; Greenly 1998:19). At the Rock's Road site, a large contact period component associated with the Winnacunnet people and dated between 1600 and 1630 included numerous shell-filled pit features, a large assemblage of bone tools (including some manufactured with iron tools), iron axes, iron knife handles, copper or brass triangular points, a tooth from a bone or ivory trade comb, and a deer effigy made of European sheet lead (Robinson and Bolian 1987:43-45). Incised, collared and castellated ceramic vessels were also included in this contact period assemblage (Goodby 1995:54-56). Finally, three historic Indian trails, the Abenaki, Squamscott, and Piscataqua trails, converged in the Piscataqua region (Price 1967).

Native American Site Summary and Expectations

Evidence for thousands of years of Native American occupation is preserved in archaeological sites, which are fragile and easily erased by erosion, naturally acidic soils, submergence and destruction through the activities of historic and modern times. Yet, sites are known to have survived throughout the region, with examples identified from the coastline, the margins of local streams and rivers, the urban landscape of downtown Portsmouth and the Pease Air Force Base property (NHDHR site files). While over 100 sites have been previously recorded for the Piscataqua and Great Bay environment, only one Native American site has been previously recorded within the project area in Newington, and no Native American sites have been recorded within the study area in Dover. However, the NHDHR site files assign Native American site sensitivity to Hilton Point, based on archival evidence. Outside the project area in Newington, sites have been recorded on Fox Point, Welsh Cove and Peverly Brook. Another site, Site 27-RK-302, was recognized by the presence of a biface of the Squibnocket Triangle type, dateable to ca. 4000 years before present. This was found in close proximity to the study area, on the western side of Knight Brook south of Broad Cove (NHDHR site files). Two Native American sites recorded in Newington's portion of the study area are 27-RK-275 and 27-RK-410, which are also not eligible. It was recognized by the presence of non-diagnostic and undateable quartz flaking debris on the east side of Pickering Brook. Phase II survey determined that this site lacked qualities to make it eligible for listing in the National Register of Historic Places (Hartgen Archeological Associates 1997).

On the basis of information collected from past archaeological surveys and previously recorded sites in the general Piscataqua region, we may expect to discover Native American sites within the study area. Locations where sites may be expected include shoreline margins, terraces along streams, springs and wetlands, and the upper banks of all major rivers, including the Piscataqua River itself. Sites are expected to occur on well drained soils, in fairly level terrain, and usually in close proximity to surface water features. Sites may be expected to range in size from a few square meters to hundreds of square meters, where repeated occupation occurs, with deposits up to one meter below present-day ground surface. However, given that extensive work has not been completed in the region and most areas are near water, upland areas cannot be discounted. Sites are not expected in areas which have been disturbed by repeated or extensive development and modern land use. Yet, sites may be found in areas where historic period activities, such as tree clearing, plowing and farming have modified only the upper portion of the soil column. Sites may contain components dateable to the entire cultural continuum, from early post glacial times some 10,000 years ago to the period of contact with Europeans as recent as 500 years ago. Based on archival data and analogy to known sites, no Native village sites are expected; instead smaller camps or seasonal occupation sites and special activity area sites are expected. Sites are expected to include an array of cultural materials and features such as stone tools, pottery, trade goods, hearths or pits. In locations where shell is present, soil acidity may be neutral enough to preserve such fragile remains as bone refuse or tools (*e.g.*, food remains, bone points, needles, awls, combs, knives), and other perishable objects (*e.g.*, plant materials, basketry, worked wood).

3.17.3.2 Historic Archaeological Context

Historic Landscape

Two peninsulas – Dover Point to the north, and Bloody Point to the south - face one another across the mouth of Little Bay, and comprise the landscape of the study area. These points of land were among the first places visited and used by Europeans in North America and have witnessed a sequence of continuous occupation in an area defined both by land and by water. The landscape here has shaped settlement from the early 1600s into more recent times and, in turn, man’s activity has reshaped the original landscape.

Dover Point, found in the southern sector of the present-day city of Dover, is a long spine, defined by terrain that rises gently from shorelines to an elevation slightly over 100 feet above sea level. The northern portion of

Newington has a rolling quality, with a height of land also reaching an elevation of 100 feet above sea level. The segments of each town contained within the study area are defined by the waters which surround them. To the east lies the Piscataqua River, a "wily" river of powerful currents and unpredictable nature (Bolster 2002). To the west are found both Little Bay and Great Bay, filled with waters from half a dozen rivers that drain the coastal lowlands of New Hampshire. Within this landscape, a mosaic of resources were available to people; over time, people used and shaped the land, the water and the natural resources for permanent settlement, commerce and industry.

In the 1600s, Europeans arriving here saw a wild and forested landscape, rich in resources. Fish provided the first attraction, but, as settlements were established, timber was cut, fields were cleared and agriculture began. Vast acreage of forested land is recorded throughout historic times in both Newington and Dover. Maps show that a 5000-acre forest persisted in Newington into the 1800s and stands of oak and pine figured prominently in the history of Dover, as shown on a historical map of the 1900s. The importance of timber is further evident in the creation of the Newington Town Forest, which was set aside as common ground in 1710 and is listed today on the National Register of Historic Places (NDHR Town Files). Elements of the original setting permeated the locale until the most recent times. Even in the twentieth century people recall the area as an "unlikely place" with "miles of tidal shores, fragrant pines" "ponds, brooks, and grassy pasturelands where the berry bushes grew, the salt air of the river, and the changing tides of the Piscataqua" (Bolster 2002:104).

Water nearly surrounds Newington and Dover Point and is a prominent factor in the history of these communities. The rivers and bays were alternately viewed as resource zones, barriers and corridors. Abundant fish and shellfish have been recorded here during the past, and were the first economic magnet for historic period exploration and settlement. Lobsters, oysters, alewives, eels and smelt contributed to the fishing industry (Adams 1976); as recently as 1888, immense schools of fish were seen here "hundreds at a time" "leaping out of the river" "some…over a foot in length…chasing the little minnows" (Adams 1976:140). While the rivers and tidal flats of Great Bay provided abundant fish and foods, people also needed to travel from side to side. Ferries and boats were integral to life here, not only for fishing but also for crossing the rivers and transporting people and goods between Portsmouth and interior villages. Special boats were developed for specific purposes, particularly the gundalow, unique to the Piscataqua, for its design and capabilities. The deep water of the Piscataqua was excellent for larger ships and by the time of World War I, shipbuilding became an important industry in Newington with the Shattuck Shipyard (Adams 1976; Bolster 2002; Siwtzer 1998). With time, man also modified the shoreline, removing obstacles to navigation and building ferry landings, piers and abutments for bridges. The first bridge across the river connected Fox Point to Durham, and was linked with a road extending to Portsmouth. Later, bridges connected Bloody Point in Newington to Hilton Point in Dover.

On land, resources directed industry. Forests provided lumber and masts for the first Euro-Americans. White pine was cut and transported to Portsmouth, then shipped to England (Rowe 1987:27-28). Later, wood was used for production of household and commercial goods on small scale. Notably, there was no water power, either along freshwater or tidal stream, for the development of mills here. In lieu of mills, another resource permitted industry to grow – this was clay. Extensive deposits of marine clay are located along the entire shoreline of Dover Point. These were mined during the nineteenth century for brick-making; the brick yards of Dover Point produced millions of bricks and supplied the Portsmouth building industry.

Agriculture provided a strong economy here, in addition to fishing, timbering, brick-making and other commerce. The landscape was well suited to farming, with its fertile soils. Fine sandy loams formed in glacial tills are found along low hills while loams formed in marine material are found elsewhere. These soil types are well suited to support woodlands, crops and forage, necessary for a mixed agricultural economy (USDA 1994). Family farms produced grain, potatoes and other foods. Apple orchards, dairy farms and poultry farms persisted into the twentieth century (Bolster 2002).

The landscape continued to be attractive for other purposes in the twentieth century. Large scale shipping and industry entered the Piscataqua River and the United States government developed a military installation on more than 4000 acres in Newington in the 1950s. The installation "cut the town in two" and in subsequent years growth of commercial and industrial zones has further segregated Newington (Bolster 2002:105-106). At Dover Point, lands were developed for public recreation with creation of Hilton Park, providing a beautiful vantage as well as river access. Throughout the study area, twentieth century development is visible. This includes the highway corridor itself as well as residential neighborhoods and numerous businesses and industries. Only remnants of the agricultural communities of the eighteenth and nineteenth centuries are visible and evidence of early settlement is preserved either in a few remaining standing structures or as archaeological features.

Historic Chronology

The histories of Dover and Newington are intricately linked by a number of themes. Both communities also share a long time line, with recorded events spanning some 400 years.

One of the earliest European settlements in the New World was located at Dover Point. This was the Hilton plantation, marked by the arrival of

Edward Hilton, William Hilton and Thomas Roberts in 1623. The Hiltons arrived from England to establish a cod fishing enterprise at Hilton Point. The fishery was based on a well-established international economy, within a network of coastal and land-based fisheries, including Panaway Plantation and the Isles of Shoals. The accompanying settlement was initiated as a private commercial enterprise (Harrington 1985; Hurd 1882; Rowe 1987; Scales 1923; Thompson 1965; Wadleigh 1913).

Soon, Edward Hilton was granted the Squamscot patent by the Plymouth Council from King James for extensive land holdings, including sections of present-day Dover and Newington. This was related to numerous land grants made between 1622 and 1635 in the Piscataqua and Merrimack River territories. By the early 1630s, Captain John Mason of the Council for New England, sent personnel and supplies to Hilton Point and in 1633, more people arrived from Salem, land was cleared, a meeting house established and dwellings built (Scales 1923:124). By 1640, English settlers were well established on both sides of the Piscataqua River, in a section known as the "Long Reach."

At this time, friction developed from disputes over control of the land, economy and the joining of communities to the north with Portsmouth. In 1641, Bloody Point was part of Massachusetts, but given to Strawbery Banke in 1642. Captain Neal of Strawbery Banke (Portsmouth) and Captain Wiggin of Hilton Point drew swords to settle the debate, and Bloody Point was the name given to what is now Newington. After the dispute, the land was presented to Dover in 1644 (www. Nhcentury.com).

The years from 1680 to 1700 marked more arrivals. Bloody Point became a separate parish in 1713, and its name was changed to Newington (Rowe 1987). In Dover, settlement expanded further north with the arrival of the Quakers, who met with an unfriendly welcome and proceeded up the point where they built another meetinghouse, thereby expanding the original settlement (Hurd 1882). This period also included war between the English and Native Americans, known as the French and Indian War, during which a militia was enacted by the colonial government. A period of skirmishes followed resulting in construction of garrisoned enclosures here (Rowe 1987; Scales 1923; Wadleigh 1913).

By the 1700s, sections of Newington and Dover were well established and residents were participating in vast economic enterprises, as well as local and regional development. The local economy was based on farming and fishing. Foreign commerce was based on export of such natural resources as fish and timber, carried by ship to distant ports along the North American Atlantic coast, into the Barbadoes and West Indies, and across the ocean to England, Spain and Portugal (Scales 1923). Local developments included continued land clearing and farming but the lack of water power precluded establishment of mills here. In 1710, the Newington Town Forest was established on 112 acres in three tracts including the Church, Parsonage and Downing lots. This land was held as timberland for public building construction and to provide the poor with firewood (Rowe 1987:79). In the 1790s, the First New Hampshire Turnpike and the Piscataqua Bridge were constructed, allowing a connection between Portsmouth and the interior of New Hampshire. This was built by a group of private investors and followed a route between Fox Point in Newington to Cedar Point in Durham, crossing Goat Island (Bolster 2002). Development followed this corridor, with farms, residences and taverns built along the route (Garvin and Garvin 1988).

In the 1800s, farming was the principal occupation of Newington and Dover Point residents. Crops included apples, corn and potatoes along with vegetables and dairy farming completed the scene (Rowe 1987). To the north, water power at major falls was used in development of mills. The economy of Dover, therefore grew through the textile industry. In contrast, mills did not develop in the Dover Point locale; instead brickyards were in operation here throughout the nineteenth century. A demand for brick as a building material followed the Great Portsmouth Fire of 1813, in which 15 acres of property were demolished in the city. Brickyards operated for several generations and were situated along the entire length of Dover Point, where clay was available. Clay was extracted and processed, then fired into brick, producing some seven million bricks in a single season at the height of operations in the mid- to late-1800s (Adams 1976; Rowe 1987; Scales 1923).

While ferry service was in operation between Dover Point and Newington since the 1600s, it was not until 1873 that a bridge connected the two. This was built in conjunction with the Portsmouth & Dover Railroad, chartered in 1866, and opened in 1873. The line paralleled the Piscataqua River through Newington and crossed to Dover Point. It was built to provide access to the productive farmlands of Dover and the grains grown there by Frank Jones, who operated a brewery to the south. The bridge included a rail and carriage road with a swing draw for river traffic (Rowe 1987). Stations and depots were built along the route and a popular inn, known as "Hanson Hotel" "Dover Point House," and, later, "Hilton Hall," was built in 1854 by John P. Hanson on a prominent spot at Dover Point.

By the twentieth century, new industry and development came to Newington and Dover Point. Homes were built and neighborhoods developed, summer visitors were attracted to the shorelines. When the General Sullivan Bridge was completed in 1935, the highway was extended across the river and the railroad removed. The economy shifted from agricultural to commercial and industrial. At the time of World War I, the Shattuck Shipyard was built in Newington. Other industries developed along the railroad line and a huge portion of Newington was taken for military development in the 1950s. The Piscataqua River was dredged, larger ships entered the area, and soon highways, interchanges and shopping malls appeared (Bolster 2002; Rowe 1987; Switzer 1998).

Today, portions of the original natural landscape and the historically developed cultural landscape remain intact. Parkland and open space is found in sections of Newington and on Dover Point. Yet much of the area has witnessed extreme development erasing the vernacular of the past.

Historic Themes

Several unifying themes help explain the history of Newington and Dover Point by providing a larger interpretive context, independent of culture chronology. The historic themes which pertain to known and likely archaeological resources within the study area include: maritime adaptation; first settlement; transportation; and economy. Each theme is linked to the others and all ebb and flow over time.

Maritime Adaptation

A maritime context provides the over-riding theme for both Newington and Dover Point throughout the historic Euro-American period. The river, estuary, bay and sea pervade all time periods and links people's settlement, transportation and economy through time. It was by water that the first Europeans accessed, explored and settled the area. The earliest economic enterprise was fishing. The river continued to be important in subsequent economies, playing a role in such enterprises as shipbuilding, marketing, and economy both for cash, barter and domestic use. Even the production of brick is linked to the sea and the river: clay, the natural resource used to make brick, was deposited during marine events and brick, the final product, was transported from brickyards to market by boat. The role of the Piscataqua River, Great Bay and the Atlantic Ocean is elaborated in individual contexts below.

First Settlement

The first European settlement on the New England coast focused on the sea and its bountiful fishing resources. The settlement locations along the Piscataqua River and within Great Bay fall within a clutch of early 17th century settlements along the New England and Mid-Atlantic coast. Locally the settlements are known today as Pemiquid, Portland, Portsmouth, Newburyport, Salem and Boston. These early settlements can be characterized as communities established to conduct specialized trade for the British Empire. English settlements in New Hampshire were established first as fishing outposts and later as lumber and timber contracts under the reign of James I.

At Hilton Point, Edward Hilton, a son of a fish monger and a member of the London's Fish Monger's Guild came to settle his 500-acre claim along the Piscataqua River within the Gulf of Maine. The Fish Monger's Guild was well familiar with the coast of Northern North America, for it was the Guild that controlled the fishing industry from Newfoundland to the New England shore, under the jurisdiction of John Mason. Hilton sailed four miles up the Piscataqua River from the newly established community of Strawbery Banke (modern Portsmouth) and 11 miles from the Isle of Shoals.

Once Hilton arrived at Dover Point, he began to establish his fishing station and provide for the community. This required a dependence on many sources including: trade with existing European communities; coastal and transatlantic shipments; and securing local goods from both the English and Native Americans. While the occupants of Hilton's settlement interacted with Native Americans, this was influenced by two major factors. First, the Native American population in the seacoast region was so reduced by 1633 that less than 10 percent of the Native American population before European contact survived. Second, the English interacted with the Native Americans quite differently than the French and Dutch of earlier times in that the English saw themselves as separate from Native Americans; the English viewed themselves as civilized people of God and the Native Americans as savages to be converted (Harrington 1985; Goodby 1998; Snow 1980).

The fishing station established by Edward Hilton was inventoried in 1637. This inventory gives us an understanding of the nature of the settlement, its purpose and size. The nature of the settlement can be compared with Portsmouth's inventory for the same year. An inventory and provisions in the early colonies of Newichewanock (South Berwick) and Pascatway (Portsmouth) taken in 1635 and transcribed in 1847 provides information on the structure and nature of these two early settlements which were compatible to Hilton Point. This inventory was taken in July when supplies were being delivered to Capt. Walter Neal, of Strawbery Banke, for subsequent delivery to Henry Jocelyn by the command of John Mason.

The inventory for Portsmouth includes: arms and ammunition; stores; provisions; cattle; fishing trade; and items for religious use. The items listed as "stores" and "fishing trade" show which tools were needed to conduct fishing in the Piscataqua. They included: Pitch, tar, "quoils of rope" and cables, "Herring netts", "codlines", "Mackrill lines", Gang cod hooks, 30 doz. "Mackrill hook", squid lines, 70 knots of twine, 1500 Boards and 1511 pine Planks. For the fishing trade there were 6 Great Shallops, 5 Fishing boats with Sails, Anchors & Cables and 13 skiffies. This inventory further reflects that after 15 years, Portsmouth was a substantial station, being re-supplied with considerable goods. At this station, cod, squid, herring and mackerel were being caught and processed for the English market across the Atlantic.

Portsmouth's relation with Hilton's settlement was tenuous at best during this time. Walter Neal and Thomas Wiggin averted a dual at Bloody Point; following an argument over whether to have Hilton's settlement join with those at Portsmouth. This confrontation reflected on-going political battles concerning authority for establishing fishing stations in the region.

Fisheries of New England not only supported the colonial settlements, but also exported processed fish to England. However, the economic dominance of fishing was soon overshadowed by awards of naval contracts to the Wentworth Family, prominent in provincial politics. The contract to supply the British Navy with trees for masts focused entrepreneurial efforts to the interior wilderness. Thus, the role of fisheries began to diminish and fishing became a subsistence activity practiced by individual families. Commercial enterprises began to move gradually up the coast to the north, along the Maine and Canadian coasts.

Excavation of archaeological sites, related to the extended Hilton family and their heirs in Newfields, New Hampshire and South Berwick, Maine, has also provided data for comparison. Edward Hilton's extended family settled in the region; his brother received the Squamscot Patten, along the Squamscot River, in an area which is part of modern Newfields. The Hilton family and subsequent generations solidified their alliances within the region through marriage to families who held land and operated fisheries as far north as Newfoundland. Excavation at some of these early historic sites has revealed much about 17th century life in the Piscataqua Region (Baker 1992). Households consisted of extended kin-aligned groupings, with wealth amassed in personal possessions and landholdings. The Charbourne site, excavated in South Berwick, Maine, is recognized as an earth fast building, burned in a 1690s "Indian Raid." The site contained charred material goods and stores kept by a wealthy family in the Piscataqua Region during the late 17th century (Baker 1992).

First settlement around Great Bay resulted in the clearing of land and planting of European crops that shaped the nature of the landscape and the plant communities growing today. While it is assumed that Native Americans cleared portions of Newington and Dover before European settlement for cultivation of crops and to increase habitat for game, land clearing was expanded by Europeans through the cutting and burning of the scrub oak and associated vegetation. Sawmills were established in portions of the estuary where waterpower was available. Large timbers were either processed on site or floated to mills for cutting. International and coastal trade in barrel staves, house frames and furniture all worked to deplete the forest resources within the Great Bay. As settlement increased, and the demand for timber and firewood increased, lumber and wood were sought north and west of Great Bay.

Within a generation of the original 1620s settlement, Native American survivors had regrouped and formed an alliance of traditional groups to form the Cocheco Indians. These Indians made treaties with the French and the English, who in turn broke these treaties. By 1675, Native Americans began a series of raids on English settlements in part inspired by the French military. The settlers at Hilton and Bloody Point along with their neighbors in Berwick, Maine and Oyster River and Dover fortified their homes and meetinghouses with as garrisons. These were palisaded structures of vertical boards with observation towers and a single gated entrance built around a home, group of homes, or meetinghouses. These fortifications were necessary for life in the Great Bay region in the late 1680s and early 1690s. Instigated by the rivalry of the French and English and fueled by the fighting of Queen Anne's war, Native American raids of garrisons were frequent. Isolation left settlers vulnerable to attacks. In the 1670s and 1680s raids were conducted in Greenland, Hilton Point and Bloody Point as well as at Cocheco (Dover), Salmon Falls (Rochester) and Oyster River (Durham). The leader, Hope Hood, also led an attack at Fox Point in Newington (Colby 1967; Rowe 1987).

Garrison Houses were constructed as a form of protection from attacks. While several garrisons were built in the Piscataqua region, few survived the period and even fewer remained 100 years later. At least five garrisons were built in Newington, with the Lanstaffe garrison standing on Bloody Point.

The Whipple Garrison in Kittery, Maine, provides comparison and is described as:

> *"The garrison part of this house was constructed of hemlock timber hewed square, dove-tailed together at the corners; when the present owner put the building in repair, this timber was found to be perfectly sound, and likely to last for centuries unless destroyed by fire… The form of the building was doubtless copied by the colonists from European houses, in which projecting upper stories were common; and the preference for timber over stone probably arose from the destitution of lime in early days.*
>
> *For very obvious reasons, they had but few windows, and those of small size, especially in the lower part of the house; and these furnished with strong shutters. The door was a ponderous thing, in some cases made of timber or joist, sometimes of oak, and not unfrequently hung on wooden hinges; generally, but not always, opening in two parts, well braced and barred.*
>
> *Every neighborhood, of three or four farm houses, used to have one of them a garrison house, built in this way by the united efforts of the neighbors, but held as the private property of one man, and used as the residence of one family. In times of apprehended danger nearly or quite all the neighbors lodged at the garrison"* (Brewster 1979).

Meetinghouses were the second form of community meeting place to be established during this first period of settlement. Meetinghouses served as places of worship as well as governmental meeting places. In Newington, the Meeting House was established in 1713, and marked the separation of Newington from the grant of Portsmouth and Dover. The establishment of the Newington Meeting House coincides with the time of settlement and is substantially different from other early settlements that did not establish meetinghouses early on. By establishing the Meeting House, Newington created a separate governmental identity through a symbol of its newfound independence.

The Dover Point Meeting House was built ca. 1689. It is depicted in a drawing (Wadleigh 1913) showing that it stood alone, surrounded by a palisade fence. The Pinkham Garrison is recorded nearby, but these structures were no longer standing by the first decades of the nineteenth century.

By the beginning of the 1700s a new day of settlement and economy had arrived for coastal New Hampshire. Increased population size, demand for land, and trust that the Native American raids were diminished brought settlers to Portsmouth, Dover and Newington. Accompanying this change was also dividing and selling large parcels of land into small urban lots and farms of 50 to 100 acres in size. These changes mark the end of the First Settlement period.

Transportation

By Water: Boats

Transportation in Great Bay and the Piscataqua Region, was based on a complex network of international shipping, coastal trade and tidal river drainage into the Gulf of Maine. Portsmouth Harbor was a good natural harbor because it offered deep water, rarely froze and the current and tides permitted vessels to quickly enter and exit. Further from the sea, tide and currents also controlled access to Great Bay settlements.

The vessels used for travel during the 17th century were schooners, shallops, and smaller fishing boats. They found access to the interior along coastal river tributaries. It was these ships that brought Edward Hilton up the Piscataqua to Dover Point.

These sailing vessels also carried cargoes of manufactured goods to the region from England and other ports of the British Empire. They were then reloaded with the new colony’s products, especially furs, timber and fish. Alewives and other fish were salted and shipped by barrel to the West Indies and apples were shipped to London. Sailing vessels were loaded and off-loaded by use of gundalows, a vessel designed to carry heavy loads and navigate the current, tide and narrow passages (Adams 1976: 158, 184; Gowell 2002:111).

Great Bay and all of its seven tributary rivers are tidal until each river meets a natural falls; consequently smaller craft were all dependent on the tide. The tide changes daily, with a slack and ebb tide for each portion of Great Bay. The tidal action combined with the narrows between Dover Point and Bloody Point still makes for very treacherous sailing, with one of the strongest currents found in New England waters (Gowell 2002:111). Therefore, the scheduling of boat launch and arrival times was a complex fluctuating cycle, leading to a very small and locally based transportation network comprised of ferries, gundalows and other private boats.

A locally derived watercraft was the simple gundalow. This vessel is shallow drafted, and was originally undecked. It was used in this region with great success because it could be propelled in several ways. First, it was able to utilize the fast tidal currents of the Piscataqua. In addition, the vessel could be rowed in restricted waters and sails could be hoisted to aid in power. The vessels were loaded with cargo and people and provided transport throughout Great Bay into Portsmouth. The gundalow was an essential watercraft for the Great Bay from the 1660s to the late 19th century (Gowell 2002: 111-112).

Ferries and private boats provided connection across the river, as well as, Portsmouth harbor and the Isle of Shoals. Ferries in the seventeenth century connected points of land and coves that ring Great Bay. Wharves and landings were constructed on these many points of land. The ferry between Bloody Point and Dover Point was established by Thomas Trickey as early as 1640 and purchased by John Chevalier (aka Knight) a French Huguenot in 1705 (Ewing and Chesley 1981:2). This and other ferries provided the web that connected people and goods throughout the region. One previously recorded archaeological site, 27-RK-147, is the location of Trickey's Ferry, where a marker is placed at Bloody Point in Newington.

By Land: Roads, Railroad and Bridges

Transportation networks of the seventeenth and eighteenth centuries focused on the waterways of the region. By the end of the 18th century, settlement had expanded into interior regions that were not as easily accessed by navigable waters. Foot and cart paths were used more and more with less and less success. Travel between Durham and Concord was more in demand. The solution was to build a Turnpike to connect Oyster Falls and hence Great Bay and the seacoast to the interior. The First New Hampshire Turnpike was established in 1794; it connected Durham and Concord and brought the stage from Boston to Portsmouth, then on to Dover and back. These systems were privately run enterprises and tolls were collected to fund their operation. Although built by entrepreneurs, the operations were regulated. The Turnpike system and the stagecoach routes brought great changes in transportation, particularly for residents of the seacoast (Garvin and Garvin 1988).

The Turnpike was expanded to extend over Great Bay. This expansion, while costly, greatly reduced the time to travel between Portsmouth and Durham. Plus, travelers were not dependent on the tide, water conditions and weather. Thus, the original Piscataqua Bridge was built in 1794 and was paid for with a lottery. This bridge connected Fox Point in Newington to Cedar Point in Durham *via* Goat Island. It was a beautiful structure, with a graceful arch and white rails, spanning a distance of 2600 feet. It stood until 1855, and its remains are preserved underwater (Switzer, 2003, personal communication).

The second bridge to be built was a combination railroad and road bridge that spanned the mouth of the bay between Newington and Dover Point. This bridge was built in 1873 by a private investor, Frank Jones. Jones was a brewing tycoon who used the rail to move goods and products in and out of Portsmouth and to access crops grown in Dover. The railroad came to Dover and Newington late in rail history, and had already been established in Portsmouth by 1840. Its appearance here also opened the way for industrial production of the late-nineteenth century. Portsmouth, Newington and Dover Point had not been part of the earlier industrial development that was seen elsewhere in Dover, Somersworth and Rollinsford.

The third bridge constructed here followed and replaced the railroad. This was the modern General Sullivan Bridge, completed in 1935. Finally, the Little Bay bridges were constructed in 1966 and 1984. These twentieth century bridges remain today and have effectively replaced travel across the water by ferry, gundalow, skiff, or other craft (Garvin 2002 100-103; Ewing and Chesley 1981:2).

Even when the waterways were not the primary source of transportation, paths, roads and rail networks conformed to them. The land transportation network continued to expand as roads were built into parts of the region not accessible by navigable waters. The closer to Portsmouth the more diverse the road system was. In Newington, major roads led to and from Portsmouth, with spurs providing overland connections. At Dover Point, the major roadways followed the spine of the point into Dover before branching off. The road pattern reflects the nature of settlement and land and shore use through historic and pre-contact periods. The constant pattern of the road traveling down "the spine" reflects the lay of the land and the location of resources to be accessed at the Point and in the Bay. One previously recorded archaeological site, 27-RK-158, is the general location of the railroad station located at Bloody Point in Newington.

Economy

The local economy was dominated by fishing, agriculture, shipbuilding and brick-making. These elements, while each important in its own right, have fluctuated over time in their economic importance to the region. The economy also depended on movement of goods and people into the area and was closely tied to travel and transportation routes. Of course, people practiced many other activities as part of their daily lives. People traveled to the shoreline for outings and picnics, using the railroad, and stayed at the Hilton Hall, a nineteenth century inn at the tip of Dover Point. Excursion boats were popular along the river, and parties sailed, hunted and fished here for sport. The fishing and farming of the earlier phases of Newington and Dover Point's histories was replaced by one comprised of industrial, military and commercial elements in the twentieth century.

Fishing and Farming

A mixed fishing and farming economy was conducted in this area of Great Bay that echoes the economy practiced in the lowlands of England and the coastal region of Bristol and northern British Isles. A certain perception of work and living was brought with the eighteenth century English folk who resided here. This British Isles tradition is based on family ties and daily routines, and not on abundance of material culture. Farming and fishing were successful economic strategies until the 1950's when the land was taken for the establishment of Pease Air Force Base.

English settlement of the region was first established in order to meet the demands for fish. New England and North Atlantic waters contained the fish resources necessary for the English market. Thus, the first fishing stations and settlements were supported by Queen Elizabeth and King James and served an international market. At Hilton Point, a cod fishing station was established in conjunction with other plantations established in the 1620s (Harrington 1985).

Throughout the 19th century, fishing continued as an important economic element. Smelt, alewives and eels were caught during the winter months, and were then smoked, brined and sold (Adams 1976:149). The seasonal nature of the fisheries complimented the other economic elements used by the residents of Dover and Newington. among these was agriculture. Farming in Newington and Dover Point followed patterns of the small-generalized family farm. Mixed crops were grown and included potatoes, corn, apples, grains and vegetables. While crops were grown as "cash crops" and for trade, family substance was provided for with dairy products, meat, eggs and vegetables. Dairy cows, chickens and hogs were the livestock raised for home and market production. In contrast to other coastal New England farms, salt marsh hay was not a primary crop.

Fishing and farming were not singular activities. They were woven into a complex economic strategy of trade, barter and sustainability. Records indicate that crops, fish and moonshine were often traded (Adams 1976:263; Bolster 2002:105). Cartographic data show that the family networks of the property ownership, trade and social networks are all closely aligned. Nineteenth century maps indicate that people of the same extended family occupied adjacent parcels of land for long periods of time and that farms included numerous barns, sheds and structures for diverse activities.

People's occupations in the past were both seasonal and resource specific. In the summer, people farmed their land and in the winter people turned to fishing and woodworking. "If any farmer had any time in the winter he used to make barrel staves, hoops and stuff… used some oak…some pine…put our apples in" (Adams 1976:184).

A number of previously recorded sites (27-RK-153, 154, 282, 283, 284, 285, 286, 287; Table 3.17-3) reflect aspects of rural residential life in Newington. These sites include dumps, a culvert, a spring or well head, and residential foundations. All are of unknown age, and most have been modified resulting in a loss of integrity. These sites indicate that foundations and related features have most often been previously recorded within the project area and that similar types of resources may be expected or encountered.

Shipbuilding

"Shipbuilding was a way of life on the Piscataqua" (Leavenworth 2002:89). Shipbuilding began as early as 1644 in the region and was an important aspect of economic growth from the 17th to 19th century. Boats of all types were essential to life here; they carried the earliest explorers into the region, they carried fishermen and their catch, and they carried goods, people, animals and products through Great Bay and along the Piscataqua River.

Early boat building was small scale. All that was needed to build a boat was access to water, the tool kit of saws, planes, adzes and drills, and the materials and skill needed for boat building. And many boats were built, including ferries, lighters and the gundalow, known as the work-horse of the Piscataqua.

In the nineteenth century the ships became larger, hulls had greater draft, and deep water was required for launching. Therefore, shipyards were located closer to the coast where the waters were deeper, particularly at Kittery, Elliot and Portsmouth (Leavenworth 2002:97-99).

World War I marked the final episode of shipbuilding in Newington at the Shattuck shipyard on the Piscataqua River. The Shattuck Shipyard built wooden freighters, weighing 3500 tons and measuring 270 feet in length. At any one time, six ways were in operations with vessels at various stages of completion. The yard launched fifteen vessels in 1918 and 1919, with the Newburyport, their final launch in August of 1919. Today, the yard is located within the Sprague property and consists of abandoned piles of timbers associated with structural assemblages, freighter remains, and abandoned buildings (Adams 1976; Switzer 1998). The shipyard attracted thousands of workers who resided in the fields surrounding the yard; its operation paved the way for future industrial development in Newington (Bolster 2002:105).

As ships grew in size, the waters and shoreline of the Piscataqua also changed. Shoals in the Long Reach were dredged, allowing oil tankers to dock at terminals. Boiling Rock was blown up to remove a navigation hazard. Yet, along with its removal was the loss of a cultural landmark. Gundalow drivers calculated that passing Boiling Rock marked the "halfway" point, "no matter where they were going" and provided a reason to celebrate as "everybody would have a drink aboard the ship that they'd safely passed the Boiling Rock" (Adams 1976:144; Bolster 2002).

Brick-making

Brick-making became an important industry in Newington and Dover Point during the nineteenth century, and is represented by several sites in Dover. Successful brick-making depended on several variables, all of which were present in the area. First, a reliable source of high quality clay is needed. This must be accompanied by sufficient open acreage for extracting and processing the clay, for forming and drying the brick, and for firing. Wood is also needed to fuel the kiln. In addition, labor and market are necessary, as is a transportation route to move the brick to the market.

An excellent source of marine clay was present along the shorelines, particularly along Dover Point. This clay was extracted by horse and hand, and shaped into bricks which were dried and fired on site during warm and dry seasons of the year. Firewood was cut from adjacent woodlots during the winter. Gundalows transported the brick downstream. And bricks were in demand. They were shipped to Portsmouth following a massive fire in 1813 and also to the Boston market (Adams 1976; Garvin 1994; Goldthwait 1953; Rowe 1987; Scales 1923).

Brick was made here for generations, with families well known for their brickyards. At Dover Point, the Pinkham's began brick-making in 1830 and continued for four generations" right down to the bridge … until they used up all the clay"(Adams 1976:109). Production was enormous, with up to 7 million bricks made at a single brickyard in one season (Rowe 1987:181).

Euro-American Site Summary and Expectations

Evidence for hundreds of years of Euro-American occupation is visible in many ways throughout the study area. The position of roads, bridges and buildings reflects the historic settlement pattern and standing historic structures are still present here. Other evidence is found in the form of ruins and archaeological remains. Sites are known to exist in Dover and Newington, despite the effects of erosion and massive modern landscape alterations.

Several sites have been previously recorded in the study area in the NH Division of Historical Resources site files. Among these is a cluster of foundations, dumps and other features discovered during the cultural resources management survey for Pease Air Force Base. These sites include:

27-RK-282, a residential foundation, composed of fieldstone, concrete block, brick and poured concrete, determined to be demolished and filled, dating from the mid-nineteenth century, and not meeting eligibility criteria for National Register listing due to lack of integrity

27-RK-283, a residential foundation, composed of concrete, block and brick, with remains of a garage, dating from the nineteenth century, and not meeting eligibility criteria for National Register listing due to lack of integrity

27-RK-284, a dump, containing household trash, reflecting nineteenth and twentieth rural domestic patterns, but does not meet eligibility criteria for National Register listing due to lack of context

27-RK-285, a road grade and culvert, dated to the twentieth century, which does not meet eligibility criteria for National Register listing due to lack of integrity

27-RK-286, a stone-lined well or spring head, possibly used for watering livestock, considered as part of the rural agricultural landscape but does not meet eligibility criteria for National Register listing due to lack of context

27-RK-287, a dump, containing household trash, reflecting nineteenth and twentieth century rural domestic patterns, but does not meet eligibility criteria for National Register listing due to lack of context

Investigations of these resources led to a determination that none of them exhibited qualities to make them eligible for inclusion to the National Register of Historic Places.

Elsewhere, other sites have been previously recognized in Newington. Their eligibility for the National Register of Historic Places has yet to be determined. These sites include:

27-RK-147, a stone marker indicating the location of Trickey's Ferry, recorded in the NH Division of Historical Resources site files. The age, extent and components were not previously established by NHDHR and detailed data on the site have not been collected. The site may be pertinent to transportation related themes, particularly ferrying operations.

27-RK-153, the likely location of 2 foundations, recorded in the NH Division of Historical Resources site files. Age, affinity, extent and precise location or cultural components and artifacts have not been established by NHDHR and detailed data on the site have not been collected. The site may be pertinent to domestic related themes.

27-RK-154, a foundation of a residence of unknown age, with evidence of extreme landscape modifications, recorded in the NH Division of Historical Resources site files. Age, affinity, extent and precise location or cultural components and artifacts have not been established by NHDHR and detailed data on the site have not been collected. The site may be pertinent to domestic related themes.

27-RK-158, the vicinity of the Bloody Point railroad station recorded in the NH Division of Historical Resources site files, although age, affinity, extent and precise location of subsurface and cultural components as well as artifacts have not been established by NHDHR and detailed data on the site have not been collected. The site may be pertinent to transportation related themes, particularly the establishment of rail service in Newington and the crossing of the Piscataqua River.

In addition, records of the NH Division of Historical Resources note that two other locations are considered archaeologically important. The first is Hilton's Point in Dover, which has been recorded in the files at the NH Division of Historical Resources, but detailed archaeological data have not been collected. The second is the Shattuck Shipyard site that was recorded in 1998 (Switzer) but is not designated with a NH Division of Historical Resources site survey number.

On the basis of information collected from numerous primary and secondary sources, we may expect to discover Euro-American sites, features and artifacts throughout the study area. Locations of particular sensitivity for these resources include any undeveloped tracts and shoreline sections which have not been impacted by modern growth and development. Sites and components may reflect a long chronological sequence, from the 1620s to the 1900s, and may contain artifacts and features reflective of an array of past activities. Sites or components may reflect such themes as first settlement, fishing, farming, commerce, trade, shipbuilding, brick-making, recreation, travel or other activity. Types of artifacts and features may vary considerably: first settlement meetinghouses or garrisons may contain a composite of Native American and early Euro-American materials, and there may be evidence of earth fast construction; fishing stations may contain elements of drying racks, wharves, tools, and structures; nineteenth century farms may contain evidence of building foundations, farmstead layout, and field arrangements, as well as varying amounts of sheet midden and trash deposits, industrial sites may contain work yards, tools, structural remains, and raw materials, including brick at brickyards and timber at shipbuilding sites. Further, many sites may be expected to contain overlays reflecting multiple use and activities deposited over the course of several hundred years. Overall, the historic period archaeological record is expected to be complex with the occurrence of numerous artifacts and features.

Historic sites and elements that may be expected or encountered include:

- Abandoned residences, farmsteads, outbuildings, and features (*e.g.*, barns, hay barns, dairy barns, stables, sheds, ice houses, spring houses, privies, trash deposits, dumps, wells, and stone- or wood-lined root cellars),

- Other historic elements of abandoned farmsteads, such as yards, activity areas, stone walls, stone piles, depressions, drainage trenches, abandoned equipment, and animal pens,

- Historic landscape features, including agricultural fields and patterns, former perimeter boundaries represented by tree lines and hedgerows, orchards and domesticated plants (*e.g.*, herbs, ground cover), gardens, and fences,

- Industrial ruins and deposits including building foundations, shipyards, brickyards, kilns, and blacksmith shops, *etc.*, and

- Historic land transportation corridors, including early roads, bridges, and railroad lines.

Such cultural resources, if found in the project area, may correspond with numerous New Hampshire Division of Historical Resources historic contexts, including:

- Early settlement of the NH seacoast, 1623-1660,
- Commerce, industry and trade in New Hampshire cities, 1630-present,
- Fishing on the NH Seacoast and the Isle of Shoals, 1660-1820,
- Wooden shipbuilding on the NH seacoast, 1630-1920,
- Modern shipbuilding on the NH seacoast, 1900-present,
- World War I in NH,
- Mixed agriculture and the family farm, 1630-present,
- Grain farming and grist milling, 1650-present,
- Poultry farming, 1870-present,
- Dairy farming for urban markets, 1880-1940,
- Orchards and cider production, 1650-present,
- Pre-automobile land travel, 1630-1920,
- Railroads in NH, 1842-1960, and
- Brick-making for local and regional markets, 1650-1920.

Throughout the project area, however, elements of the historic landscape have been impacted and/or obliterated due to erosion and/or alterations, such as road construction. Changes have been made to the physical character of the historic landscape in association with the construction of residences, commercial properties, and industries and their associated parking lots, access drives, utilities, and other features. Alterations have also resulted from rough grading, the hauling and depositing of fill, steel work and concrete pouring for the bridges and culverts, and the construction of the highway and associated road shoulders and drainage. Changes have also accompanied property transfers and land division. As a result, many zones of the proposed highway construction and improvement have not been assigned archaeological sensitivity.

As such, potential archaeological evidence in less disturbed areas is considered important considering the early settlement and gradual development, until more recent times, as well as the significance of the transportation corridor along the project area. Locations of particular sensitivity for these resources include former historic site locations that have not been impacted by modern growth and development. While repeated site use over time periods may have altered original contexts, it is expected that some sites may have intact components preserved in subsoil contexts with artifacts and features which may reflect aspects of historic period economies, activities, settlement patterns and adaptations.

Areas of Archaeological Resource Sensitivity: Nautical

Underwater and nautical archaeological resources survey did not reveal archaeological resources of a maritime nature, such as shipwrecks or vessel remains, deposited within the channel of the study area. This is due to the make-up of the sea and river bed. With the exception of the shallow margin areas composed of mud, sand and crushed shell, the deeper areas that extend into the wider channel are rock strewn. The channel bottom is composed of tightly packed cobbles with interspersed boulders. This mixture has created a surface that defies penetration or imbedding, that, in turn, negates the possibility of preservation of wooden remains, including the hulls of vessels. Further, the current, which at ebb and flow flows at a rate exceeding 6 m.p.h., has scoured the bottom of any submerged resources. The features observed along the channel bottom include such objects as trees, branches, and items of great weight such as I-beams. These are considered anomalies, lying "captured" by bottom conditions. Therefore, the conditions in the study area do not exhibit the potential to allow the retention of marine-related archaeological resources constructed of wood.

Other resources which constitute features of the past historic built environment were noted during survey for marine resources. These include elements both underwater and at the shoreline margins: Foundations associated with the former railroad bridge; a ferry landing; and a shipyard.

The remains of the former railroad bridge (Area 22 on **Figure 3.17-2**) include pilings and drawbridge support foundations along the former railroad corridor. A portion of the abutment constructed of cut granite block around wooden pilings was observed along the shoreline at Bloody Point and pilings were observed in riprap on the shoreline at Dover Point. In addition, video camera track data revealed submerged granite with drill marks, representing sections of underwater bridge pilings in the river channel.

Other related resources included the Trickey's Ferry Landing (Area 23 on **Figure 3.17-3**) and the Shattuck Shipyard (Area 67). The Trickey's Ferry Landing was observed along the shoreline and includes remnants of a jetty constructed of stone. The Shattuck Shipyard includes remains of wharves, pilings and abandoned, unfinished vessels.

Areas of Archaeological Resource Sensitivity-Terrestrial

In the Newington and Dover portions of the study area there are many elements and resources that reflect human settlement and adaptation in the Great Bay and Piscataqua region over a period of thousands of years. These are preserved as standing structures, ruins, features and archaeological sites. The cultural landscape changed over the course of 10,000 years, due to continuous occupation and landscape use through both pre-contact and historic periods.

Archaeological research and field investigation within the proposed study area have documented a long and varied sequence of past human use, by both Native American and Euro-Americans. Past landscape manipulation is extensive. The scale of recent commercial, industrial and military alterations is believed to have disturbed and erased many potential types of archaeological resources. However, sections of the study area are believed to contain important in-ground remains and resources.

The components and resources recognized during archaeological survey provide information of the past cultural landscape and history of the study area. They reflect settlement and land use in the locale. Survey has confirmed the following:

Pre-contact Native American archaeological sites have been recorded throughout Great Bay and the Piscataqua drainage. Several sites are known to exist in close proximity to the study area. Three sites (27-RK-275, 27-RK-302 and 27-RK-410) were previously recorded in Newington within the study area but were determined not to be eligible for the National Register of Historic Places. Research also revealed that pre-contact Native American sites may be expected throughout the study area because the area likely served as a transportation corridor for thousands of years. The shorelines and stream margins exhibit high sensitivity for pre-contact Native American sites. While areas exhibiting sensitivity for the occurrence of pre-contact Native American sites have been delineated (such as Areas 49, 53, *etc.*) throughout the study area, no new sites were recorded during the current survey.

Historical archaeological sites previously recorded in the NHDHR archaeological inventory are documented in and adjacent to the project area. NHDHR determined six of these sites, which are all in Newington, including 27-RK-282; 27-RK-283; 27-RK-284; 27-RK-285; 27-RK-286, and 27-RK-287 ineligible for the National Register of Historic Places. They represented foundations, dumps, farm roads, a spring, and culvert. Although known to contain historical archaeological remains of undetermined integrity, Hilton Point and Shattuck Shipyard are not recorded in the NHDHR site files. NHDHR records do document sites 27-RK-147; 27-RK-153; 27-RK-154; 27-RK-158, whose eligibility for the National Register remain undetermined. These sites are associated with the railroad corridor and Trickey's Ferry.

The current investigations located and completed archaeological inventory site forms for eleven historical archaeological sites. They include brickyards in areas 7, 8, 13, 17, and 21; house foundations in areas 1, 58, and 23; a spring in area 9; and four cemeteries. While the four cemeteries are not eligible for the National Register under criterion A or C as above-ground resources (see inventory forms NWN0008; NWN0009; NWN0010; and NWN0011), they may be eligible under criterion D for the information they contain. The cemeteries would require relocation if affected. In addition, the Phase IA survey identified and delineated sensitivity areas that have a high potential to contain historical archaeological sites. These areas are associated with the following historic contexts: first settlement, fishing, agriculture, industry, and transportation resources associated with roads, railroads, and water.

The Phase I-A study documented archaeologically-sensitive areas and identified sites. The extent of these sensitivity areas are shown on **Figures 3.17-2 and 3.17-3**, and largely represent undisturbed areas or areas with a veneer of disturbance across the project area.

3.18 Potential Petroleum, Hazardous Materials, and Solid Waste

3.18.1 Overview and Methodology

An assessment of potential petroleum and hazardous materials sites at the corridor level was performed to identify existing conditions including the release or threat of release of oil and/or hazardous materials (OHM) within the study area. The scope for this Initial Site Assessment follows AASHTO guidance on performing such investigations at the corridor level. This included a review of federal and state environmental computer databases; review of state and local records; site reconnaissance; and interviews with people knowledgeable about the study area.

File reviews were conducted to help identify properties within the study area that have had a release or pose a threat of release of oil and/or hazardous materials, and which may impact the environmental quality of the study area. Included in these reviews were federal and state environmental databases from FirstSearch[67] and the NHDES.

Additionally, a visual survey of the study area was conducted in an effort to locate potential petroleum and hazardous materials sites and to confirm the results of database reviews. Observations within the study area included several industrial properties, fueling facilities, former military activities, an underground petroleum pipeline, existing railroad rights-of-way, marinas and an above-ground tank farm. In addition to the file reviews and field survey, an interview was conducted with NHDES regarding sites associated with the former Pease Air Force Base (now the Pease International Tradeport), due to the special nature of this area.

The locations of the properties identified by these investigations are shown on **Figure 3.18-1**.

67 First Search is a proprietary computer database that contains and organizes information on potential petroleum and hazardous materials sites.

3.18.2 Summary of Corridor Initial Site Assessment

3.18.2.1 Confirmed and Potential Contaminated Sites

Resources contained within the proprietary environmental databases, included:

- National Priorities List (NPL);
- Comprehensive Environmental Response;
- Compensation and Liability Information System (CERCLIS);
- Resource Conservation and Recovery Act (RCRA);
- Treatment, Storage, and Disposal (TSD) facilities list;
- RCRA generators (GEN);
- RCRA corrective action sites (COR);
- RCRA no longer registered (NLR) generators;
- State hazardous waste sites;
- State list of spills sites;
- Active Solid Waste Landfill (SWL) facilities;
- Registered underground storage tanks (USTs);
- Leaking USTs (LUSTs);
- Emergency Response Notification Site (ERNS).

Several additional databases were obtained directly from the NHDES including:

- Registered ASTs/USTs;
- Leaking storage tanks including: leaking underground storage tanks (LUST), leaking motor oil storage tanks (MOST), leaking above-ground storage tanks (LAST);
- Hazardous Waste Sites; and
- Remediation Sites.

Table 3.18-1 summarizes the sites identified from these searches within the study area.

3.18.2.2 Storage Tank Locations

Several identified above-ground storage tanks (ASTs) and underground storage tanks (USTs) are located within the study area, as identified by the proprietary and NHDES databases. Table 3.18-2 lists the tanks identified within the study area, while their locations are shown on **Figure 3.18-2**.

A total of 54 sites were identified by database search and/or field observations. To the degree possible, these sites are depicted on **Figure 3.18-1.** However, since data on the location of each record of site is not always available, several sites could not be reliably mapped. Many of the sites identified are believed to pose no risk either because they have been remediated or because the site/release was not of a nature to be considered a risk. A summary of the sites potentially affected by the various roadway alternatives is presented in Chapter 4. From this data, further research to better define the risk posed by the site will be conducted for the Selected Alternative following the Hearing.

3.18.2.3 Solid Waste Sites

The only known solid waste sites in the study area are located within the Pease International Tradeport. Several closed landfills associated with the former Pease AFB are present west of Arboretum Drive and north of the runway apron. Contamination related to these landfills is now managed under the terms of a Groundwater Management Permit issued by NHDES.

3.18.2.4 Railroad Corridors

There are several railroad rights-of-way located within the study area. Railroad operations are commonly associated with residual metal and petroleum contamination due to the following processes:

- Herbicide Application – Herbicides, often arsenic-based solutions, were historically applied to railroad lines to control vegetation along the tracks;

- Treated Wood – Railroad ties are commonly treated with creosote, coal tar, or arsenic as preservatives.

- Oil Releases – Lubricating oil often drips from trains onto surrounding surface soil.

- Coal Releases – Coal and coal ash from earlier train engines were likely deposited along railroad tracks, introducing lead and polycyclic aromatic hydrocarbon (PAH) compounds to surface soil.

Table 3.18-1
Confirmed and Potential Contaminated Sites Within the Study Area

Address	Town	NHDES Site ID #	Database	Description	Figure ID # (See Figure 3.18-1)
Dover Point Rd	Dover	199902013	LUST RISK 6	Former Marina	1
"			MOST RISK 8		"
"			UIC RISK 3		"
"		NHD073977340	RCRA -SQG (NV)		"
"		93-162	SPILLS-FIXED		"
River Rd	Dover	94-328	SPILLS	Auto Store	NM
Old Rochester Rd	Dover	93-306	SPILLS	Tractor Trailer Truck	NM
Wentworth Terrace	Dover	199906016	LUST RISK 8	Pumping Station	4
Fox Point Rd	Newington	NHD008819526	RCRA –SQG (NV)	Boat Store	5
"		96-60	SPILLS-FIXED	Marina	"
Fox Point Rd	Newington	199902026	GW HAZ INV – Closed	Estate	6
"		NHD986482610	RCRA – CEG RISK 8	Retail Store	"
"		NHD986474070	RCRA - CEG RISK 8	Auto Body Shop	"
Fox Run Mall	Newington	199112005	LUST RISK 8	Retail Store	7
"		199008035	LUST RISK 8	Retail Store	"
"		95-324	SPILL/RLS – FIXED	Retail Store	"
"		NHD986484509	RCRA –SQG (NV)	Retail Store	"
"		NHD510155344	RCRA -CEG (NV)	Retail Store	"
"		NHD510077118	RCRA –SQG (NV)		"
"		NHD986485589	RCRA –SQG (NV)	Retail Store	"
"		NHD981211949	RCRA -CEG (NV)	Retail Store	"
Gosling Rd	Newington	NHD000842666	RCRA –SQG (NV)	Electric Utility	8
"			RCRA –SQG (NV)		"
Gosling Rd	Newington	NHD018960112	RCRA –SQG (NV)	Leasing Co.	NM
Gosling Rd	Newington	NHD982200628	RCRA –SQG (NV)	Retail Store	10
Gosling Rd	Newington	199112013	LUST-UIC	---	11
"		NHD000791517	RCRA-LQG	---	"
"		199112013	LAST RISK 6, UIC RISK 8	Marina	"
"		NHD000791517	RCRA –LQG (NV)	Fuel Storage	"
"		240202, D30704	ERNS- FIXED	Service Station	"
Gosling Rd	Newington	199312028	LUST RISK 8	Retail Store	12
"			UIC RISK 8		"
Gosling Rd	Newington	199807053	LAST RISK 8		13
Gosling Rd	Newington	199312028	LUST RISK 8	Retail Store	NM
			UIC RISK 8		

Table 3.18-1 (Continued)

Address	Town	NHDES Site ID #	Database	Description	Figure ID # (See Figure 3.18-1)
Gosling Rd	Newington	NHD986486009	RCRA -CEG (NV)	Tire Shop	14
Gosling Rd	Newington	199204011	LUST RISK 8	Service Station	15
"		NHD986486132	RCRA –SQG (NV)	Service Station	"
"		NHD092054899	RCRA –SQG (NV)	Service Station	"
Gosling Rd	Newington	NHD510120637	RCRA –SQG (NV)		16
"		94-336	SPILLS-FIXED	---	"
Gosling Rd	Newington	NHD986474179	RCRA –VQG (NV)	Print Shop	NM
"			RCRA-TSD (NV)		"
Gosling Rd	Newington	NHD500003579	RCRA –CEG (NV)	Truck Rental	18
Gosling Rd	Newington	NHD986470052	RCRA -CEG (NV)	Retail Store	19
Gosling Rd	Newington	426652, D50225	ERNS – UNKNOWN	Service Station	20
Gosling Rd	Newington	NHD000791491	RCRA –SQG (NV)	Electric Utility	21
"			RCRA-TSD (NV)		"
Old Dover Rd	Newington	NHSP-0203-I-99	SPILLS FIXED	---	NM
Old Dover Rd	Newington	200106040	SPILL/RLS, UIC RISK 8	---	22
Old Dover Rd	Newington	198404023	GW HAZ INV – RISK 8	---	23
"		NHD046312468	LUST RISK 8	---	"
"			CERCLIS –NFRAP	---	"
"			RCRA –SQG (NV)	---	"
"		NHD073962920	RCRA –SQG (NV)	---	"
"		NHD986470144	RCRA –SQG (NV)	Shipping	"
"		NHD510131295	RCRA –LQG (NV)		"
Old Dover Rd	Newington	NHD510173701	RCRA –CEG (NV)	Power Co.	24
"		NHD510167653	RCRA –SQG (NV)	Power Co.	"
"		NRC578042	ERNS – FIXED	---	"
Old Dover Rd	Newington	NHD986482552	RCRA –SQG (NV)	Building Materials	25
"			RCRA –CEG (NV)	---	"
"		NHD058542044	RCRA –SQG (NV)	---	"
"		94-319	SPILL/RLS – FIXED	Manufacturer	"
Old Dover Rd	Newington	NHD500014840	RCRA –SQG (NV)	Contractor	26
Patterson Ln	Newington	NHD500022918	RCRA –CEG (NV)		27

Table 3.18-1 (Continued)

Address	Town	NHDES Site ID #	Database	Description	Figure ID # (See Figure 3.18-1)
Patterson Ln	Newington	199001012	LUST RISK 8		28
"		199010083	LAST RISK 3		"
"			SPILL/RLS RISK 8		"
"			LUST RISK 8		"
"		NHD066754722	RCRA –LQG (NV)	---	"
"		NHD986472223	RCRA –LQG (NV)		"
"		NH2971590003	RCRA –LQG (NV)	Former Military Base	"
"			CERCLIS –NFRAP		"
"		97-68, 00-74	SPILLS-FIXED	Waste Facility	"
"		93-205, 94-316	SPILLS-FIXED	Waste Facility	"
"		D50858, 436470	ERNS- NOT FIXED	Shipyard	"
"		463225, 426369	ERNS - UNKNOWN	Shipyard	"
"		D60196,468563	ERNS - UNKNOWN	Fuel Storage	"
"		426597, D41607	ERNS - UNKNOWN	---	"
"		NRC-524078	ERNS - UNKNOWN	Former Military Base	"
"		D50085	ERNS - UNKNOWN		"
"		X51473, 184364	ERNS – FIXED	Fuel Storage	"
Newington Mall	Newington	199404004	LUST RISK 8	Retail Store	29
"			LUST RISK 8	---	"
"		NHD085582443	RCRA –SQG (NV)	Auto Shop	"
"		NHD982203655	RCRA –SQG (NV)	Tire Shop	"
"		292661	ERNS – NOT FIXED	Delivery Service	"
"		NHD982200628	RCRA –SQG (NV)		"
Newington Park	Newington	NHD073979676	RCRA –SQG (NV)	R&D Facility	30
"		NHD088584719	RCRA –SQG (NV)	---	"
Nimble Hill Road	Newington	198807012	UIC RISK NDY		31
"		NHD986472017	RCRA –CEG (NV)	Manufacturing	"
Pole No. NEL-9/B&M ROW	Newington	200106019	HAZWASTE RISK 8	Utility Pole	33
River Rd (Formerly)	Newington	199311025	LUST,RISK 8	Pool Co.	34
"		NHD043515865	RCRA –SQG (NV)	Pool Co.	"
River Rd (Formerly)	Newington	198705051	GW HAZ INV, LUST RISK 6	Energy Co.	35
"		NHD000477638	RCRA -LQG (RV)	Energy Co.	"

Table 3.18-1 (Continued)

Address	Town	NHDES Site ID #	Database	Description	Figure ID # (See Figure 3.18-1)
River Rd (Formerly) Cont'd		Several #'s	ERNS – FIXED	Energy Co.	"
"		581488, 499808	ERNS – UNKNOWN	Energy Co.	"
"		431141, D40758		---	"
"		431467, 540491	ERNS – NOT FIXED	Energy Co.	"
"		571352		Energy Co.	"
"		93-234, 94-253	SPILL/RLS – FIXED	Oil Co.	"
River Rd (Formerly)	Newington	199411029	LUST RISK 8	Remediation Contractor	36
"		NHD980521843	NH REG WASTE	Remediation Contractor	"
"			RCRA-TSD (RV)	---	"
"			RGRA-LQG (UV)	---	"
"		00-74, 93-205, 94-316	SPILL FIXED	Waste Facility	"
River Rd (Formerly)	Newington	NHD986473577	RCRA –SQG (NV)	Auto Shop	37
Spaulding Turnpike	Newington	199101004	LUST RISK 8	Former Country Store	38
Spaulding Tpke	Newington	93-455	SPILLS	Tractor Trailer Truck Spill	39
Spaulding Tpke	Newington	481427	ERNS NOT FIXED	---	NM
Spaulding Tpke	Newington	94-328	SPILL/RLS	Auto Store	NM
Spaulding Tpke	Newington	00-90	SPILL/RLS – FIXED	---	NM
Spaulding Tpke	Newington	198909005	LUST RISK 7	Service Station	43
"		NHD000003413	RCRA –CEG (NV)		"
Woodbury Ave	Newington	571332	ERNS-FIXED	Unknown	NM
Woodbury Ave	Newington	199201011	LUST RISK 7	Design Shop	45
Woodbury Ave	Newington	198905024	LUST RISK 6	Auto Dealer	46
"			UIC RISK 8	---	"
"		NHD018962621	RCRA –SQG (UV)	Auto Dealer	"
Woodbury Ave	Newington	NHD510093644	RCRA –SQG (NV)	---	47
Woodbury Ave	Newington	198706005	HAZWASTE RISK 3, LUST	Telecom Co.	48
"			UIC RISK 8	---	"
Woodbury Ave			SPILL/RLS RISK 8	---	49

Table 3.18-1 (Continued)

Address	Town	NHDES Site ID #	Database	Description	Figure ID # (See Figure 3.18-1)
Woodbury Ave Cont'd		NHD041463456	RCRA –LQG (RV)	Cable Co.	"
"		387527, H41440	ERNS – FIXED	---	"
"		387510		Fire Co.	"
"		92-31, 92-323	SPILLS-FIXED	Fire Co.	"
"		94-108		Fire Co.	"
Woodbury Ave	Newington	NHD510157340	RCRA –CEG (NV)	Retail Store	50
"		NHD500015862	RCRA –VGN (NV)	Retail Store	"
Shattuck Way	Newington	445721		Marine Terminal	51
Spaulding Turnpike	Newington	N/A	N/A	Soil Disposal Area	52
Pease Air Force Base	Newington	NHD510161391	RCRA –SQG (NV)	Former Military Base	53 - 57
"		100330113	LUST RISK 8	Former Military Base	"
"		100330126	CERCLA RISK NDY	Former Military Base	"
"		100330123	CERCLA RISK NDY	Former Military Base	"
"		NH7570024847	NPL	Former Military Base	"
"			RCRA-LQG (RV)	Former Military Base	"
"		NHD8572824847	RCRA –LQG	Former Military Base	"
"		94-317	SPILLS/RLS FIXED	Former Military Base	"
"		94-142		Former Military Base	"
"		199409078	SPILL/RLS RISK 8	Former Military Base	"
"		198404025	CERCLA RISK 2	---	"
"					

Notes:
ID #32, used to represent a cluster of sites on the Pease Tradeport in the DEIS, was replaced by Sites 53-57 in this table and on Figure 3.18-1.

NFRAP -	No Further Remedial Activity Planned
HAZWASTE -	Site has non-petroleum related contamination *(i.e,.* chlorinated solvents). This type does not indicate severity of contamination, it is only an identifier of the type of contamination.
LAST -	Leaking above ground bulk storage facilities containing motor fuel.
LUST –	Leaking underground storage tank.
MOST -	Leaking motor oil storage tank.
SPILL/RLS -	Oil spills or release.
UIC -	Underground injection control: discharges of benign wastewaters not requiring a groundwater discharge permit or request to cease a discharge *(i.e.,* floor drain closure requests).
RISK –	1=Immediate risk to human health, 2=In well head protection area or within 1000' of well, 3=Free product or high level source, 4=Surface water impact, 5=Groundwater impact no alter. water, 6= High concentration, alter. water available, 7=Low concentration, alter.water available, 8=No sources, no ambient groundwater quality standards violations onsite-remediation complete, NYD=not yet defined.
CEG-	Conditionally exempt generator.
NV -	No violations listed.
RV-	Resolved violations
TSD -	Transport, storage or disposal
ERNS -	Emergency response notification site
NM –	Not Mapped. Site is located in the study area, but the location cannot be mapped given currently available information.
VGN-	Very small quantity generator.
SQG-	Small quantity generator.
LQG –	Large quantity generator.

Table 3.18-2
Registered ASTs/USTs in the Study Area

Address	Town	Type	Facility ID	# of Tanks	Figure ID# (See Fig. 3.18-2)
Boston Harbor	Dover	UST	0111712	1	1
Dover Point Rd	Dover	UST	0112442	1	2
Wentworth Terrace	Dover	UST	0115223	0	3
Fox Run Mall	Newington	UST	0220275	0	4
Fox Run Mall	Newington	UST	0220272	0	5
Gosling Rd	Newington	UST	0220307	0	6
Gosling Rd	Newington	UST	0112801	0	7
Off Gosling Rd	Newington	AST	9712068	1	8
Gosling Rd	Newington	UST	0111448	4	9
Gosling Rd	Newington	AST	980841A	35	10
Old Dover Rd	Newington	UST	0110408	1	11
		UST	0111138	0	
Old Dover Rd	Newington	UST	0112054	0	12
Old Dover Rd	Newington	AST	0000055	20	13
Patterson Ln	Newington	UST	0111536	6	14
Patterson Ln	Newington	UST	0111136	0	15
	Newington	AST	901083A	20	
Pease Air National Guard Base	Newington	UST	0114216	1	16
Pease Air National Guard Base	Newington	AST	940978A	17	17
Shattuck Way (Formerly River Rd.)	Newington	UST	0220274	0	18
		UST	0111942	0	
		AST	870551A	32	
River Rd	Newington	AST	991222A	1	19
Shattuck Way (Formerly River Rd.)	Newington	UST	0110779	0	20
Shattuck Way (Formerly River Rd.)	Newington	AST	941129A	12	21
Nimble Hill Rd.	Newington	UST	0111470	4	22
Woodbury Ave	Newington	UST	0220273	0	23
Woodbury Ave	Newington	AST	9812055	1	24
Woodbury Ave	Newington	UST	0113896	0	25
Woodbury Ave	Newington	UST	0110535	0	26
		AST	870605A	6	

Note: Facilities with removed tanks have a value of zero.

4

Environmental Consequences

4.1 Introduction

The main objective of this Environmental Impact Statement is to describe and explain the differences among the various alternatives, especially with regard to their impact on the environment. This chapter describes the impacts associated with each of the alternatives that were carried forward for further study (Section 2.5.6).

A concise summary of the impacts presented in this chapter is provided in Section 2.5 and on **Figure 2.5-1**.

4.2 Traffic Impacts

This section describes the future traffic volume demands and summarizes the traffic operating conditions at key locations for each of the proposed alternatives. Alternatives include the No-Build condition as a base comparison, various highway widening and interchange configuration options, TSM options to accommodate limited, low-cost improvements at selected locations, and TDM measures to attempt to reduce the traffic demand on a facility. The criteria used for evaluation are described below.

4.2.1 Traffic Criteria

This section describes the procedure used to establish an appropriate design hour volume condition, describes the level of service methodology used for evaluation, and presents the procedure used to determine the basic lane requirements for the highway.

4.2.1.1 Design Hour Volumes

The first step in evaluating previously described alternatives is to establish an appropriate traffic volume condition. As described in Section 3.2.2.4, the 30th highest hour volume is used for design purposes because it is a volume level that is not exceeded very often (only 29 other hours a year), while on the other hand, it is not so high that full use of the facility would only rarely occur.

Based on the data collected at the NHDOT permanent count station located adjacent to the Little Bay Bridges in Newington, the 30th highest hour volume is approximately 9.5 percent of the average daily traffic (ADT). The Directional Design Hourly Volume (DDHV) split shows approximately 62 percent of the total hourly traffic traveling in the peak direction (*i.e.* southbound in the weekday morning peak hour and northbound in the weekday evening peak hour).

The DDHV, which is neither specifically a morning (AM) nor an afternoon/evening (PM) volume, is the design volume in the peak direction that is used to evaluate the segments of the Spaulding Turnpike and to determine lane requirements. AM and PM peak hour volumes are used to evaluate interchange and intersection movements. The use of DDHV for mainline analysis and AM and PM peak hour volumes for intersection design is in keeping with national standards.

4.2.1.2 Levels of Service

A level of service (LOS) analysis, similar to the procedure used to evaluate the existing condition (described in Chapter 3) was conducted for the corridor segments, interchanges, and intersections. Six levels of service are defined ranging in letter designation from LOS A to LOS F, with LOS A representing the best operating condition and LOS F representing the worst. LOS C describes a stable flow condition and is considered to be desirable for peak or design hour traffic flow. LOS D is generally considered acceptable where the cost and impact of making improvements to provide LOS C is deemed unjustified. Level of service E reflects traffic operations at capacity. The traffic performance measures, and the evaluation criteria used in the operational analyses, are based on the methodology presented in the 2000 Highway Capacity Manual (HCM).

For the design of new roadway facilities, the NHDOT has established LOS C as desirable and LOS D as minimally acceptable. However, despite establishing LOS D as the minimal acceptable level of service, the NHDOT has expressed a general policy of not constructing highways with more than eight basic lanes (four lanes in each direction). Therefore, for the purpose of this evaluation, the objective is to provide at least an LOS D operation in the year 2025 while constructing no more than four basic lanes in each direction.

In addition to the freeway and interchange (merge, diverge, and weave) operations, operational analyses were conducted at intersections located at or near the Turnpike interchanges for each of the Build Alternatives and for various options. For signalized intersections, level of service is based on delay in seconds experienced by motorists at an intersection. A secondary performance measure, which is not directly related to level of service, is the volume to capacity (v/c) ratio. The results of the operational analyses at signalized intersections are presented in terms of LOS, delay, and v/c ratio.

For unsignalized intersections, level of service is not defined for the intersection as a whole, but rather for each minor movement (left-turns from the major street and all movements from the minor street). Similar to signalized intersections, unsignalized intersection level of service is based on delay expressed in seconds per vehicle. However, it is important to point out that the delay thresholds for unsignalized level of service are lower than for signalized intersections. This is due to the driver expectation that signalized intersections are designed to carry higher volumes of traffic and experience greater delay than unsignalized intersections. The relationship between delay and LOS for signalized and unsignalized intersections is summarized in Table 4.2-1.

Table 4-2-1
LOS Intersection Criteria

LOS	Signalized Intersection Delay (Seconds)	Unsignalized Intersection Delay (Seconds)
A	≤10	≤10
B	>10 – 20	>10 – 15
C	>20 – 35	>15 – 25
D	>35 – 55	>25 – 35
E	>55 – 80	>35 – 50
F	>80	>50

4.2.1.3 Basic Lane Criteria

The basic lanes of a highway are the travel lanes along a facility that are needed solely to accommodate the movement of through traffic. These basic lanes serve to provide a consistent number of lanes over an extended length of highway. Basic travel lanes do not include traffic management lanes such as climbing, acceleration/deceleration, weaving, merging and auxiliary lanes, which may be needed in the vicinity of an interchange to accommodate vehicles entering and exiting the highway. However, in this particular case, it is important to point out that the proximity of the interchanges within the study area to each other and to the Little Bay Bridges creates a unique condition under the Build Alternatives where there is the need for an auxiliary lane to facilitate movements on and off the Turnpike for an extended length of freeway between Exits 3 and 6. Therefore, contrary to the traditional analysis methodology described above, the analyses to determine the number of basic lanes required for the segments on the Spaulding Turnpike between Exits 3 and 6 will include one auxiliary lane.

To determine the number of basic lanes that will be needed to accommodate traffic flow along each segment of the Spaulding Turnpike within the project area, the HCM level of service criteria was applied to the future year design hour traffic volumes.

Each segment of the Turnpike was evaluated to determine the basic lanes that would be needed to provide at least a LOS D operation during the 2025 design year.

4.2.2 Traffic Model

As previously described under Section 3.2.2.5 (Traffic Modeling), the Seacoast Regional Travel Demand Model was used to develop weekday morning and evening peak hour traffic forecasts for the years 2005 and 2025. The 2005 traffic projections were used to assess transportation system management (TSM) alternatives. The 2025 traffic projections were used to assess the No-Build Alternative and to evaluate the various Build Alternatives. The model projections used in the No-Build and Build Alternatives analyses do not reflect any potential reduction in the peak hour volume of traffic that would occur as a result of the implementation of travel demand management such as rail, transit, HOV lanes, and employer-based programs. An evaluation of these other modes of transportation and changes in travel characteristics is provided in Chapter 2 (Tables 2.4-1 to 2.4-4).

In addition, the 2025 design hour volumes for the No-Build condition represent the volume of traffic during a one-hour period without taking into account the peak spreading that currently occurs. The peak travel demand on the Turnpike actually exceeds a one-hour period resulting in more hours of congestion or "peak spreading." Expansion of the Turnpike's traffic capacity as proposed in the Build Alternatives will result in Turnpike traffic that currently travels outside the peak hour returning to the peak hour of the Turnpike. Under the 2025 Build scenarios, it is anticipated that the Turnpike will experience an inflow of volume from the hour before and the hour after the design hour as the capacity of the highway is increased with additional travel lanes. Therefore, it is anticipated that the design hour volumes on the Turnpike will be higher under the Build scenarios than under the No-Build.

It is also anticipated that 2025 design hour volumes on the Turnpike will increase as additional lanes are provided as a result of "trip diversion." Under the existing condition, some motorists choose to travel alternative routes to avoid the congestion on the Turnpike. The alternative routes include ME 236, NH 108, and NH 125. The number of motorists diverting to these alternative routes will continue to grow as congestion increases on the Turnpike under the No-Build condition, as indicated by the regional traffic model. However, with additional capacity available on the Turnpike under the Build scenario, motorists will choose to save time and travel *via* the Turnpike, reducing travel demand on alternate routes.

A comparison of 2025 No-Build to Build peak hour traffic volumes from the traffic model shows that approximately 700 vehicles per hour in the peak directional flow (southbound in the AM and northbound in the PM) will be drawn back to the Turnpike and traverse the Little Bay Bridges between Exits 3 and 6 as a result of reversing the "peak spreading" and "trip diversion" trends with the additional capacity available on the Turnpike. Whereas the project's traffic model did not track specific No-Build to Build traffic volume changes on alternative routes outside of the project study area, recent 2026 No-Build and Build model runs being performed by the RPC (for conformity purposes) were reviewed for this purpose. The RPC model runs show similar increases on the Bridges comparing No-Build to Build conditions: approximately 500 vehicles per hour southbound during the AM peak hour and 750 vehicles per hour northbound during the PM peak hour. Review of the worst case weekday evening peak hour conditions from the recent RPC model runs suggest that the alternative routes cited above would see an overall reduction of approximately 400 vehicles in the northbound direction. Under the 2026 Build condition, approximately 170 vehicles from ME 236, 150 vehicles from NH 108 and 80 vehicles from NH 125 would be drawn back to the northbound Turnpike traffic stream during the weekday peak hour condition (see Appendix N, 2026 Rockingham Planning Commission Model Output).

It is also important to note that the No-Build and Build traffic analyses were not based on the same set of land use assumptions. Although the total land use for the region was a controlled parameter in the modeling process, the land use allocation model included growth forecasts and land use assumptions (including housing, employment, and population) for the 2005 and 2025 scenerios were developed by the regional planning staff (Rockingham Planning Commission and Strafford Regional Planning Commission). The land use allocation model was re-run for each individual analysis scenerio (No-Build and Build Alternatives), which resulted in the model allocating trip "demands" while considering the available capacity of the roadway infrastructure. Nevertheless, negligible changes were observed in the land use allocation on a county level based on accessibility to and from the Turnpike.

4.2.3 No-Build Alternative

The No-Build Alternative is essentially the continuation and perpetuation of the existing safety and operational deficiencies inherent on the existing Turnpike and Little Bay Bridges. However, the No-Build Alternative will serve as a baseline condition for comparison to other alternatives.

The projected 2025 No-Build ADT, DHV and, most importantly for determining the number of lanes needed, DDHV for each segment of the Turnpike are shown in Table 4.2-2. The 2025 future morning and evening average weekday peak hour volumes for the study area interchanges and intersections are shown in **Figures 4.2-1 and 4.2-2**.

As shown in the table, the projected 2025 DDHVs range from 3,000 vehicles per hour (vph) north of Exit 6 to 5,600 vph between Exits 4 and 6. Traffic projections for the segments of the Turnpike between Exits 1 and 6 are expected to be at or exceed the capacity of the existing freeway, resulting in LOS E or F operations at different segments of the Turnpike. Therefore, the No-Build Alternative would not meet the project's Purpose and Need, and in fact would result in a substantial degradation of traffic safety and mobility. (Also see Section 3.2.)

Table 4.2-2
2025 Average Weekday and Design Hourly Volumes (No-Build)

Turnpike Segment	AADT[1]	DHV[2]	DDHV[3]	LOS[4]
Between Exits 1 and 2	65,900	6,300	3,900	E
Between Exits 2 and 3	64,700	6,200	3,800	E
Between Exits 3 and 4	88,000	8,400	5,200	F
Between Exits 4 and 5 (Little Bay Bridges)	94,300	9,000	5,600	F
Between Exits 5 and 6	94,600	9,000	5,600	F
North of Exit 6	51,600	4,900	3,000	D

Notes:
1 AADT – Average Annual Daily Traffic.
2 DHV – Design Hourly Volume.
3 DDHV – Directional Design Hourly Volume.
4 LOS – Level of Service.

The results of the freeway segment analyses indicate that, in order to provide LOS D operation in the future year 2025 and lane balance approaching the nearby toll plaza, the following number of lanes would be required along the Turnpike:

- Eight lanes (three basic lanes and one auxiliary lane in each direction between Exits 3 and 6,
- Six lanes (three basic lanes in each direction) between Exits 1 and 3 to match the existing cross-section at Exit 1, and
- Six lanes (three basic lanes in each direction) north of Exit 6 to the toll plaza.

In addition to the analyses performed for the freeway segments, ramp junction analyses were also performed for the 2025 No-Build condition. The results are summarized in **Figures 4.2-3 and 4.2-4**, as well as Table 4.2-3. The analyses results indicate that poor operating conditions (LOS F) are expected at the on and off-ramps at Exits 3, 4, 5, and 6 by the year 2025.

In summary, under the 2025 No-Build condition, delays and congestion currently experienced along the Spaulding Turnpike and at the Exit 3, 4, 5 and 6 Interchanges will worsen during the peak hours. In addition, congestion will expand to longer periods of the day and to a greater number of days during the year. As such, the No-Build Alternative does not satisfy the project's Purpose and Need.

4.2.4 Build Alternatives

4.2.4.1 Freeway Segment Operations

Preliminary screening of traffic operations on the Little Bay Bridges (previously discussed in Section 2.5) determined that 4 lanes in each direction (3 basic travel lanes and 1 auxiliary lane) are required on the Spaulding Turnpike between Exits 3

Table 4.2-3
2025 No-Build – Ramp Junctions Analysis Summary

Interchange Movement	Node[1]	Weekday Time Period	LOS[2]
Exit 2			
NB off-ramp	2A	AM Peak Hour	B
NB on-ramp	2B		B
NB off-ramp	2A	PM Peak Hour	D
NB on-ramp	2B		D
Exit 3			
NB on-ramp	3A	AM Peak Hour	B
SB off-ramp	3C		F
NB on-ramp	3A	PM Peak Hour	F
SB off-ramp	3C		D
Exit 4			
NB 4 off-ramp			
NB Shattuck Way on-ramp	4B	AM Peak Hour	C
SB Nimble Hill Rd on-ramp	4C		B
SB Nimble Hill Rd off-ramp	4E		F
	4F		F
NB 4 off-ramp	4B	PM Peak Hour	F
NB Shattuck Way on-ramp	4C		F
SB Nimble Hill Rd on-ramp	4E		C
SB Nimble Hill Rd off-ramp	4F		D
Exit 5			
NB on-ramp	5B	AM Peak Hour	B
NB off-ramp	5A		B
NB on-ramp	5B	PM Peak Hour	F
NB off-ramp	5A		F
Exit 6			
NB (Cote Drive) on-ramp	6A	AM Peak Hour	C
NB 6N off-ramp	6B		C
NB 6W off-ramp	6C		B
SB Spur Rd off-ramp	6D		C
NB (Cote Drive) on-ramp	6A	PM Peak Hour	F
NB 6N off-ramp	6B		F
NB 6W off-ramp	6C		F
SB Spur Rd off-ramp	6D		B

Notes:
1 See **Figures 4.2-3 and 4.2-4**.
2 Level of Service

and 6 to provide LOS D traffic operations for the year 2025. Three basic lanes in each direction are required to achieve acceptable levels of service for the segments of the Turnpike between Exits 1 and 3. North of Exit 6, south of the Dover Toll Plaza, only two basic travel lanes in each direction are required to maintain LOS D traffic operations; however, three lanes are required to provide lane balance between Exit 6 and the nearby toll plaza. Table 4.2-4 summarizes the recommended number of lanes for each segment of the Turnpike.

Table 4.2-4
2025 Build Freeway Segment Analysis Summary

Turnpike Segment	DDHV[1]	Number of Lanes in each Direction	LOS[2]
Between Exits 1 and 3	3,900	3	D
Between Exits 3 and 4	5,200	4	D
Between Exits 4 and 6 (Little Bay Bridges)	5,600	4	D
North of Exit 6	3,000	3[3]	C

Notes:
1 DDHV – Directional Design Hourly Volume.
2 LOS – Level of Service.
3 Minimum LOS D requires two lanes in each direction. However, three lanes in each direction are required to maintain lane balance between Exit 6 and the Dover Toll Plaza.

4.2.4.2 Interchange Operations

In addition to the freeway segment evaluation, level of service analyses were conducted for the ramp and intersection movements at each of the interchange options (Alternatives 2 and 3 in Dover and Alternatives 10A, 12A, and 13 in Newington) considered under the Build Alternatives. The ramp, signalized intersection, and unsignalized intersection analyses for these various interchange configurations are summarized in Tables 4.2-5, 4.2-6, and 4.2-7.

As shown in Table 4.2-5, all on and off-ramps associated with the various interchange configurations are projected to operate at LOS C or better through the year 2025. Some ramp junctions could not be analyzed based on the HCM methodology. For example, under all three Build options for Exit 3 (Alternatives 10A, 12A, and 13), three basic lanes are proposed on the Turnpike northbound approaching Exit 3. The northbound on-ramp at Exit 3 runs parallel to the main line and becomes the fourth lane (auxiliary lane) on the highway. Under this condition, there is no ramp junction (merge) to analyze; instead, there is a free flow condition. Similar conditions will exist at the Exit 6 northbound and southbound on-ramps under both Alternatives 2 and 3.

Table 4.2-6 summarizes the analysis of all of the proposed signalized intersections associated with the Build Alternatives. All signalized intersections are expected to operate at LOS C or better through the year 2025.

Table 4.2-5
Interchange (Ramp Junction) Analysis Summary – 2025 Build Alternatives

Interchange	Level of Service			
	Alternative 10A & 12A		Alternative 13	
Exit 3	**AM**	**PM**	**AM**	**PM**
NB off-ramp	B	C	B	C
NB on-ramp	NA	NA	NA	NA
SB off-ramp	C	B	NA	NA
SB on-ramp	C	B	C	A
	Alternative 10A & 12A		**Alternative 13**	
Exit 4	**AM**	**PM**	**AM**	**PM**
NB off-ramp	B	C	B	C
NB on-ramp	A	C	A	C
SB off-ramp	C	B	C	B
SB on-ramp	NA	NA	NA	NA
	Alternative 2		**Alternative 3**	
Exit 6	**AM**	**PM**	**AM**	**PM**
NB off-ramp	A	B	A	B
NB on-ramp	NA	NA	NA	NA
SB off-ramp	C	B	C	B
SB on-ramp	NA	NA	NA	NA

NA = Not Applicable

Table 4.2-6
Signalized Intersection Analysis Summary – 2025 Build Alternatives

		Alternatives 10A & 12A			Alternative 13		
	Period	v/c[1]	Delay[2]	LOS[3]	v/c	Delay	LOS
Exit 3							
Woodbury Avenue at NB Ramps	AM Peak	0.38	6	A	0.36	8	A
	PM Peak	0.50	11	B	0.46	14	B
Woodbury Avenue at SB Ramps	AM Peak	0.42	13	B	0.69	17	B
	PM Peak	0.45	12	B	0.81	35	C
Woodbury Avenue at Local Traffic Connector	AM Peak	0.37	14	B	NA	NA	NA
	PM Peak	0.40	16	B	NA	NA	NA
		Alternative 2			**Alternative 3**		
Exit 6							
US 4 at NB Ramps	AM Peak	0.66	17	B	0.74	15	B
	PM Peak	0.80	21	C	0.80	21	C
US 4 at SB Ramps	AM Peak	0.56	6	A	0.60	15	B
	PM Peak	0.50	3	A	0.50	4	A
US 4 at Boston Harbor Road/Spur Road	AM Peak	0.63	14	B	NA	NA	NA
	PM Peak	0.65	11	B	NA	NA	NA
US 4 at Dover Point Road[4]	AM Peak	0.40	3	A	0.43	4	A
	PM Peak	0.49	3	A	0.49	3	A

NA = Not Applicable.
1 Volume to capacity ratio.
2 Average delay per vehicle in seconds.
3 Intersection level of service.
4 Traffic signal control recommended based on systems analysis and safety conditions; minimum volume signal warrants are not met.

Table 4.2-7 summarizes the analysis results for the major proposed unsignalized intersections associated with the Build Alternatives. The unsignalized intersections shown in the table include Shattuck Way at the Exit 4 northbound ramps, Nimble Hill Road at Shattuck Way/local connector road, US 4 at Spur Road/Boston Harbor Road, Spur Road at the local connector road, and Boston Harbor Road at the local connector road. The analysis results indicate that left-turns from the major streets (mainline traffic) are projected to operate at LOS A during the weekday morning and evening peak hours through the year 2025. Vehicles exiting from the minor (side) streets are projected to operate at LOS D or better at all locations, with the exception of vehicles exiting from Shattuck Way and the local connector road at Nimble Hill Road during the evening peak hour.

Under Alternatives 10A and 12A, vehicles exiting from the local connector road are expected to operate at LOS F with long delays and vehicles exiting from Shattuck Way are expected to operate at LOS E. Under Alternative 13, these levels of service improve to LOS E for the local connector road and LOS D for Shattuck Way with only moderate delays. These types of delay are common during the peak hour conditions for minor streets and driveways intersecting major roadways, and do not necessarily indicate that additional roadway or traffic control improvements are required. Additionally, it is important to note that none of the unsignalized intersections evaluated herein meet the Manual on Uniform Traffic Control Devices (MUTCD) minimum volume criteria for traffic signal installation.

Conduit for future signalization at the Nimble Hill Road/Shattuck Way/Local Road has been installed as part of the Interim Safety Improvement Project in Newington. Should traffic volumes increase due to additional development beyond 2025 travel demand and meet the traffic signal warrants for signal installation, traffic signals at the intersection will be installed.

Under Alternative 3, turning movements from Boston Harbor Road and from Spur Road are restricted to right turns and will operate at LOS C or better under both 2025 AM and PM peak hour conditions. The intersections of Spur Road and Boston Harbor Road with the local connector road will allow full access/egress. All movements at these two unsignalized intersections are projected to operate at LOS A.

4.2.4.3 Improved Safety

Section 3.2.4, Geometric Deficiencies, details the substandard physical conditions that currently exist along the corridor, including substandard shoulders, deficient weave distances, and inadequate acceleration and deceleration lengths at interchanges. These physical deficiencies, coupled with traffic volumes exceeding the capacity of the existing Turnpike compromise the overall safety of the roadway system. Studies[68, 69] of

68 "Safety Effects Resulting from Approval of the National Highway System," Bellomo-McGee, Inc. for the AAA Foundation for Traffic Safety, June 1995.
69 "Effects of Highway Standards on Safety", H.W. McGee, W.E. Hughes, K. Daily, NCHRP Report 374, 1995.

Table 4.2-7
Unsignalized Intersection Analysis Summary – 2025 Build Alternatives

		Alternatives 10A & 12A			Alternative 13		
Exit 4	Period	Demand[1]	Delay[2]	LOS[3]	Demand	Delay	LOS
Shattuck Way at NB Ramps							
Left from Shattuck Way NB	AM Peak	5	1	A	5	1	A
Left from NB Off-ramp		100	11	B	115	12	B
Right from NB Off-ramp		120	11	B	120	12	B
Left from Shattuck Way NB	PM Peak	85	6	A	85	4	A
Left from NB Off-ramp		60	12	B	140	15	C
Right from NB Off-ramp		5	12	B	5	15	C
Nimble Hill Rd at Shattuck Way/Local Connector Road							
Left from Nimble Hill Road EB	AM Peak	110	9	A	110	8	A
Left from Nimble Hill Road WB		150	8	A	20	7	A
All movements Local Connector Road		35	35	D	40	15	B
Left/through from Shattuck Way		50	30	D	50	19	C
Right from Shattuck Way		85	11	B	110	11	B
Left from Nimble Hill Road EB	PM Peak	305	9	A	290	9	A
Left from Nimble Hill Road WB		120	8	A	15	7	A
All movements Local Connector Road		155	435	F	50	49	E
Left/through from Shattuck Way		20	40	E	35	30	D
Right from Shattuck Way		80	10	B	210	11	B

		Alternative 3		
Exit 6	Period	Demand	Delay	LOS
US 4 at Spur Road/Boston Harbor Road				
Right from Spur Road	AM Peak	30	11	B
Right from Boston Harbor Road		35	18	C
Right from Spur Road	PM Peak	35	19	C
Right from Boston Harbor Road		40	14	B
Spur Road at Local Connector Road				
Left from Spur Road	AM Peak	115	6	A
All movements from Local Connector Road		45	9	A
Left from Spur Road	PM Peak	40	5	A
All movements from Local Connector Road		40	10	A
Boston Harbor Road at Local Road				
Left from Boston Harbor Road	AM Peak	50	4	A
All movements from Local Connector Road		100	10	A
Left from Boston Harbor Road	PM Peak	30	3	A
All movements from Local Connector Road		115	10	A

NA = Not Applicable.
1 Demand indicates number of vehicles making movement.
2 Average delay per vehicle in seconds.
3 Level of service.

highway safety indicate that improvements such as increasing freeway shoulder width to a minimum of eight feet will reduce accidents. The Selected Alternative meets present day AASHTO and NHDOT design criteria, which will eliminate all of the existing physical deficiencies. As a result, the Spaulding Turnpike will become a safer roadway with fewer accidents. Review of crash statistics indicates that crashes increase with increasing average daily traffic volumes, and those roads with recurrent congestion experience higher crash rates compared to roads that infrequently experience congested flow conditions. In this regard, the incidence of crashes on the Turnpike within the study area over the 1997-2003 time period has increased an average of 14 percent annually, while traffic growth during the same seven-year period has increased by only 2.3 percent per year. As traffic demands continue to grow on the Turnpike, safety will continue to deteriorate under the No-Build Alternative. As proposed, the Selected Alternative will accommodate future year 2025 traffic volume demands and improve traffic operations from LOS E-F under the No-Build condition to LOS C-D. As such, the Selected Alternative will improve overall safety conditions along the Turnpike.

4.2.5 Transportation Systems Management (TSM)

Transportation Systems Management (TSM) refers to short range and relative low-cost measures that are aimed at reducing congestion and improving safety on the existing transportation system or roadway network. As described in Section 2.4.2, a number of possible actions were developed for consideration and some of these have been implemented:

- Signage to reinforce the safety importance of not changing lanes on the Little Bay Bridges and their approaches has been implemented.

- Better directional signage to improve northbound drivers' recognition of the Exit 6N and 6W off-ramps has been implemented.

- Extension of the northbound Exit 6W deceleration lane by approximately 400 feet to prevent weekday evening peak hour exiting traffic from queuing back onto the northbound through lane was implemented in June 2005.

- The Interim Safety Improvements in Newington address existing safety deficiencies resulting from substandard weaving conditions, substandard acceleration and deceleration lanes and poor access management in the vicinity of Exits 3, 4 and 4N. Construction of these improvements was initiated in 2005 and completed in 2006.

- At Exit 6 in Dover, reconfiguration of the two-lane southbound on-ramp to a single lane prior to the merge with the Turnpike mainline will improve the traffic operation at this location. Drivers will find it safer and easier to be in the proper lane (either inside or outside) when planning to Exit at Nimble Hill Road (Exit 4) or at Woodbury Avenue (Exit 3). Reconfiguration is scheduled for 2008.

- At Exit 3 in Newington, following the implementation of the Interim Safety Improvements, the existing southbound deceleration lane to Woodbury Avenue can be lengthened to improve safety and traffic operations.

These TSM actions will provide measurable short-term relief, but would not address the long-term safety and capacity needs of the Turnpike and study area.

4.2.6 Travel Demand Management (TDM)

Travel 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. TDM measures typically provide means by which commuters (and travelers) can reach destinations utilizing alternatives to the single occupant motor vehicles. TDM measures include consideration of infrastructure investments to provide and expand alternative modes of transportation, such as HOV lanes, park-and-ride facilities, bicycle facilities, bus services and rail service.

Section 2.4.3, Travel Demand Management, and Section 2.4.4, Mode Alternatives, describe various strategies that were considered. The collective impact of combining a number of these strategies does not eliminate the need to widen the Turnpike and Little Bay Bridges between Exits 3 and 6. However, a number of TDM strategies and actions are proposed to complement the infrastructure improvements, which will benefit commuters and travelers during the construction period and will provide opportunities to utilize modes of travel other than SOV. They are as follows:

- Park-and-ride facilities, which will support existing and expanded transit service and employer-based TDM strategies, are proposed for the Exit 9 area in Dover, the Exit 13 area in Rochester and the US 4/NH 125 intersection area in Lee.

- Intercity bus service between Dover, Portsmouth and Boston, MA, is proposed to be expanded north to Dover to the proposed Exit 9 park-and-ride lot, and further north to Rochester to the proposed Exit 13 park-and-ride lot.

- Express bus service between Rochester and Portsmouth, scheduled for 2008, is proposed to be expanded to provide reduced peak period headways.

- Local bus service between Rochester and Portsmouth, and between Durham and Portsmouth is proposed to be expanded to provide reduced peak period headways and a better transfer connection in the vicinity of Exit 1.

- Expansion of the *Downeaster* rail service to provide a fifth daily roundtrip between Portland and Boston, and improve the commuter peak period service, was implemented in August 2007.

- Funding to extend the services of Seacoast Commuter Options, the greater Portsmouth and seacoast area TMA, for a maximum period of five years is proposed to mitigate the effects of construction on travelers through the area. Seacoast Commuter Options aggressively promotes employer-based measures to encourage travel other than by SOV.

4.3 Socio-Economic Resources

This section examines impacts relating to proposed improvements identified for the Spaulding Turnpike on social and economic resources within the study area (**Figure 1.2-2**). The analysis evaluates possible impacts within three different categories that are briefly defined below.[70]

- **Direct effects** are caused by the action and occur at the same time and place.

- **Indirect effects** are caused by the action and are later in time or further removed in distance, but are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

- **Cumulative impacts** are the impacts on the environment, which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of which agency (Federal or non-Federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively substantial actions taking place over a period of time.

In addition to an evaluation of possible direct, indirect and cumulative impacts, this section also contains a brief summary of major findings relating to social and economic trends in the identified socio-economic study area. This summary is included in order to provide supporting information and context for examining possible indirect and cumulative impacts.

70 The following descriptive definitions are based on a Memorandum titled "Interim Guidance: Questions and Answers Regarding the Consideration of Indirect and Cumulative Impacts in the NEPA Process." (Federal Highway Administration, January 31, 2003).

4.3.1 Social and Economic Trends[71]

It has been widely acknowledged that large projects, such as roadway improvements, can influence both regional and local development patterns. However, the type and intensity of future developments is also strongly linked to existing social and economic trends. The socio-economic study area (**Figure 1.3-1**) for this project has both regional and local components. The broader regional study area includes 33 municipalities within Strafford, Carroll and Rockingham Counties in the southeast portion of New Hampshire. It should be noted that although two communities, Brookfield and Wakefield, were not directly included in the analysis prepared with the economic model (REMI), both communities would most likely be impacted in a manner similar to communities in northern Strafford County, which were included in the analysis. The more localized project area includes portions of the Town of Newington and the City of Dover that border the 3.5-mile section of the Spaulding Turnpike being evaluated for upgrading.

4.3.2 Direct Effects

4.3.2.1 Property Acquisition

This section identifies the type and location of properties that may need to be acquired or relocated as a result of each of the Build Alternatives. These estimates are considered to represent a determination of potential acquisitions and relocations that may ultimately change following input at the Public Hearing and once final engineering design for the project has been completed and a required right-of-way layout has been approved.

Overall, the assessment of project alternatives indicates that only two to three properties (*i.e.* residences or businesses) may need to be acquired, depending on the combination of project alternatives selected (see Table 4.3-1). Along with specific properties identified for acquisition, partial takings of land necessitated by slope impacts have also been estimated. These estimates may also be revised once a final right-of-way boundary has been determined following input from the Public Hearing.

Alternative 10A

The construction of Alternative 10A is expected to result in the acquisition of a single residential property located on Shattuck Way in Newington. According to municipal

71 Much of the information presented in this subsection in the DEIS has been moved to subsection 4.3.4.1 of this FEIS to provide a clearer explanation of the trends affecting cumulative impacts.

assessment records, this residence is a duplex structure on 0.4 acres of land. No businesses are expected to be acquired or relocated as a result of this alternative. It is also anticipated that this alternative will require partial land acquisitions for new or widened rights-of-way that will total approximately 41 acres, which includes roughly 29 acres of land located within the Pease International Tradeport with the remaining 12 acres being privately owned.

Table 4.3-1
Estimated Property Acquisitions and Municipal Tax Impacts[1]

	Roadway Alternatives					Bridge Alternatives	
	Newington			Dover		Widen West	
	Alt 10A	Alt 12A	Alt 13	Alt 2	Alt 3	Rehab GSB	Remove GSB
Property Acquisition							
Structures							
Residential	1	0	0	0	0	0	0
Businesses	0	0	0	2	2	0	0
Land (Acres)							
Full Parcels	0.4	0	0	2.5	2.5	0	0
Partial Parcels[2]	41	43	42	1	1.5	0	0
Total acres	41.4	43	42	3.5	4.0	0	0
Municipal Tax Impacts							
Removed Taxable Value							
Buildings	$52,700	$0	$0	$366,800	$366,800	$0	$0
Land	$2,021,930	$2,240,000	$960,000	$745,900	$830,900	$0	$0
Total	$2,074,630	$2,240,000	$960,000	$1,112,700	$1,197,700	$0	$0
Estimated Reduction in Municipal Tax Revenues	$19,336[3]	$20,877[3]	$8,951[3]	$20,229[4]	$21,774[4]	$0	$0

Notes:
1 Data is from Assessor's Records 2004, Dover and Newington; VHB, Inc.; and RKG Associates, Inc.
2 The acreages reported in this table are based on preliminary estimates of the property acquisitions. The majority of the estimated partial takings involve land at the Pease Tradeport which is tax exempt and therefore, results in no reduction in municipal tax revenues.
3 The total 2004 municipal tax revenue commitment to the Town of Newington was $6.1 million on a total valuation of $781 million.
4 The total 2004 municipal tax revenue commitment to the City of Dover was $43.7 million on a total valuation of $2.4 billion.

Alternative 12A

This alternative will not require the acquisition or relocation of any residences or businesses. Partial land acquisitions due to new right-of-way construction, or widening of existing corridors, are estimated at about 43 acres. Approximately 29 acres of this total acquisition is located at the Pease International Tradeport, with an estimated 14 acres of privately owned property.

Alternative 13

This alternative will not require the acquisition or relocation of any residences or businesses. Land impacts from Alternative 13 will require the acquisition of approximately 42 acres, 36 of which are located within the Pease Tradeport with the remaining six acres being privately owned land.

Alternative 2

The construction of Alternative 2 is expected to necessitate the acquisition of two Dover businesses located in the commercial district on Dover Point Road. One of the businesses is a retail establishment and one is a service business (dog daycare) that is a home-based establishment, which includes a single family home, barn and yard space for kennels. The acquisition of only the barn and a portion of the lot are anticipated at this time. Both businesses are located on parcels of approximately 1¼ acre in size. Additional partial land acquisitions of approximately one acre may be necessary for roadway slope impacts at various locations.

Alternative 3

Property acquisitions for this alternative are expected to be the same as those identified for Alternative 2. Partial land acquisitions of approximately 1.5 acres may also be necessary for slope impacts related to roadway construction.

4.3.2.2 Municipal Tax Impacts

Estimated impacts on municipal taxes are based on the removal of taxable properties from the local tax base, resulting from property acquisitions related to project alternatives, and the corresponding decrease in local property tax revenues. These types of direct impacts will occur only in the City of Dover and the Town of Newington where actual project construction would take place. The estimated property tax impacts are based on the assessment of property acquisition described in the previous section. The values of acquired properties that are expected to be a complete taking, as opposed to only a partial taking of land, are based on municipal assessment records as of 2004. For partial land acquisition related to roadway widening, the actual assessed value per acre has been applied although the ultimate value of such acquisitions could vary greatly depending on the characteristics of the property and the amount of land acquired. The estimated acreage to be acquired was calculated using Geographic Information System software in conjunction with digital data layers for both the project alternatives and land parcels in the project area. Average land values for partial land acquisition in the Newington portion of the project are established at approximately $160,000 per acre and $170,000 per acre in Dover. A summary of municipal property tax impacts is presented in Table 4.3-1. It should be noted that in a few instances where an entire parcel is expected to be acquired, the total local assessed valuation costs in Table 4.3.-1 do not represent an average per acre cost for the total cost identified for acquisition.

As noted in the previous section on property acquisitions, a portion of the estimated land area required for roadway construction is located within the Pease International Tradeport. This land is owned by the state under an agreement with the Federal

Aviation Administration and not subject to a local property tax levy. Therefore, no municipal property tax impacts have been assessed for the potential acquisition of this property in the Town of Newington, only for the privately owned land identified for possible acquisition.

Alternative 10A

The construction of Alternative 10A is expected to result in the acquisition of a single residential property (a duplex) and approximately 12 acres of privately owned land in the Town of Newington. The estimated assessed value of this property is approximately $2.07 million, as illustrated in Table 4.3-1, which would reduce future annual property taxes by just over $19,300 for the town. This reduction represents less than one half percent of total property tax revenues raised by the Town in 2004.

Alternative 12A

The only property acquisitions anticipated for this alternative are partial land acquisitions associated with roadway widening at various locations. It is estimated that such acquisitions will affect 14 acres of privately owned land with an approximate assessed value of $2.24 million. This would result in reduced annual property tax revenues of approximately $20,880 for the Town of Newington, which represents less than one half percent of the total property tax revenues raised by the Town in 2004.

Alternative 13

Anticipated property acquisitions for this alternative are comparable to those discussed for Alternative 10A. However, the estimated acreage of privately owned land acquired for this alternative is reduced from 12 to 6 acres. The assessed value of acquired property is approximately $960,000 which would result in a reduction of property taxes for Newington of approximately $8,951 annually, which represents approximately 0.15 percent of the total property tax revenues raised by the Town in 2004.

Alternative 2

As noted in the previous section, Alternative 2 is expected to require the acquisition of two businesses, as well as partial acquisitions of land at various locations in Dover. These properties have an estimated assessed value of $1,112,700, which would result in decreased future property tax revenues for the City of approximately $20,229 annually. This decrease represents less than one percent of the amount raised in property taxes by the City in 2004, which represents less than one tenth of a percent of the total property tax revenues raised by the City in 2004.

Alternative 3

The estimated municipal tax impacts of this alternative are essentially identical to those of Alternative 2. The acquired properties have an estimated assessed value of

$1,197,700, which would result in reduced annual property taxes of approximately $21,774, which represents less than one tenth of a percent of the total property tax revenues raised by the City in 2004.

4.3.3 Indirect/Secondary Effects

Considerable research has been conducted over the years in order to evaluate the possible effects that transportation improvements have on future land uses. A review of literature devoted to this issue indicates a majority of analysts agree that investments in highway infrastructure do impact land use within a specific area of upgraded highway facilities. However, the potential impacts can vary greatly depending on the type and function of the existing roadway being evaluated, the type of improvements being proposed, and existing land use characteristics (such as school, local roads, employment base, *etc.*) in the affected area. With regard to the last item, affected area, there is often both a local impact area, which would include properties that have direct or generally immediate access to the transportation improvements, as well as a regional impact area, where the effects are more dispersed within broadly defined boundaries. This dual nature of local and regional impact areas is considered relevant for the proposed Spaulding Turnpike improvements since it is a regional highway facility that also serves an important localized function with regard to access in the project study area in the Town of Newington and the City of Dover.

4.3.3.1 Project Area

Land Uses

All of the proposed project alternatives are designed to upgrade the ability of the Spaulding Turnpike to accommodate regional through traffic, while also reconfiguring local access points to and from the portions of the roadway within Newington and Dover. This section addresses the more localized impacts related to possible changes in land use that may occur in the project area that encompasses portions of these two communities. Other regional land use impacts are discussed in the next section and are based on the output generated by an economic forecasting and policy analysis model.

<u>Alternative 10A</u>

This alternative includes a new network of proposed connector roadways that would link Woodbury Avenue and Shattuck Way, which are located on the east side of the Turnpike, with Arboretum Drive on the west side. The network of proposed connector roadways on the west side of the Turnpike would be located on land that is part of the Pease International Tradeport and subject to the control of the PDA. There are approximately 57 acres of land at Pease bounded by Arboretum Drive, Railway Brook, Pickering Brook, and the Turnpike that would be directly affected, in terms of improved access, due to the new connector roadways. However, the zoning for this area is designated as Natural Resource Protection under PDA's regulations, which limits the types of development that can occur there to uses such as natural resource management (*e.g.* tree farms, wildlife preservation), public utilities, communications facilities, access roads and rail related activities. Therefore, the potential for possible future growth in this area related to the proposed highway construction is limited to these relatively low intensity types of land uses.

These connector roads would also provide an additional means of ingress and egress for the Tradeport that would improve access to the northern section of this facility, where existing roadway approaches are presently limited solely to Arboretum Drive. This portion of the Tradeport, which is adjacent to the airfield's north apron area containing approximately 100 acres zoned for Airport Industrial uses, has experienced limited development. Part of the reason for the lack of development in this area is that the Airport zoning district restricts uses to those that are related to the aviation industry, which has not been a strong growth sector in the region. Improved access to this zoning district could provide an additional incentive for prospective businesses that require proximity to apron/runway facilities to consider the Tradeport during a site selection process. However, improved access is only one factor in attracting future development to this location given that the area is zoned for aviation and this industry has very specialized needs with regard to site development standards and employment.

In addition to the land within the confines of the Tradeport, there is also a 16 acre privately-owned parcel located within the perimeter of proposed connector roads described above. This parcel may be affected, with regard to access, as a result of the improvements. This undeveloped parcel (Newington Assessor's map/lot 12-13), formerly a drive-in theater, has frontage on the Turnpike with access available to the site as right-in/right-out turning movements onto the Turnpike requiring a high speed merge to access or egress the site. The property is zoned for office uses under the Town of Newington's zoning ordinance. Since the Turnpike is proposed to have a limited access right-of-way, a new access point to this property from the proposed connector roadways is part of this alternative. This change will likely make the site more appealing from a development perspective since it would be safer and easier to reach the site from either the northbound or southbound approaches on the Turnpike. This alternative would also require the acquisition of approximately six acres of this parcel in order to construct the new Exit 3 southbound off-ramp, which would reduce the total amount of development that could potentially occur on the property.

Alternative 12A

With the exception of the location of the connector road linking Shattuck Way with Arboretum Drive, this alternative involves relatively the same configuration as proposed in Alternative 10A. Therefore, the anticipated land use impacts are expected to be the same as discussed in the preceding section.

Alternative 13

From a land use perspective, the configuration of Alternative 13 varies from 10A and 12A primarily in that it does not have a connector road linking Shattuck Way with Arboretum Drive and Nimble Hill Road. Instead, this alternative relies solely on the existing underpass north of Exit 4 to provide this access. A connection is also maintained between Woodbury Avenue and Arboretum Drive as part of Exit 3, which also provides access into the northern portion of the Tradeport. The potential impacts would not be expected to differ substantially from Alternatives 10A or 12A despite the elimination of the connection between Shattuck Way and Arboretum Drive. One notable difference, however, is the fact that this alternative will require a small triangular acquisition of a portion of the former drive-in theater property. Additionally, the parcel will no longer have direct access to the Turnpike. Rather, it would be accessed by a new town roadway, which could be constructed in the future along the abandoned southbound barrel of the Turnpike. .

Alternative 2

From a land use perspective, this alternative is not expected to have any substantial localized impacts on future development patterns in the Dover Point area. Existing development in the area, as well as the overlying zoning district, is predominantly residential in nature with the exception of a small business zone located between the Turnpike and the southern end of Dover Point Road. It is estimated that, with the exception of approximately 25 acres, all the land in this portion of the study area is essentially built-out at this time. The proposed reconfiguration of the existing access points to and from the Turnpike represents fairly minor changes and therefore, would not be expected to affect future land use patterns.

Alternative 3

The configuration of proposed Alternative 3 varies relatively little from that of Alternative 2. Given this fact, the potential localized impacts to future land use in the Dover Point area are expected to be essentially the same as those discussed under Alternative 2 above.

Bridge Alternatives

Neither of the proposed bridge alternatives is expected to have any localized land use impacts within the study area.

Businesses

The results of the economic model, which are discussed later, provide a regional perspective about economic and social changes that may result from implementation of the various project alternatives. However, there may be some minor localized impacts, due to changes in roadway configurations that could affect visibility and access presently available to one business located in the project area. Changes in access or visibility (*i.e.,* how well potential customers can see, or how easily they can get to a business, while traveling on the normal commercial roadway corridors) will affect certain types of businesses more than others. Research conducted concerning impacts on businesses due to highway improvements has identified certain types of businesses as being more traffic-dependent than others. Traffic-dependent businesses tend to rely on pass-by traffic (*i.e.,* traffic passing by or near the frontage of the business) for a substantial portion of their revenues. Businesses that are less reliant on pass-by traffic tend to be destination businesses that will draw customers to the area whether or not they have good visibility or direct access. Generally speaking, retail-oriented businesses are considered to be more traffic-dependent than non-retail businesses. And within the retail sector, businesses such as restaurants, hotels, gas stations, and convenience stores, are considered to be the most dependent on pass-by traffic.

Alternative 10A

Several changes would occur in the existing configuration of access points between the Spaulding Turnpike and the local roadway network within the commercial and industrial areas of Newington, as a result of this alternative. Overall, these changes are not expected to have any negative impacts on area businesses since no existing access points are eliminated, only reconfigured.

The two most substantial changes in access, from a business impact standpoint, resulting from this alternative are the reconfiguration of the exits from the Turnpike to Woodbury Avenue and Nimble Hill Road. Woodbury Avenue is a major retail corridor in the Town of Newington and also provides access to the town’s industrial waterfront area. This corridor and its adjacent land area form a regional shopping area that contains in excess of 2.8 million square feet of existing commercial and industrial development. It constitutes a major hub of retail sales and employment that is not expected to be adversely affected by the proposed Exit reconfiguration.

Nimble Hill Road is the corridor that provides access to Newington’s town center area and also has a small concentration of office and commercial uses near the existing Exit to the Turnpike. The reconfiguration of this Exit proposed by this alternative would not be expected to adversely affect most of the businesses in this office district area since the types of uses located here are generally not considered to be traffic-dependent. The only exception to this is the gas station/convenience store located at the intersection of Nimble Hill Road and the southbound lanes of the Turnpike. This establishment currently has direct access to and from the Turnpike. The proposed alternative would maintain the southbound Exit from the Turnpike at Exit 4, but require a more circuitous route to return to the Turnpike *via* a new connector road to Exit 3. Since gas stations tend to be more reliant on pass-by traffic for a greater percentage of their revenues, the proposed change in travel patterns could result in reduced revenues for this business. However, maintaining the southbound Exit at Nimble Hill Road will help to minimize potentially greater impacts that might otherwise be expected to occur if this access point was totally eliminated.

Alternative 12A

The potential impacts to businesses associated with this alternative would not be expected to vary in any substantial way from those discussed under Alternative 10A.

Alternative 13

Alternative 13 would be expected to have essentially the same potential impacts to area businesses as those described for Alternative 10A. The only notable difference is related to the gas station/convenience store located at Nimble Hill Road and Exit 4. Alternative 13 eliminates direct access to the Turnpike. However, this alternative maintains access to the southbound on and off ramps *via* a newly constructed access road adjacent to and south of the ExxonMobil facility. Therefore, there would be no anticipated negative impacts for this business related to changes in travel patterns, as discussed under Alternative 10A above.

Alternative 2

The Dover Point portion of the project area contains approximately seven commercial establishments with an estimated 30,000 square feet of building space. Generally, these businesses are not classified as traffic-dependent in that they do not rely on pass-by traffic for a substantial percentage of their sales. Although there is a restaurant located on Dover Point Road, which is typically classified as traffic-dependent, its current visibility or access will not be affected by the proposed alternative. In fact, the proposed alternative's reconfiguration of Exit ramps and other connecting roadways are not expected to have any localized secondary impacts to businesses located in this portion of the project area.

Alternative 3

The differences in configuration between Alternatives 2 and 3 are inconsequential with regard to potential impacts on area businesses. Therefore, as noted in the previous section, no localized secondary impacts are expected to businesses in this portion of the project area.

Bridge Alternatives

No localized secondary impacts to area businesses are anticipated as a result of either proposed bridge alternative.

Neighborhoods

The impacts related to neighborhood cohesion refer to the potential impacts that can occur when discrete residential areas are bisected, or otherwise divided, by roadway improvements. Disruption of neighborhood cohesion is essentially the result of establishing a "barrier," which is represented by the roadway that disrupts the historical "links" of interaction within the neighborhood.

Residential neighborhoods within the project area potentially affected by the proposed alternatives are found in two primary locations. The first is the Dover Point area of Dover that has two neighborhood areas, with approximately 480 housing units, located on both sides of the existing Turnpike corridor. This includes the Spur Road residential neighborhood. The second is a smaller enclave of approximately 15 houses located on Patterson Lane that is encompassed by the waterfront industrial development along the Piscataqua River in Newington.

Alternative 10A

The Spaulding Turnpike presently represents a barrier that bisects the Town of Newington into two distinct areas requiring residents of the community to merge onto a high-speed roadway in order to cross from one side to the other. This alternative will eliminate this merging maneuver and is generally expected to have an overall positive impact on area neighborhoods since it would improve connectivity between the east and west sides of the Turnpike. The new connections provided between Shattuck Way and Nimble Hill Road will provide safer access to the Newington town center area for Patterson Lane residents. Furthermore, the new link between Woodbury Avenue and Nimble Hill Road will also provide safer access for Newington residents on the west side of the Turnpike when attempting to reach the commercial shopping district on the opposite side of the highway.

Alternative 12A

This alternative would be expected to have the same positive impacts on area neighborhoods, as well as the Town of Newington as a whole, due to improved connectivity between the east and west sides of the Turnpike. The proposed connection of Shattuck Way to Arboretum Drive and Nimble Hill Road, *via* a new Turnpike underpass would in fact, be expected to provide an even more convenient connection point for residents from the Patterson Lane neighborhood when accessing the Newington town center area.

The proposed Pease Rail Spur associated with this alternative does introduce a new right-of-way corridor into the vicinity of the Patterson Lane neighborhood; however, the fact that this rail spur would tie into the existing Pan Am Railways line north of Patterson Lane will essentially avoid any disruption to residential access within this neighborhood area.

Alternative 13

This alternative would not be expected to have any adverse impacts on area neighborhoods. Although this alignment would provide a new connection between Woodbury Avenue and Arboretum Drive at the Pease Tradeport, this new Exit configuration will not offer the same degree of improved connectivity for neighborhoods and the Town due to the lack of the industrial connector road discussed for Alternatives 10A and 12A above.

Alternative 2

The Dover Point portion of the project area contains approximately 480 residential dwelling units that are separated into four or five neighborhood groups by the Turnpike corridor and adjoining roadway network. Alternative 2 would result in the realignment of several existing Exit ramps and other connecting roadways that are in proximity to these neighborhood areas. Overall, this alternative is not expected to have any negative impacts on area neighborhoods since the majority of construction would occur within existing highway rights-of-way.

One substantial change is the elimination of Exit 5 that currently provides direct northbound Turnpike access to the Wentworth Terrace neighborhood, an enclave of approximately 20 homes on the east side of the highway. This Exit would be replaced by an improved underpass (*i.e.*, two-way) connecting the neighborhood with Dover Point Road on the west side of the highway. This new roadway configuration would require residents to take a more circuitous route to reach their home when driving north on the Turnpike, but will provide better and safer connectivity to neighborhoods and the park area located on the opposite side of the highway.

Alternative 3

Overall, the reconfiguration of Exit ramps and connector roads associated with this proposed alternative varies in relatively minor ways from those proposed in Alternative 2. The primary exception to this is the proposed construction of a new connecting roadway that would link Boston Harbor Road and Spur Road, *via* a US 4 underpass. This connector would terminate at Boston Harbor Road in proximity to a small enclave of houses, approximately 20 (including a small group of mobile homes), that lies between US 4 and Boston Harbor Road. Although this new roadway would create a perimeter that encircles this enclave of homes, it will not create a new barrier that divides the neighborhood to an extent greater than the current configuration of the present roadway network.

This reconfigured intersection of Boston Harbor Road, Spur Road, and US 4, would also eliminate the existing traffic signal at this location. The new alignment would provide an underpass that links Boston Harbor Road directly to Spur Road. This change would improve local connectivity between these two neighborhoods.

Bridge Alternatives

No impacts to any neighborhood would be expected as a result of either bridge construction alternative. Both the rehabilitation of the General Sullivan Bridge, or the creation of a new multi-use pathway, would preserve the existing pedestrian/bicycle linkages that presently exist for area neighborhoods.

4.3.3.2 Regional Study Area

As noted earlier, projects such as highway improvements frequently impact communities in a region larger than the immediate area of construction activities. As illustrated in **Figure 1.3-1**, a 33-community socio-economic study area (including all of Strafford County, a portion of Rockingham County, and two communities in Carroll County) was identified for evaluation of indirect economic and social effects.

In order to evaluate possible indirect impacts, various economic and policy models developed by Regional Economic Models, Inc. (REMI)[72] were used to forecast key social and economic indicators relating to the proposed development and to estimate possible induced development in the regional study area.

The base model for this analysis was REMI Policy Insight, a structural economic forecasting and policy analysis model that integrates traditional input-output, general equilibrium, econometric and economic geography methodologies. The model is dynamic, with forecasts and simulations generated on an annual basis with behavioral responses to wage, price and other economic factors. Unlike static models (*e.g.* RIMS II or IMPLAN), REMI tracks the effects of an economic event over multiple time periods, calculating the interrelated impacts as the local and regional economies adapt to these changes. For example, an increase in wages in a particular area results in migration of workers over a period of time to that region, resulting in population growth, new demand for housing and increased competition for existing jobs.

The REMI model consists of thousands of simultaneous equations that use data from a variety of sources, including the US Bureau of Economic Analysis and the US Census. The model is multi-regional to the county level, and is based on a comprehensive model of the national economy, developed and maintained by Regional Economic Models, Inc. of Amherst, Massachusetts. It is a proprietary software system, available on a contractual basis that is used extensively by public and private agencies around the country to provide reliable strategic decision support. The REMI model was chosen for its ability to track complex economic changes over time and across geographies, so that short and long-term impacts could be analyzed.

However, the Policy Insight model only accounts for construction and operational spending impacts. It does not account for transportation efficiency created by projects such as improvements on the Spaulding Turnpike. In order to incorporate improved economic efficiency due to transportation improvements, the REMI TranSight model was also used. The TranSight model provides a link between the proposed transportation improvements on the Spaulding Turnpike and the economic vitality of the region by converting changes in travel efficiency into economic output.

72 The Regional Economic Model, Inc. website (www.remi.com) provides a wide range of information about both the Policy Insight and Transight models and includes articles about the use of the programs, documentation, tours of the models and download demos.

These simulations are then entered into the Policy Insight model to project possible impacts. For example, while jobs will be created because of the construction and operation expenditures of a particular scenario, more substantial long-term job creation and economic development will likely occur as a result of improved transportation efficiency in the region.

Traditionally, the link between transportation improvements and the economy has been viewed as a reduction of business costs. The TranSight model employs new economic geography theory to examine the importance of transportation systems to a region's economy. The theory uses effective distances between products and employees to simulate transportation projects. By simulating a change in distance (measured by travel time between separate regional economies), the model can change the relationships among economies. Depending on the economy's existing market-share size in each industry, a change in the transportation infrastructure between the areas can, over time, shift the market shares of these industries. In other words, the economic geography can project the future economic impacts associated with the implementation of transportation improvements. The methods used to bridge the gap between analysis of transportation projects and total economic activity is based on the concept of effective distance.

One of the defining characteristics of this theory is how it describes the dependency of economic systems on the cost of transportation. The costs to move intermediate inputs, final goods, and labor directly affect a firm's production costs. In other words, a firm's production costs increase as its transportation costs rise. The three main transportation factors in production costs are a firm's access to intermediate inputs, access to labor, and the firm's ability to deliver their goods and services to consumers.

Effective distance describes the logistical efficiency between regions. The concept is based on the gravity model in economic geography. A gravity model describes how firms in similar industries tend to "gravitate" towards each other to keep production costs low. This effect is also called agglomeration of industries. The amount of gravitation toward the economic center of a region depends on the effective distance between firms. A firm will want to decrease its effective distance to reduce its production costs.

There are several ways to alter the effective distance between regions. One is to move a firm geographically closer to its intermediate inputs. Another way is to alter the modes of transportation by adding new or improving existing arteries or modes of transportation. For example, adding a new highway lane can decrease congestion, making transportation quicker and more efficient. Reducing the effective distance for intermediate inputs, laborers and/or shipping finished goods lowers the production costs of a firm. In turn, the firm gains a competitive advantage in price, increasing its market share and promoting growth. Conversely, an increase in effective distance can have a negative affect on a firm, increasing its delivered price and therefore reducing its market share.

For purpose of this analysis it was determined that the key transportation options involved the size of possible bridge improvements (six or eight lanes), estimated construction costs, changes in travel time, and the length of the construction period (5 years). This information, outlined in Table 4.3-2, was then entered into the TranSight model to determine the economic impact of each bridge alternative (six or eight lanes) in order to calculate the economic impact of each alternative. The results were then used with the Policy Insight model to project future economic and social impacts.

Table 4.3-2
REMI Model Inputs

Bridge Travel Lanes	Estimated Construction Cost (million) [2]	Estimated Change in Travel Time 2005 -2025 (Minutes) [1]			
		AM		PM	
		Southbound	Northbound	Southbound	Northbound
No-Build (Four Lanes)		7.5	0.7	3.5	10.7
Six Lanes	$127.5	0.2	0.4	0.0	-3.1
Eight Lanes	$138.3	-2.6	0.3	-0.9	-6.2

Notes:
1 Estimated travel time through the project area (Exit 1 to the Dover toll plaza)
2 Estimated construction cost is based on 2004 dollars

No-Build Alternative

Using the REMI Policy Insight model, key social and economic effects for the No-Build Alternative were identified. Under this approach, changes from 2005 to 2025 that addressed the following key indicators were projected for both Strafford and Rockingham Counties (see Table 4.3-3).

- Population – Changes in population are an indication of the desirability of an area as a place to live. Regions that provide the most attractive combination of quality of life, employment opportunities, recreational amenities and ease of access to other regions tend to experience the largest population gains.

  Conversely, areas that have poor employment opportunities, have low quality of life, and are geographically remote or isolated, tend to have flat or negative population changes.

- As indicated in Table 4.3-3, the population in both Strafford and Rockingham Counties is projected to increase by about 18.9 percent (22,188) and 23.7 percent (70,653) respectively, over the 20-year period. This equates to about 0.9 percent per year for Strafford County and 1.2 percent per year for Rockingham County. Historically the population of Strafford County grew at an average yearly rate of 1.6 percent between 1970 and 2000, but only 0.7 percent between 1990 and 2000.

In Rockingham County, the population increased by 2.3 percent per year between 1970 and 2000, but only 1.2 percent per year between 1990 and 2000. On a comparative basis, the New Hampshire Office of Energy and Planning projects that by 2025 Strafford County will have a population of 142,870 (a rate of yearly increase of 0.97 percent between 2000 and 2025) and that Rockingham County will have a population of 356,800 by 2025 (a rate of increase of 1.01 percent between 2000 and 2025).

Table 4.3-3
Key Social and Economic Indicators for the No-Build Alternative

	2005	2025	Total Change	Percent Change	Avg. Change/ Year
Strafford County					
Population	117,637	139,825	22,188	18.9%	0.9%
Employment	58,758	69,433	10,675	18.2%	0.9%
Households	49,015	58,260	9,245	18.9%	0.9%
Gross Regional Product (Billion)	$3.3	$6.7	$3.4	103%	5.2%
Disposable Income (Billion)	$2.9	$4.7	$1.8	62%	3.1%
Rockingham County					
Population	297,749	368,402	70,653	23.7%	1.2%
Employment	188,198	228,345	40,147	21.3%	1.1%
Households	124,062	153,500	29,438	23.7%	1.2%
Gross Regional Product (Billion)	$13.8	$28.9	$15.1	109.0%	5.4%
Disposable Income (Billion)	$10.3	$17.3	$7.0	67.9%	3.4%

Notes: Data from REMI and RKG Associates, Inc. Since only two communities in Carroll County (Brookfield and Wakefield) were part of the study area, data for Carroll County was not included in this table.

- During the period from 1990 to 2000, the average number of persons per household has declined from 2.6 to 2.5 in Strafford County and from 2.72 to 2.63 in Rockingham County. This trend is expected to continue. Based on an estimated average of 2.4 persons per household it is projected that these population changes by 2005 will result in an increase of 9,245 households (approximately 462 per year) in Strafford County and 29,438 (approximately 1,472 per year) in Rockingham County. It should be noted that the communities in the Rockingham portion of the study area only represent about 40 percent of the total number of households (104,586) located in the County during the 2000 US Census. Based on this simple percentage, yearly household increases in the Rockingham portion of the study area would equate to about 588 per year or approximately 11,775 over the twenty-year period.

- Employment – Similar to the population growth, changes in employment levels are a good indicator of economic vitality within a region. Regions that provide competitive advantages to businesses, including lower labor, transportation and fuel costs, will attract more commercial development than those that have high costs for doing business. As illustrated in Table 4.3-3, employment would increase by about 18.2 percent (10,675) in Strafford County and 21.3 percent (40,147) in Rockingham County. This equates to a yearly increase of about 0.9 percent in Strafford County and 1.1 percent in Rockingham County. Between 1990 and 2002 employment increased in Strafford County by 5,010 (about 0.9 percent per year) and by 26,720 (about 1.4 percent per year) in Rockingham County.

- Gross Regional Product – The concept of Gross Regional Product (GRP) is a measure of total economic output analogous to Gross Domestic Product, which is used to describe national economic activity. The REMI model measures the past and projected GRP for each County. In Strafford County, it is projected that the GRP will increase by $3.4 billion or about 5.2 percent per year. In Rockingham County, the GRP will increase by approximately $15.1 billion or about 5.4 percent per year.

- Real Disposable Income – Real disposable personal income measures the amount of net income remaining for all employed persons that live within a particular region after adjusting for taxes and cost of living. Changes in real disposable personal income indicate whether the wages of residents are increasing faster, slower or at the same rate as their basic expenses. Increases in average real disposable personal income is generally an indicator of positive job growth and increases in salaries and wages above basic expenses. Conversely, a decrease in real disposable personal income is an indication that taxes and cost of living are increasing faster than salaries and wages. The real disposable income (in fixed dollars) is projected to increase by about $1.8 billion in Strafford County (about 3.1 percent per year) and $7.0 billion in Rockingham County (about 3.4 percent per year).

Build Alternatives

As discussed earlier the TranSight model was used to identify possible economic changes based on specific impacts involving estimated construction costs and changes in travel time (minutes) related to the two Turnpike widening (six and eight lanes) alternatives (Table 4.3-2). The results of these changes were then used with the Policy Insight model to project future economic and social impacts. Outlined below are the results of this analysis, in terms of changes to the No-Build results (such as increases in population and households) for the two basic bridge alternatives – six lanes and eight lanes.

- Population – Based on this analysis, it is estimated that the Six-Lane Alternative would result in an increase in population by 2025, of 905 in Strafford County and 452 in Rockingham County over the No-Build Alternative, for a total population increase of 1,357. The Eight-Lane Alternative would result in a total population increase of 1,865 over the No-Build Alternative. Strafford County's population would increase by 1,151 compared to 714 in Rockingham County (Table 4.3-4).

As illustrated in **Exhibit 4.3-1**, most of the population increase would occur after 2015 when bridge construction is completed. Based on a similar estimate of 2.4 persons per household, the population increase would result in an additional 377 households in Strafford County under the Six-Lane Alternative and 480

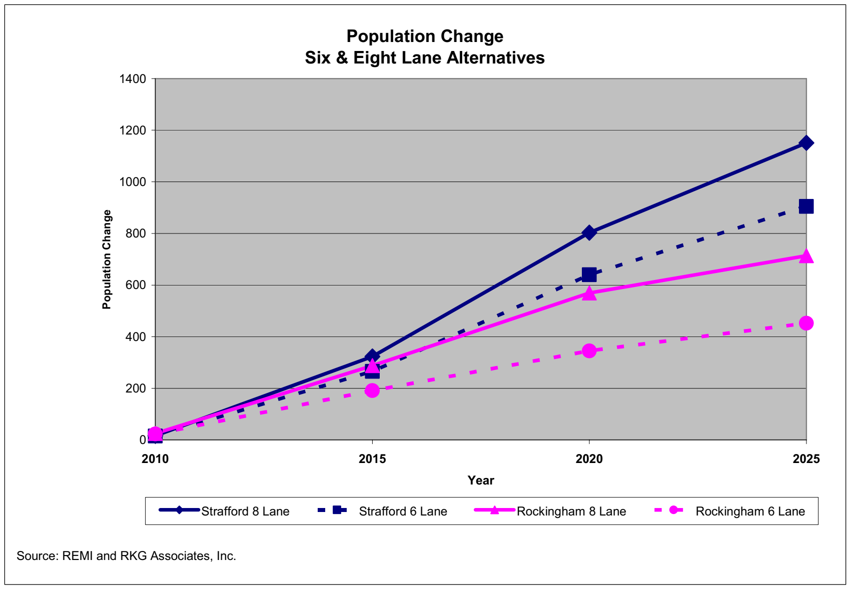
Table 4.3-4
Projected Population and Employment Changes from No-Build Alternative for 2010 and 2025

	Six-Lane		Eight-Lane	
County	**2010**	**2025**	**2010**	**2025**
Strafford				
Population	15	905	16	1,151
Employment	134	737	146	887
Household	6	377	7	480
Rockingham				
Population	23	452	25	714
Employment	189	613	205	1,010
Household	10	188	10	298
Strafford & Rockingham				
Population	38	1,357	41	1,865
Employment	323	1,350	351	1,897
Household	16	565	17	778

households under the Eight-Lane Alternative. In Rockingham County the increase in households would be 188 (six-lane) and 298 (eight-lane). However, because the communities located in the regional study area represent only about 40 percent of the households in Rockingham County, the total number of increased households for the study area are estimated at 452 (75 in Rockingham) for the Six-Lane Alternative and 600 (120 in Rockingham) for the Eight-Lane Alternative by 2025.

- A comparison of projected population difference for the year 2025 between the Six and Eight-Lane Alternatives was larger for Rockingham County (262) than Strafford County (246). It is also noted that the difference in employment was larger in Rockingham County (397) than Strafford County (150). Also, the projected population difference between the two counties for both alternatives indicates that the increase in Strafford County is greater than Rockingham County. As illustrated in **Exhibit 4.3-1**, the change in Strafford County is projected to increase at a faster rate than Rockingham County, which can be attributed to improved travel across the Little Bay Bridges.

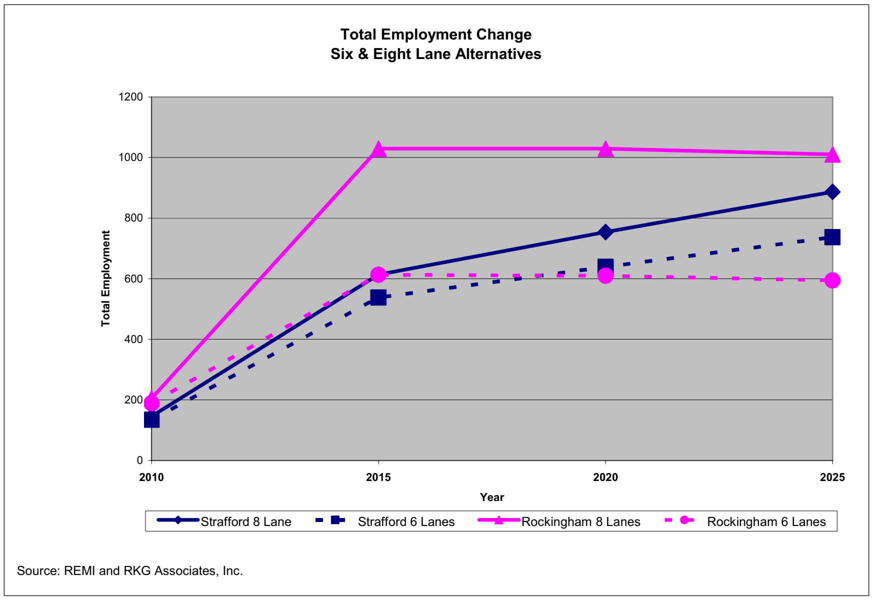
Exhibit 4.3-1



- Employment – Similar to population increases, it is projected that most of the employment increases would also occur after 2015. As indicated in Table 4.3-4 and **Exhibit 4.3-2**, employment in Strafford County, by 2025, would increase by 737 under the Six-Lane Alternative and 887 under the Eight-Lane Alternative over the No-Build Alternative. In Rockingham County the increase, by 2025, would be 613 (Six-Lane Alternative) and 1,010 (Eight-Lane Alternative). This equates to a total increase of employment of 1,350 (Six-Lane Alternative) and 1,897 (Eight-Lane Alternative) by 2025.

As noted earlier in Table 4.3-3, it is projected that employment will increase at 1.1 percent per year in Rockingham County between 2005 and 2025. This compares to a yearly rate of 0.9 percent in Strafford County during the same time period. **Exhibit 4.3-2** indicates that under the two Build Alternatives, additional employment growth related to the Build Alternatives (six-lane and eight-lane) increases at a faster rate in Strafford County than Rockingham County. In fact, additional employment growth, beyond the No-Build level in Rockingham County, levels off after construction is complete only for the additional increment of employment growth due to new construction.

Exhibit 4.3-2

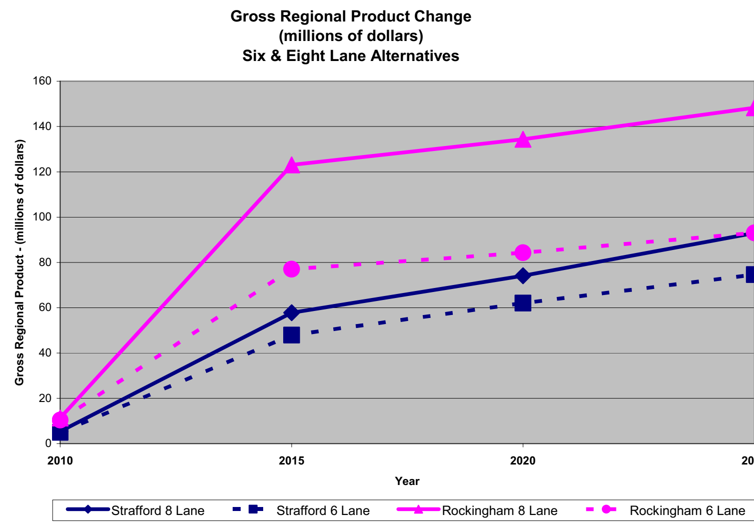


- The employment numbers under the Eight-Lane Alternative are also larger (Table 4.3-4), but as illustrated in **Exhibit 4.3-2**, the rate of change in Rockingham County is declining (after 2015) in comparison to Strafford County (Eight-Lane Alternative). It needs to be emphasized that the population and employment base is substantially higher in Rockingham County than Strafford County (see Table 4.3-3). That data indicates that in 2005 the population of Strafford County was about 40% of Rockingham County and employment in Strafford County was about 31% of Rockingham County. It is estimated that a similar relationship will occur in 2025. Consequently, the growth of Rockingham County in terms of population and economic activity, with or without the bridge alternatives, will continue to expand.[73]

- Gross Regional Product – Changes in gross regional product (GRP) increase substantially after 2015 (See **Exhibit 4.3-3**). By 2025 GRP in Strafford County increases by approximately $74.6 million under the Six-Lane Alternative and $93 million under the Eight-Lane Alternative. In Rockingham County GRP increases by $93.1 million (Six-Lane Alternative) and $148 million (Eight-Lane Alternative). It should be noted, however, that a portion of the GRP in Rockingham County included communities not located in the study area.

73 Since job location within REMI is based on the county in which the business is located, it is assumed that many of the new construction jobs will be attributed to Rockingham County. The place of residence for projected new employees however, cannot be identified.

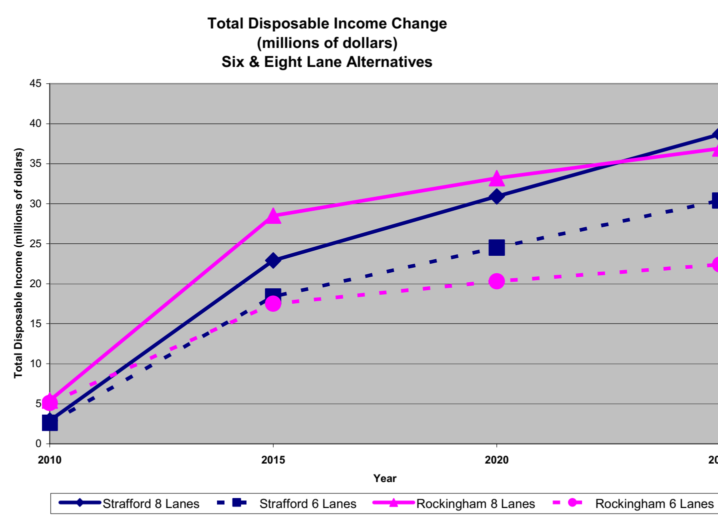
Exhibit 4.3-3



Source: REMI and RKG Associates, Inc.

- Disposable Income – Similar to the GRP, disposable income increases both in Strafford and in Rockingham Counties (see **Exhibit 4.3-4)**. Strafford County increased by $30.4 million in 2025 under the Six-Lane Alternative and $38.7 million under the Eight-Lane Alternative over the No-Build Alternative. In Rockingham County, the increase is $22.4 (six-lane) and $36.9 (Eight-Lane Alternative). In Rockingham County's case, the increase levels off after 2015 under both Build Alternatives.

Exhibit 4.3-4



Source: REMI and RKG Associates, Inc.

- Households - As noted earlier, it is projected that under the No-Build Alternative over 9,245 households (approximately 462 per year) would be established in Strafford County and 11,775 households (approximately 588 per year) in the Rockingham County portion of the study area by 2025.[74] This equates to an increase of about 21,020 households (9,245 + 11,775 = 21,020) in the study area by 2025 or approximately 1,051 households per year over the 20-year period (2005 to 2025). As noted in Table 4.3-4, projected increases from the No-Build Alternative (21,020 household) equate to 565 additional households under the Six-Lane Alternative and 777 additional households under the Eight-Lane Alternative by 2025. Tables 4.3-3 and 4.3-4 provide a comparison of the key social indicators for the No-Build and Build Alternatives (six and eight lanes) for Strafford County and the Rockingham County portion of the study area. As the tables indicate, the two Build Alternatives have minimal impact on population, employment and household growth between 2005 and 2025.

Construction Employment

Based on the use of the REMI model, it is estimated that both Build Alternatives would create approximately 330 temporary jobs during the construction period relating to the two bridge alternatives and associated roadway improvements. Another methodology indicated that based on the Build Alternative (six or eight lanes) the construction jobs could range from a low of 310 to a high of 390. [75]

Summary of Indirect/Secondary Economic Effects

The analysis of secondary economic effects is summarized in **Exhibits 4.3-5** and **4.3-6.** The marginal nature of the socio-economic changes that can be expected as a result of the project is clearly illustrated in these graphs**.** That is, the overall change in population, employment and households is predicted to be essentially the same whether the project is built or not. Put in terms of the overall change in the socio-economic study area, it becomes apparent that the secondary growth is negligible, amounting to less than a 1 percent increase (over the 20-year forecast period) for population, employment and housing in all cases, except for employment in Strafford County, which will increase a little more than 1 percent under both the Six-Lane and the Eight-Lane Alternatives.

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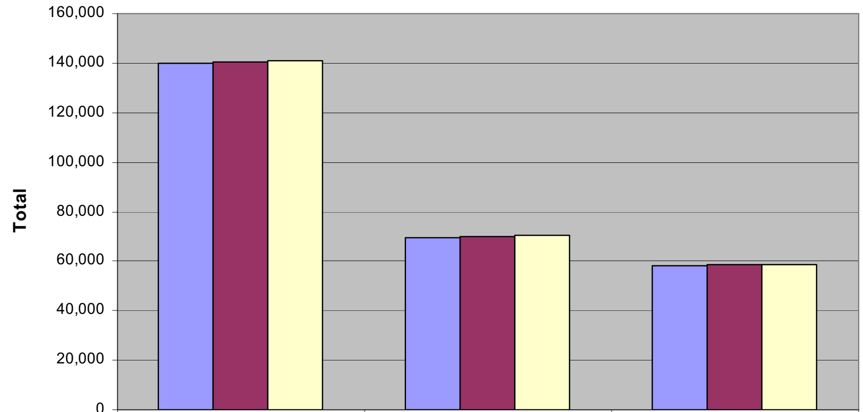
74 As discussed in Section 4.3.3.2 under the No-Build Alternative, the Rockingham County portion of the study area involves about 40% of the total households in the entire County in the 2000 U.S. Census. This same percentage was used to project the number of households under the 2025 Build Alternative (see Table 4.3-4).

75 Based on *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II)*, published by the US Department of Commerce, 1992.

Exhibit 4.3-5

**Comparison of Key Social and Economic Indicators
for the No-Build and Build in Year 2025
for Strafford County**

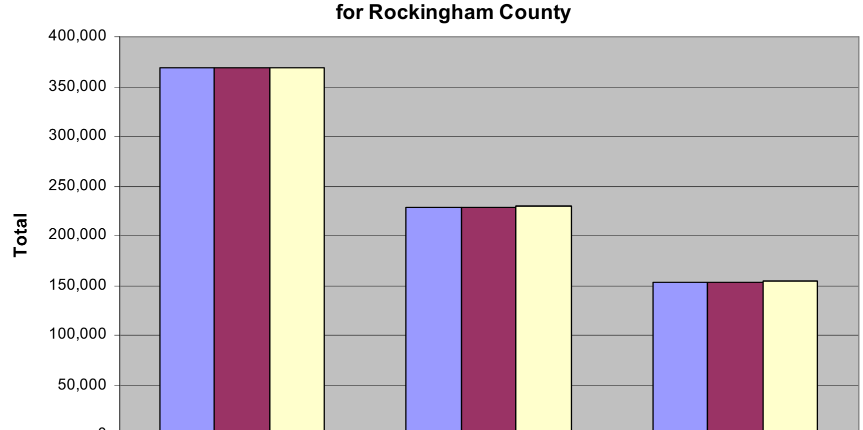


	Population	Employment	Housing
No Build	139,825	69,433	58,260
6 Lane	140,330	70,170	58,673
8 Lane	140,976	70,320	58,740

Source: REMI and RKG Associates, Inc.

Exhibit 4.3-6

**Comparison of Key Social and Economic Indicators
for the No-Build and Build in Year 2025
for Rockingham County**



	Population	Employment	Housing
No Build	368,402	228,345	153,500
6 Lane	368,854	228,958	153,755
8 Lane	369,116	229,355	153,920

Source: REMI and RKG Associates, Inc.

4.3.3.3 Indirect Land Use and Environmental Resource Impacts

This subsection further evaluates the potential indirect land use impacts resulting from the Spaulding Turnpike Improvements. As part of the evaluation, the amount of land development associated with secondary growth is discussed, and the general effects on environmental resources that would be most vulnerable to such indirect land use impacts are identified and discussed.

Indirect impacts are those impacts caused by the proposed project that occur later in time or removed in distance, but are still reasonably foreseeable.[76] For this project, indirect impacts may be more specifically defined as those impacts that may result from the Spaulding Turnpike Improvements outside of the immediate study area. Such impacts may be influenced by the increased traffic capacity of the highway and the resultant improved accessibility within the area served by the Turnpike. Indirect impacts to natural resources would typically result from the conversion of existing undeveloped lands that contain such resources to residential, industrial, commercial and governmental land uses. In addition, indirect impacts can have a positive impact on socio-economic resources in terms of improving the potential for more housing and employment opportunities.

While the expected indirect growth resulting from the improvements to the Turnpike is minor, a concern has been expressed that suburban development would accelerate as a result of improved highway capacity and due to incremental decision-making by local communities in the socio-economic study area (see **Figure 1.3-1**). To assess this concern and meet the requirements of the National Environmental Policy Act (NEPA) of 1969, potential indirect land use impacts have been considered and presented below.

Alternatives Considered

For discussion of indirect land use impacts, the No-Build Alternative and an Eight-Lane (or Build) Alternative were considered, consistent with the methodologies used to project indirect socio-economic effects for the regional study area (See Section 4.3.3.2).

The No-Build Alternative assumed that no capacity improvements or substantial safety improvements would be constructed along the project corridor. The Eight-Lane Alternative assumes that the highway would be widened to four lanes in both the northbound and southbound directions between Exit 3 and Exit 6.

▼

76 The phrases "secondary impacts" and "induced growth" are often used interchangeably with "indirect impacts," which are specifically defined by CEQ regulations [40 CFR 1508.8].

It is consistent with the recommendations discussed in Chapter 2 to consider only the Eight-Lane Alternative. Specifically, it was determined during the project planning that widening the Turnpike to six lanes in conjunction with a range of transportation system improvements and travel demand management strategies would not provide sufficient traffic capacity for the design year (2025). This Six-Lane Alternative therefore does not meet the project purpose and need. Thus, although a Six-Lane Alternative was modeled and discussed in Section 4.3.3.2, it was not carried forward for analysis of impacts to environmental resources and will not be discussed in this section.

Land Conversion Methodology

Land development and associated impacts depend on general regional and statewide economic conditions, federal and state permitting requirements, local zoning and land use ordinances and their administration, as well as the decisions of individual landowners. Given these influences and changing conditions over time, it is difficult to forecast with a high level of confidence the specific areas that may be developed, and the impacts of such development, under the No-Build and Eight-Lane Alternatives. However, an approximation of the total amount of land conversion due to secondary growth can be estimated with the acceptance of several simplifying assumptions as discussed below.

In order to estimate the potential effect of indirect land use development on land conversion and environmental resources in the study area, the following procedure was used:

1. The relationship between land conversion and population was explored by establishing a correlation (using a linear regression method) between the population of each of the communities in the study area and the amount of developed land in each of those communities.
2. The REMI model's estimates of population growth by 2025 were converted into land area needed (in acres) to accommodate consequent indirect land use development.
3. The general locations of environmental resources in the socio-economic study area were identified by using available GIS data; and
4. The amount of each environmental resource within the socio-economic study area was extrapolated from historic rates of land consumption to estimate total additional environmental resource impacts.
5. The rates of land consumption were verified by comparison with population and land development data from the 1960s through the 1990s to validate the regression models.

Because the amount of additional population growth is relatively minor, it was determined that an attempt to allocate this secondary growth at any level below the county level would be overly speculative and provide little valuable information. Therefore, the analysis predicts natural resource impacts at the county level, even though data at the municipal level is used to establish the relationship between population and land conversion.

Developed land was identified from the New Hampshire Land Cover Assessment GIS dataset developed by the Complex Systems Research Center at NH GRANIT (Justice, *et al.* 2002).[77] Developed lands were initially identified as "Residential/ Commercial/Industrial Development" areas in the data set. Total land areas and total developed lands for each of the study area towns were then estimated from these GIS data. Population for each community in the socio-economic study area was taken from the US Census Bureau's statistics for the 2000 Census.

Based on initial results of the analysis, it was determined that using only the "Residential/Commercial/Industrial Development" land category substantially underestimates the total amount of developed land in many communities within the study area, especially in more rural areas. To eliminate this bias, following a review of the distribution of land use categories in a sub-set of study area communities, it was determined that inclusion of four land cover categories in the spatial definition of "developed area" provided a conservative, yet more reliable estimate:

- Residential/Commercial/Industrial Development;
- Transportation;
- Disturbed Land (*e.g.*, gravel pits, construction sites);
- Other Cleared (*e.g.*, cleared areas in rural neighborhoods).

The resulting data on land consumption are presented in Table 4.3-5.

Using the relationship of population to total developed area in a community is a simple approach to projecting land use attributable to secondary growth. However, the regression analysis on the data in Table 4.3-5 indicates a strong and statistically significant relationship between the two measures, as shown in **Exhibits 4.3-7** and **4.3-8**. A variety of regression types were performed in addition to the linear regression reported in the Exhibits (*e.g.,* polynomial, exponential, logarithmic) and it was determined that a simple linear regression provided the best fit to the data, with significance levels exceeding 90% for both the Strafford and Rockingham County data. The resulting relationships allow a projection of the total amount of future developed land in each county under the No-Build and Eight-Lane Alternatives, as discussed later in this section.

77 The NH Land Cover Assessment presented in Justice, *et al.* (2002) was released by NH GRANIT in 2001 and is considered the most recent and most detailed land cover data available in NH. The study categorizes land use/cover into 23 classes by analyzing satellite imagery acquired by the Landsat Thematic Mapper.

Comments received on the DEIS expressed the concern that the estimates of land consumption developed using the regression methodology may understate the actual per capita use of land in the region. A related concern was that the methodology,

Table 4.3-5
Per Capita Land Consumption, Socio-Economic Study Area

Municipality	Developed Land[1] (acres)	Total Area (acres)	Population (2000 Census)	Land Consumption Rate (acres/person)
Rockingham County[2]				
Brentwood	2,736	10,863	3,197	0.86
East Kingston	1,271	6,381	1,784	0.71
Epping	3,623	16,776	5,476	0.66
Exeter	3,349	12,813	14,058	0.24
Greenland	2,173	8,524	3,208	0.68
Hampton	3,349	9,073	14,937	0.22
Hampton Falls	1,241	8,078	1,880	0.66
Kensington	1,342	7,668	1,893	0.71
New Castle	313	1,348	1,010	0.31
Newfields	770	4,647	1,551	0.50
Newington	2,238	7,917	775	2.89
Newmarket	2,277	9,080	8,027	0.28
North Hampton	2,441	8,923	4,259	0.57
Northwood	2,033	19,357	3,640	0.56
Nottingham	2,564	30,997	3,701	0.69
Portsmouth	5,813	10,763	20,784	0.28
Rye	2,357	8,406	5,182	0.45
Stratham	2,594	9,902	6,355	0.41
Total/Average	**42,483**	**191,513**	**101,717**	**0.42**
Strafford County				
Barrington	4,001	31,117	7,475	0.54
Dover	7,216	18,592	26,884	0.27
Durham	2,902	15,852	12,664	0.23
Farmington	3,724	23,640	5,774	0.64
Lee	2,775	12,927	4,145	0.67
Madbury	1,574	7,799	1,509	1.04
Middleton	1,784	11,843	1,440	1.24
Milton	3,457	21,936	3,910	0.88
New Durham	3,116	28,054	2,220	1.40
Rochester	10,105	29,081	28,461	0.36
Rollinsford	1,279	4,843	2,648	0.48
Somersworth	2,755	6,398	11,477	0.24
Strafford	2,503	32,779	3,626	0.69
Total/Average	**47,191**	**244,861**	**112,233**	**0.42**

Notes:
1 Developed land areas include four land cover categories (residential/commercial/industrial lands, transportation, disturbed land, and other cleared land) and were developed using the NH Land Cover Assessment based on satellite imagery (Justice, *et al.* 2002).
2 This table was modified from the version contained in the Draft EIS by the deletion of the communities of Fremont, Seabrook and South Hampton. These Rockingham County towns are not located within the socio-economic study area.

Exhibit 4.3-7[78]

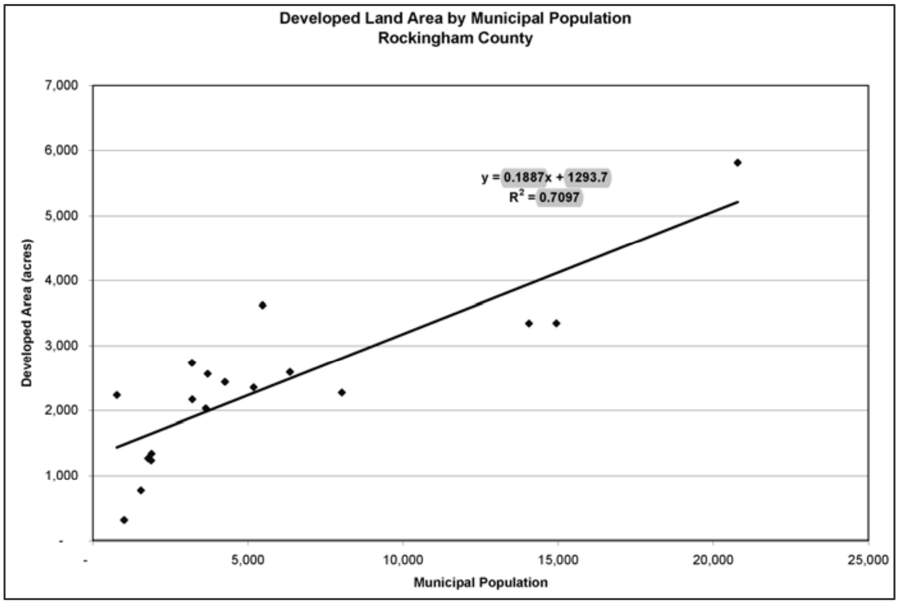
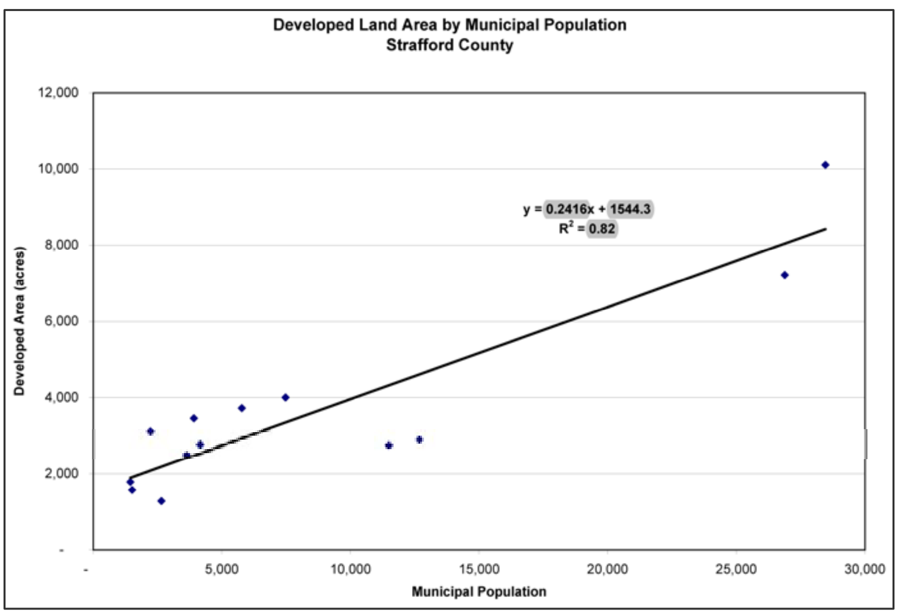


Exhibit 4.3-8[79]



78 Like Table 4.3-5, this Exhibit was modified from the version contained in the Draft EIS by the deletion of the communities of Fremont, Seabrook and South Hampton.
79 A small error in the reported correlation equation and correlation coefficient for Strafford County in the Draft EIS was corrected in this revised Exhibit 4.3-6.

which uses "cumulative" data may underestimate the rate of land consumption, based on the finding of a recent study which used historical "incremental" data to provide evidence that per capita land consumption has increased with time.[80] It was suggested that use of "incremental" data may provide a more reliable predictor.

Specifically, USEPA comments dated October 2, 2006 (see Volume 4) cite data from the Rockingham Planning Commission's Regional Open Space Plan (Lang *et al.*, 2000). This report re-analyzed land use data developed from interpretation of black and white aerial photography from 1953, 1974 and 1982 which was published by the University of New Hampshire (Befort, *et al.*, 1987). The RPC report used the historical data to calculate an increase in the "cumulative" per capita land consumption rate (in the RPC region) from 0.45 acre/person in 1953 to 0.76 acre/person in 1982. The RPC also calculated an "incremental" rate that considered the change in developed acres and population between 1953 and 1974, which was equivalent to 0.75 acre/person. The corresponding incremental rate from 1974 to 1982 was found to be 1.59 acres/person, more than double the previous period. These data led RPC to conclude that "the way in which land is being developed is far more wasteful of land, and perhaps less sustainable, than was historic development."

However, the data presented in Befort, *et al.* (1987) effectively used a different definition of "development" than was used to generate the data in Table 4.3-5. Limited by the technology available at the time of the study (black and white photography, limited computing resources), Befort, *et al.* (1987) used only six classes of land uses, and limited the resolution of their mapping to a 5-acre grid. These methodological factors, while very reasonable at the time of the analysis, would tend to bias (in the statistical sense) the results of the analysis and apparently overestimated the amount of developed land. This prevents direct comparisons between the data in Table 4.3-5 and the earlier data.

In fact, the RPC study recognized that the amount of developed land in Rockingham County reported by Befort, *et al.* (1987) appears to be an overestimate. In developing their own analysis based on 1992 aerial photography, Lang, *et al.* (2000) estimated that about 74,100 acres of land within the RPC region met the definition of developed. However, Befort, *et al.* (1987) reported about 110,410 acres of developed land in the same region – for the year 1982, ten years prior to the RPC's data. The data in Table 4.3-5, are consistent with the lower development estimates provided by Lang *et al.* (2000), which supports the validity of the analysis presented in the DEIS and suggests that drawing conclusions from the Befort, *et al.* (1987) data must be done with great caution.

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80 A "cumulative" analysis considers data from a single time period. For example, a rate based on the total developed land and total population in 1974 would be considered "cumulative" because it reflects a single point in time, but is actually a function of all previous growth trends prior to the time period. An "incremental" analysis, however, uses the change between two points in time to focus on the rate of change within that time period. Thus, with data on the population and amount of developed land in 1962 and 1974, one could estimate the rate specific to that time period, without prior trends (i.e., before 1962) affecting the analysis.

The regression model derives a formula that eliminates the bias inherent in the calculation of an average rate. It also conclusively establishes the statistical significance of the relationship between population and land development, which is assumed by previous studies, and seems intuitively correct, but which has not been critically examined.[81] Regression has the advantage that it accounts for the fact that the communities in the study area range from very urbanized to very rural, have varying degrees of commercial and industrial development, and have grown at different rates. For example, Portsmouth has developed at a much different rate than Newington and New Castle. Similarly, Rochester and Dover have grown differently than Middleton or New Durham and the regression approach accounts for these variances. Therefore, the use of the regression approach is preferred over calculating a simple rate.

However, the results reported in Table 4.3-5 and Exhibits 4.3-7 and 4.3-8 do represent a "cumulative" analysis, which may or may not capture increasing historical rates. In order to examine this question, similar studies from the region were examined and new data on historical land use in the socio-economic study area were generated. Table 4.3-6 provides a summary of historical rates of land consumption in the Rockingham and Strafford County portions of the socio-economic study area, listed by community. Note that the Table 4.3-6 data are derived from GRANIT imagery which are not directly comparable to the data provided in the Justice, *et al.* (2002) data set reported in Table 4.3-5 and which were not available to the RPC in its 2000 study.[82]

Unlike the RPC's analysis, the new historical land use data do not contain strong evidence that land consumption rates have increased over time. For example, the average "cumulative" rate of land consumption in the Rockingham portion of the study area increased only slightly, changing from 0.29 acre/person in 1962 to 0.31 acre/person in 1974 to 0.35 acre/person in 1998. The cumulative rate calculated for Strafford County shows a similar pattern, with only very slight increases from 0.26 acre/person in 1962 to 0.28 acre/person in 1974, to 0.30 acre/person in 1998.

Calculation of an "incremental" land consumption rate, which accounts for the growth in developed area over a specific time interval, yields results that are inconsistent with the assertion that land consumption rates are increasing with time. For Rockingham County, the incremental land consumption rate from 1962 to 1974 is estimated to be 0.45 acre/person. The corresponding rate from 1974 to 1998 is identical, 0.45 acre/person, which does not support the conclusion that land consumption rates have increased in the study area over time. The data set for

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81 A rate for virtually any phenomenon can be calculated, even if there is no relationship between the two variables used. A regression analysis, by generating a correlation coefficient and a significance level, is considered proof that the relationship is valid.

82 The historical land use data Table 4.3-6 were derived from an inventory completed by the Complex Systems Resource Center (NH GRANIT) based on analysis of historical black and white aerial photography. The inventory uses 13 land cover categories which are similar, but not directly comparable, to the categories used in the Justice *et al.* (2002) data presented in Table 4.3-5. Therefore, it would be inappropriate to attempt to calculate an incremental rate from 1998 to 2001 using a combination of these data.

Strafford County leads to the same conclusion; the incremental land consumption rate remains constant at 0.35 acre/person for the time period 1962 to 1974 and 0.34 acre/person for the time period 1974 to 1998. It is therefore not readily apparent that per capita land consumption rates are increasing, based on the best available data for this study area. Thus, further consideration of alternative rates or methodologies was determined to be unnecessary, and it was concluded that the methodology used in the Draft EIS produced a reasonable estimate of future land consumption.

Using the regression model derived from the Justice *et al.* (2002) data, it is estimated that the study area communities in Rockingham County will contain approximately 14,626, acres of newly-developed land in 2025 under the No-Build Alternative, and approximately 14,761 acres under the Eight-Lane Alternative. Approximately 6,905 acres of newly-developed land are projected for Strafford County in 2025 without the project, while that amount increases to approximately 7,183 acres if the Eight-Lane Alternative is constructed. The net difference in developed land between the No-Build and Eight-Lane Alternatives is therefore approximately 135 acres and 278 acres for Rockingham and Strafford Counties, respectively. (See Table 4.3-7.)

It is important to note that nearly all of the growth in the study area is expected to occur regardless of whether the Turnpike is improved or not. Growth is expected to occur, even without the project, in response to other influences (such as the cost of housing) involving the overall quality of life conditions and continued economic prosperity found in New Hampshire. In addition, it is not clear whether the additional growth, and the associated land conversion, is growth that otherwise would not occur, or growth that would simply occur later in time if the project were not completed.

Potential Indirect Impacts on Environmental Resources

The potential land use impacts on environmental resources that could be attributed to secondary growth in the study area are discussed in this subsection. Additionally, brief discussions are presented later in this Chapter for certain environmental resources.

To estimate the amount of resource impacts resulting from secondary growth, it is first necessary to determine the amount of each environmental resource within Rockingham and Strafford counties. By determining the amount of wetlands in Strafford County, for example, it is possible to derive the percentage of wetland (*vs.* upland) per acre. See Table 4.3-8 for these data.

Note that Table 4.3-8 reflects only the portion of the study area that meets the definition of “undeveloped,” based on the reasoning that most future development will occur in undeveloped land and that undeveloped land has a higher incidence of wetlands, steep slopes and other developmental constraints than developed areas. This approach is a conservative one, since the definition of “developed land” used in

Table 4.3-6 - Land Consumption Rates based on Rockingham & Strafford County Land Use -1962, 1974, & 1998

Town	Town Area (ac)	1962 Developed Land (ac)[1]	Population (1960 Census)[2]	1962 Cumulative Consumption Rate (ac/person)	1974 Developed Land (ac)[1]	Population (1974 Projected)[3]	1974 Cumulative Consumption Rate (ac/person)	1962 – 74 Incremental Consumption (ac/person)	1998 Developed Land (ac)[1]	Population (1998 Projected)[3]	1998 Cumulative Consumption Rate (ac/person)	1974 – 98 Incremental Consumption Rate (ac/person)
Rockingham County												
Brentwood	10,863	537	1,072	0.50	835	1,630	0.51	0.53	1,821	3,003	0.61	0.72
East Kingston	6,381	325	574	0.57	461	976	0.47	0.34	830	1,647	0.50	0.55
Epping	16,776	871	2,006	0.43	1,224	2,447	0.50	0.80	2,301	5,572	0.41	0.34
Exeter	12,813	1,468	7,243	0.20	1,978	9,900	0.20	0.19	3,129	13,409	0.23	0.33
Greenland	8,524	577	1,196	0.48	760	1,980	0.38	0.23	1,429	3,083	0.46	0.61
Hampton	9,073	2,028	5,379	0.38	2,424	9,264	0.26	0.10	3,350	13,342	0.25	0.23
Hampton Falls	8,078	537	885	0.61	691	1,452	0.48	0.27	1,236	1,755	0.70	1.80
Kensington	7,668	462	708	0.65	639	1,200	0.53	0.36	944	1,787	0.53	0.52
New Castle	1,348	251	823	0.31	333	907	0.37	0.97	337	831	0.41	-[4]
Newfields	4,647	277	737	0.38	316	831	0.38	0.41	711	1,332	0.53	0.79
Newington	7,917	1,225	1,045	1.17	1,485	700	2.12	-[4]	1,676	777	2.16	2.49
Newmarket	9,080	671	3,153	0.21	877	3,615	0.24	0.45	1,759	7,715	0.23	0.22
North Hampton	8,923	944	1,910	0.49	1,254	3,500	0.36	0.20	1,916	3,984	0.48	1.37
Northwood	19,357	921	1,034	0.89	1,172	1,872	0.63	0.30	1,815	3,283	0.55	0.46
Nottingham	30,997	714	623	1.15	1,035	1,152	0.90	0.61	2,018	3,251	0.62	0.47
Portsmouth	10,763	3,570	26,900	0.13	4,166	22,651	0.18	-[4]	4,972	23,100	0.22	1.80
Rye	8,406	1,385	3,244	0.43	1,630	4,355	0.37	0.22	2,111	4,738	0.45	1.26
Stratham	9,902	588	1,033	0.57	850	1,850	0.46	0.32	2,317	5,810	0.40	0.37
TOTAL	**191,513**	**17,352**	**59,565**	**0.29**	**22,130**	**70,282**	**0.31**	**0.45**	**34,672**	**98,419**	**0.35**	**0.45**
Strafford County												
Barrington	31,117	1,178	1,036	1.14	1,979	2,900	0.68	0.43	3,669	6,896	0.53	0.42
Dover	18,592	3,394	19,131	0.18	3,964	23,233	0.17	0.14	5,307	26,658	0.20	0.39
Durham	15,852	1,110	5,504	0.20	1,820	9,085[5]	0.20	0.20	2,687	12,900	0.21	0.23
Farmington	23,640	1,129	3,287	0.34	1,474	3,687	0.40	0.86	2,371	6,009	0.39	0.39
Lee	12,927	679	931	0.73	1,024	1,550	0.66	0.56	1,927	4,093	0.47	0.35
Madbury	7,799	378	556	0.68	483	769	0.63	0.49	889	1,525	0.58	0.54
Middleton	11,843	311	349	0.89	578	471	1.23	2.19	831	1,242	0.67	0.33
Milton	21,936	883	1,418	0.62	1,094	2,196	0.50	0.27	1,661	3,781	0.44	0.36
New Durham	28,054	737	474	1.56	1,040	902	1.15	0.71	1,618	2,055	0.79	0.50
Rochester	29,081	3,309	15,927	0.21	4,782	18,856	0.25	0.50	7,348	27,800	0.26	0.29
Rollinsford	4,843	536	1,935	0.28	645	2,098	0.31	0.67	898	2,740	0.33	0.39
Somersworth	6,398	1,201	8,529	0.14	1,555	9,573	0.16	0.34	2,055	11,679	0.18	0.24
Strafford	32,779	879	722	1.22	1,087	1,062	1.02	0.61	1,914	3,294	0.58	0.37
TOTAL	**244,861**	**15,723**	**59,799**	**0.26**	**21,525**	**76,382**	**0.28**	**0.35**	**33,176**	**110,672**	**0.30**	**0.34**

Notes:

1 Developed land areas are based on VHB analysis of land cover data supplied by GRANIT.
2 US Census Bureau data.
3 NHOEP data, except see Note 5 below.
4 Communities where population declined were not included in incremental calculations to avoid inappropriate skewing of the data since population decline is not associated with a corresponding decline in developed land as defined in this study.
5 The population projection for 1974 in Durham is 5,558. However, review of the population data for that decade in Durham appears to make this value highly inaccurate. The value used in calculating the land consumption rate (9,085) was therefore taken from a straight-line interpolation of the 1970 and 1980 Census.

Table 4.3-7
Projected Indirect Land Use, No-Build vs. Eight-Lane Alternatives, 2025

County	Population[1]					Additional Developed Land (ac)[2]		
	2005 (Actual)	2025 No-Build	2025 8-Lane	Growth 2025 No-Build	Growth 2025 8-Lane	No-Build	8-Lane	Difference (Secondary Effect)
Strafford	117,637	139,825	140,976	22,188	23,339	6,905	7,183	278
Rockingham	297,749	368,402	369,116	70,653	71,367	14,626	14,761	135[3]

Notes:
1 Population data are based on REMI model predictions by RKG Associates, as detailed in Table 4.3-3.
2 Developed land projections are based on regression analysis depicted in Exhibits 4.3-7 and 4.3-8, using projected population growth by county. Projections of developed lands have been updated since the Draft EIS to account for minor adjustments in the regression analysis.
3 Note that this figure represents allocation of all of the secondary population growth in Rockingham County (*i.e.*, 714 persons) to the 18 communities in that portion of the socio-economic study area.

the analysis includes numerous undeveloped parcels and many areas where substantial wetlands also occur. With a renewed emphasis on smart growth and in-fill development in New Hampshire, clearly some portion of the future growth would occur in areas that fall within the definition of "developed land." So, an approach that allocates 100% of the future growth to undeveloped land would represent a very conservative estimate.[83]

It can be seen from these data that the two counties differ in their environmental characteristics. For example, stratified drift aquifers are substantially more common in Strafford County (34.0 percent of the total land area) than in Rockingham County (only 8.0 percent), due to the differing glacial geology of the two regions. This suggests, if we assume that development occurs in a random spatial pattern, that approximately 0.34 acre of aquifer will be impacted for every acre of development in Strafford County, while only about 0.08 acre of stratified drift deposit would be impacted in Rockingham County per additional acre of development. Given that the secondary growth land conversion methodology predicts that about 278 acres of additional land will be converted by 2025 in Strafford County, then as much as 95 acres (0.34 x 278 acres) of stratified drift aquifer could be impacted due to secondary growth in the Strafford County portion of the socio-economic study area. The corresponding prediction for Rockingham County would be that approximately 11 acres of stratified drift aquifer could be impacted, due to the fact that less land conversion is predicted in this region and because the resource is far less common. Table 4.3-9 shows similar estimates for several important environmental resources for Strafford and Rockingham Counties.

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83 This revised approach was taken in this FEIS in response to comments from the USEPA and the Seacoast MPO.

Table 4.3-8
Natural Resources in the Undeveloped Portion of the Socio-Economic Study Area

County	Undeveloped Area (acres)	Aquifer[1] (acres)	Aquifer[1] (percent)	Farmlands[2] (acre)	Farmlands[2] (percent)	Wetlands[3] (acres)	Wetlands[3] (percent)	Wildlife Habitat[4] (acres)	Wildlife Habitat[4] (percent)	100-year Floodplain[5] (acres)	100-year Floodplain[5] (percent)
Rockingham	149,030	11,846	8.0	2,729	1.8	28,383	19.1	132,935	89.2	13,503	9.1
Strafford	197,670	67,162	34.0	11,122	4.5	18,994	9.6	173,808	87.9	44,441	22.5

Notes:
1 Stratified drift deposits, per USGS mapping.
2 Important Farmland Soils, per Natural Resource Conservation Service (NRCS) published soils surveys.
3 Wetlands have been updated from the Draft EIS based on newly available data in the NHF&GD Wildlife Action Plan GIS database, which is based on National Wetlands Inventory, USFWS and Hydric Soils from the NRCS. Based on comments received on the DEIS, the proportion of wetlands in each county was re-evaluated using additional data sources and the totals adjusted in this FEIS to reflect the resource agency's technical recommendations.
4 Wildlife habitat estimates have been updated since the Draft EIS to use definitions in the NHF&GD's Wildlife Action Plan, 2005
5 Flood Insurance Rate Map, Federal Emergency Management Agency.

Table 4.3-9
Estimated Natural Resource Impacts Potentially Caused by Secondary Growth

Resource	Strafford County[1] (percent)[3]	Strafford County[1] (acres)	Rockingham County[2] (percent)[3]	Rockingham County[2] (acres)	Total (acres)
Aquifer	34.0	95	8.0	11	106
Farmland Soils	4.5	13	1.8	2	15
Wetlands	9.6	27	19.1	26	53
Wildlife Habitat	87.9	244	89.2	120	364
100-year Floodplain	22.5	63	9.1	12	75

Notes:
1 Assumes 278 acres of secondary land development for Strafford County.
2 Assumed 135 acres of secondary land development for Rockingham County.
3 Data from Table 4.3-8 represent a measure of how common the resource is on the undeveloped portion of each county's landscape.

A basic assumption of this methodology is that the future land development will occur in a "spatially random" pattern. That is, land development is assumed to occur without regard to the occurrence of environmental resources. This assumption is obviously simplistic, given that communities, the State of New Hampshire and the Federal government all have established policies and regulations to discourage development that impacts sensitive resources. In addition, the method assumes that the current relationship between population and land development remains constant into the future. This assumption may not hold true either, since planning in the region has begun to emphasize "Smart Growth" concepts whereby cluster development, in-fill, and redevelopment is encouraged over the "sprawl" pattern of the past several decades. Nevertheless, the fact that these assumptions are simplistic does not invalidate the approach, but does suggest that the methodology results in a very conservative (worst case) estimate of possible indirect impacts.

For example with regard to wetlands, the above estimate ignores the fact that all wetlands in New Hampshire are protected under State statutes, local ordinances, and as such, are subject to scrutiny and permitting. At the federal level, most wetlands fall under the protection of the Clean Water Act. Records kept by NHDES indicate that in New Hampshire, between 1999 and 2006 the authorized conversion of wetlands statewide (*i.e.,* with approved dredge and fill permits) totaled about 1,168 acres, or an average of approximately 146 acres per year. During that same eight-year period, the statewide population grew by approximately 114,000 people.[84] This equates to a wetland impact rate of approximately 0.01 acre/person. Note that this actual rate of impact is roughly one-third of the projected rate derived by the regression methodology (53 acres/1,851 persons = 0.03 acre/person), which supports the conclusion that the estimates are very conservative.

The estimated environmental impacts presented in Table 4.3-9, while not trivial, are minor when considered in light of the total amount of growth and concomitant development pressure that study area will face in the future, particularly when considering more than 21,500 acres of additional land are projected to be developed under the 2025 No-Build condition in the study area communities. The results indicate that communities in the region should prepare for future growth whether the Turnpike improvements are constructed or not. They also suggest that area communities should evaluate their current land use policies. For example, some of these most vulnerable resources (such as wetlands) are protected by regulation, whereas unfragmented habitat, farmland, and aquifers are not necessarily protected.

4.3.3.4 Traffic Sensitivity Analysis of Potential Secondary Growth

Table 4.3-4 shows the potential secondary population growth in 2025 of 1,865 people in Strafford and Rockingham Counties as a result of the Eight-Lane Alternative. Applying the projected estimated average of 2.4 persons per household for the project area (2025) to the anticipated increase in population results in 777 additional households within the two counties in 2025 under the Build condition. A traffic sensitivity analysis was performed to evaluate if this secondary growth would have any substantial affect on the traffic operations analysis results previously presented herein for the 2025 Build condition. The following analysis focuses on the critical weekday peak hour conditions, specifically at the Exit 6 northbound off-ramp during the weekday evening peak hour and at the Exit 3 southbound off-ramp during the weekday morning peak hour.

Whereas the potential increase in population and households are considered to be nominal for the overall project area, an absolute worst case scenario was constructed to demonstrate the project's ability to absorb the potential secondary growth. For example, it was assumed that all 777 additional households would be single family homes (which is the highest residential trip generation land use) and that residents of each of the additional single family homes (regardless of where they reside) will

84 Data from the NH Office of Energy and Planning, http://www.nh.gov/oep/programs/DataCenter/index.htm

commute across the Little Bay Bridges during the critical weekday evening peak hour. It is important to note that these assumptions are considered overly conservative and somewhat unrealistic, and are only being used for this traffic sensitivity analysis. Applying the Institute of Transportation Engineer's (ITE) trip generation rates for single family homes (Land Use Code 210), the 777 additional households would generate approximately 785 new trips during the weekday evening peak hour. Assigning all of these trips to the Turnpike and to crossing the Little Bay Bridges (using the existing 65% northbound and 35% southbound directional split during the weekday evening peak hour), results in 510 additional trips northbound and 275 trips southbound. Again adding to the level of conservatism in this evaluation, no reduction in single occupant passenger vehicles was assumed to account for the use of transit or ride-sharing in the study area.

Existing travel patterns show that approximately 58% of the weekday evening peak hour northbound traffic on the Turnpike continues on the Turnpike past Exit 6, 25% exit the highway at this location to connect with westbound US 4, and 17% exit eastbound to Dover Point Road. Applying these existing percentages to the 510 additional trips northbound on the Turnpike results in 214 trips exiting via Exit 6 with 127 vehicles turning left and 87 vehicles turning right. These increases were applied to the 2025 Build weekday evening peak hour volumes at the intersection of Dover Point Road and the Exit 6 northbound off-ramp and the signalized intersection capacity analyses were recalculated. The analysis results show that the intersection will continue to operate at LOS C as previously reported under Table 4.2-6 under the 2025 Build condition with the additional trips associated with the potential secondary growth. In addition, the projected maximum queues for the off-ramp will still be less than the 550 feet of storage that is intended to be provided for each turn lane. Carrying this analysis to the intersections adjacent to the Exit 6 northbound ramps, US Route 4 at the Exit 6 southbound ramps to the west and US Route 4 at Dover Point Road to the east, yields similar results with no change in level of service. Both intersections continue to operate at the same level of service (with no appreciable increase in delay) as previously reported in Table 4.2-6 under this conservative evaluation of potential secondary growth.

Conducting a similar analysis for the weekday morning peak hour, results in the 777 households generating approximately 585 new trips. Again, assuming that all of these trips are single occupant vehicles (SOVs) traversing the Little Bay Bridges during the weekday morning peak hour results in 410 additional trips (70%) in the southbound direction and 175 trips (30%) in the northbound direction. Of the trips traveling southbound approximately 105 trips (26%) would potentially exit the Turnpike via Exit 3 with 70 vehicles turning right (to Woodbury Avenue) and 35 vehicles turning left (to Arboretum Drive) at the signalized off-ramp intersection. Table 4.2-6 shows that this signalized intersection is projected to operate at LOS B during the weekday morning peak hour under the 2025 Build condition. The minor increases associated with the potential secondary population growth will have no substantial impact on traffic operations at this location which will continue to operate at LOS B. This sensitivity analysis was carried east to the Woodbury Avenue intersection with the Exit 3 northbound ramps, which will also continue to operate at the same LOS B or better as previously reported with no increase in intersection delay.

In addition to the critical intersection analyses noted above, freeway segment analyses were performed for the weekday morning and evening peak hour conditions along various segments of the Turnpike assuming the secondary growth projections. Consistent with the conservative analysis assumptions previously described above, it was assumed that 100 percent of the commuter traffic generated by 777 additional households associated with secondary growth would travel via the Turnpike and traverse the Little Bay Bridges during the peak hour conditions. For these particular freeway segment analyses it was assumed that during the 2025 weekday evening peak hour, the 510 additional northbound trips cited above would travel the length of the Turnpike from Exit 1 to Exit 6 with 214 trips exiting via Exit 6 and the remaining 296 trips continuing north toward the toll plaza. Similarly, for the 2025 weekday morning peak hour analysis it was assumed that the 410 additional trips cited above would travel southbound on the Turnpike from the toll plaza to Exit 3, with 105 trips exiting at Exit 3 and the remaining 305 trips continuing south through Exit 1.

Table 4.3-10 shows the freeway segment analysis results for the 2025 Build scenario including the secondary growth projections. These results are compared with the analysis results for the 2025 No-Build and 2025 Build (without secondary growth) conditions. As shown, all freeway segments along the Turnpike are anticipated to operate at acceptable levels of service under the Build Alternative with no change in levels of service as a result of the potential secondary growth.

Table 4.3-10
2025 Freeway Segment Analysis Summary – Secondary Growth

	2025 No-Build			2025 Build			2025 Build + SG*		
	Volume+	# Lanes	LOS^	Volume	# Lanes	Volume	Volume	# Lanes	Volume
PM Peak Hour									
Exit 1 to 3 NB	3,805	2	E	4,015	3	D	4,525	3	D
Exit 3 to 4 NB	4,685	2	F	5,580	4	D	6,090	4	D
Little Bay Bridge NB	5,145	2	F	5,850	4	D	6,360	4	D
Exit 6 to Toll Plaza	2,890	2	D	3,330	3	C	3,625	3	C
AM Peak Hour									
Toll Plaza to Exit 6 SB	2,915	2	D	3,900	3	D	4,310	3	D
Little Bay Bridge SB	4,805	2	F	5,505	4	D	5,915	4	D
Exit 4 to 3 SB	4,235	2	F	5,245	4	D	5,655	4	D
Exit 3 to 1 ESB	3,250	2	D	3,900	3	D	4,205	3	D

* Secondary growth.
\+ Volume measured in vehicles per hour.
^ Level of service.

These analysis results demonstrate that the Selected Alternative has adequate capacity along the Turnpike segments, as well as at the major intersections along US Route 4, Dover Point Road and Woodbury Avenue to accommodate the anticipated increases in population resulting from the potential secondary growth, even under the exaggerated conditions assumed for the sensitivity analysis. It is important to keep in mind that in reality, traffic volume increases associated with secondary growth will be substantially less on the Turnpike and local roadway system than evaluated in this sensitivity analysis. Based on the secondary growth trip assignments described above for the exaggerated scenario, it can be concluded that actual traffic volume increases that will be realized within the project area resulting from secondary growth will have no substantial impact on the Turnpike or local roadway system feeding the Turnpike.

4.3.4 Cumulative Impacts

Cumulative impacts are defined by NEPA and the CEQ as the impact on the environment that results from the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over time. The time period considered for this analysis of cumulative impacts is approximately 35 years prior (1970 to 2005) and 20 years into the future (to 2025).

4.3.4.1 Historical Development Context[85]

An examination of the economic and social trends in the regional study area indicates that key structural relationships, especially between Strafford and Rockingham Counties, have changed substantially during the past 20 to 30 years. Key trends that will provide a foundation for future growth patterns in the study area are briefly outlined below:

- The regional study area has experienced substantial growth over the past 20 to 30 years. However, the rate of growth over the most recent decade, between 1990 and 2000, was considerably slower than in the two previous decades (1970-1990). In addition, population growth in Strafford County consistently exceeded that of the Rockingham County portion of the study area for all three decades examined. Rockingham County as a whole, however, grew somewhat faster than Strafford County.

85 Note that the majority of this Section of the Final EIS was contained in Section 4.3.1, Social and Economic Trends, of the Draft EIS. It has been reorganized to present a clearer discussion of the trends affecting cumulative effects.

- It is unlikely that the growth rates experienced during the 1970s and 1980s will be repeated within the foreseeable future for several reasons. The first is due to a diminishing land supply and escalating costs of housing construction. The second is that considerable changes have been made to land use regulations in the study area communities since the boom growth of the 1980s, as well as the fact that many communities are now taking a more pro-active approach to managing growth and preserving open space.

- Based on New Hampshire Office of Energy and Planning projections, population within the study area is expected to increase by approximately 60,000 between 2000 and 2025, representing a growth of 27 percent (average annual growth rate of 0.95 percent). In comparison, the study area's population increased by approximately 78,000 between 1970 and 2000, a 55 percent increase (average annual growth rate of 1.5 percent).

- The average household size has declined within almost all communities in the study area over the last decade. Consequently, the projected decline in the rate of population growth for the study area will not necessarily result in a corresponding decrease in the number of new households and new housing units created within the study area in the future.

- The study area has a relatively small percentage of minority and economically disadvantaged residents. Based on Census 2000 data, less than 4 percent of all residents are characterized as being in the racial minority and 7.3 percent are living below the poverty income threshold.

- Approximately 27,250 dwelling units were added to the study area's housing supply over the past 20 years. This represents a total increase of 39.5 percent, or an average annual growth rate of 1.6 percent. Total housing growth in the Rockingham County portion of the study area was somewhat higher than that of the Strafford County portion (14,211 versus 13,290, respectively) if the decrease of 1,183 dwelling units in Portsmouth's housing supply, caused primarily by the closing of Pease AFB, is not considered.

- Residential construction trends in the study area have fluctuated substantially over the last 15 to 20 years. Overall, building permits for 25,272 residential dwellings were issued between 1985 and 2002, representing an annual average of approximately 1,400. Total permits issued went from a high of 3,752 in 1986 to a low of 579 in 1991. As of 2002, the number of permits issued (1,576) had returned to approximately half the number issued annually during the boom growth of the late 1980s.

- Housing costs rose steadily throughout the study area with home sale prices increasing annually by approximately 8 percent between 1992 and 2002. The Strafford area consistently had lower average prices throughout the decade, in comparison to the Rockingham area, although its rate of appreciation (119 percent) during this time period exceeded Rockingham's (106 percent). This is an indication of the substantial role that the Strafford housing market plays in offering more affordable housing in contrast to the higher priced homes available in the Rockingham portion of the study area.

- There has been considerable fluctuation in the area's labor force and unemployment rate over the last decade due to changing economic conditions at both the regional and national levels. At the beginning of the 1990s, the recession resulted in the highest unemployment rates of the decade at 7 percent as well as a corresponding decline in the total labor force, which decreased by approximately 5,000 during the first part of the decade. Through the middle part of the 1990s, the economy began to rebound, which resulted in a sharp drop in the unemployment rate. As the unemployment rate began to drop, the area's labor force also started to recoup some of the losses incurred at the beginning of the decade. By 2002, the total labor force exceeded the 1990 level by approximately 7,000.

- Total employment within the study area, as of 2001, was approximately 106,900. Employment increased by 26 percent between 1993 and 2001, slightly exceeding the State of New Hampshire's 24 percent growth. During this time period, total private sector employment increased by approximately 21,000, or almost 30 percent, while government sector employment increased by approximately 1,500, or 11 percent. The redevelopment of the Pease International Tradeport has played a substantial role in the area's employment growth. Since the facility was converted to civilian use in the early 1990s, approximately 4,900 jobs have been created there, roughly equivalent to 20 percent of the total increase that occurred within the study area over the decade.

- The number of private sector establishments in the study area experienced a net increase of approximately 1,270 between 1993 and 2001. This represents a growth of 24 percent, which is somewhat less than the rate of employment growth. This suggests that a shift toward slightly larger firms (in terms of total number of employees) occurred within the study area over the last decade, although this increase would be relatively modest. Notable changes occurred in the services sector, which experienced a net gain of approximately 19,360 jobs over the course of the decade; a 97 percent increase. Conversely, the retail sector experienced the largest decline in total employment with a net loss of approximately 3,270, a decrease of 17 percent, which eliminated gains that had been recorded toward the end of the 1990s. The manufacturing sector lost employment as well, albeit at a lesser rate (668 jobs, or a 4.2 percent decrease), despite also having experienced gains during the previous decade.

- Vacancy rates in the office and industrial building markets within the study area are relatively high. As of 2002, vacancy rates were estimated to be 15 percent for office properties and 12 percent for industrial facilities. Retail properties, however, appear to be in better condition with an estimated vacancy rate of about 7 percent. At the Pease International Tradeport alone, vacancies for office and industrial facilities were even higher with respective rates of 20 percent and 31 percent. These higher vacancies are largely attributable to the downsizing that occurred in the high-tech industrial sector. Despite the high vacancies at the Tradeport, there is presently 278,000 square feet of space under construction and another 436,500 square feet approved for future construction. The facility presently has approximately 2.6 million square feet of existing building space.

- A review of journey-to-work commuting data shows that approximately 74 percent (85,221) of all workers living in the study area are also employed at businesses located within the study area. This indicates that there is a strong internal movement of residents related to employment occurring within the study area.

- In Strafford County, the number of residents working outside the County increased by approximately 20 percent between 1990 and 2000. The largest portion of this increase represented workers going to Rockingham County, which received approximately 65 percent of all outbound commuters from Strafford County as of 2000. There was a decrease in the number of Strafford County residents commuting to Maine during the decade, which may be attributable to a reduction in workforce at the Portsmouth Naval Shipyard in Kittery, Maine.

- Rockingham County had a larger percentage of residents (47 percent) commuting outside the county in 2000 than did Strafford County (39 percent). Of the total residents commuting outbound, the largest percentages traveled to Hillsborough County (24 percent) and the State of Massachusetts (59 percent). Only 6 percent (4,254) of those commuting outside the county for work had Strafford County as a destination. Although this data represents the whole of Rockingham County, and not just the portion of the County in the study area, it still provides a level of magnitude concerning the directional flow of commuters residing in the County.

4.3.4.2 Present and Future Development Context

Historical population growth trends, as well as population projections, indicates that the rate of growth within the study area appears to have leveled off for the foreseeable future. However, due to a decline in average household size over the last several decades the rate of new household formation has remained somewhat higher than the population growth rate. The combination of these factors suggests that the number of housing units constructed in the future may occur at a rate that exceeds population growth, a fact that is significant with regard to transportation planning efforts within the region.

Another observation, based on the data analyzed, is that the Portsmouth-Rochester metropolitan area has become much more integrated from an economic perspective, particularly within the last ten years. This finding is supported by commuting patterns, which show that over three-quarters of all people living in the metropolitan study area also work within the area. This transportation linkage is especially prevalent among residents of Strafford County, many of whom commute to jobs located in Rockingham County. While this trend is also true for residents of the Rockingham County portion of the metropolitan area, there is a somewhat higher percentage of people living in Rockingham County that commute outside the study area to employment locations in Massachusetts and elsewhere in New Hampshire.

Two major factors have helped to shape the commuting patterns mentioned above. The first is that a substantial portion of the business and job growth in the metropolitan study area has occurred within Rockingham County. This observation is illustrated by the closure of Pease Air Force Base and its redevelopment as the Pease International Tradeport in Portsmouth/Newington, where the number of jobs created since 1990 account for approximately 20 percent of the net job growth over the last decade within the study area. Combined with this higher job growth in the southern tier is a commensurate increase in the cost of housing. Housing costs in Rockingham County have remained consistently higher than those in Strafford and Carroll Counties over the last decade. This fact has attracted sustained residential growth to the northern portion of the study area, which has supported an expanding workforce of commuters who require access to the regional transportation system.

However, there are a number of new activities that may alter the economic relationship between the portion of the study area located in Strafford and Rockingham Counties. Due to population growth in Strafford County, it is expected, as outlined below, that new employment and retail activities will be developed in the Strafford County portion of the study area.

4.3.4.3 Past, Present and Future Development Activities[86]

In addition to these possible changes related to the Spaulding Turnpike project, there are also other past, present and future development activities that could impact the study area. These possible cumulative impacts are described below.

New Hampshire Seacoast Region Wastewater Management Study

In 2003, the Great Bay Estuary Commission was created by the New Hampshire State Legislature to work with the NHDES to examine options for addressing wastewater treatment and disposal, restoring the estuary habitat, and creating a watershed district

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86 The discussion in this Section was presented in Section 4.3.4, Cumulative Impacts, of the Draft EIS. It has been reorganized to present a clearer discussion of the trends affecting cumulative effects.

for the Great Bay Estuary. The Great Bay Estuary is a tidally dominated embayment covering approximately 17 square miles, with 144 miles of shoreline in both Strafford and Rockingham Counties.

In the fall of 2004, an 18-month feasibility study was initiated with the purpose of weighing alternatives to meet the wastewater and septage management needs of the 44 communities. (These 44 communities include all 33 of the municipalities in the Spaulding Turnpike socio-economic study area). There are 16 wastewater treatment plants in the study area that discharge treated wastewater into streams that empty into the Great Bay Estuary. Thirty-one communities in the region currently have no municipal collection or treatment systems, relying on private on-site septic systems.

The ultimate goal of the study is the identification of four preliminary alternatives for final evaluation that will be vetted using water quality, engineering, economic, environmental impact, and public acceptance criteria, as well as 20-year growth projections for the region. Possible alternatives include:

Upgrade to advanced treatment: Upgrade existing plants to advanced wastewater treatment and continue to discharge treated effluent at present locations.

Discharge to the Atlantic Ocean: Continue with the same level of treatment, with discharge of treated effluent to the Atlantic Ocean. Three alternatives discharge sites at different distances from the shore will also be evaluated.

Advanced treatment with land application of treated effluent: Upgrade the existing plants to advanced wastewater treatment and discharge treated effluent *via* land application (up to four sites will be evaluated).

Build a new regional wastewater treatment facility: Replace the existing treatment plants with a new regional wastewater treatment facility with secondary treatment and a regional wastewater conveyance system. Treated effluent would be discharged to the Atlantic Ocean at one of three alternative sites at different distances from the shore. Septage receiving treatment would also occur at the regional wastewater facility.

For the first three options, non-sewered communities with a need for a wastewater treatment facility would build a collection system and connect to one of the existing wastewater plants. In addition, septage receiving treatment would be considered if septage capacity were over one million gallons per day. These changes could substantially alter development patterns within the study area.

Pease International Tradeport

The redevelopment of the Tradeport, formerly Pease AFB, is a substantial economic initiative within the study area. Since the closure of the base in 1991, it has evolved into a major hub of commercial, industrial, and airport-related land uses that is located adjacent to the southern edge of the project area. As of 2003, approximately 2.6 million square feet of buildings have been constructed, renovated and occupied since the facility was converted to civilian use. According to the PDA, the agency overseeing redevelopment of the property, an additional 278,000 square feet are under construction and 436,500 square feet have been approved for future construction.

Although development is still occurring at the Tradeport, the facility has not remained unaffected by past economic downturns. According to a 2003 real estate report, office and industrial vacancy rates were 20 percent and 30 percent respectively, at the end of 2002. This represented approximately 639,000 square feet of unoccupied space at the facility. Given current economic conditions, these vacancies, which are primarily attributed to recent high-tech downsizing, are being slowly absorbed by the market.

Remaining undeveloped land at the Tradeport totals approximately 110 acres of commercially and industrially zoned land (some of which is constrained by wetlands) and 110 acres of airport-zoned land. Although this is a relatively small amount of acreage in terms of the Tradeport's total land area, there is still potential for substantial building square footage to be developed in the future, based on a transportation plan[87] completed for the facility in 2002. Estimates presented in that report suggest that an additional 1.5 million square feet of buildings could potentially be constructed at the Tradeport in the future. Some of this development represents the expansion of existing facilities, but also includes the potential for construction of 300,000 square feet related to aircraft manufacturing, expansion of the commercial airport passenger terminal and New Hampshire Air National Guard operations, as well as other new office, industrial, and hotel uses.

It should be noted that the build out of the Tradeport is included in the land use component of the Seacoast Travel Demand Model. Thus, the future transportation demand created by Tradeport development is included in the traffic modeling for this EIS and is therefore accounted for in the Selected Alternative.

Liberty Mutual Expansion

The Liberty Mutual Insurance Company, a Boston-based international insurance company, is in the process of a major expansion of its existing office facility complex in the City of Dover. The office complex, located on Sixth Street in Dover with direct access to Exit 9 of the Spaulding Turnpike, *via* Indian Brook Drive, was constructed during the mid-1990s when the company first established facilities at this location.

The company presently employs approximately 1,400 people at this site, which contains roughly 255,000 square feet of building space on 220 acres. The planned

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87 *Update - Pease Surface Transportation Master Plan,* Vanasse Hangen Brustlin, Inc. October, 2002.

expansion will add 300,000 square feet to the site and still allow land for future growth. The company expects to add approximately 1,600 additional workers in the new facility, which will bring the total employees on-site to approximately 3,000, making it the largest employer in the city.

Liberty Mutual also employs 1,400 people at its Borthwick Avenue facility in Portsmouth, as well as 1,100 at leased facilities at other Seacoast locations. Although no official announcements have been made, it is anticipated that the company will relocate some portion of its employees from leased facilities to the new building in Dover. This could result in a shift in traffic commuting patterns along the Spaulding Turnpike corridor

Regional Retail Expansion

Like many areas of the country, Strafford and Rockingham Counties have experienced growth in the retail sector of the economy driven largely by the construction and expansion of what is commonly referred to as “big box retailers,” such as Wal-Mart, Home Depot, and Lowe’s. Although these retailers have numerous locations within the study area, one recent development of regional significance is the Epping Crossing project located at the intersection of NH 101 and NH 125 in the Town of Epping. This site contains approximately 450,000 square feet of retail space that includes a Wal-Mart Supercenter and a Lowe’s Home Improvement store. Potential future development on an adjacent site includes 200 acres of industrial land. This development is substantial in that it represents a new major retail hub on the NH 125 corridor between Plaistow and Rochester that is likely to result in additional satellite development around this highway interchange. This will attract consumers, who had previously frequented other retail locations within the study area.

The Epping Crossing development project, based on building size or number of employees, is in and of itself considered a project of regional significance. However, retail expansion within the Spaulding Turnpike regional study area has exhibited overall growth trends over the last decade and a half that are considered substantial from a cumulative impact perspective. These trends might best be defined as a decentralization of retail growth. The term decentralization is used in this case to refer to growth outside the historical retail centers located, for example, in areas such as Portsmouth, Dover, Rochester, and Newington. In some instances this decentralized growth has resulted in the expansion of existing “second tier” retail areas like NH 33 in the Stratham/Exeter area. In other cases, it represents the establishment of new retail nodes in areas like US 4 in Northwood or the Lee Traffic Circle, at the intersection of NH 125 and US 4, in Lee.

The occurrence of this decentralized retail growth does not mean that the historical retail centers have stagnated. On the contrary, these areas have both expanded and experienced in-fill and redevelopment of existing sites. The fact that these historical areas have continued to grow while secondary and rural areas have also expanded or been established is interpreted as an indication that population levels within the study area have reached substantial thresholds capable of supporting these outlying retail locations. This type of growth has ramifications for traffic and commuting patterns as a whole within the study area that may result in a redistribution of traffic levels and congestion areas that affects a broader portion of the regional roadway network.

Spaulding Turnpike Improvements, Exits 11 - 16

In addition to the Spaulding Turnpike improvements that are the subject of this EIS, other improvements from Exit 11 to Exit 16 are planned, which were analyzed in a 2001 Environmental Assessment, and which are currently in final design.

Within the City of Rochester, the Turnpike's limited two-lane capacity is taxed by commuter and recreational-related through traffic in conjunction with locally generated residential and employment-related traffic. North and south travel lanes are not separated in this area, which presents an unsafe condition for this high-speed Turnpike facility. The purpose of the Rochester project is to alleviate existing and projected levels of congestion and improve safety on this two-lane section of the Spaulding Turnpike, and to relieve resulting traffic problems at interchanges and intersections with city streets.

Peak hour traffic flow along the Turnpike between Exit 12 and Exit 16 is capacity constrained (Level of Service E) and subject to congestion and long delays in both northbound and southbound directions. In addition, the Exit 12 northbound and southbound off-ramp intersections with Route 125, the Farmington Road intersection with the northbound on and off-ramps at Exit 15, and the Washington Street/Walnut Street/North Main Street intersection also operate at capacity. Off-ramp turning movements are difficult and subject to long delays. As such, peak hour traffic congestion results in delays on the Turnpike and within the influence areas of the interchanges.

The current need to increase Turnpike capacity and to plan for future improvements, that include the upgrade of the interchange areas, has been heightened by several factors. Regional population and employment growth trends are expected to continue. Expansion of the Port of Portsmouth and the redevelopment of Pease Air Force Base have also taken place. Local Rochester development pressures have continued, particularly in proximity to interchange areas such as Exit 13. Several areas of on-going and projected residential and industrial development do not have direct access to the Turnpike, and traffic from these areas must pass through the center of Rochester to connect with the Turnpike or other east-west highways.

The project would align new northbound and southbound roadways between the west and east side of the existing Spaulding Turnpike. This alignment would begin at a point 2,000 feet south of Exit 12 with a new southbound roadway constructed to the west of the existing Turnpike as far as Exit 13. In the vicinity of the bridge crossing with Exit 13, this alternative would begin a weave to the east, where the existing Turnpike would become the southbound roadway and the proposed barrel would be the northbound roadway. This alignment would be maintained until Exit 15 where the alignment would weave back to the west side.

The proposed roadway would travel over the Cocheco River north of Exit 15 and bridge over the former B&M Railroad right-of-way and Chestnut Hill Road. Parallel structures would be constructed west of the existing structures at the Cocheco River, B&M Railroad and Chestnut Hill Road. The existing structures would be maintained in this area for northbound traffic. The roadway would also pass over the Chestnut Hill Road Connector and the Route 16 Connector. After passing the Exit 16 northbound and southbound on- and off-ramps, respectively, the Turnpike would be tapered to meet existing conditions (one lane in each direction, undivided roadway). The limit of work would be approximately 5,500 feet north of the Exit 16 interchange.

Spaulding Turnpike, Exit 10

The Spaulding Turnpike is the only road providing limited access, freeway service from Interstate Route 95 in Portsmouth to the tri-city area of Rochester, Dover and Somersworth. However, there is no direct interchange access from the Spaulding Turnpike to the City of Somersworth. Due to the lack of a direct connection to Somersworth, access to this city from the Spaulding Turnpike is presently provided at Exits 9 and 12.

The State Legislature enacted the Laws of 1993, Chapter 259, which directed NHDOT to proceed with the environmental study necessary for the construction of Exit 10 and the necessary road network to connect the new interchange to a major highway east and west of the proposed interchange.

The basic purpose of the Exit 10 project is to improve the regional transportation system, thereby providing opportunities for orderly and coordinated economic development within the tri-city region of Dover, Rochester and Somersworth by enhancing access to the Spaulding Turnpike from the east.

The study of Exit 10 still needs to be completed and the Selected Alternative has yet to be identified. However, the NHDOT's recommended alternative includes a new interchange located in Rochester, just south of the Blackwater Road underpass of the Spaulding Turnpike, with a connecting road extending easterly for approximately two miles where it would intersect along Interstate Drive with NH 108. It then extends further east to West High Street. Creation of the new Interchange will have direct environmental effects which are the subject of a NEPA study.

4.3.4.4 Environmental Consequences of Cumulative Impacts

Direct and indirect impacts of the Selected Alternative are discussed in other sections of this FEIS. Cumulative impacts are not causally linked to the Selected Alternative, but are the total effect of actions with similar impacts in a broader geographic area. The purpose of a cumulative impacts analysis is to look for impacts that may be minimal and therefore neither significant nor adverse when examined within the context of the proposed action, but that may accumulate and become both significant and adverse over a large number of actions.

The predicted growth in the socio-economic study area will result in the conversion of vacant land and agricultural land for residential, commercial, institutional, industrial, and recreational use. The effects of this process of conversion are likely to be most notable in the undeveloped portions of the study area, given current development activity and the land regulations governing development today. However, it should be noted that a renewed focus on community planning in an effort to stop land sprawl and encourage better land use policies has recently created new opportunities for in-fill and redevelopment. Therefore, some portion of future development would occur within already-urbanized areas.

As discussed above, based on current trends in population growth, it can be expected that the conversion of land from undeveloped to developed will impact natural, social and cultural resources. Table 4.3-7 contains a summary of quantitative predictions of future land consumption. One way to interpret these data is to consider the “No-Build” impacts to be indicative of likely future land consumption, *i.e.,* cumulative impacts resulting from other actions not under the control of NHDOT and/or the FHWA. As shown in this table, more than 21,000 acres of land within the socio-economic study area is expected to be converted from undeveloped to developed land by the year 2025 even without completion of the Spaulding Turnpike Improvements. This development will likely impact natural and cultural resources as the seacoast region grows.

To supplement these data, the following discussion below provides additional information on the general types of cumulative impacts that could be expected in the socio-economic study area, as well as the measures that the federal, state, and local governments can take to mitigate these potential cumulative impacts.

Agricultural Land

The location and degree of land conversion will be guided by zoning regulations in each of the communities. Current zoning in the study area communities recognizes agricultural uses, but in some situations permits rural residential uses that could alter the sparsely populated agricultural landscape. The current northeastern farm economy, in combination with increasing land values, will provide incentives for remaining farmers to sell agricultural land for other uses. The comprehensive plans of many area communities recognize the value of productive agricultural land and have taken measures to protect farmland as part of their planning efforts. Local zoning regulations adopted to protect areas of prime agricultural land can regulate cumulative impacts to agricultural land uses. However, substantial loss of valuable farmland could occur as willing sellers and buyers contribute to conversion of farmland or open space to residential or commercial uses.

As part of the mitigation for project-related impacts, NHDOT and FHWA have cooperated with the City of Dover and the Strafford Rivers Conservancy to permanently preserve 120 acres of the Tuttle Farm on Dover Point. This property is reportedly the oldest family-owned farm in the country, being in the Tuttle family since the 17th century. It represents a natural and cultural resource and its protection will help protect a piece of New Hampshire's agricultural heritage.

Wetlands

The continued growth and development associated with the trend of urbanization throughout the socio-economic study area would bring a corresponding continued impact on wetlands. Similarly, expansion of existing or construction of new transportation facilities may also impact wetlands.

Excavation of marsh or wet meadow wetlands may occur as residential development encroaches on wetlands and as a result of the preference of developers and residents for the aesthetics of open water over emergent or meadow vegetation. A resulting effect of increased open water wetlands could be a decrease in typical wetland species (biodiversity) in the area. Potential indirect impacts on wetlands from residential development could occur from stormwater discharges into wetlands. Increased flow into wetlands could alter hydrology, causing changes in plant communities and disrupting life cycles of wetland inhabitants. Increases in stormwater flow and increased nutrients and sediment also could result in wetland degradation.

Fragmentation of wildlife habitat could also occur with increased development. Many animals use both wetlands and uplands during their life cycles. Isolating or developing all the uplands surrounding wetlands would negatively affect animals commonly associated with wetlands. Direct impacts, such as filling, would be likely to occur in smaller wetlands. While these smaller, isolated wetlands are regulated by the NHDES Wetlands Bureau, and mitigation for larger impacts is often required, some loss of these small, isolated wetlands could occur.

All wetlands in New Hampshire are protected under State statutes, local ordinances, and as such, are subject to scrutiny and permitting. At the federal level, most wetlands fall under the protection of the Clean Water Act. In New Hampshire, there is a Statewide Programmatic Program for sharing this responsibility between NHDES and the USACOE. Records kept by NHDES indicate that in New Hampshire, between 1999 and 2006 the authorized conversion of wetlands statewide (*i.e.,* with approved dredge and fill permits) totaled about 1,168 acres in New Hampshire or an average of approximately 146 acres per year. Offsetting this loss during the same eight-year period has been the creation or restoration of more than 320 wetland acres and the preservation of another 12,860 acres of upland and wetland.

The existing regulations protecting wetlands reduce the potential for cumulative adverse effects on wetlands. Additionally, NHDES rules concerning compensatory mitigation provide minimum ratios for creation, restoration or preservation to compensate for wetland losses.

Wildlife

Additional development and associated construction of roadways in the study area could reduce or fragment wildlife habitat and place stress on wildlife species. Roadways can also create barriers to wildlife movement and can result in wildlife/vehicle collisions. Development in the larger communities in the study area would generally fall within urbanized areas, so few impacts on wildlife populations would be expected. Increased urbanization would introduce a shift in diversity within the vegetative landscape as a result of the transition from forest land and agricultural use to rural/suburban residential uses. Future development could also result in some loss of grassland, forest, and wetland habitat, particularly if large, wooded tracts and wetlands are not protected.

Local development controls, conservation easements, and other measures could protect or increase available wildlife habitat if local units of government are willing and able to undertake such actions. Within the study area, large amounts of habitat would continue to exist in a natural state through the protection of state, local and private conservation lands throughout the area. Given the amount of available habitat and the overall health of wildlife populations in the study area, it is not anticipated that the proposed project, in combination with other reasonably foreseeable future actions, would result in substantial adverse impacts on wildlife.

Water Quality and Quantity

At present, there is no precise data available regarding the type and density of development that would occur. However, urbanization of existing open land would likely continue to result in increased impervious surfaces. As the percent of impervious surface is increased in a watershed, the volume of stormwater runoff increases. Increased runoff, if not properly managed, can have a variety of negative impacts on receiving water bodies. These potential impacts include increased chances of flooding, erosion of streambanks and drainage ways, warming of stream waters, and decreased groundwater base flow due to less infiltration.

Stormwater management practices are routinely used to reduce the magnitude of these potential impacts. It is notable that NHDES regulations on stormwater management are undergoing a major revision, and future stormwater treatment practices will be much more effective than past practices. Included in the revisions to the regulations that are currently being contemplated are more stringent stormwater treatment standards, which are designed to focus increased management efforts on water quality in addition to the traditional runoff volume standards.

In addition to increased impervious surface area, other infrastructure requirements of urbanization can negatively affect water quality. Water supply wells are often required in developed areas. A potential effect of removing large amounts of groundwater for water supply can be to reduce groundwater base flows in groundwater-fed water bodies. This effect can be exacerbated by the increase in impervious surfaces discussed above. It is noteworthy that newer stormwater best management practices are being developed, such as permeable pavement and infiltration basins, which could mitigate these effects as they become more commonplace in future development designs.

Additional wastewater treatment facilities may also be required in urban areas. While treatment of this wastewater would be required and current wastewater treatment technology can remove almost all of the nutrients in wastewater, trace levels still exist in their effluent. Discharge of this treated wastewater can affect the quality of receiving water bodies. Some of the local jurisdictions planning for growth assume that wastewater can be managed by a private septic system, addressed on a lot-by-lot basis. There is some potential for these systems to seep into groundwater when the soil conditions in which they are constructed are inadequate for the role they must perform. Existing land use regulations at the state and town levels specify a minimum lot size, which allows adequate land for septic systems and private wells to function effectively.

Finally, increased traffic on the Turnpike and other roads increases the risk of toxic spills occurring near a waterbody or within a sensitive aquifer. Such a spill could have serious impacts on water quality and aquatic habitat if a variety of stormwater treatment and runoff detention measures are not in place to prevent adverse impacts on water resources. A spill response team, coordinated by the NHDES, currently exists for the tidal waters of the Piscataqua River, as well as the Little Bay and Great Bay. However, this team is geared towards managing large-scale spills resulting mainly from the commercial use of the waterways and is not well suited to smaller spills. This responsibility lies mainly with the local emergency responders, most of whom are generally well trained and equipped to handle this type of situation.

Floodplain

Substantial floodplains are associated with nearly all of the major streams and rivers in the study area, as well as all of the tidal portions of the Great Bay estuary. Most of the communities in the study area participate in the National Flood Insurance Program, which requires these participating communities enact local regulations to manage floodplain development. Much of these regulations, however, are focused on building standards for structures located within the floodplain to minimize damage to those structures, and do not necessarily prevent development.

Thus, population growth and the concomitant increase in development of residential, commercial and industrial properties have historically and will likely continue to impact floodplain resources. Although the proposed action has negligible effects on floodplain, additional cumulative impacts to floodplains can be expected to result from development and conversion of land resources in the study area.

Air Quality

Traffic increases in the project area will occur as land develops. While transportation is a major source of the carbon monoxide, air toxics, volatile organic compounds, and nitrogen oxides that contribute to ozone formation, emissions from motor vehicles and industrial sources are expected to continue to decrease due to improvements in technology and new regulatory approaches.

A benefit of the project will be the reduced congestion and reduced energy use that will result from the transportation improvements, including the TSM and TDM measures. Emissions from mobile sources are likely to decrease due to new national standards for fuels and engines that will be implemented over the next two decades. These reductions will take effect gradually over two decades as existing vehicles and engines are replaced by newer and cleaner models. Given the effect of these air pollution reduction measures and despite the additional traffic (direct and indirect) in the project area, it is not anticipated that the proposed project, in combination with other future actions, would result in substantial adverse impacts on air quality.

Noise

Anticipated land development in the socio-economic study area will increase the number of sensitive receptors (*e.g.*, homes, parks, recreation areas, churches, nursing homes). The number of noise generators, such as roadways that generate traffic-related noise and other sources such as manufacturing facilities and mechanical units on commercial or institutional buildings, is also expected to increase. The most notable change in noise levels will be observed in the relatively undeveloped portion of the study area. However, the effects of traffic noise involve several characteristics, such as the distance between the noise source and sensitive receptor, the amount of traffic on a particular road, whether there are natural or man-made barriers, the layout and density (large lot *vs*. cluster or more compact subdivision) of adjacent neighborhoods, topography and many other factors.

Where feasible and reasonable, noise mitigation (noise walls or barriers) along high-volume highways could be considered to satisfy state and federal requirements, thereby lessening these cumulative effects. In addition, local governmental units have the authority to decrease noise impacts on sensitive receptors by designating exclusive land uses in areas of highest noise impact, requiring appropriate subdivision design that would create a buffer to reduce the impacts of noise on sensitive receptors, requiring noise insulation, or restricting time periods when noise can be generated. Given the variety of available noise mitigation strategies, it is not anticipated that the traffic (direct and indirect) associated with the proposed project, in combination with other future actions, would result in substantial adverse noise impacts.

Community Resources

The conversion of some rural, small town communities to a more urbanized character will have effects that are difficult to measure. Protecting the character of and maintaining the services available to a community will be the charge of the local units of government and will depend on the values and priorities of elected officials.

Changes to communities that result from growth and urbanization can be seen as either positive or negative, depending on one's perspective. Increasing development pressure will require careful policy- and decision-making by local units of government to minimize adverse cumulative impacts on the affected communities. However, increased development is strongly related to economic expansion, which creates jobs, and therefore opportunities, for area residents.

Parks and Recreational Lands

Community plans in the area typically include the adequate provision of recreational facilities to serve the community. Additional development in the area could place pressures on park and recreation area operations, as visitors to these facilities increase and nearby development begins to limit opportunities for park expansion. Potential development could also limit activities (such as hunting) or diminish the quality of the outdoor experience (nearby development creates visual or noise intrusions).

Aesthetics

Additional development and associated roadway construction may affect the aesthetic qualities of the study area. However, the need to protect the most universally valued environments are recognized in resource management and comprehensive plan policies in the area. The pleasing aesthetic values of the river corridors, agricultural lands, and hillsides in the region are recognized in community planning documents. And many communities are devoting resources to actively protect these areas by acquiring conservation easements of key parcels (for example, the Dover Open Lands Committee efforts in protecting lands in Dover).

Individuals who value natural and rural environments will view further development in the socio-economic study area as a degradation of aesthetic value. Orderly and well-designed built environments may be equally valued by others. These differences in values cannot be clearly interpreted as adverse impacts.

Archaeological and Historical Resources

The seacoast region of New Hampshire is particularly rich in historical resources, with an abundance of pre-historic Native American and historic colonial European and early American settlements. Background to help the study area communities better understand these resources is included in Sections 3.17 and 4.17 of this Final EIS.

Increasing development pressures in the socio-economic study area could encourage the demolition of vacant or under-utilized historic buildings and farmsteads if reuse of such properties is not found to be economically viable. Changes in land-use patterns associated with development could alter the setting of some historic properties. Development of parcels surrounding historic farmsteads could make it more difficult for farmers to continue active agriculture in close proximity to urban residential and commercial development. Conversely, the potential for development may provide financial gain on properties that have languished or been unproductive. Increasing property values and desirability of the area could also provide economic incentives and market support for the rehabilitation and reuse of historic buildings. Further development of previously undeveloped lands may also disturb existing archaeological sites, both in rural areas and the historic archaeology in urbanized areas such as Portsmouth. However, as a result of the USACOE permitting process, NHDHR is taking a more active role in reviewing new development proposals than at any time in the past, which will tend to better identify and preserve these cultural resources.

Potential impacts to National Register-listed or eligible properties will be reviewed under the Section 106 process if federal funds, permits or licenses are required as part of an undertaking. National Register listing, however, does not prevent demolitions or other negative effects on properties if federal funds, licenses or permits are not required. Privately funded development would only be reviewed if located in a local historic district, or applied to a locally designated property.

Local communities can enact further controls to protect historic properties. Designation of historic properties by local governments can provide some protection for their preservation, as well as design review to guard against inappropriate changes that can destroy the historic characteristics of properties.

4.3.5 Environmental Justice

In accordance with Executive Order 12898 and subsequent procedures developed by the US Department of Transportation, activities that have the potential to generate a disproportionately high and adverse effect on human health or the environment shall include explicit consideration of their effects on minority and low income populations. In making an assessment of whether or not Environmental Justice (EJ) has been served, information regarding race, color or national origin, and income level should be obtained where relevant, appropriate and practical. Specific consideration should be given to those populations that are most directly served or affected by the proposed action.

Executive Order 12898 does not define the terms "minority" or "low-income." However, guidance provided by CEQ (EPA 1998) describes these terms in the context of EJ analysis. These definitions are unique to EJ analysis and are the basis for the methodology that follows:

- Minority Individual - A minority individual is classified by the US Bureau of Census as belonging to one of the following groups: American Indian or Alaskan Native, Asian or Pacific Islander, Black (not of Hispanic Origin), and Hispanic.
- Minority Populations - According to the CEQ Guidelines, minority populations should be identified where either (a) the minority population of the affected area exceeds 50 percent or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.
- Low-income Population - Low-income populations are identified where individuals have incomes below the US Department of Health and Human Services poverty guidelines. A low-income population is either a group of low-income individuals who live in proximity to one another or who share common conditions of environmental exposure or effect. However, concentrations of the elderly, children, disabled, and other populations protected by Title VI and related nondiscrimination statutes in a specific area or any low-income group should be discussed if they are described as low-income or minority. The basis for this determination should also be documented.

Although not specifically mentioned in Executive Order 12898, an impact assessment of the elderly, children, and disabled population groups protected under Title VI should also be included in the EJ analysis, since these groups could experience adverse impacts as a result of an action. The elderly population are defined as individuals who are age 65 and over, while people with disabilities have a mobility and/or self-care limitation, as defined by the U. S. Census Bureau.

As part of the Socio-Economic Baseline Conditions Report completed in August 2004[88], the following data were used to identify minority and low-income populations in the study area:

- Population data regarding racial composition from the 2000 US Census;
- Income data from the 2000 US Census; and
- Graphical representations of Census Block Group (Block Group) boundaries from the 2000 US Census.

88 *Socio-Economic Baseline Conditions Technical Report for the Newington-Dover, Spaulding Turnpike Widening Project*, prepared for the NHDOT by RKG Associates, Inc., August 1, 2004.

This EJ analysis evaluates the characteristics of minority and low-income persons within the project area block groups that have the potential to be disproportionately impacted by the proposed project alternatives. The Baseline Report indicated that approximately 3.8 percent of the project area's population would be classified as minority as compared to 3.2 percent for the regional study area. The Baseline Report included several block groups in the City of Portsmouth that are not within the project area, but are adjacent to it along the Gosling Road corridor. These block groups were included because of the existence of a subsidized housing project (Gosling Meadows) that contains 124 units of housing for low-income families.

Based on a subsequent review completed by the NHDOT, only two block groups (812.2 and 685.3) were defined as being within the area impacted by the project. The minority, elderly, low-income, and disabled populations of these block groups were compared against the populations of the immediately surrounding block groups as part of the EJ evaluation process. This evaluation revealed that the EJ population within the impacted area was meaningfully greater than the surrounding population, as illustrated in Table 4.3-11. One reason for this is the location of the Great Bay School on Woodbury Avenue in Newington, which provides vocational training for disabled individuals and operates a group home on-site that contains 12 single occupancy rooms.

The conclusion of the NHDOT Environment Justice evaluation is that additional outreach efforts should be taken to encourage public comment and participation from the minority and low-income population groups. The minimum accessibility design requirements must be met in accordance with Title II of the Americans with Disabilities Act and it may be necessary to alter the existing pedestrian right-of-way within the scope of the project. It is recommended that Notices of public information meetings will be sent to the Great Bay Residential Facility in Newington, which is the facility where the disabled population is housed.

Table 4.3-11
Environmental Justice Population Analysis[1]

Study Area	Avg. % Elderly Population	Avg % Minority Population	Avg. % Low-Income Population	Avg. % Disabled Population
Impacted Area (BGs 812.2 & 685.3)	13.5%	4.7%[2]	4.3%[2]	25.3%
Surrounding Area[3]	17.6%	2.8%	2.5%	25%

Notes:
1 Data is from NHDOT Inter-Office Communication, dated June 21, 2005
2 The population percentage identified is meaningfully greater than the surrounding area and constitutes an EJ population. Targeted outreach efforts to solicit public participation have been taken due to the characteristics of this particular study area.
3 Defined as all block groups immediately adjacent to the impacted area.

4.3.6 Socio-economic Conclusions and Mitigation[89]

4.3.6.1 Direct Impacts

The social and economic analysis indicates that the 3.5 miles of proposed improvements identified for the Spaulding Turnpike would have minimal direct impacts on the communities of Dover and Newington. Property acquisitions for the five Build Alternatives evaluated range from approximately 4 to 43 acres. In addition, possible reduction in municipal property tax revenues is also extremely small, representing less than one percent of total property tax revenues in 2004. As discussed in Section 3.3, a major market related shift has occurred during the last 10 to 15 years between Rockingham and Strafford Counties that has substantially altered the economic and social linkage between the two counties. This change, due to employment growth in Rockingham County and the lower cost of housing in Strafford County, has resulted in an integrated regional economy that is still continuing to evolve. Recent data now indicates that Strafford County, due to a variety of factors, is now attracting more employment producing business activities. This will probably further alter the economic relationship between the two counties.

Although the direct economic effects associated with the Selected Alternative are relatively small, the impact to landowners will be mitigated. Property requiring acquisition will be appraised utilizing techniques recognized and accepted by the appraising profession and in conformity with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended, and applicable to New Hampshire State Law. The amount offered for partial acquisitions is the difference between the fair market value of the property before the highway is built and its value after the portion needed for the highway has been acquired and the highway constructed. Completed appraisals are carefully reviewed by an independent appraiser to ensure that requirements of condemnation law and acceptable appraisal methods are met.

The Selected Alternative currently does not require the full acquisition of any residential properties. If the Selected Alternative requires residential acquisitions, the displaced residents would be eligible for relocation benefits, which include:

- Fair market value for acquired property
- Relocation advisory assistance services
- Payments for moving and relocation costs
- Replacement housing payments for the home owner
- Residential mortgage interest differential payments and closing costs

89 This information was largely contained in the Draft EIS in Section 4.3.7, Conclusions and Mitigation, and Section 4.3.5.4, Mitigation, but has been reorganized to better present the information.

Two businesses would be acquired under the Selected Alternative. The displaced businesses will be eligible for relocation benefits, which include:

- Fair market value for acquired property
- Relocation advisory assistance services
- Payments for actual reasonable moving
- Business re-establishment costs

If identification of affordable housing for any resident displaced by the Selected Alternative proves unfeasible, last resort housing will be made available in accordance with Section 206 of the Uniform Act and governing regulations. As part of the right-of-way acquisition process, particular attention will be given to the current residents of these properties to assure that the needs of the displaced parties are adequately addressed and the project will not knowingly discriminate against low-income and minority residents of the project area.

4.3.6.2 Indirect and Cumulative Effects

An economic forecasting and policy analysis model (the REMI model) was used to evaluate indirect social and economic impacts on 33 communities located in the study area. A No-Build analysis revealed that the present rate of fairly brisk growth (in terms of population, employment and income), experienced by these communities since the 1970s would likely continue, but at a slightly slower rate. However, an evaluation of possible indirect effects due to improvements on the Spaulding Turnpike indicated only a small impact on population and employment growth rates within the Strafford and Rockingham communities included in the study area. Although the rate of population growth in Strafford County communities is slightly higher than Rockingham County communities within the study area, under the Build Alternatives, the differences within the counties are less than two percent of the population growth rate identified under the No-Build analysis. Employment under both alternatives would also increase at a slightly faster rate after project completion in 2015. Although the change in employment and population due to the roadway improvements may seem small, the results of the REMI model indicates that the economic integration of the two counties will likely continue into the future.

A number of factors were identified that could contribute to cumulative impacts. These include continued development at the Pease International Tradeport, business growth in Strafford County such as the expansion of Liberty Mutual in Dover, continued decentralization of retail growth in the region and possible implications of a regional wastewater management study.

Neither the Council on Environmental Quality (CEQ) regulations nor FHWA's environmental policy or guidance documents implementing NEPA requires mitigation of indirect land use impacts associated with highway improvement projects. Specifically, the CEQ regulations are silent regarding the issue of mitigation for indirect impacts. FHWA policy as governed by 23 CFR 771.105, discusses mitigation in Sections (d)(1) and (d)(2) for adverse impacts that actually result from a project and that the mitigation represents a reasonable public expenditure. The section does not specifically address mitigation for secondary impacts.

In addition, the permitting requirements associated with Section 404(b)(1) Guidelines governing the US Army Corps of Engineers' wetland permit are limited to requiring mitigation for indirect impacts that are quite specific and predictable relative to location and degree. More generalized secondary impacts like those associated with possible future growth in a region do not require mitigation. Instead, such potential impacts are identified, evaluated, and documented in relation to all other impacts so decision-makers have pertinent information on hand to make informed decisions.

4.4 Topography, Geography and Soils

Construction activities associated with the project will cause perceivable changes in topography, geology and soils within portions of the study area in Newington and Dover. These changes will be due to the removal, filling, and grading of rock and soil necessary to construct the new travel lanes, intersections, *etc.* Estimated amounts of cut and fill quantities are presented in Table 4.4-1.

There will be limited economic effects on the geology of the study area from the proposed project. There are no operating rock quarries or sand/gravel pits within the study area. An abandoned gravel pit containing soils derived from till is located to the south of Arboretum Drive in Newington. The gravel pit area which is now becoming vegetated will not be impacted by the proposed project.

4.4.1 Newington Segment

Newington Alternatives 10A and 12A result in substantially more fill than Alternative 13 because these alternatives raise the grade of the Turnpike, relocate the railroad spur, or construct substantially more infrastructure at the new Exit 3 interchange. More specifically, Alternative 10A proposes to elevate the Turnpike over the Pease Spur Railroad by up to 30 feet at the railroad. Similarly, Alternative 12A raises the Turnpike over the relocated Pease Spur Railroad, and the constructed southbound off-ramp and northbound on-ramp at Exit 3 are also raised over the relocated spur. Since Alternative 13 would leave the Turnpike largely at grade, much less fill is required. Any future rail line would pass over the Spaulding Turnpike. For all three alternatives, the excavation of material occurs primarily along the southbound travel lanes from the start of the project to Exit 3.

Table 4.4-1
Estimated Cut and Fill Volumes of Soil and Rock

Alternative	Cut [1] (cubic yards)	Fill (cubic yards)	Net Fill (cubic yards)	Rock[1] (cubic yards)
Newington				
10A	100,000	1,050,000	950,000	15,000
12A	190,000	1,090,000	900,000	40,000
13	215,000	450,000	235,000	40,000
Bridge Segment				
Widen/Rehabilitate	10,000	100,000	90,000	0
Widen/Remove	10,000	100,000	90,000	0
Dover				
3	60,000	290,000	230,000	0
2	55,000	290,000	235,000	0

Note:
1 Rock totals are an estimate of required ledge removal, and are included in the total cut volumes.

4.4.2 Bridge Alternatives

Both bridge alternatives would result in the same amount of cut and fill. This is to accommodate the widening of the approaches leading to and from the Little Bay Bridge.

4.4.3 Dover Segment

Both Alternative 2 and 3 require generally the same amount of cut and fill. The excavation of material is related primarily to the removal and adjustment of existing roadway sub-base materials. Fill materials are generally related to the need to maintain the Turnpike and ramps approximately four feet or higher above the floodplain elevation in most locations, as well as widening and reconfiguring the Exit 6 Interchange ramps and Dover Point Road over the existing Turnpike.

4.5 Farmlands

4.5.1 Impact Methodology

Impacts on Important Farmland Soils (see Section 3.5.2 for definitions) were calculated by overlaying the roadway alternatives on a map identifying the particular soil series associated with prime, unique, statewide important, and locally important farmlands (see **Figure 3.5-1**). Areas identified as "urbanized" according to the most recent US Census have been excluded consistent with the Farmland Protection Policy Act (FPPA) of 1984.

The FPPA requires that all Federal agencies assess the effect of converting existing or potential farmland areas to non-agricultural use. The FPPA specifically directs Federal agencies to (1) identify the effect of federally-funded projects on farmland; (2) consider alternative actions to lessen impacts; and (3) ensure the project, to the extent practicable, is compatible with local, state, or federal programs to protect farmlands. The FPPA excludes land already in or committed to urban development or water storage. Important farmland soils that lie within NHDOT's right-of-way were hence excluded from analysis as having already been "converted" to highway use. Results of the analysis were used to prepare the US Department of Agriculture's Farmland Conversion Impact Rating Form (see Appendix C).

Impacts on active farmland or areas currently in use for row crops, hayfields/pastures, and orchards were estimated by field inspection and thorough review of the aerial color orthophotos available for the project area. It should be noted that some areas that were identified as "Pasture/Field" for the analysis of wildlife habitat (see Section 3.7.2) may be large mown areas and not necessarily active farmlands. Exclusion of any of these areas for this analysis was made by a site-by-site inspection.

4.5.2 Build Alternatives

Table 4.5-1 summarizes impacts to the various types of farmland soils by alternative.

Table 4.5-1
Farmland Soil Impacts (acres)

		Segment and Alternative					
		Newington			Bridge	Dover	
Resource	No-Build	Alt. 10A	Alt. 12A	Alt. 13	Widen West	Alt. 2	Alt. 3
Prime Farmland	0	3.8	7.8	2.7	0	0	0
Unique Farmland	0	0	0	0	0	0	0
Statewide	0	0	1.5	0	0	0	0
Local	0	0.01	0.01	0.01	0	0	0
Total	0	3.8	9.3	2.7	0	0	0

Newington Alternatives

Impacts on important farmland soils for the Newington alternatives vary from 2.7 to 7.8 acres of prime farmland, 0 to 1.5 acres of statewide important (Alternative 12A only), and less than 0.1 acres of locally important (same for all three alternatives).

One notable difference among the alternatives is the relatively large impact to Prime Farmland that would result from Alternative 12A. Note that the relocated railroad spur accounts for the majority of this impact. There are no impacts to unique farmland soils.

There are no impacts to any active farmland in the Newington section.

Bridge Alternatives

There are no impacts to either important farmland soils or active farmland in the Bridge Segment.

Dover Alternatives

The US census mapping identifies the Dover portion of the study area as an urbanized area. Since urbanized areas are excluded from consideration under the FPPA, it was determined that there are no farmland soils in this area (see **Figure 3.5-1**). Therefore, there are no impacts to important farmland soils. There are also no impacts to any active farmland.

Summary of Farmland Impacts

The above impacts to important farmland were evaluated using the US Department of Agriculture's Farmland Conversion Impact Rating Form (AD-1006; Appendix C). Parts I, III, and VI were prepared by NHDOT. The NRCS completed Parts II, IV, and V.

Using the rating form, none of the project alternatives has a total score that exceeds 160 points, which the threshold established by NRCS requiring further consideration. As a consequence, no additional alternatives or protective measures need to be evaluated (*Supplemental Guidance for Implementation of Farmland Protection Act, FHWA, Jan. 23, 1985*).

4.5.3 No-Build Alternative

The No-Build Alternative would not affect important farmland soils or active farmland, since there would be no new construction.

4.5.4 Secondary Impacts

Indirect and cumulative land use impacts are described in Sections 4.3.3 and through 4.3.5. The land conversion estimates attributed to potential future population growth and the associated residential and business development are provided. It is difficult to estimate how much important farmland soil area may be affected by the possible growth attributed to the Turnpike widening. Projections are speculative and dependent to a large extent on the relative strictness of local land use regulations and policies. For planning considerations, it was calculated that about 1.8 percent and 4.5 percent of the landscape in the undeveloped portion of the socio-economic study area contains important farmland soils in Rockingham and Strafford Counties, respectively. The possible future conversion of an additional 135 acres of land in Rockingham County and 278 acres in Strafford County under the Build condition therefore equates to about 2 acres and 13 acres of additional farmland soils affected in each county, respectively.

4.5.5 Mitigation

Although the project results in relatively minor impacts on important farmland soils and does not impact any active farmland, the project does mitigate its potential effects. First, property owners will be compensated through the right-of-way acquisition process for unavoidable impacts to their land. Any valuable topsoil (*i.e.*, loam) salvaged during construction will be re-used on roadway slopes. Finally, as part of the project's mitigation, NHDOT partnered with the City of Dover and the Strafford Rivers Conservancy to permanently preserve 120 acres of the Tuttle Farm on Dover Point. This property is reportedly the oldest family-owned farm in the country, being in the Tuttle family since the 17th century. It represents a natural and cultural resource and its protection will help protect a piece of New Hampshire's agricultural heritage.

4.6 Freshwater Wetland Resources

NEPA, Section 404 of the Clean Water Act, and Executive Order 11990 require consideration of impacts to wetland acreage and functions and values. Other impacts considered include habitat fragmentation, the effects of runoff (*e.g.,* erosion, sedimentation, and flooding), impoundment, and other hydrologic modifications, and temporary disturbances incurred during road construction that may adversely affect wetland functions.

This section of the EIS discusses impacts to non-tidal (freshwater) wetlands. Tidal wetland impacts, which occur only in the Bridge Segment, are fully addressed in Section 4.10. Freshwater wetland resources were mapped and evaluated according to the methodologies presented in Section 3.6.2. In Newington, mapping includes thirty-two wetlands (N-1 through N-23, including several multi-part systems) that were identified as being potentially subject to impacts from one or more of the various Build Alternatives. Functional evaluations were performed on each of these wetlands. In Dover, thirteen wetlands (D-1 through D-12) were analyzed for functions and values as they are subject to potential impacts from one or more of the Build Alternatives.

In general, wetland resources within the study area consist of fragmented habitats that have been impacted by the construction of the Spaulding Turnpike, other roadways, rail beds, and residential, commercial and industrial development that characterize large sections of the study area. Hydrologic flows are constricted by this development in some wetlands (*e.g.* at culverted road crossings), while other wetlands appear to have formed in response to stormwater runoff from roadways in drainage ditches or swales, or are associated with commercial development (*e.g.* stormwater detention basins). The least developed portion of the study area exists in Newington to the west of the Turnpike between Arboretum Drive and Nimble Hill Road. This area has a relatively high diversity of habitat and wetland functions and values.

As described in Section 3.6.3, wetland functional evaluations were performed during the summer of 2005. **Figure 3.6-4** provides a summary listing of these functional evaluations. In Newington and Dover, functional evaluations indicate that most of the wetlands provide a minimum of three principal functions related to water quality and wildlife habitat, with an average of four principal functions found in the 44 assessed wetlands.

Perhaps the most valuable wetlands in Newington (as indicated by functional assessments) are Wetlands N-2 (a large forested and shrub wetland complex located to the east of Railway Brook) and Wetland N-4b (emergent marsh and deadwood swamp associated with Upper Pickering Brook and Railway Brook). These wetland systems were documented to provide up to seven functions and values.

In Dover, substantial wetland areas include Wetland D-2 (a forested, shrub, and emergent wetland complex located north of Pomeroy Cove and east of the Exit 6 off-ramp to Dover Point Road.), Wetland D-7a (a forested wetland located to the north of Spur Road, comprising portions of Bayview Park), and Wetland D-10 (located between the Spaulding Turnpike and southbound on-ramp at Exit 6). These wetlands provide between five and six principal functions and values.

Impacts to wetlands associated with the three alternatives in Newington (Alternative 10A, 12A, and 13) and two alternatives in Dover (Alternative 2 and 3), as well as the freshwater wetland impacts in the Bridge Segment, are described in more detail in the following sections. A wetland impact database is included in Appendix K.

A comprehensive mitigation package is being proposed. The proposed mitigation package considers the wetland functions and values lost due to the project-related impacts and compensates to the degree practicable, for these lost functions and values. The compensatory mitigation to offset these proposed project impacts is discussed in Section 4.6.5.

4.6.1 Impact Methodology

Wetland impacts must be addressed under the USACOE Highway Methodology, a process that merges the NEPA/Section 404 requirements to facilitate decision-making. Wetland issues must also be addressed under Executive Order 11880, State of New Hampshire regulations, and local wetland regulations. To comply with all levels of wetland regulations, the proposed project must adhere to the following "sequencing test" of the USEPA Clean Water Act, Section 404(b)(1) Guidelines.

First, it must be shown that wetland impacts are being avoided to the maximum extent practicable (*i.e.*, within reasonable economic and engineering design parameters). Then, wetland impacts that cannot be avoided must be minimized through design techniques (*e.g.*, steeper than normal fill slopes, crossing wetlands at narrowest possible locations, *etc.*, as practicable). Finally, compensatory mitigation for the unavoidable loss of wetland functions must be provided. Compensation can be provided by enhancing existing wetlands, restoring degraded wetlands, preserving important existing wetland/upland systems, creating new wetlands, or some combination of these techniques.

For the purposes of comparing alternatives, the areas of wetland impacts were determined by measuring the wetland area to be permanently excavated or filled (not including clear zones and easements) based on wetland mapping. The total amount of permanent wetland impact, by cover type, for each alternative, was determined and is shown on Table 4.6-1.

4.6.2 Build Alternatives

Impacts to freshwater wetlands result from the proposed highway improvements, particularly from changes in the vicinity of Exits 3 and 6. The total amount of freshwater wetland impacts from each of the Eight-lane Build Alternatives show minimal variability from each other in both Newington and Dover. Impact quantities among specific wetland cover types show a greater range between alternatives than do total wetland impacts. As in much of New England, the most common types of wetlands in the study area in both Newington and Dover are forested wetlands, with lesser amounts of emergent and shrub wetlands. Project-related impacts to these wetlands are roughly proportional to their extent on the landscape.

As explained below in the sections for Newington, Dover and Bridge segments, proposed roadway improvements affect differing freshwater wetland cover types and their corresponding functions and values. Impacts to intertidal and subtidal wetlands within the Bridge Segment are discussed briefly in this section only in relation to the wetland mitigation package (see Section 4.6.5). A more detailed discussion of impacts to tidal wetlands and marine habitats is addressed in Section 4.10.

Table 4.6-1 shows impacts to freshwater wetlands by alternative. There are no direct or indirect impacts to either of the two verified vernal pool locations with any of the Build Alternatives.[90]

Newington Segment

In Newington, most of the wetlands within the project corridor to the east of the Turnpike and in the northern one-third of the project corridor on both sides of the highway are associated with surface water features such as perennial and intermittent streams, shallow drainageways, or beaver-influenced ponds. The remaining wetlands in the western two-thirds of the study area are largely influenced by underlying glacial outwash deposits and thus either recharge or discharge associated aquifer areas.

Table 4.6-1
Freshwater Wetland Impacts (acres)[1]

		Segment and Alternative					
			Newington		Bridge	Dover	
Resource	No-Build	Alt. 10A	Alt. 12A	Alt. 13	Widen West	Alt. 2	Alt. 3
Emergent Marsh (PEM)[2]	0	4.7	4.7	3.2	0.2	2.6	2.5
Forested Swamps (PFO)[2]	0	6.7	6.4	6.8	0.2	5.4	5.4
Scrub-Shrub Swamps (PSS)[2]	0	2.2	1.7	1.6	0	0.1	0
Total	0	13.6	12.8	11.6	0.4	8.1	7.9

Notes:
1 Impacts to estuarine wetlands are discussed in Section 4.10. Therefore, the totals shown here do not reflect total project impacts.
2 Wetlands are classified according to Cowardin *et al*. (1979). See Section 3.6 and **Figure 3.6-1** for more information.

Primarily due to their larger size and diversity, wetlands located to the west of the Turnpike associated with Railway Brook and Pickering Brook provide the largest number of wetland functions and values. These wetlands are located in a relatively unfragmented landscape (compared with the rest of the study corridor), much of which is located in the former expanses of Pease Air Force Base (and now owned by the Pease Development Authority). Large undeveloped portions of the Tradeport exhibit a variety of vegetative cover classes and interspersion of wetland and upland habitats. Because of this ecological complexity, most of this western area serves principally to provide wildlife habitat and water quality functions. Specific functions and values include: groundwater recharge/discharge, floodflow alteration, fish and shellfish habitat, sediment/toxicant retention, nutrient removal, production export, wildlife habitat, recreation, educational/scientific, uniqueness/ heritage, visual

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90 Neither of the verified vernal pools (PVP4 and PVP8) is located within 200 feet of any new paved area associated with the Selected Alternative. PVP8 is located more than 500 feet upgradient of grading/paving associated with the Selected Alternative. PVP4 is located in Newington in the extreme eastern portion of the study area, more than 1,000 feet from any proposed highway work.

quality/aesthetics, and endangered species. (Although endangered species are a function supported by one wetland in the study corridor, this area is not directly impacted by the proposed highway improvements.)

Each of the three Newington alternatives impacts differing amounts and types of wetlands and, in general, a proportional amount of the functions and values. Alternative 10A impacts the most amount of wetland area at 13.6 acres, with approximately 50 percent occurring to PFO wetlands, almost 35 percent of the impacts occurring to PEM wetlands, and the remaining impacts to PSS wetlands. Alternative 12A impacts a lesser amount of total wetland area than Alternative 10A at 12.8 acres, though nearly an equivalent percentage of impacts to each type of wetland would occur. Alternative 13, the Selected Alternative, impacts the least amount of wetland of each of the three Newington alternatives, with 11.6 acres. Over 58 percent of these impacts are to PFO wetlands, approximately 28 percent are to PEM wetlands, and the remaining 14 percent of impacts are to PSS wetlands.

PFO Wetland Impacts

PFO wetlands are the type of wetland that would incur the most impact from each of the three alternatives. Alternative 10A would impact 6.7 acres; Alternative 12A would impact 6.4 acres; and Alternative 13 impacts 6.8 acres of PFO wetland. The largest area of direct impact to forested wetlands occurs as a result of constructing the new Woodbury Avenue Interchange which will allow access and egress from the Turnpike and provide a connection for local access between Woodbury Avenue and Arboretum Drive. Wetlands N-2, N-3a, and N-3b are affected by these construction activities. The proposed improvements for this portion of the project result in similar impacts to PFO – 3.3 acres and 3.2 acres, respectively – for Alternative 10A and Alternative 12A. Alternative 13 results in 3.9 acres of wetland impact but the overall footprint on the landscape of this alternative is less (*i.e.* less impervious surface is created) than Alternative 10A or 12A, largely because a local traffic connector road to the west of the Turnpike and the industrial traffic connector between Shattuck Way and the local traffic connector is not proposed with Alternative 13.

Another large area of impacted PFO (Wetland N-8a) occurs as a result of shifting the northbound and southbound lanes of the Turnpike together in the vicinity of Exit 4. Each of the three alternatives would impact a similar amount of PFO, varying between 2.0 and 2.2 acres. As this wetland is vegetated largely with facultative plants and appears to be slowly transitioning to upland, functions and values are limited to wildlife habitat, groundwater recharge/discharge, and sediment/toxicant retention.

Smaller areas of impacted PFO are located within the highway median associated with Lower Pickering Brook (Wetland N-9b). As a result of shifting the northbound and southbound lanes together, Alternatives 10A and 12A would impact approximately 0.6 acre, while Alternative 13 would impact about 0.5 acre. Impacted functions and values include groundwater recharge/discharge, floodflow alteration, wildlife habitat, sediment/toxicant retention, and nutrient removal. Another smaller area of PFO (Wetland N-20b) located to the east of Asia Restaurant would be impacted by construction of the industrial traffic connector that is proposed with Alternative 10A. Less than 0.2 acre of wetland impact, with resultant lost functions similar to Wetland N-9b, would be lost as a result of the proposed connector road. Since Alternative 12A and 13 do not propose this connector road, no impacts would occur to Wetland N-20 from these alternatives.

PEM Wetland Impacts

PEM wetlands would incur less impact than PFO wetlands with Alternative 10A impacting 4.7 acres; Alternative 12A impacting 4.7 acres; and Alternative 13 impacting 3.2 acres.

The proposed Woodbury Avenue Interchange improvements also impact PEM wetlands. Alternative 10A and 12A would result in a total of 2.2 acres of impact, while Alternative 13 would result in only 1.6 acres of total impact because the local traffic connector road that is proposed for Alternatives 10A and 12A is not proposed as part of the Alternative 13, thus avoiding additional impacts to Wetland N-2. The majority of PEM impacts (approximately 1.5 acres) due to the new interchange from all three alternatives occur to Wetland N-3b. Consisting primarily of cattail marsh and vegetated manmade roadside ditches (which are mowed and rutted), impacted functions and values include sediment/toxicant retention, nutrient removal, and groundwater recharge/discharge (due to high groundwater table). Alternatives 10A and 12A would impact an additional area of 0.5 acre of PEM (Wetland N-2) further to west of the highway. Although this wetland area has less anthropogenic disturbance, it provides a higher level of functions due to its connection to adjacent forested and scrub-shrub wetland. Alternative 13 does not include this impact as the local traffic connector road would not be constructed. The remaining PEM impacts (Wetland N-2) associated with the Woodbury Avenue Interchange occur at Arboretum Drive and amount to less than 0.2 acre for all three alternatives. A minimum amount of sediment/toxicant retention and nutrient uptake functions would be lost at this location.

As a result of shifting the northbound and southbound lanes together, several smaller areas of PEM wetlands (Wetlands N-3c, N-8a, and N-9b) are impacted. These wetlands consist of primarily roadside ditches, detention basins and shallow marshes that receive and treat roadway drainage. Alternative 10A and 12A would impact similar amounts of these wetlands (2.2 acres and 2.1 acres, respectively). Alternative 13 would impact 1.7 acres of PEM.

Impacts to PEM would also occur with construction of the industrial traffic connector that ties Shattuck Way with the local traffic connector to the west of the Turnpike. The industrial connector is proposed for Alternative 10A and 12A, with PEM impacts amounting to nearly 0.5 acre and 0.3 acre, respectively. Alternative 10A would impact Wetland N-20b, N-21, and N-22 all of which provide sediment/toxicant retention, floodflow alteration, and nutrient removal as principal functions of these roadside wetlands. Alternative 12A proposes the industrial traffic connector approximately 2,000 feet to the south, with similar functions and values impacted in Wetland N-19b and N-19c. Because this connector is not proposed with Alternative 13, no additional PEM impacts would occur with this alternative.

PSS Wetland Impacts

As with the other types of wetlands, portions of existing PSS wetlands would be impacted by each of the three alternatives. Alternative 10A would impact 2.2 acres; Alternative 12A would impact 1.7 acres; and Alternative 13 would result in approximately 1.6 acres of impact to shrub wetlands.

The new Woodbury Avenue Interchange would result in impacts to Wetland N-2 and N-3b. Alternative 10A and 12A would result in impacts of 0.8 acre and Alternative 13 would impact 0.7 acre of these shrub wetland. Wetland functions lost due to these impacts include groundwater recharge/discharge, floodflow alteration, nutrient removal, and wildlife habitat.

As a result of shifting the northbound and southbound lanes together, several smaller areas of PSS wetlands (Wetlands N-3c, N-8a, and N-9b) are impacted. Alternative 10A would impact 1.0 acre; Alternative 12A would impact 0.8 acre; and Alternative 13 would impact 0.7 acre of shrub wetland. Wetland functions lost due to these impacts include mostly sediment/toxicant retention, floodflow alteration, nutrient removal, and wildlife habitat.

The remaining impacts to PSS wetlands occur as a result of construction of the industrial traffic connector road. With Alternative 10A, this amounts to 0.3 acre. Alternative 12A results in an insignificant additional impact (<0.1 acre) and Alternative 13 does not include this impact as the industrial traffic connector road would not be constructed with this alternative.

Bridge Segment

Two Bridge Alternatives were considered:

- Widen the Little Bay Bridges to the west, with the rehabilitation of the General Sullivan Bridge for bicycle and pedestrian access, *i.e.,* the "Selected Alternative"; and

- Widen the Little Bay Bridges to the west, accommodating bicycle and pedestrian on the widened bridge, and Remove the General Sullivan Bridge.

With regard to impacts to freshwater wetlands, however, both alternatives result in identical impacts. Both bridge alternatives shift the northbound and southbound lanes together, resulting in PFO and PEM wetland impacts of 0.4 acre. The PFO impact occurs to Wetland D-12, located to the west of the Turnpike, due to construction of the widened approach to the bridge. Wetland D-12 provides sediment/toxicant retention, nutrient removal, and floodflow alteration. As these impacts are to the edge of the wetland, remaining portions of Wetland D-12 will still provide these functions, albeit proportionally reduced because of the proposed impacts. The PEM impacts involve wetlands that have formed in roadside drainage ditches near the current on and off-ramps to Hilton Park (part of Wetland D-1). Principal functions of these roadside ditches include sediment/toxicant retention, nutrient uptake, and floodflow alteration.

Dover Segment

In Dover, sizeable, primarily forested wetlands are near to Exit 6 and further west in the vicinity of Bayview Park at Royals Cove. Smaller areas of emergent marsh are found adjacent to forested wetlands or have formed in response to highway stormwater drainage or other disturbances (*e.g.,*. gas pipeline construction). In contrast to wetlands in Newington, which are primarily associated with surface water and drainage features, the dominant wetland type (forested) in Dover has formed on glacial outwash deposits containing sand and gravel aquifers. Depending on the time of year, these wetlands either discharge from or recharge to the underlying aquifers. Functional assessments indicate that this is a primary role of many wetlands located in Dover. Other principal functions provided by these wetlands include: wildlife habitat (primarily for smaller mammals and birds), sediment/toxicant retention (mostly associated with areas of emergent marsh along roadways), floodflow alteration, and nutrient uptake.

Impacts to freshwater wetlands from both Dover Alternatives 2 and 3 are very similar as many elements of the proposed improvements are identical. Proposed improvements common to both alternatives include: a grade-separated Hilton Park connector, closure of Exit 5, reconfiguration of the Exit 6 northbound off-ramp to a signalized diamond interchange, closure of the northbound on-ramp from Cote Drive, conversion of the US 4 overpass to two-way traffic flow and construction of a new northbound on-ramp at Exit 6. The only substantial design difference between Alternative 2 and Alternative 3 exists in the vicinity of Spur Road, where Alternative 3 proposes construction of a grade-separated connector road between Spur Road and Boston Harbor Road.

In addition to impacts associated with the reconfiguration of Exit 6 within the study area as described below, the construction of Noise Barriers, #3 and 4 north of the Dover Tolls will impact a total of 1.7 acres of wetlands (see **Figure 4.6-1**).

PFO Wetland Impacts

As is the case in Newington, PFO wetlands are the most common type of wetland in Dover. As a result, these wetlands would incur the largest amount of impact from the two proposed alternatives. Alternatives 2 and 3 would result in 5.4 acres of impact. Perhaps the most substantial impact is to Wetland D-10, which would be impacted by both alternatives by the southbound on-ramp. In addition to providing habitat, Wetland D-10 receives and provides treatment for roadway drainage. Principal functions of Wetland D-10 include: groundwater recharge/discharge, wildlife habitat, sediment/toxicant retention, nutrient uptake, and floodflow alteration. Impacts to this wetland are unavoidable given the current configuration of the highway interchange, which originally segmented Wetland D-10 from Wetland D-2, that is located to the east of the Turnpike and Exit 6N. Wetland D-2 would receive the remainder of the impacts from both proposed alternatives due to reconfiguration of the off-ramp to Dover Point Road. Similar impacts to functions and values of Wetland D-10 would result from construction of this ramp.

PEM Wetland Impacts

PEM wetlands would be subject to nearly equivalent impacts of 2.6 or 2.5 acres from both Alternative 2 and Alternative 3, respectively. The largest PEM impact areas are associated with shallow roadside drainage areas that are part of Wetland D-2 and Wetland D-10. Additional PEM impacts occur to Wetlands D-1, D-3, D-6, and D-11. Each of these wetlands is similar in characteristic to other PEM wetlands in Dover and the rest of the study area, *i.e.* areas of shallow marsh that receive direct highway drainage and provide water quality functions. Principal functions include sediment/toxicant retention, nutrient removal, and floodflow alteration.

PSS Wetland Impacts

No PSS wetlands are impacted by the proposed alternatives.

4.6.3 No-Build Alternative

The No-Build Alternative would not have any direct impacts on wetland resources, since there would be no new construction.

4.6.4 Secondary Impacts

Impacts associated with potential secondary growth are discussed in Section 4.3 of this document. This evaluation involved designation of a socio-economic study area (*i.e.*, the region subject to the project's influence); forecasting potential population growth under both the build and no-build scenarios; interpreting how this growth would translate into future land use changes; and finally predicting how natural resources might be affected by those changes.

The secondary impact evaluation process used the results of the REMI model (Section 4.3.3.2) to predict economic activity and population growth for the year 2025 under the No-Build Alternative and under the assumption that the Turnpike would be widened to a total of eight lanes (four in each direction) between Exits 3 and 6. This approach led to a prediction that the Build Alternative could result in an additional population increase of approximately 1,865 people and an increase of approximately 1,897 new jobs by the year 2025, as compared to the No-Build

Alternative. In comparison, population in the socio-economic study area is expected to increase by approximately 50,450 and employment is expected to increase by approximately 26,734 by 2025 for the 20-year period between 2005 and 2025.

By establishing a relationship between the population of the Rockingham and Strafford County portions of the socio-economic study area, it was further estimated that 135 acres (Rockingham County) and 278 acres (Strafford County) of additional undeveloped land will be converted to accommodate development under the Build Alternative (see Table 4.3-6).

Using Geographic Information Systems (GIS), an analysis was performed to determine the percentage of the landscape covered by wetlands and assigning that proportion of the predicted growth as representing impacts to wetlands (see Section 4.3.3.3).

Assuming that additional growth will occur without consideration for sensitive resources (*i.e.*, future growth would occur in an unregulated manner), the analysis suggests a worst case scenario where a total of about 53 acres of additional wetlands (as mapped by the National Wetlands Inventory) would be lost to future development.
The above estimate ignores the fact that all wetlands in New Hampshire are protected under State statutes, local ordinances, and as such, are subject to scrutiny and permitting. At the federal level, most wetlands fall under the protection of the Clean Water Act. In New Hampshire, there is a Statewide Programmatic Program for sharing this responsibility between NHDES and the USACOE. Records kept by NHDES indicate that in New Hampshire, between 1999 and 2006, the authorized conversion of wetlands statewide (*i.e.,* with approved dredge and fill permits) totaled about 1,168 acres in New Hampshire or an average of approximately 146 acres per year. Offsetting this loss during the same seven-year period has been the creation or restoration of approximately 327 wetland acres and the preservation of another 12,860 acres of upland and wetland. In this context, some wetland loss could be expected to occur as an inevitable consequence of growth by the year 2025. This is the case with or without the project. However, this loss would be offset by compensatory mitigation, which is typically required for approval of wetland dredge and fill permits.

4.6.5 Compensatory Wetland Mitigation

This section presents preliminary wetland mitigation recommendations to compensate for approximately 22.8 acres of both freshwater and tidal wetland impact associated with the Selected Alternative, as well as three previously permitted or ongoing projects located in the vicinity of the Newington-Dover project. (See Table 4.6-2.)

4.6.5.1 Wetland Mitigation Summary

Background research and field assessments of candidate mitigation sites were conducted to develop these recommendations. Consultations with municipal officials, the Newington and Dover Conservation Commissions, as well as land protection specialists at the Nature Conservancy were also important in developing the mitigation proposal.

Numerous meetings were held with the natural resource agencies and other parties, including several field meetings to view potential mitigation parcels beginning in June 2005 and extending through March 2007. A list of these meetings is contained in Chapter 8.

Since publication of the Draft Environmental Impact Statement, progress has been made on acquisition of preferred preservation areas in both Dover and Newington, and public comment and new technical information have prompted recommendation of a preferred alternative for the restoration of Railway Brook in Newington, as discussed in more detail below.[91]

The mitigation proposal is guided by two general principles:

- The amount of mitigation in each community should be roughly proportional to the amount of impact in those respective communities; and
- The recommended package should contain a mix of restoration and preservation. [92]

The recommended package has four preferred components:

- **Newington – Restoration ("Alternative A") of approximately 3,100 linear feet of Railway Brook** (also known as Site NN-8 and Site NN-9)[93] - including restoration and expansion of floodplain wetlands adjacent to the stream within an approximately 300-foot wide corridor. The restored riparian corridor owned by the Pease Development Authority (PDA) would also be preserved by establishment of a permanent conservation easement. While the Draft EIS identified two alternatives for restoration of the brook, recent coordination with the Pease Development Authority, the NH Department of Environmental Services - Waste Management Division and the US Air Force has highlighted the environmental risk associated with "Alternative B" which lies in close proximity to Landfill 5 of the former airbase. Groundwater in this area is being monitored in association with the remediation of hazardous waste contamination at Landfill 5. Alternative A, as discussed in the Draft EIS, is therefore proposed as the preferred restoration alternative, since it lies mostly outside of the

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91 At the Public Hearing on September 21, 2006, many comments were presented on the mitigation package by the public, virtually all of which were supportive.

92 Recent guidance and practice at the Federal level has re-emphasized the importance of restoration, although many projects use a preservation strategy exclusively. Early guidance from the USACOE on this project had expressed a preference for wetland restoration as a primary mitigation measure, suggesting that restoration could focus on removal of areas of historic fill within the study area (based on the long history of land use in the area).

93 These codes (*i.e.*, NN-# and DR-#) are taken from a recent inventory of mitigation sites produced by the NH Estuaries Project.

groundwater management zone and therefore has relatively minimal environmental risk.

- **Preservation of the Watson property (35 acres) in Newington** – protects upland forest (portions of which are old orchard) and tidal wetlands adjacent to Little Bay at Trickys Cove precluding further coastal development. Potential opportunity for partnering with The Nature Conservancy (TNC) which could also hold title to the conservation easement for the purpose of maintenance and monitoring with the NHDOT listed as an executory interest holder.[94]

- **Preservation of the 120-acre (+) Tuttle Farm in Dover** – In response to the property owner's request, NHDOT, in partnership with the City of Dover, has expedited the acquisition of a conservation easement on the Tuttle Farmstead to permanently preserve the 120-acre farm. The preservation was consummated on January 29, 2007 with the conservation easements executed and property rights on 109.1 acres transferred to the City, the NHDOT, and the Strafford Rivers Conservancy (SRC). Another conservation easement on 11.0 acres was secured on September 14, 2006 through the Farm and Ranch Land Protection Program with the easement rights held by the City, SRC and US Department of Agriculture.

- **Preservation of 30 to 40 acres in the Blackwater Brook Area in Dover** – Preservation of this land, which is located adjacent to existing conservation properties owned by the City and State, would provide additional protection to a valuable riparian corridor, including portions of adjacent upland and wetland areas. This area has been a focus of the Dover Open Lands Committee, and recent conservation activity has created the nucleus of an important preserve in this area.

  Approximately 202 acres have been identified as potentially available and desirable for mitigation. Specifically, NHDOT is working with the City to possibly partner and permanently protect approximately 99 acres of the 105-acre Tsimekles property in the Blackwater Brook watershed that is undergoing the threat of development. If an agreement with the City and developer to acquire the parcel or large portion thereof is not reached, **Figure 4.6-3** identifies several other parcels in the Blackwater Brook area that are deemed worthy of preservation and permanent protection, which NHDOT could pursue to fulfill the mitigation requirements of the project in Dover. It is expected that 30 to 40 acres would be acquired if the Tsimekles property is not preserved.

94 The conditions of the conservation easement and easement interest holders for the Watson Property, as well as any parcel protected in the Blackwater Brook area or Knights Brook area, will be identified during the right-of-way process following the FHWA issuance of the ROD. The NHDOT's standard conservation easement language or easement language that is approved by the USACOE and NHDES will be used. An environmental steward will be identified to ensure the easement conditions are being met.

If negotiation of an easement on the Watson Property is not successful, then NHDOT would pursue preservation of upland buffers to Knight Brook in Newington:

- **Newington – Preservation of 60 to 70 acres of the 100-acre area within the Knight Brook riparian corridor** (also known as "Site NN-3"). These parcels would lie adjacent to the recently-preserved Frink Farm and would provide additional expansion of a large contiguous area of preserved land extending to Fox Point.

4.6.5.2 Impacts to be Mitigated

The Newington-Dover Spaulding Turnpike Improvements, with implementation of Selected Alternative, will directly impact an estimated 20.4 acres of wetlands. Approximately 0.6 acre of impact is also associated with the reconstruction of Exits 4 and 4N, Shattuck Way and Nimble Hill Road, as an interim safety improvement project (NHDOT Project #11238-C and 11238-E). Additionally, the proposed package also compensates for 1.3 acres of wetland impact associated with replacement of the NH 155 Bridge and Pudding Hill Road intersection relocation project (NHDOT Project #12922), and 0.45 acre of wetland impact associated with the construction of a Park-and-Ride facility at Exit 9 in Dover (NHDOT Project #14287). Combined, these three smaller projects have approximately 2.4 acres of impact as summarized in Table 4.6-2.

Table 4.6-2
Summary of Permanent Wetland Impacts, Selected Alternative

Town	Spaulding Turnpike Improvements (#11238)	Exit 4 Interim Improvements (#11238C and E)	Exit 9 Park and Ride (#14287)	NH 155 Bridge Replacement/ Intersection (#12922)	Total For Mitigation)
Newington	11.9	0.6	0	0	12.5
Dover	8.5	0	0.45	0	9.0
Madbury	0	0	0	1.3	1.30
Total	**20.4**[1]	**0.6**	**0.45**	**1.3**	**22.8**

Notes:
1 Spaulding Turnpike Improvements (#11238) total impacts include both freshwater and tidal impacts. See Section 4.10.3 and Table 4.10-4 for a summary of impacts to tidal wetlands.

4.6.5.3 Identification and Prioritization of Potential Mitigation Opportunities

To find potential mitigation opportunities, reports and data were collected and reviewed from various sources. Individuals and organizations were also contacted for input. Informational sources include:

- *Freshwater Wetland Mitigation Inventory for Nineteen Coastal Communities,* (New Hampshire Estuaries Project, September 2003)
- *Evaluation of Restorable Salt Marshes in New Hampshire,* (Natural Resource Conservation Service, October 1994, Reissued October 2001)
- *Pease International Tradeport: Development Plan Update,* (Vanasse Hangen Brustlin, Inc., *et al.*, June 1995, Revised September 1995)
- *Coarse Filter Analysis of Potentially Significant Wildlife Habitat,* GIS data, (New Hampshire Fish & Game Department, 2005)
- Historical Aerial Photographs and USGS Topographic Maps (University of New Hampshire)
- Discussion with impacted municipalities (Newington and Dover Conservation Commissions)
- Discussions with non-profit land protection specialists such as the Nature Conservancy, the Land and Community Heritage Investment Program and local land trusts
- Resource Agency review and commentary (NHDES, NHF&GD, USACOE, USFWS, USEPA)

Review of these data sources and consultations generated a long list of potential mitigation sites. Each was visited in the field in order to gain information on resources present and the current conditions of the sites. Sites were then prioritized using the criteria presented below. Appendix O contains information on the full range of sites identified during the search for mitigation parcels.

Creation/Restoration Parcels

Potential creation and restoration areas were identified based on knowledge of the Seacoast, through consultations with natural resource scientists familiar with the area, and through field work during project development. Wetland scientists visited all streams in the project corridor during the review of potential mitigation sites and other field work. The following criteria were used to evaluate the suitability of creation/restoration areas:

- Restoration sites are preferred to creation sites;
- The site must have a suitable geomorphic setting;
- The restoration/creation must not conflict with existing infrastructure or private properties;
- Preference should be given to restoration/creation sites that would involve only one or a small set of land owners;

- For restoration, the impairments to the system to be restored should be clearly understood and should be of relatively recent origin; and
- Preferably, the site should be related to the wetland systems impacted by the project.

A number of appropriate restoration sites were identified in Newington. During prioritization, it was determined that the highly altered Railway Brook and the drive-in theatre properties would be the most suitable for restoration in Newington, as discussed below. In Dover, only two small potential restoration sites (both on Varney Brook) were identified, but neither was considered a strong candidate due to substantial cost for minimal benefit. (See Appendix O.)

The conceptual plans for restoration are described in more detail in Section 4.6.5.4.

Preservation Parcels

Potential preservation parcels within Newington and Dover were identified in consultation with local and state resource agencies, through review of existing reports and information (listed above), and by using GIS analysis. To identify candidate preservation parcels, published information was reviewed, including aerial photographs, USGS mapping, NWI mapping and the location of existing conservation areas. Combining these sources, priority mitigation parcels were selected using the following criteria:

- The parcels should contribute to a block of contiguous undisturbed land at least 100 acres in size;
- Parcels should contain a mix of wetlands and uplands, with not more than 50 percent wetland;
- Parcels should provide an upland buffer to a resource with functional value equal to, or greater than, the wetlands impacted by the project;
- Parcels should abut existing conservation lands; and
- The lots should be largely undisturbed/undeveloped.

Using these selection criteria, a number of potential preservation parcels were identified in Newington and Dover. Each of these sites was visited to review the parcel's condition and ecological value. This review quickly pointed to the Tuttle Farm and Blackwater Brook watershed as priority conservation areas in Dover, with areas to the west of the Bellamy River also considered valuable habitat suitable for protection. In Newington, numerous potential preservation parcels were identified, with the Watson Property and the properties surrounding Knight Brook determined to have the highest potential.

4.6.5.4 Description of the Proposed Mitigation Package

Figures 4.6-2 and **4.6-3** show the approximate boundaries for each of the Dover and Newington properties listed below. The general goals of mitigation relate closely to the amount and types of impacts in each community; that is, preservation of the Tuttle Farm and Blackwater Brook areas preserves over 150 acres of land that buffers important aquatic resources within the City. In Newington, the strategy incorporates restoration of Railway Brook and associated wetlands with preservation of the Watson Property to achieve similar goals in Newington. Each of these options is described in more detail below.

Recommended Mitigation Components

Newington – Restoration – Railway Brook

The Railway Brook riparian corridor provides an excellent opportunity for restoration. Railway Brook was once a natural tributary to Pickering Brook, which flowed north and east to discharge directly to the Piscataqua River. The stream corridor was severely altered and straightened during development of the former Pease AFB, and was diverted to Flagstone Brook which discharges to Trickys Cove on the Little Bay (see Section 3.9). Numerous concrete flood/spill control structures were added to detain flow and drop the elevation of the stream several feet at each weir as the watercourse descends in grade toward its outlet at Trickys Cove. The current function and necessity of these structures is questionable, and they effectively destroy the habitat value of the stream and adjacent wetlands. Much of the adjacent vegetation along the stream has been cut and cleared. A habitat assessment of Railway Brook clearly indicates the stream has poor water quality and lacks a diversity of habitat and aquatic life. (See Section 3.9 for stream bioassessment data.)

Three major factors were considered in the recommendation to restore Railway Brook. First, the history of alteration of the system and its current impairment are clearly understood. Second, the former channel and its floodplain and riparian wetlands are still intact, which can form the basis of a restoration strategy that has a very high potential for ecological success. Third, the majority of the impacted stream channel is owned by a single landowner, which greatly simplifies the project.

Note that the watershed of Railway Brook is dominated by the former Pease AFB, including several landfills with a known history of contamination. A major factor in deciding whether the restoration is feasible, therefore, will be determination of the ecological and human health risks associated with the concept.

As shown on **Figure 4.6-2**, preliminary stream restoration design concepts involve direct stream restoration (*i.e.*, creating new stream channel and associated wetlands) in areas located to the west of the existing Railway Brook. Additionally, a portion of

Railway Brook to the south of Arboretum Drive is also a good candidate for restoration.[95]

The goals of this restoration include:

- Restore stream morphology, adjacent wetlands and improve water quality thereby enhancing habitat for aquatic life and diadromous fish;
- Permanent protection of riparian corridor through a conservation easement;
- Compensation for direct wetland and stream impacts from the project. (All project stream impacts occur in Newington.)

Below, two possible restoration concepts are discussed. As noted above, the Restoration Alternative A is the preferred alternative. Due to environmental risks associated with potential groundwater contamination, Restoration Alternative B described below was eliminated from further consideration.

Restoration Alternative A. This alternative would create a "B/C" Stream Type (Rosgen, 1996) between the wetland to the west and railroad bed to the east (see **Figure 4.6-4**). The restored stream would be created beginning just downstream from Arboretum Drive and extending downstream to within approximately 500 feet of the confluence of Railway Brook and Pickering Brook. The new alignment would be confined between the railway bed to the east and wetland to the west. The existing channel geometry would be modified by reducing the degree of incision, *i.e.*, raising the elevation of the streambed, thereby creating a flood-prone area for natural dissipation of energy contained in high flow/low frequency events. Sinuosity would be increased as much as possible given site constraints.

Based upon preliminary morphological field measurements, "Bankfull" discharge in this reach is estimated to be between 75 and 100 cubic feet per second (cfs). A thorough field investigation combined with hydrologic/hydraulic modeling of the watershed and stream valley will determine the validity of this estimate and allow for appropriate calibration.

Alternative A would also involve creation of new wetlands along the restored corridor. In order to avoid disturbance to the existing railroad bed, most of the increase in flood-prone area and sinuosity would be created to the west and designed to interface with and enhance the existing wetlands. Fill material for raising the streambed would be obtained from the berm along the left side of the channel and from an off-site source if additional material is needed.

95 Although a large portion of the former channel can be found to the east of the railway corridor, restoration in this area would be impacted by the proposed roadway improvements associated with the new configuration of the Exit 3 interchange.

Though this alternative does not reconnect the stream with its historic floodplain, it would substantially improve the hydrologic and biologic function of Railway Brook as well as enhance/expand the existing wetland system. A variety of natural rock/boulder structures would be incorporated to ensure long term stability of the proposed alignment as well as creation and maintenance of aquatic habitat features. Assuming that the restoration would begin a short distance downstream from Arboretum Drive, the project would extend downstream a valley distance of 3,100 feet. Using a sinuosity factor of 1.105 yields a total of 3,425 feet of potential stream restoration. A conservation easement of more than 20 acres encompassing the restoration area and upland buffer will be secured.

Restoration Alternative B. A second alternative was evaluated that would reconnect the west branch of Railway Brook south of Arboretum Drive with its historic channel and floodplain, which lies to the west of the existing alignment (see **Figure 4.6-2**). Although Alternative B was determined to have a high probability of achieving a stable and ecologically healthy stream corridor, it was determined following the Public Hearing to have unacceptable risks associated with working within a groundwater management zone associated with a closed landfill on the property of the former Pease Air Force Base.

Newington – Preservation – Watson Property

This property (35 acres) has been identified as a high priority area for preservation. Consisting mostly of forested upland, the parcel borders Trickys Cove and includes a fringe of saltmarsh habitat which would create a preserve of almost 50 acres. The Watson Property is directly adjacent to the "Beane Parcel," a 13.5 (±) acre conservation easement that was recently acquired by the Great Bay Partnership. Acquisition of this additional land would prevent coastal development and further protect Little Bay.

Dover – Preservation – Tuttle Farm

The Tuttle Farm consists of 120 acres of roughly equal amounts of upland and wetland located between the Spaulding Turnpike and Dover Point Road. Preservation of the Farm is a joint effort among NHDOT, the City of Dover, and the Strafford River Conservancy. Protection of this piece of property was identified as a priority by the City of Dover in late 2005. Preservation will provide protection to important woodland habitat and agricultural fields that border Varney Brook within the Bellamy River watershed.

Dover – Preservation – Blackwater Brook Watershed

This large area (approximately 200 acres) has been identified as a priority for preservation by the City of Dover and The Nature Conservancy. Conservation of 30 to 40 acres in this area would protect from development a wide variety of interspersed habitats that provide important wildlife habitat and would connect to existing conserved areas to the east and west. Additional conservation land in this area would also provide protection to nearby city water supply wells located to the east of the Spaulding Turnpike. Ecological attributes of the area include:

- Portions mapped as Exemplary Natural Community (Red maple floodplain forest: low variant) by the New Hampshire Natural Heritage Bureau;
- Possible historic dam site/road crossing ruins at stream constriction;
- Historic beaver dams and dead wood swamp; and
- Varied aquatic habitat for fish, shellfish (eastern brook floater mussel) and turtles.

As of the date of this FEIS, there are nine individual parcels that could be considered for acquisition, including the following lots: Tax Map-Lot: A-28, B-8, B-8A, B-9, B-10, B-10C, B-10E, B-13, and B-24. Details, including the acreage and owner of each of these parcels, are listed on **Figure 4.6-3**.

Alternate Mitigation Options[96]

If the recommended mitigation areas become unavailable due to technical reasons or the transfer or acquisition of land for development or preservation by others prior to acquisition by NHDOT, an optional component could be considered in Newington for inclusion in the compensatory wetland mitigation package. This option involves preservation, requiring the acquisition of the property outright or the purchase of development rights in order to conserve the land.

Newington – Preservation – Knight Brook

This 100-acre assemblage of parcels includes a diverse wetland complex surrounded by variety of upland habitats (wooded and agricultural fields) that connect to existing conservation land at Fox Point. The most notable features of this area include remnant bog-like areas (wooded fens) found along Little Bay Road and agricultural fields, as well as Knight Brook itself, a perennial stream.

96 Input received during the Public Hearing and in subsequent written comments, as well as Agency coordination and discussion with land owners, prompted elimination of three components of the potential mitigation package: 1) Alternative B for the restoration of Railway Brook as discussed above; 2) The preservation and restoration of the Drive-In Theater property in Newington; and 3) Preservation of additional land on the west side of the Bellamy River in Dover.

4.6.6 Wetlands Finding

Under Executive Order 11990, federal actions (in which impacts to wetlands are unavoidable) require a "finding" that there are no practical alternatives to the proposed construction in wetlands and that the proposed action included all practical means to reduce harms to wetlands.

The project has been carefully studied with respect to its effects on wetlands. All of the Build Alternatives involve unavoidable impacts to wetlands. Direct wetland impacts resulting from the Selected Alternative total approximately 20.4 acres of freshwater and tidal wetlands, including impacts from the Turnpike improvements, construction of barriers to mitigate noise impacts, and estuarine impacts resulting from expansion of the bridge piers. In general, the proposed highway improvement follows an existing corridor. As such, most of this wetland impact will occur in areas directly adjacent to the existing Turnpike corridor and are therefore already impacted to some degree. Some wetlands, in fact, appear to have formed as a result of the original Turnpike construction. However, the construction of a new interchange in Newington will impact a substantial forested and riparian system associated with Pickering and Railway Brooks. None of the project alternatives would have direct or indirect effects on vernal pools, which are essential breeding habitat for certain types of salamanders and wood frogs.

Mitigation for wetland impacts followed a sequential approach of 1) avoidance, 2) minimization, and 3) compensation. Avoidance of wetland impact was a primary concern in the screening of alternatives.

A project mitigation and enhancement package is proposed in Dover and Newington to offset wetland impacts. Restoration and preservation of Railway Brook in Newington is proposed as mitigation (involving a total of approximately 3,400 linear feet of restored perennial stream), and approximately 150 to 250 acres of land preservation in Dover and Newington will help to offset these wetland impacts. This significant restoration and land protection effort reduces the overall project impacts to an acceptable level. The NHDES, the USEPA, the USFWS, the NMFS, the NHF&GD and the USACOE have all found the mitigation proposal to be acceptable.[97]

Based on the above considerations, it is determined that there is no practicable alternative to the proposed construction in wetlands and that the proposed action includes all practicable measures to minimize harm to wetlands which may result from such use.

97 At a meeting of the various state and federal natural resource agencies, the NHDOT and the FHWA on March 21, 2007, all parties attending, including representatives from the agencies noted here, indicated their general consensus in favor of the recommended mitigation package. Notes of this meeting are included in Appendix B2.

4.7 Wildlife Resources

4.7.1 Short-Term Versus Long-Term Impacts

Highway construction has both short-term and long-term impacts on wildlife habitats and populations. Short-term impacts are directly related to disturbance caused by construction activities and include the construction footprint, as well as increased noise and visual disturbance from land-clearing, earth-moving, construction machinery, and the presence of humans (see also Section 4.20). Long-term impacts include the permanent loss of wildlife habitat, and can involve, in the case of new roads on new location, long-term changes in the availability and types of habitat, including loss of connectivity between types and increasing fragmentation of large habitat blocks.

Direct mortality due to construction impacts will most likely occur for fossorial (burrowing) mammals, reptiles and amphibians, and breeding animals and their young, whose dens or nests are destroyed by the clearing and grading. More mobile animals may move to other habitats when disturbed by construction. These animals may find habitat that has sufficient food and cover to support them, if adjacent habitats are not already at carrying capacity. Those animals that are unable to locate sufficient food, cover or space may fail to breed successfully, be forced to wander further, or eventually die.

Noise and Disturbance

Many animal species habituate to continuous noise, including traffic noise from highways; however, sudden loud noises, such as construction noise, can be more of a disturbance (Busnel 1978). Wildlife using habitats near the Turnpike are tolerant of traffic noise, but could be sensitive to construction noise and activities. Loud noises associated with construction could mask territorial vocalizations of species living near the highway, at least temporarily interfering with breeding (Busnel 1978).

Sudden changes in habitat types and quality due to construction can have important effects on wildlife, especially if these changes occur during critical periods. Disturbance of breeding habitat during the breeding season and while young are being reared can reduce or prevent successful reproduction. Disturbance during severe winter weather may force wildlife from protective cover, which can result in lower reproductive rates and increased mortality.

Studies have shown that some species of birds, including blue jay, winter wren, Nashville warbler, bay-breasted warbler, blackburnian warbler, and savannah sparrow (Ferris 1977, Adams and Geis 1981), and some mammals, such as red-backed vole and fisher (Palman 1977), tend to avoid habitats adjacent to highways. Others are attracted to the roadside vegetation or the highway opening and tend to occur more frequently near a highway than in the adjacent forests. These species include: American robin, chestnut-sided warbler, common yellowthroat, eastern meadowlark, white-throated sparrow, indigo bunting, red fox, coyote, rabbit, and woodland jumping mouse (Ferris 1977; Palman 1977; Michael 1975, and Adams and Geis 1981). Other species may be temporarily attracted to the roadside edge for opportunistic reasons, such as to eat road salt (deer and moose) or feed on road kills (crows and vultures).

Home Range Impacts

Impacts to amphibians, reptiles and small mammals would be anticipated since these species generally have small home ranges, which may be totally eliminated with highway widening. Potential impacts to medium-sized and large mammals would generally be less severe due to the larger home ranges associated with these species and their ability to move to other habitats nearby. However, in those cases involving reduction in habitat connectivity, the impacts may make such movements difficult with long-term effects on the local population's viability.

Wildlife/Vehicle Collisions

Increasing the number of highway lanes can increase wildlife mortality due to potential collisions with vehicles as animals attempt to cross a wider highway. The ease with which some wildlife can cross a highway also varies with median widths. Wide medians can provide a refuge for animals attempting to cross divided highways. Nonetheless, highway mortality is generally not a threat to species' population levels (Leedy and Adams 1982) except when populations are already low or when the highway is near a critical habitat. Breeding amphibians, like mole salamanders and wood frogs, require vernal pool areas for breeding and any widening that makes migration to these habitats more difficult may have serious consequences on the local populations. In general, vehicle collisions with larger species of wildlife, like deer and moose, pose a far greater risk to human safety than to the wildlife populations.

Travel Corridors

Riparian corridors, *i.e.*, areas along streams or other waterbodies, are important wildlife habitats and are often used as travel corridors. These are areas where it makes the most sense to focus on investigating possible wildlife crossing measures. Noss (1987) noted that riparian corridors help to maintain the natural connectivity of habitats that would otherwise be fragmented by development.

Habitat Impacts

It is generally thought that projects like the one proposed, which involves widening of an existing facility, are of less consequence to wildlife resources than would otherwise be the case with the construction of a new facility on new location. As such, fragmentation of wildlife habitat is not an issue, except where new spur or access roads bisect relatively large and currently undisturbed blocks of habitat. In addition, habitats directly adjacent to a highway are generally considered of lesser quality than the same type of habitat far removed from a highway.

Of concern with a widening project are new impacts to sensitive or important habitats that currently exist in the project area. These habitats include wetlands, agricultural fields, and early successional areas like grasslands and shrublands.

In order to provide a quantitative comparison of impacts among the various project alternatives, the NHF&GD's "Coarse Filter Analysis of Potentially Significant Wildlife Habitats" was used during the GIS analysis of impacts. The following data layers were used: riparian corridors, unfragmented habitat blocks greater than 25 acres, and agriculture and other non-forested lands (*i.e.*, grasslands and shrublands). Wetland habitat impacts were determined using the values provided in Section 4.6 and are considered more accurate than NHFG&D's coarse filter analysis, since the wetlands in the project area have all been field-checked.

4.7.2 Build Alternatives

Newington Alternatives

Impacts on high value wildlife habitat like grasslands and shrublands for the three Newington alternatives range from 20.9 to 26.7 acres and on wetland habitats from 11.8 to 13.6 acres (see **Figure 2.5-1**). [98] Alternatives 10A and 12A affect 24.9 and 26.7 acres, respectively, of this habitat, while Alternative 13 affects somewhat less with 20.9 acres. With the tighter interchange configuration at Woodbury Avenue under Alternative 13, the southbound off-ramp avoids impacting the grassland and shrubland habitats on the former drive-in theatre site and in areas immediately adjacent to the highway. The compact design of the Alternative 13 – Woodbury Avenue Interchange also reduces its impacts on wetland habitat. The largest wetland impacts regardless of alternative occur to Palustrine Forested Wetlands, Palustrine Emergent Marsh, and Palustrine Scrub-Shrub Wetlands, in that order. Additional details on wetland impacts are provided in Section 4.6.

Impacts on unfragmented lands (those greater than 25 acres) for the three Newington alternatives range from 9.0 to 13.1 acres. The largest amount of disturbance occurs to the large undisturbed forest block just west of existing Exit 3. All three alternatives affect a portion of the riparian corridor along Railway Brook, as well as the riparian corridor where Pickering Brook flows through the median north of Exit 3. Impacts on riparian corridors are 6.8 and 6.9 acres for Alternatives 10A and 12A, respectively. In comparison Alternative 13 affects only 4.6 acres because of the tighter interchange configuration for Woodbury Avenue.

98 The majority of the affected upland habitat occurs in the mowed median or side slopes of the Turnpike and hence is of low value.

Bridge Alternatives

The two bridge alternatives affect 0.9 acres of freshwater and tidal wetland habitat and 2.3 acres or 2.6 acres of high value early successional habitats for the Widen West/Remove and Widen West/Rehabilitate, respectively. Wildlife habitat impacts for both bridge alternatives are limited to low value roadside and median areas that are regularly mowed for maintenance purposes. No riparian corridors or large blocks of unfragmented habitat are impacted in this roadway segment.

Dover Alternatives

The Dover alternatives affect 6.6 to 8.3 acres of tidal and freshwater wetlands and 3.6 to 3.7 acres of high value wildlife habitat for Alternatives 2 and 3, respectively. Similar to the bridge alternatives – wildlife habitat impacts are limited to low value maintained roadside and median areas. No blocks of unfragmented habitat (greater than 25 acres) are affected by the alternatives. Both Dover alternatives affect an insignificant amount of riparian corridor just east of the approach to Scammell Bridge along US 4.

4.7.3 No-Build Alternative

The No-Build Alternative would not result in any new impacts on wildlife or their habitats since there would be no new construction.

4.7.4 Secondary Impacts

The methods used to evaluate indirect (secondary) impacts of the project are described in detail in Section 4.3. This impact analysis predicted that the project could result in an additional population increase of 1,865 people by the year 2025 in Rockingham and Strafford Counties when compared to the No-Build Alternative. It was then estimated that approximately 413 additional acres of undeveloped land would be converted to accommodate the associated development as compared to the No-Build condition. Based on the proportion of the study area that is classified as high value habitat, the total size of additional wildlife habitat that would be affected with the Build Alternative was estimated to be about 364 acres.

As explained in Section 4.3, the estimation of indirect effects requires the conservative assumption that sensitive resources like wildlife habitats will remain unprotected in the 33 New Hampshire communities within the socio-economic study area. As previously stated, these growth projections and land use impacts are speculative and strongly influenced by locally-controlled land use regulations and policies.

In addition to the potential loss of habitat, fragmentation of habitat blocks is an issue wherever development breaks up large tracts of undisturbed land and severs wildlife corridors linking them. In contrast, conversion of small blocks of habitat is less of an issue (although still important) when they are totally surrounded by development such as in urban landscapes. Without site-specific information as to where secondary growth will take place, it is impossible to provide any substantive elaboration on the extent or significance of habitat fragmentation.

4.7.5 Mitigation

Consideration for mitigation for wildlife impacts will be incorporated into the goals of the wetland mitigation, since wildlife habitat is an important functional value of the wetlands impacted by this project. The proposed wetland mitigation package includes preservation of over 190 acres of land that includes both upland and wetland wildlife habitat. Details of this mitigation package are provided in Section 4.6.5, Compensatory Wetland Mitigation.

4.8 Rare, Threatened and Endangered Species

4.8.1 Plants

4.8.1.1 Federal Endangered and Threatened Species

No federally listed endangered or threatened plant species will be affected by any of the project alternatives.

4.8.1.2 NH Endangered and Threatened Species

Historical records for one State-listed plant species, prolific knotweed indicate that it was at one time present at Hilton Park on Dover Point (see Section 3.8.1.2 and **Figure 3.8-1**). Field investigation for this project in 2004 failed to find this species and it is believed to be no longer present. Records for two other species, bulbous bitter-cress and small spike rush, indicate these two species may occur in the vicinity of the project area (see Section 3.8.1.2). Habitat for bulbous bitter-cress is wet woods and for small spike rush, wet saline or brackish soils along the coast (Magee and Ahles 1999). No evidence of their presence within or adjacent to the footprint of any of the alternatives has been found. Therefore, the project is not expected to have any effect on these three plant species.

4.8.2 Wildlife

4.8.2.1 Federal Endangered and Threatened Species

Only one federally-listed threatened wildlife species, the bald eagle, has been recorded for the project area (see Section 3.8.2.2). Bald eagles overwinter in the vicinity of the project area and require open water for feeding, primarily waterfowl and fish. This foraging habitat will not be affected by the project. Winter roosting habitat typically consists of tall pine trees and daytime perch sites are characteristically located along the shorelines of open water.

Reconfiguration of the US 4 interchange on Dover Point and construction of a detention basin at that location will require the clearing of a portion of the block of mature trees that exist today between the southbound on-ramp and Spaulding Turnpike. NH Audubon was asked to check their database for any records of eagle use in this area or elsewhere within the study corridor**.** They reported that although there are several documented locations just outside the bounds of the corridor (*i.e.*, on the west side of the mouth of the Bellamy River in Dover, on Fox Point in Newington, and on the Great Bay National Wildlife Refuge) there were no records of perch or roosting sites within the study area. Further, they concluded "there are no land-based locations in the study area that are of critical importance to them [bald eagles]" (C. Martin, NH Audubon, e-mail dated November 1, 2005). Based on this research, no impacts on bald eagles are expected with the proposed project.

The USFWS has requested a review of the suitability of habitats in the project area for the New England cottontail, a species currently under petition for review for designation as a candidate endangered species. Therefore, during preparation of the Draft EIS, NHDOT commissioned an assessment of the status of New England cottontails and their habitat along the project corridor (Liviatis 2006).

The assessment of the distribution of New England cottontails is based on previous field work on this species as well as new work to identify potential habitat within the project area. The assessment found that the distribution of New England cottontails within the project area is restricted to the corridor from the Toll Plaza south to the General Sullivan and Little Bay Bridges. Suitable habitats in Newington are occupied exclusively by eastern cottontails. Habitats within the project area occupied by New England cottontails are marginal. Previous observations suggest that the majority of these largely function as "stepping stones" to more suitable sites outside of the project area. As a result, the planned expansion will have little or no impact on New England cottontails.

4.8.2.2 NH Endangered and Threatened Species

There are four wildlife species with records from the study area that are either State-listed as threatened or endangered, or species of concern (see Section 3.8.1.2). Potential effects on roosting habitat for overwintering bald eagles are discussed above. There will be no impacts on foraging or nesting habitat of the common tern, a summer resident. A third species, Henslow sparrow, which historical records indicate as occurring near the project area, is now officially classified as extirpated (see Section 3.8.1.2).

Records for the fourth species, grasshopper sparrow, indicate it as occurring in the vicinity of the Pease runway and Short Road (now Exeter Street). This species prefers open fields, like hayfields, with tall herbaceous cover. It avoids habitats that have been invaded by shrubs and is totally absent when shrub cover exceeds 35 percent (DeGraff and Rudis 1983). The only habitat suitable for this species that will be affected by the project is the Turnpike's grassy edge and center median. Since this habitat is immediately adjacent to the highway and is currently maintained by periodic mowing, it is not considered of high quality for grasshopper sparrows. Hence, no impact on this species is expected with the project.

4.8.3 Secondary Impacts

Without site-specific information on where future development will occur and because threatened and endangered species locations are not well known, it is impossible to provide a meaningful prediction of potential indirect impacts on these species. Some loss of suitable habitat may occur, even though these habitats may or may not be currently occupied.

Note that the REMI model, outlined in Sections 4.3.3 and 4.3.4, indicates that population and employment growth differs only by a minor amount for the Build versus No-Build Alternatives. This suggests that potential indirect impact on threatened and endangered species will be similar for the Build versus No-Build Alternatives.

4.8.4 Mitigation

Since the project will not have any effect on federal or state threatened or endangered species, no mitigation is necessary.

4.9 Surface Water Resources

4.9.1 Introduction

The major waterbodies in the study area include the Great Bay Estuary and the Piscataqua River. The Great Bay Estuary is a large tidal embayment that includes the Little Bay and the Bellamy River estuary. The Piscataqua River is a major river system that is formed by the confluence of the Salmon Falls and Cocheco Rivers. The Little Bay, at the confluence of the Great Bay Estuary and the Piscataqua River, is known to have very strong tidal currents due to the large volume of water exchanged during the tidal cycle. The northernmost portion of the study area in Dover is within the drainage area of Bellamy River estuary.

Additionally, the Newington portion of the study area includes several perennial streams, including Pickering Brook, Flagstone Brook, Railway Brook, Paul Brook and two other smaller, unnamed tributaries to the Piscataqua River. Two small ponds are located in the eastern portion of the study area in Newington. A discussion of the existing freshwater and marine biota and associated habitat conditions is included Section 3.9.

One of the principal water quality concerns expressed by the NH Coastal Program personnel during project scoping meetings relates to the potential adverse effects on water quality in the area streams and tidal waters due to increases in impervious area and associated stormwater runoff as a result of the proposed project. Much of the study area has become highly urbanized with extensive areas of pavement resulting from the commercial and industrial development that has occurred over the years, especially in the Town of Newington. This development, as well as historic releases of contaminants associated with the former Pease AFB, has led to a decline in water quality in some of the study area surface waters. As noted in Section 3.9.3.2, many of the area streams are listed as impaired by NHDES due to either past industrial activities or as a result of a general statewide problem of elevated mercury levels in fish tissue resulting from atmospheric deposition (NHDES 2004).

Water quality measurements, conducted on three occasions under relatively low flow conditions in September and early October of 2005, indicated that Railway Brook, Upper Pickering Brook and Flagstone Brook had relatively low specific conductance levels ranging from 92 to 243 µS/cm. However, Paul Brook and the larger Unnamed Tributary 1 along Gosling Road, had comparatively higher levels that ranged from 638 to 1,758 µS/cm, with the highest levels generally observed in Paul Brook. Specific conductance levels above 850 µS/cm may indicate that the State chronic water quality standard for chloride at 230 mg/L may be exceeded. The results of extensive sampling of specific conductance and chloride in other New Hampshire streams indicates a specific conductance level of 850 µS/cm to be equivalent to a chloride concentration of 230 mg/l (USGS 1999, NHDOT 2003, 2004 and 2005). However, NHDES' chronic water quality standard of 230 mg/l for chloride is based on a 4-day average concentration not to be exceeded more than once every three years and not just an instantaneous concentration (Env-Ws 1700). Paul Brook receives much of the stormwater runoff from the Fox Run Mall pavement area, but is anticipated to be minimally affected by the proposed project given its juxtaposition to the project area, which is discussed further below.

4.9.2 Impact Analysis Methodology

The impact analysis discussed herein quantifies the net increase in impervious area within each subwatershed area as a result of each of the proposed project alternatives. Subwatershed areas were delineated for each of the six perennial streams and certain tidal cove areas based on the USGS topographic data contained in the NH GRANIT data layers. The NH GRANIT data was also used to quantify the amount of existing impervious area associated with the existing roadways and other land uses. The area of focus was primarily on the Newington portion of the study area since this is where the identified stream resources are located. Impervious area estimates were also determined for the Pomeroy Cove drainage area in Dover.

The project alternatives evaluated in the impact analysis include Alternatives 10A, 12A and 13 in Newington and Alternatives 2 and 3 in Dover. With any of three Newington alternatives, the proposed northbound and southbound lanes will be shifted into the existing median area and would also eliminate paved areas associated with the existing roadway, which is factored into the analysis.
In addition, the impact analysis evaluated the anticipated level of treatment to be provided by each of the various Best Management Practices (BMPs) to be included in the project design. Extended-detention basins will be used as the primary treatment measure and they will be designed to treat runoff from both the proposed new and existing roadway areas (where appropriate). Grassed swales will also be used to treat runoff from smaller roadway areas.

The revised BMP design guidelines, currently being drafted as part of the proposed revisions to the NHDES Site Alteration Program regulations (Env-Ws 415), will be utilized in the project design. The revised regulations are expected to be adopted in early 2008. The most recent draft of the proposed regulations (2/16/06 Draft) requires extended detention basins to have pretreatment measures *(i.e.*, sediment forebay, grassed swale, or vegetated filter strip), maintain a permanent pool volume, have a 3 to 1 length to width ratio and treat the water quality volume produced from the first inch of rainfall over the entire project area. The minimum drawdown time for extended detention is 24 hours. These design guidelines may change, however, as the proposed revisions to the regulations go through the approval process.

The third component of the impact analysis consists of an evaluation of the potential net increase in sodium and chloride loading as a result of proposed increase in roadway lanes and associated road salt applications on the improved roadway.

Increased chloride concentrations in streams and rivers has recently become a major concern of NHDES and USEPA on a statewide and regional basis, respectively. Within the study area streams, chloride concentrations are likely to be already elevated somewhat, due to the increased presence of chloride in rain water in coastal areas. As stated earlier, recent field measurements recorded in September and early October 2005, indicate that Paul Brook and the Unnamed Tributary 1 (along Gosling Road) had some of the highest specific conductance levels within the study area ranging between 638 and 1758 µS/cm, whereas the other three streams generally had specific conductance levels below 250 µS/cm. As mentioned above, NHDES has recently used a specific conductance level of 850 µS/cm as a surrogate standard for the chronic water quality standard for chloride concentration of 230 mg/L even though the true standard is based on a 4-day average concentration not to be exceeded more than once in a three-year period (NHDES, 2003).

4.9.3 Build Alternatives

4.9.3.1 Newington Segment

Table 4.9-1 presents a comparison of the estimated existing and proposed increases in impervious area associated with the each of the proposed Build Alternatives in the Newington portion of the study area. The comparison shows that for most streams, including Railway Brook, Flagstone Brook, Paul Brook and the two unnamed tributaries, there would be a minimal increase in impervious area (*i.e.*, < 1.0 percent of drainage area) with any of the three proposed Build Alternatives. Much of the new impervious area associated with the proposed Build Alternatives in the Newington area would occur in the lower Pickering Brook watershed. The additional impervious area associated with Alternatives 10A, 12A and 13, would account for 4.8, 5.0 and 4.2 percent of the watershed area, respectively. Currently, about 19.0 percent of the lower Pickering Brook watershed (*i.e.*, east of Railway Brook) is estimated to be comprised of impervious area. Based on estimated impervious area changes, Alternative 13 would likely generate the least amount of impact to all surface waters in the study area, except for some very slight differences in the Flagstone Brook watershed.

Within the Pickering Brook watershed, the total amount of additional roadway area is estimated to be 11.5, 12.0 and 9.9 acres for Alternatives 10A, 12A and 13, respectively. Much of this roadway includes areas associated with the new Woodbury Avenue Interchange and connector roads that drain into lower Pickering Brook during high flow periods. With the proposed shifting of both the northbound and southbound lanes into the center median area, the estimated net increase in new roadway area does account for the portions of existing roadway that will be removed as a result of the shift.

By conservatively assuming that pollutant loads contributed from highway runoff are directly proportional to the net increase in new roadway area, the proposed alternatives could increase the pollutant loads to the lower Pickering Brook by roughly 20 to 25 percent, with any of the Build Alternatives. However, this is a conservative analysis since research has shown that pollutant contributions from highway runoff are dependent on many factors aside from just roadway area including adjacent land use, traffic volumes, vehicle crashes (*i.e.,* fuel spills) and the duration and extent of vehicle congestion (Driscoll *et al.*, 1990; Buckler and Granato, 1999; Coleman *et al.*, 2001). The latter two factors could have a greater influence on future pollutant accumulation than roadway area. In addition, as discussed in Section 4.9.5, the proposed Build Alternatives will provide water quality treatment of runoff from both the existing and proposed roadway area with the use of extended-detention basins and grassed swales, which will minimize, if not eliminate, any increase in pollutant loading associated with the additional impervious area.

With the No-Build Alternative, traffic congestion and vehicle crashes are expected to increase steadily in future years. Traffic congestion causes more wear and tear of moving parts, particularly brakes and tires, as vehicles slow down or make frequent stops. Traffic congestion can greatly increase the potential for vehicle crashes and related spills and leaks of gasoline, antifreeze, and other hazardous materials. The roadway improvements of the proposed Build Alternatives are expected to improve traffic flow, vehicle safety and reduce the crash potential. Pollutant accumulation from vehicle exhaust can also increase in traffic congestion, particularly if vehicles sit idling for extended periods of time. Thus, it could be reasonably argued that the potential pollutant accumulation on pavement on an areal basis could be as much or greater under the No-Build Alternative than that under the proposed Build Alternatives, even though the Build Alternatives would have more roadway area.

In addition, the proposed Build Alternatives will incorporate BMPs for water quality treatment within the drainage system, where presently minimal treatment exists. The anticipated pollutant removal efficiency for grassed swales and extended detention basins designed for water quality treatment can generally range between 20 and 80 percent depending on the type of pollutant and the various features included in the BMP design manual (NHDES 1996). This additional stormwater treatment would greatly reduce and potentially offset any increased pollutant loading associated with the increased roadway area. Also, these BMPs would provide initial containment for any vehicle-related hazardous spills.

It is worth noting that the proposed alternatives would have minimal increases in stream watersheds that currently have the highest percentages of impervious area, such as Paul Brook and the Unnamed Tributary 1 along Gosling Road. These stream watersheds have existing imperviousness of around 42 and 34 percent, respectively.

Table 4.9-1
Estimated Impervious Area within Newington Watersheds

Water Resource	Drainage Area (acres)	Existing Impervious Area[1]		Additional Impervious Area					
				Alternative 10A		Alternative 12A		Alternative 13	
		(acres)	(%)[2]	(acres)	(%)[2]	(acres)	(%)[2]	(acres)	(%)[2]
Railway Brook	417	103.2	25.0	3.6	0.9	4.0	1.0	3.5	0.9
Pickering Brook	237[3]	43.1	19.0	11.5	4.8	12.0	5.0	9.9	4.2
Flagstone Brook	647[4]	117.6	18.2	0.03	<0.1	0.03	<0.01	0.06	<0.1
Paul Brook	218	91.0	41.6	0.25	0.1	0.25	0.1	0.25	0.1
Unnamed Tributary 1 (Gosling Road)	465	156.5	33.7	0.8	0.2	0.8	0.2	0.9	0.2
Unnamed Tributary 2 (Shattuck Way)	72	7.0	9.8	(0.1)[5]	(0.1)	(0.1)	(0.02)	0.1	<0.1

Notes:
1 Existing impervious area includes all roadways, parking lots, other paved areas and commercial buildings using NH GRANIT land use data.
2 Expressed as the percentage of the total drainage area.
3 Pickering Brook drainage area represents the lower watershed portion east of Railway Brook.
4 Flagstone Brook drainage area estimate includes the drainage areas of Railway Brook and upper Pickering Brook.
5 Values in parentheses represent reductions in pavement area.

In addition, the NH GRANIT data layers, depicting existing land use and impervious areas used in the analysis, do not include any recent land use changes that may have occurred since 2003, especially two restaurants that were built along Woodbury Avenue across from the Fox Run Mall and in the Paul Brook watershed.

4.9.3.2 Bridge Segment

The preliminary sizing for the proposed extended-detention basins have included the runoff from the entire bridge sections to allow for the use of a closed drainage system. The potential costs and benefits of a closed system will be evaluated during final design of the bridge and roadway. At least one extended detention basin would be included on either side of the bridge. This would represent a substantial improvement from the existing drainage system where runoff is discharged directly to the Little Bay *via* bridge scuppers. However, the dilution and assimilative capacity of the waters directly beneath the Little Bay bridges would be expected to be quite substantial given the volume and velocity of water that passes through this connection between the Little Bay and the Piscataqua River during the tide cycles. With a closed drainage system on the bridge sections, minimal water quality impacts are expected as a result of the widened bridge sections.

4.9.3.3 Dover Segment

Table 4.9-2 presents a comparison of the existing impervious area with the estimated increases in impervious area resulting from each of the proposed alternatives on the Dover side of the project area. The differences in the estimated new impervious area between Alternatives 2 and 3 are relatively minor. Both alternatives are expected to increase the amount of pavement area draining to Pomeroy Cove by slightly more than 3 acres resulting in roughly a 5 percent increase in the overall impervious area in the drainage area. Alternative 3 is estimated to have slightly more impervious area (*i.e.*, approximately 0.5 acre) draining to Pomeroy Cove, but the difference is quite small. Currently, impervious area accounts for approximately 23 percent of the Pomeroy Cove drainage area. The impervious area and drainage area estimates assume that the existing drainage patterns are maintained with the Build Alternatives. Depending on the actual roadway profiles and drainage infrastructure for the Build Alternatives, there may be opportunities to divert runoff away from Pomeroy Cove and into larger waterbodies, such as the Little Bay or Bellamy River.

Bellamy River would be minimally affected by the proposed alternatives with less than a 0.5 acre of new pavement area expected to be added with either of the two Build Alternatives. The amount of new pavement area draining to Little Bay would increase by approximately 4.5 acres resulting in a 3 percent increase in impervious area for the portion of limited drainage area that is within the project area. Given the larger watershed and the overall size of the Little Bay, the relatively small increases in impervious area are expected to result in minimal impact on existing water quality. This finding is further supported by the fact that, similar to the Newington side, various water quality treatment measures will be included in the final project design, that do not otherwise currently exist.

Table 4.9-2
Estimated Impervious Areas within Dover Watersheds

Water Resource	Drainage Area (acres)	Existing Impervious Area[1] No-Build (acres)	Existing Impervious Area[1] No-Build (%)[2]	Additional Impervious Area Alternative 2 (acres)	Additional Impervious Area Alternative 2 (%)[2]	Additional Impervious Area Alternative 3 (acres)	Additional Impervious Area Alternative 3 (%)[2]
Pomeroy Cove	60	13.8	23.0	3.1	5.2	3.5	5.8
Bellamy River	55[3]	9.7	17.8	0.4	0.7	0.2	0.4
Little Bay	146.4	30.5	21.0	4.5	3.1	5.0	3.4

Notes:
1 Existing impervious area includes all roadways, parking lots, other paved areas and commercial buildings using NH GRANIT land use data.
2 Expressed as the percentage of the total drainage area.
3 Only the subcatchment areas affected by the project are included in drainage area estimate.

4.9.3.4 Road Salt Impact Analysis Results

Similar to the results of the impervious area analysis, lower Pickering Brook is the one stream that is most likely to be affected by the potential increase in road salt use associated with the proposed roadway improvements. Currently, there is about 5,000 linear feet or nearly four lane miles of the Spaulding Turnpike mainline within the lower Pickering Brook watershed. Alternative 13 would add about another four lane miles, while Alternatives 10A and 12A would add even more roadway area with the local connector road between Nimble Hill Road and Arboretum Drive and portions of the Woodbury Interchange on and off-ramps. Approximately 1.5 lane-miles of roadway associated with the remaining portions of the Woodbury Avenue Interchange would be added to the Railway Brook watershed. There would be only slight differences in the amount of new roadway area within the Railway Brook watershed among the three alternatives. The other four streams would have relatively minor increases in roadway area and associated increased salt use within their watersheds. Of these streams, only Paul Brook is listed by NHDES as being impaired for chloride.

The lower Pickering Brook watershed downgradient or east of the existing and proposed roadway flows for about 1,000 feet through two coastal ponds before its empties into the Piscataqua River. The lower half or approximately 500 feet of this channel is tidally-influenced and, therefore, already supports brackish or relatively saline waters during tidal cycles. So, the extent of the stream that remains susceptible to increased chloride loadings is the upper 500 feet or so, between the Turnpike and just below the upper pond outlet. This is offset somewhat by the fact the southbound lanes will be shifted eastward under the proposed alternatives which results in about 200 feet of stream channel on the upstream side that will be outside the influence of the roadway drainage system. Thus, the net effect would be that approximately 300 feet of stream channel may be subject to higher salinity and chloride loading due to the anticipated increase in road salt usage.

4.9.3.5 Impacts to Aquatic Resources

As discussed in Section 3.9.3.6, the various streams on the Newington side of the project area primarily support the more tolerant warm-water fish species and other aquatic organisms. The benthic communities were determined to have low diversity and comprised of the more tolerant species that typically prevail in poor stream habitat conditions or where water quality conditions are diminished due to upstream pollution sources. Poor habitat conditions were particularly evident in the lower Pickering Brook due to the lack of flow observed during the later summer months and because the low stream gradient results in stagnant flow conditions. As discussed earlier, the proposed roadway improvements on the Newington side will be located primarily in the lower Pickering Brook watershed. Given the proposed water quality treatment measures for highway runoff, minimal impacts are anticipated to the aquatic resources in this stream.

As mentioned in the previous section, there is the potential for increases in chloride concentrations due to an increase in road salt use. Chloride, because of its high solubility, is not mitigated or reduced by storm water treatment BMPs. However, given the types of tolerant species that exist in the lower Pickering Brook, increases in chloride concentrations are not expected to affect the types, or reduce the numbers, of aquatic species that can be found in lower Pickering Brook.

4.9.4 Direct Stream Channel Impacts

In addition to potential water quality effects, the project will also directly impact the lower portions of Pickering Brook. These impacts will result from filling and cutting associated with creation of a widened mainline Turnpike, and from the construction of the new Exit 3 Interchange.

As noted in the Table 4.9-3, Alternative 13 impacts approximately 290 linear feet of stream channel, which is 120 linear feet and 40 linear feet less than Alternative 10A and 12A, respectively. These differences are due primarily to the fact that Alternative 13 has a more compact footprint at the proposed Exit 3 Interchange.

In addition to the direct impacts a portion of Pickering Brook could also be indirectly affected by removal of streambank vegetation especially during construction. Overhanging vegetation provides a major food source for benthic communities (Minshall 1967), overhead cover for fish, shade, and a buffer to sedimentation. Removal of riparian vegetation could intensify daily water temperature fluctuations and potentially change the benthic macroinvertebrate community composition from leaf litter consumers to algal consumers. Maintaining a buffer strip of vegetation near streams will avoid these impacts. Streamside areas cleared of vegetation will be revegetated as quickly as possible.

Table 4.9-3
Net Direct Stream Channel Impacts[1]

	Alternative 10A		Alternative 12A		Alternative 13	
Resource	# Crossings	Total Impact (ft)	# Crossings	Total Impact (ft)	# Crossings	Total Impact (ft)
Perennial Streams	1	420	1	330	1	290
Intermittent Streams	0	0	0	0	0	0
Total	1	420	1	330	1	290

Note:
1 Due to the shifting of roadways, some stream channel which is currently in a culvert will be restored. The impact totals account for these restored channel lengths.

4.9.5 No-Build Alternative

No new impervious surface area would be created under the No-Build Alternative. Rates of urban stormwater runoff and atmospheric deposition would therefore remain unchanged. However, the current untreated stormwater runoff would continue, and existing water quality issues would be expected to persist. Under the No-Build, no direct impacts to stream channels (*i.e.*, culverting) would occur, and aquatic habitat from these direct impacts would be avoided.

4.9.6 Secondary Impacts

The potential water quality impacts associated with the project-induced secondary development are difficult to assess in any quantitative manner without knowing exactly where the secondary development might occur. On a regional basis, the analysis of potential secondary development, discussed in Section 4.3.3, indicates that the increases in population are expected to be relatively minor. The proposed roadway improvements are expected to increase the residential population by 1,151 over the No-Build Alternative in Strafford County by 2025 with the Eight-Lane Alternative. In Rockingham County, the residential population is projected to increase by 714 by 2025 over the No-Build Alternative with the Eight-Lane Alternative. These projected population increases resulting from the Eight-Lane Alternative represent about 1.0 and 0.24 percent of the total 2005 population of 117,637 and 297,749 in Strafford and Rockingham counties, respectively.

On a local level, the secondary development analysis indicates that there is limited development potential within the Newington and Dover portions of the study area given the lack of undeveloped land and the existing land use zoning restrictions, particularly in the Newington portion of the project area. Much of the undeveloped land area in Newington, west of the Turnpike, is designated as Natural Protection Area, under Pease Development Authority’s regulations. These regulations limit the types of future development to uses such as natural resource management, public utilities, communication facilities, access roads and railroad activities.

There are two areas within local project area that are identified as having development potential which could contribute to cumulative impacts. These include a 16-acre parcel along the west side of the Turnpike that was formerly a drive-in theatre, and is zoned for office use under the Town of Newington’s zoning ordinance. The former drive-in parcel is located within the lower Pickering Brook watershed, which currently is estimated to be comprised of 45 percent impervious area. The other location consists of approximately 100 acres of undeveloped land within the Tradeport along the northeast section of the runway apron, which is zoned for Airport Industrial uses. This area sits on the drainage divide between the Railroad Brook watershed and the Hodgson Brook watershed area. Any future development of these two parcels would presumably require stormwater treatment measures as part of the regulatory approval process.

4.9.7 Mitigation

As many as eight extended-detention basins or other appropriate BMPs are anticipated to be included in the project design.[99] On the Newington side, at least five extended-detention basins will be designed for stormwater treatment, with three of the basins in the lower Pickering Brook watershed. Numerous grassed swales will also be used to treat runoff from various roadway sections especially around the proposed Woodbury Avenue Interchange area. The extended-detention basins will consist of a two-stage design with the lower stage sized to detain the first one-inch of runoff for approximately 24 hours. The upper stage will be designed to provide peak flow control for the 2-year and 10-year storm events. The extended-detention basins will include a sediment forebay, have a minimum length to width ratio of 3 to 1 to avoid "bypassing" treatment and will include a shallow permanent pool volume near the outlet to promote vegetative uptake and minimize re-suspension. Research has shown that these types of basins can effectively remove 60 to 80 percent of the settleable material, such as sediment and various adsorbed metals, and 40 to 60 percent of the various nutrients and 10 to 20 percent of the more soluble pollutants contained in runoff.

On the Dover side, at least three extended-detention basins or other appropriate BMPs have been preliminarily sized to receive and treat runoff from much of both the existing and new roadway areas. Numerous grass swales will also be included to treat smaller sections of roadway that cannot be directed to the extended-detention basins.

Although the current stormwater plan is to construct extended-detention basins and swales to treat stormwater discharges, a pollutant loading analysis using Schueler's Simple Method (Schueler 1987) or other method approved by NHDES will be completed during the preliminary stage of the final design. If needed, additional BMPs such as gravel wetlands will be considered to ensure, to the maximum extent practicable, that the project results in no net increase in the estimated pollutant loading relative to existing conditions. NHDOT and FHWA have collaborated with the UNH Stormwater Center to explore the latest in innovative treatment measures that can provide a high level of treatment for the various pollutants associated with highway runoff. Gravel wetlands have been found to have relatively high removal efficiencies for a number of pollutants, particularly for nitrogen, which is a principal parameter of concern in coastal waters. Nitrogen is typically the limiting nutrient in coastal and estuarine waters, such that any substantial increases in loading could stimulate undesirable algae growth. The use of gravel wetlands for stormwater treatment on this project will therefore be evaluated as part of the final design process.

▼

99 Extended-detention basins have a higher pollutant removal efficiency than conventional stormwater treatment management practices such as dry basins.

To minimize the potential for water quality impacts during construction, the NHDOT and FHWA will require construction contractors to provide detailed erosion control plans including contingency measures and periodic turbidity monitoring of the site discharge during wet weather events. Contractors will also be required to develop a Stormwater Pollution Prevention Plan (SWPPP), will require NHDOT approval. Frequent inspections of construction sites will be required to maintain compliance with permit conditions. These requirements are typically a condition of the USACOE and NHDES Wetlands Bureau permits, as well as part of the 401 Water Quality Certificate that will be required for the project and are thus legally enforceable.

With respect to minimizing road salt usage, NHDOT has been experimenting with various measures and technologies including the use of brine, as a means of reducing overall salt use. As these measures become more widely tested over the next few years, and as new technologies become available, the potential impacts associated with road salt may be greatly reduced.

4.10 Marine Environment

Widening of the Little Bay Bridges will require extension of the existing bridge piers to the west. This construction will have impacts to the marine environment, both natural and human. Assessment of these impacts as presented below, considers effects on the seabed and the habitat it provides, the water column, and on human uses through potential changes in navigation. The analysis: 1) quantifies the direct impacts to bottom habitats in the intertidal and subtidal zones; 2) discusses the effects of hydrodynamic changes on bottom habitats; and 3) considers potential changes in tidal and current energy as well as obstructions that might affect navigation. A key tool in this analysis is a hydrodynamic model prepared by the University of New Hampshire, Department of Mechanical Engineering, Ocean Engineering Laboratory. This model is described in Section 4.10.2, and biological and navigational issues are discussed in Sections 4.10.3 through 4.10.6.

4.10.1 Bridge Pier Construction

Section 2.4.8.4 discusses the numerous bridge options considered during the development of alternatives. Following the preliminary screening of alternatives in 2003 and 2004, it was determined that only two bridge alternatives warranted full consideration in this EIS:

- Widen the Little Bay Bridges to the west, with the rehabilitation of the General Sullivan Bridge for bicycle and pedestrian access, *i.e.,* the "Widen West/Rehabilitate" or the "Selected Alternative"; and

- Widen the Little Bay Bridges to the west, accommodating bicycle and pedestrian on the widened bridge, and Remove the General Sullivan Bridge (*i.e.,* the "Widen West/Remove" Alternative).

While these two alternatives differ in some substantial ways, such as cost and impact to the historical General Sullivan Bridge, for the purpose of analysis to the marine environment, they essentially reduce to a single alternative, since the impact of the widened bridge is directly related to the extension of the bridge piers. Preliminary engineering indicates that this widening would be similar for both alternatives.

The existing Little Bay Bridges are supported by eight piers in the Bay. In general, the pier elements consist of three layers of construction: the granite faced walls which extend above the water level, a reinforced concrete footing (visible at low tide at the northern pier), and an unreinforced rectangular concrete subfooting which is founded on bedrock. The existing General Sullivan Bridge also has eight piers in the bay. The General Sullivan piers generally consist of granite-faced walls which extend above the water level and an unreinforced rectangular concrete footing which is founded on bedrock.

The proposed widening of the Little Bay Bridges will extend the existing footings and subfootings toward the General Sullivan Bridge. It is anticipated that the footings will be joined below the water level with the General Sullivan Bridge and the granite faced pier walls will either be joined together or a very small separation will occur between the two sets of walls. More detail on the proposed pier design will be determined during final design.

4.10.2 Hydrodynamic Model

To better understand how the proposed project might affect the marine environment, a computer-based hydrodynamic model was built to predict tidal currents and tidal heights and allow a comparison of bridge alternatives. This section presents the findings of this hydrodynamic modeling study. The hydrodynamic computer model investigated the potential impacts of proposed bridge pier configurations on vertically-averaged tidal currents within the vicinity of the proposed bridge (see **Figure 4.10-1** for the location of observation points in the model) as well as tide elevations for the entire estuarine system (see **Figure 4.10-2**).

The hydrodynamic model included the Great Bay estuarine system from the mouth of the estuary in Portsmouth Harbor to the first dam on each of the river systems discharging freshwater into the estuarine system, including the "study area" in the vicinity of the existing Little Bay and General Sullivan Bridges (**Figure 4.10-2**).

The hydrodynamic computer model, once calibrated for existing conditions, was used to evaluate alternative bridge pier configurations. Model results for each case were then compared with the existing conditions (Case Study 1) to identify potential impacts to predicted tide elevations within the estuarine system and tidal currents at specified locations in the vicinity of the Little Bay Bridge project.

4.10.2.1 Description of Estuary

The Great Bay estuarine system is a drowned river valley with a watershed area of approximately 930 square miles. The main body of the estuary extends 16.2 miles from the Gulf of Maine up the lower Piscataqua River through Little Bay to Great Bay. The Great Bay estuarine system is the confluence of seven major rivers. The Lamprey, Squamscott, and Winnicut Rivers flow into Great Bay, the Bellamy and Oyster Rivers flow into Little Bay, and the Salmon Falls and Cocheco Rivers combine to form the upper Piscataqua River. The Piscataqua River is divided into the upper and lower portions at Dover Point (Pavlos, 1994). The Great Bay estuarine system has a low tide volume of 5.9×10^{9} cubic feet. The tidal volumes were calculated using depth and area information from the 1960 National Oceanic Atmospheric Administration (NOAA) chart (Reichard, 1976). The resulting tidal prism[100] entering the estuary from the Gulf of Maine is estimated at 2.8×10^{9} cubic feet (Brown and Swift, 1983). The tidal waters of the estuarine system cover approximately 17 square miles and are encircled by about 100 miles of shoreline. The fresh water input accounts for less than 1 percent of the estuarine system volume at low tide and less than 2 percent of the tidal prism (Reichard and Celikkol, 1978; Brown and Arellano, 1979).

4.10.2.2 Summary of Modeling Approach

To analyze potential hydrodynamic impacts, the following procedure was utilized:

1. Apply and calibrate a two dimensional hydrodynamic model (finite element) of the Great Bay estuarine system using topographic, bathymetric and tidal data, collected by others. As part of the model application, develop a universal mesh such that each Bridge Pier configuration mesh could be created by either deleting or adding specific elements within the pier footprint while keeping the element size and bathymetry values constant in each case.

   Development of the model included:

   - Application of the USACOE hydrodynamic model (RMA2 Version 4.56)[101] to the Great Bay estuarine system using the following data:

     - Bathymetry supplied by NOAA from their digital database (Marine Geophysical Custom Data from GEODAS (Geophysical Data System) (CD Order Number 205155)**;**

100 The “tidal prism” is the volume of water stored in the estuary between high and low tide, *i.e.*, the volume that moves into and out of the estuary during one tidal cycle.
101 USACOE, Engineer Research and Development Center, Waterways Experiment Center, September 2000.

  - Shorelines supplied by National Geodetic Data Center (NGDC) (Shorelines for the area of interest were downloaded directly from the NGDC site);
  - Shorelines and bathymetry digitized from NOAA Chart 13285 (10th edition) for portion of rivers to the first dam – not in the NOAA digital database;
  - Field location using GPS (Global Positioning System) positioning of the first dam on each river discharging into the estuarine system; and
  - Bridge pier location and geometries for the case studies.

- Calibration of the model with spring tide conditions using tide station data collected at Adams Point supplied by the Center for Coastal and Ocean Mapping at UNH for Case Study 1: Existing Conditions.

2. Run specific case studies of the model, which included:

CASE STUDY 1:	Existing Conditions with the existing bridge piers;
CASE STUDY 2:	Hydraulic Alternative One, *i.e.,* increasing the Little Bay Bridge Pier lengths by approximately 90 feet;
CASE STUDY 3:	Hydraulic Alternative Two, *i.e.,* increasing the Little Bay Bridge Pier lengths by approximately 75 feet;
CASE STUDY 4:	No bridge piers, representing the condition prior to any bridge construction in the area;
CASE STUDY 5:	Increase the Little Bay Bridge Pier lengths by combining them with the General Sullivan Bridge Piers (except for the northern most piers); and
CASE STUDY 6:	Little Bay Bridge Piers the same as CASE STUDY 2 with the General Sullivan Bridge Piers removed.

The model for each case study was run for a simulated period of 90 hours. The footprints of the various case studies are depicted in Figures 4.10-3 through 4.10-14, which also graphically depict the results of the model.

4.10.2.3 Hydrodynamic Model Results

Current velocity data from each model case study run were tabulated and plotted. The changes in current velocity from the existing conditions (Case Study 1) were determined by subtracting the predicted currents for the existing conditions from the case under consideration. For example, a positive current velocity would represent an increase in current velocity for the case under consideration over the modeled current velocity for existing conditions.

Tidal height data from each model case study run were tabulated for eight (8) locations in the upper estuarine system (**Figure 4.10-2**). Similarly, the difference in tidal height between the existing conditions (Case Study 1) and the other case studies was calculated by subtracting the modeled tidal height at the eight locations under existing conditions from the modeled tidal height for the other case studies. All values used were generated by a Spring Tide that was high at model time 69.5 and low at model time 75.5 hours.

CASE STUDY 1: Model Results with Existing Conditions

This case study modeled the currents and tide heights with the existing General Sullivan Bridge piers and the Little Bay Bridge piers. The General Sullivan Bridge piers vary from about 34.5 feet long by 8.2 feet wide to 58.2 feet long by 13. 8 feet wide. The Little Bay Bridge piers vary from about 53.8 feet long by 11.8 feet wide to 59.9 feet long by 16.4 feet wide.

Flood Tide Currents. Maximum predicted flood current velocities vary from 8.8 feet per second to 2.1 feet per second in the vicinity of the bridge piers at the 45 locations (Table 4.10-1 and **Figure 4.10-3**).

Ebb Tide Currents. Maximum predicted ebb current velocities vary from 9.7 feet per second to 1.3 feet per second in the vicinity of the bridge piers, except for location 22. The maximum predicted ebb current velocity at location 22 is 12.5 feet per second; however, the predicted velocity at this location is probably an anomaly of the model and should be viewed as not representative. Location 22 has a sharp depth gradient in this area; therefore, the model is least stable in this area at the time of maximum flow on the ebb tide (Table 4.10-1 and **Figure 4.10-4**).

Tidal Height. Maximum predicted tidal heights on the Great Bay side of the bridges on a high tide vary from 9.0 to 8.8 feet and the minimum heights on a low tide vary from 1.8 to 1.4 feet, (Table 4.10-2).

Maximum predicted tidal heights at Pomeroy Cove and the junction of the Cocheco and Salmon Falls Rivers on a high tide vary from 9.1 to 9.0 feet and the minimum heights on a low tide vary from 1.2 to 1.0 feet, (Table 4.10-2).

CASE STUDY 2: Model Results with Hydraulic Alternative One Piers

This case study modeled the currents and tide heights with the existing General Sullivan Bridge piers and the Little Bay Bridge piers modified to extend the length to accommodate the Eight-Lane Alternative. The General Sullivan Bridge piers vary from about 34.4 feet long by 8.2 feet wide to 58.2 feet long by 13.8 feet wide. The extended Little Bay Bridge piers for Alternative One vary from about 141.1 feet long by 11.8 feet wide to 147.6 feet long by 16.4 feet wide.

In this case mesh elements were deleted to create the increased length for the Little Bay Bridge Piers and the mesh was renumbered. The piers for the General Sullivan Bridge were left in place in the model mesh.

Flood Tide Current. Maximum predicted flood current velocities vary from 9.1 feet per second to 2.0 feet per second in the vicinity of the bridge piers at the 45 locations (Table 4.10-1 and **Figure 4.10-5).**

The differences between the flood tide current velocities modeled for existing conditions (Case Study 1) and the conditions specified in Case Study 2 can be summarized as follows. (It should be noted that data points 1 through 16 and 40 through 42 are upstream of the piers based on the direction of the flow on a flood tide.):

- Predicted current velocities with the lengthened piers are greater on the flood tide at locations 5 through 12, 19 through 22, 25, 30, 33 through 38, 40, 41, 43 and 45.

- Predicted current velocities with the lengthened piers are less than the existing pier velocities on the flood tide at locations 1 through 4, 13 through 18, 23, 24, 26 through 29, 31, 32, 39, 42 and 44.

The predicted current direction for a flood tide is such that the longer piers in Case Study 2 impede the flow in the northern area (locations 1 through 4) and in the southern area (locations 13 through 16); consequently, the velocities at these locations are less than the velocities for the existing conditions (Case Study 1). Because the flow direction in the center of the channel is aligned with the bridge piers and the opening between bridge piers for the two bridges is reduced, the velocities at these locations are greater than the existing conditions (locations 5 through 12).

The same is true of the locations inside of the pier area where locations 19 through 22 have higher predicted velocities with these pier lengths than with the existing conditions. Also the locations in this area on the northern edge and the southern edge have lower velocities (locations 17, 18 and 23).

The current velocities at the locations on the downstream side (Little Bay side) of the bridge piers are not as well ordered as the upstream side current velocities and as a result the velocities are higher at locations 25, 30, 33 through 38, 43 and 45. Current velocities are lower at locations 24 through 29, 31, 32, 39 and 44. Turbulence created by the piers probably influences the pattern of the current velocities in the downstream area of the piers.

Table 4.10-1
Maximum Flood/Ebb Rates (feet/second)[1]

Model Observation Point (Location)	Case Study 1		Case Study 2		Case Study 3		Case Study 4		Case Study 5		Case Study 6	
	EC max[2] Flood	EC max[2] Ebb	Alt1 max[3] Flood	Alt1 max[3] Ebb	Alt2 max[4] Flood	Alt2 max[4] Ebb	NP max[5] Flood	NP max[5] Ebb	CP max[6] Flood	CP max[6] Ebb	GSNP max[7] Flood	GSNP max[7] Ebb
1	4.6	1.7	4.2	1.8	4.3	1.8	5.8	1.7	4.2	1.8	4.4	1.6
2	5.0	2.3	4.9	2.5	4.9	2.5	5.5	1.8	4.9	2.6	5.0	2.5
3	5.2	2.0	5.1	2.2	5.1	2.1	5.9	1.9	5.1	2.2	5.1	2.0
4	6.3	3.1	6.2	3.2	6.2	3.2	6.7	2.3	6.2	3.2	6.2	2.8
5	6.6	3.4	6.7	3.6	6.7	3.6	7.3	30	6.7	3.6	6.7	3.1
6	8.8	6.6	9.1	7.0	9.0	7.0	8.8	4.9	9.2	6.9	9.1	6.1
7	8.2	6.9	8.6	7.0	8.4	7.0	8.9	7.0	8.6	7.0	8.5	6.7
8	8.6	9.7	9.0	9.9	8.9	9.9	8.4	9.2	9.1	9.8	9.0	9.7
9	6.2	7.0	6.4	6.8	6.3	6.8	6.7	8.3	6.4	6.8	6.5	6.9
10	5.9	8.4	6.0	8.5	6.0	8.5	6.0	8.0	6.0	8.5	6.1	8.6
11	4.7	5.5	5.0	5.7	4.8	5.6	5.3	7.8	4.8	5.8	4.9	6.1
12	4.3	7.5	4.4	7.4	4.5	7.4	4.5	6.9	4.4	7.3	4.6	7.4
13	3.4	3.3	3.3	3.1	3.3	3.1	3.8	5.6	3.2	3.2	3.3	3.4
14	3.5	5.4	3.2	5.2	3.3	5.2	3.5	4.9	3.2	5.2	3.3	5.3
15	3.7	4.3	3.3	4.3	3.3	4.3	3.7	5.9	3.3	4.2	3.3	4.6
16	3.5	4.8	3.2	4.8	3.3	4.8	3.5	4.0	3.3	4.8	3.2	4.6
17	6.0	2.6	5.9	2.9	5.9	2.9	5.8	2.8	5.9	3.0	6.1	2.9
18	6.4	3.0	6.1	3.2	6.2	3.2	6.2	2.8	6.1	3.1	6.3	2.9
19	5.9	3.4	6.3	3.7	6.2	3.8	5.1	3.2	6.3	3.7	6.2	3.3
20	6.3	6.2	6.7	6.3	6.5	6.3	5.7	6.0	6.7	6.2	6.6	5.9

Table 4.10-1 (continued)

Model Observation Points (Location)	Case Study 1		Case Study 2		Case Study 3		Case Study 4		Case Study 5		Case Study 6	
	EC max[2] Flood	EC max[2] Ebb	Alt1 max[3] Flood	Alt1 max[3] Ebb	Alt2 max[4] Flood	Alt2 max[4] Ebb	NP max[5] Flood	NP max[5] Ebb	CP max[6] Flood	CP max[6] Ebb	GSNP max[7] Flood	GSNP max[7] Ebb
21	6.5	8.3	6.6	8.9	6.6	8.8	6.0	7.7	6.6	8.8	6.8	8.6
22	7.3	12.5	7.9	13.8	8.0	13.7	7.0	11.1	7.9	13.7	8.3	13.8
23	4.8	6.4	4.1	6.6	4.2	6.6	4.1	6.1	4.0	6.5	4.2	6.5
24	5.1	5.0	5.0	4.7	5.1	4.8	5.2	5.5	5.0	4.6	5.2	5.0
25	5.1	5.0	5.3	4.7	5.2	4.8	5.1	5.3	5.2	4.6	5.2	4.9
26	4.6	4.6	4.5	4.4	4.5	4.5	5.0	5.1	4.5	4.4	4.8	4.7
27	5.5	5.3	5.5	5.1	5.5	5.1	5.0	5.5	5.4	5.1	5.1	5.2
28	4.6	5.6	4.3	5.4	4.3	5.5	5.1	6.1	4.1	5.4	4.5	5.8
29	6.0	5.7	5.8	5.4	5.8	5.5	5.6	5.8	5.7	5.4	5.3	5.5
30	4.9	5.1	4.9	5.0	4.9	5.0	6.1	6.1	5.0	5.0	5.8	5.8
31	6.8	6.2	6.7	6.1	6.8	6.1	6.0	6.3	6.7	6.1	6.3	6.1
32	4.3	4.9	4.3	5.0	4.2	5.0	5.7	6.1	4.4	5.1	5.3	6.1
33	6.0	5.8	6.0	6.0	6.0	5.9	5.4	5.8	6.0	6.1	5.6	5.9
34	3.9	4.5	4.0	4.6	3.9	4.5	5.1	5.8	4.1	4.7	4.8	5.8
35	4.5	5.4	4.6	5.6	4.5	5.6	4.4	5.4	4.5	5.7	4.2	5.5
36	3.3	4.0	3.4	4.1	3.4	4.1	3.9	4.9	3.5	4.2	3.6	4.9
37	3.5	4.4	3.6	4.6	3.6	4.5	3.3	4.4	3.6	4.7	3.5	4.5
38	2.4	2.8	2.6	2.9	2.6	2.9	2.6	3.6	2.4	3.0	2.8	3.6
39	2.1	2.7	2.0	2.7	2.1	2.7	1.2	2.7	1.8	2.7	1.6	2.7
40	3.5	1.3	3.6	1.5	3.6	1.5	3.6	1.0	3.6	1.6	3.6	1.3
41	3.9	4.8	3.9	4.8	3.9	4.7	4.0	5.3	3.9	4.9	4.0	5.1

Table 4.10-1 (continued)

Model Observation Points (Location)	Case Study 1		Case Study 2		Case Study 3		Case Study 4		Case Study 5		Case Study 6	
	EC max[2] Flood	EC max[2] Ebb	Alt1 max[3] Flood	Alt1 max[3] Ebb	Alt2 max[4] Flood	Alt2 max[4] Ebb	NP max[5] Flood	NP max[5] Ebb	CP max[6] Flood	CP max[6] Ebb	GSNP max[7] Flood	GSNP max[7] Ebb
42	2.7	4.4	2.7	4.0	2.7	4.1	2.8	5.5	2.7	4.0	2.7	4.2
43	4.3	6.0	4.4	5.9	4.4	5.9	4.5	6.2	4.4	5.9	4.4	6.0
44	6.2	6.1	6.1	6.1	6.2	6.1	6.2	6.3	6.1	6.1	6.1	6.2
45	3.7	4.3	3.7	4.3	3.7	4.3	4.1	4.4	3.8	4.4	3.9	4.4

Notes:
1. Velocities shown here are the predicted maxima for each model observation point during the flood and ebb tides.
2. EC = Existing Conditions (*i.e.*, Case Study 1).
3. Alt1 = Hydraulic Alternative 1 (*i.e.,* (Case Study 2)
4. Alt2 = Hydraulic Alternative 2 (*i.e.*, (Case Study 3)
5. NP = No Piers (*i.e.*, GSB and LBB piers removed, Case Study 4)
6. CP = Combined Piers (*i.e.*, Case Study 5)
7. GSNP = LBB piers extended, but GSB piers removed (*i.e.*, Case Study 6)

Table 4.10-2
Predicted Tidal Heights (Feet)

	Case Study 1		Case Study 2		Cast Study 3		Case Study 4		Case Study 5		Case Study 6	
	EC HT	EC LT	Alt1 HT	Alt1 LT	Alt2 HT	Alt2 LT	NP HT	NP LT	CP HT	CP LT	GSNP HT	GSNP LT
Squamscot Marsh	8.938	1.830	8.945	1.824	8.941	1.827	9.050	1.752	8.951	1.814	9.000	1.784
Sandy Point	8.958	1.545	8.964	1.538	8.961	1.545	9.066	1.453	8.971	1.528	9.017	1.492
Pickering Brook	8.958	1.427	8.968	1.420	8.964	1.427	9.066	1.325	8.971	1.410	9.020	1.368
Lubberland Creek	8.954	1.496	8.961	1.489	8.958	1.496	9.059	1.404	8.968	1.479	9.013	1.443
Adams Point	8.869	1.450	8.876	1.440	8.872	1.450	8.968	1.335	8.882	1.430	8.925	1.384
Durham Town Landing	8.823	1.483	8.830	1.476	8.826	1.483	8.918	1.361	8.836	1.463	8.876	1.414
Pomeroy Cove	9.046	1.027	9.046	1.033	9.046	1.030	9.023	1.014	9.043	1.033	9.033	1.030
Junction Cocheco River and Salmon Falls River	9.148	1.200	9.145	1.207	9.148	1.207	9.112	1.197	9.145	1.207	9.128	1.210

Notes:
HT = High Tide
LT = Low Tide
EC = Existing Conditions (*i.e.*, Case Study 1).
Alt1 = Hydraulic Alternative 1 (*i.e.,* Case Study 2)
Alt2 = Hydraulic Alternative 2 (*i.e.*, Case Study 3)
NP = No Piers (*i.e.*, GSB and LBB piers removed, Case Study 4)
CP = Combined Piers (*i.e.*, Case Study 5)
GSNP = LBB piers extended, but GSB piers removed (*i.e.*, Case Study 6)

The predicted greatest changes in magnitude of current velocity for the maximum flood tide modeled is +0.42 feet per second at location 8 and a -0.68 feet per second change in magnitude at location 23.

Ebb Tide Current. Maximum predicted ebb current velocities vary from 9.9 feet per second to 1.5 feet per second in the vicinity of the bridge piers. If location 22 is included then they vary from 13.7 to 1.5 feet per second; however, this change is probably an anomaly of the model and should be viewed as not representative. Location 22 has a sharp depth gradient in this area; therefore, the model is least stable in this area at the time of maximum flow on the ebb tide (Table 4.10-1 and **Figure 4.10-6**).

The predicted current velocities at the 45 locations in the area of the piers for an ebb tide condition provide the following information (It should be noted that locations 24 through 39 and 43 through 45 are upstream of the piers based on the direction of the flow on an ebb tide):

- Predicted current velocities with the lengthened piers are greater than the existing pier velocities on an ebb tide at locations 1 through 8, 10, 11, 15, 17 through 23, 32 through 39, 40, 44 and 45.

- Predicted current velocities with the lengthened piers are less than the existing pier velocities on an ebb tide at locations 9, 12 through 14, 16, 24 through 31, 41, 42 and 43.

The predicted current flow direction (**Figure 4.10-6**) for an ebb tide is such that the longer piers in Case Study 2 impede the flow in the northern half of the upstream area (locations 24 through 31 and 43); consequently the velocities are lower than the velocities for the existing conditions (Case Study 1). The current velocities are higher in the southern half with the lengthened piers (locations 32 through 39, 44 and 45) since in this area the current flow direction is more closely aligned with the pier orientation. Within the pier area the predicted velocities are higher (locations 17 through 23) under Case Study 2 conditions than the velocities under the existing conditions (Case Study 1).

Predicted current velocities again are not as well ordered on the downstream side of the piers with locations 1 through 8, 10, 11, 15, 17, and 40 having higher predicted velocities and locations 9, 12 through 14, 16, 41 and 42 having lower predicted velocities. Again these results are attributed to turbulence in the pier area.

The predicted greatest change in magnitude of velocity for the maximum ebb tide modeled is +0.5 foot per second at location 21 and a -0.4 foot per second change at location 42.

Current velocity at location 22 is higher with the Case Study 2 conditions than with the Case Study 1 with a positive change of 1.3 foot per second; however, because of the sharp depth gradient this change is probably an anomaly of the model.

Tidal Height. Maximum predicted tidal heights on the Great Bay side of the bridges on a high tide vary from 9.0 to 8.8 feet and the minimum heights on a low tide vary from 1.8 to 1.4 feet (Table 4.10-2).

Maximum predicted tidal heights at Pomeroy Cove and at the Junction of the Cocheco and Salmon Falls Rivers on a high tide vary from 9.1 to 9.0 feet and the minimum heights on a low tide vary from 1.2 to 1.0 feet (Table 4.10-2).

Predicted tide height changes between Case Study 2 and existing conditions (Case Study 1) are up to 0.1 inch decrease (level lower than existing conditions) on a low tide and up to 0.1 inch higher on a high tide on the Great Bay side of the bridges. These results are attributed to this pier configuration permitting slightly more efficient flow into and out of Great Bay.

At Pomeroy Cove the predicted heights are up to 0.1 inch higher (level higher than existing conditions) on a low tide, with no change at the high tide. At the junction of the Cocheco River and the Salmon Falls River the predicted heights are up to 0.1 inch higher on a low tide and up to 0.1 inch lower on a high tide. These results are attributed to this pier configuration permitting slightly more efficient flow into and out of Great Bay and as a result creating a slightly lower tidal range in the Upper Piscataqua River.

CASE STUDY 3: Model Results with Hydraulic Alternative Two Piers

This case study modeled the currents and tide heights with the existing General Sullivan Bridge piers and the Little Bay Bridge piers modified to extend the length. The General Sullivan Bridge piers vary from about 34.5 feet long by 8.2 feet wide to 58.2 feet long by 13.8 feet wide. The extended Little Bay Bridge piers for Alternative Two vary from about 124.7 feet long by 11.8 feet wide to 131.2 feet long by 16.4 feet wide.

In this case mesh elements were deleted to create the increased length for the Little Bay Bridge Piers and the mesh was renumbered. The piers in this case study are not as long as the Hydraulic Alternative One Piers. The piers for the General Sullivan Bridge were left in place in the model mesh.

Flood Tide Current. Maximum predicted flood current velocities vary from 9.0 feet per second to 2.1 feet per second in the vicinity of the bridge piers at the 45 locations (Table 4.10-1 and **Figure 4.10-7**).

The differences between the flood tide current velocities modeled for existing conditions (Case Study 1)) and the conditions specified in Case Study 3 can be summarized as follows. (It should be noted that locations 1 through 16 and 40 through 42 are upstream of the piers based on the direction of the flow on a flood tide.):

- Predicted current velocities with the lengthened piers are greater on the flood tide at locations 5 through 12, 19 through 22, 25, 33, 35 through 38, 40, 41, and 43.

- Predicted current velocities at locations 1 through 4, 13 through 18, 23, 24, 26 through 32, 34, 39, 42, 44 and 45 are less than predicted with the existing piers on a flood tide.

The predicted current direction for a flood tide is such that the longer piers Case Study 3 impede the flow in the northern area (locations 1 through 4) and in the southern area (locations 13 through 16); consequently, the current velocities at these locations are less than the velocities for the existing conditions (Case Study 1). Because the flow direction in the center of the channel is aligned with the bridge piers and the opening between bridge piers for the two bridges is reduced, the velocities at these locations are greater than the existing conditions (locations 5 through 12).

The same is true of the locations inside of the pier area where locations 19 through 22 have higher predicted velocities with these pier lengths than with the existing conditions. Also the locations in this area on the northern edge and the southern edge have lower velocities (locations 17, 18 and 23).

The current velocities at the locations on the downstream side (Little Bay side) of the bridge piers is not as well ordered as the upstream side current velocities and as a result the velocities are higher at points 25, 33, 35 through 38, and 43. Current velocities are lower at locations 24, 26 through 32, 34, 39, 44 and 45. Turbulence created by the piers probably influences the pattern of the current velocities in the downstream area of the piers.

The predicted greatest change in magnitude of current velocity for the maximum flood tide modeled is +0.4 foot per second at location 6 and a -0.6 foot per second change in magnitude at location 23.

Ebb Tide Current. Maximum predicted ebb current velocities vary from 9.9 feet per second to 1.5 feet per second in the vicinity of the bridge piers. If location 22 is included then they vary from 13.7 to 1.5 feet per second; however, this change is probably an anomaly of the model and should be viewed as not representative. Location 22 has a sharp depth gradient in this area; therefore, the model is least stable in this area at the time of maximum flow on the ebb tide (Table 4.10-1 and **Figure 4.10-8**).

The predicted current velocities at the 45 locations in the area of the piers for an ebb tide condition provide the following information (It should be noted that locations 24 through 39 and 43 through 45 are upstream of the piers based on the direction of the flow on an ebb tide.):

- Predicted current velocities with the lengthened piers is greater than the existing pier velocities on an ebb tide at locations 1 through 8, 10, 11, 15, 17 through 23, 32 through 40, and 45.

- Predicted current velocities with the lengthened piers is less than the existing piers on an ebb tide at locations 9, 12 through 14, 16, 24 through 31 and 41 through 44.

The current flow direction is such that the longer piers impede the flow in the northern half of the upstream area (points 24 through 31, 43 and 44) consequently the velocities are lower for the lengthened piers than for the existing piers. The current velocities are higher in the southern half with the lengthened piers (locations 32 through 39 and 45) since in this area the current flow direction is more closely aligned with the pier orientation.

Within the pier area the predicted current velocities are higher (locations 17 through 23) under Case Study 3 conditions than the velocities under the existing conditions (Case Study 1).

Predicted current velocities again are not as well ordered on the downstream side of the piers with locations 1 through 8, 10, 11, 15 and 40 having higher predicted velocities and locations 9, 12 through 14, 41 and 42 having lower predicted velocities. Again these results are attributed to turbulence in the pier area.

The predicted greatest change in magnitude of velocity for the maximum ebb tide modeled is +0.5 foot per second at location 21 and a -0.3 feet per second change at location 42. Because of the sharp depth gradient at location 22, a higher positive change of 1.3 foot per second was modeled, but this change is probably an anomaly of the model.

Tidal Height. Maximum predicted tidal heights on the Great Bay side of the bridges on a high tide vary from 9.0 to 8.8 feet and the minimum heights on a low tide vary from 1.8 to 1.4 feet (Table 4.10-2).

Maximum predicted tidal heights at Pomeroy Cove and the junction of the Cocheco and Salmon Falls Rivers on a high tide vary from 9.1 to 9.0 feet and the minimum heights on a low tide vary from 1.2 to 1.0 feet (Table 4-10-2).

Predicted tide height changes between Case Study 3 and existing conditions (Case Study 1) are up to a 0.1 inch decrease (level lower than existing conditions) on a low tide and up to 0.1 inch higher on a high tide on the Great Bay side of the bridges. These results are attributed to this pier configuration permitting slightly more efficient flow into and out of Great Bay.

At Pomeroy Cove the predicted heights are up to 0.1 inch higher (level higher than existing conditions) on an low tide and no change on a high tide. At the junction of the Cocheco River and the Salmon Falls River the predicted heights are up to 0.1 inch higher on a low tide and no change on a high tide. These results are attributed to this pier configuration permitting slightly more efficient flow into and out of Great Bay and as a result creating a slightly lower tidal range in the Upper Piscataqua River.

CASE STUDY 4: Model results with No Bridge Piers

This case study modeled the currents and the tide heights with the existing bridge piers removed.

In this case mesh elements were added in the area of the bridge piers and the mesh was renumbered.

Flood Tide Current. Maximum predicted flood currents vary from 8.9 feet per second to 1.2 feet per second in the vicinity of the bridge piers at the 45 locations (Table 4.10-1 and **Figure 4.10-9**).

The differences between the flood tide current velocities modeled for existing conditions and the conditions specified in Case Study 4 can be summarized as follows. (It should be noted that locations 1 through 16 and 40 through 42 are upstream of location of the piers based on the direction of the flow on a flood tide.):

- Predicted current velocities with no piers are greater on the flood tide at locations 1 through 7, 9 through 13, 15, 16, 24, 26, 28, 30, 32, 34, 36, 38, 40 through 43 and 45.

- Predicted current velocities at locations 8, 14, 17 through 23, 25, 27, 29, 31, 33, 35, 37, 39 and 44 are less than predicted with the existing piers on a flood tide.

The predicted current direction for a flood tide is such that no piers impede the flow in the northern area (locations 1 through 7) and in the southern area (locations 9 through 13); consequently the velocities at these locations are greater than the velocities for the existing conditions. Because the flow direction in the center of the channel under existing conditions is aligned with the bridge piers, current velocities in this case study (no piers) are not always greater than the existing conditions (locations 8 and 14).

The locations inside of the pier area (locations 19 through 23) have lower predicted current velocities in the no piers configuration (Case Study 4) than with the existing conditions pier configuration (Case Study 1) because removing the piers creates more channel volume consequently the current velocities decrease.

The current velocities at the locations on the downstream side (Little Bay side) of the bridge pier area are not as well ordered as the upstream side current velocities and as a result the velocities are higher at locations 24, 26, 28, 30, 32, 34, 36, 38, 43 and 45 relative to existing conditions. Current velocities are lower at locations 25, 27, 29, 31, 33, 35, 37, 39 and 44 relative to existing conditions. Turbulence created by the piers in the existing condition probably influences the pattern of the downstream current velocities in the area of the piers, while no piers are present to create similar turbulence in this case study.

The predicted greatest change in magnitude of current velocity for the maximum flood tide modeled is +1.4 feet per second at location 32 and a -0.9 foot per second change at location 39.

Ebb Tide Current. Maximum predicted ebb current velocities vary from 9.2 feet per second to 1.0 feet per second in the vicinity of the bridges. If location 22 is included then they vary from 11.1 to 7.5 feet per second; however, this change is probably an anomaly of the model and should be viewed as not representative. Location 22 has a sharp depth gradient in this area; therefore, the model is least stable in this area at the time of maximum flow on the ebb tide (Table 4.10-1 and **Figure 4.10-10**).

The predicted current velocities at the 45 locations in the area where the piers are located in the existing conditions case study for an ebb tide condition provide the following information (It should be noted that locations 24 through 39 and 43 through 45 are upstream of the pier area based on the direction of the flow on an ebb tide):

- Predicted current velocities with no piers are greater than the current velocities with the modeled existing piers on an ebb tide at the following locations 7, 9, 11, 13, 15, 17, 24 through 34, 36, 38, 39 and 41 through 45.

- Predicted current velocities with no piers are less than the current velocities with the modeled existing piers on an ebb tide at the following locations 1 through 6, 8, 10, 12, 14, 16, 18 through 23, 35, 37 and 40.

The current flow direction (**Figure 4.10-10**) is such that the no piers configuration permitted higher current velocities in the northern half of the upstream area (locations 24 through 34 and 43 through 45) and as a result the current velocities are higher than for the existing piers configuration. The current velocities as modeled are mixed in the southern half with no piers (locations 35 through 39). In this area the current flow direction is more closely aligned with the piers orientation (existing condition) consequently current velocities are higher at locations 36, 38 and 39. Current velocities are lower at locations 35 and 37. Within the pier area the predicted current velocities are lower (points 18 through 23) than the existing conditions except at location 17 where the velocities are higher.

Predicted velocities again are not as well ordered on the downstream side of the piers (Existing Condition only) with points 7, 9, 11, 13, 15, 41 and 42 having higher predicted velocities and points 1 through 6, 8, 10, 12, 14, 16 and 40 having lower predicted velocities. Again these results are attributed to turbulence in the pier area in the existing condition current velocities.

The predicted greatest change in magnitude of velocity for the maximum ebb tide modeled is +2.32 feet per second at location 11 and a -1.07 feet per second change in magnitude at location 18. Current velocity at location 22 is higher with the Case Study 4 conditions than with the Case Study 1 with a negative change of 1.40 feet per second; however, because of the sharp depth gradient this change is probably an anomaly of the model.

Tidal Height. Maximum predicted tidal heights on the Great Bay side of the bridges on a high tide vary from 9.1 to 8.9 feet and the minimum heights on a low tide vary from 1.7 to 1.3 feet, Table 4.10-2.

Maximum predicted tidal heights at Pomeroy Cove and the junction of the Cocheco and Salmon Falls Rivers on a high tide vary from 9.1 to 9.0 feet and the minimum heights on a low tide vary from 1.2 to 1.0 feet, Table 4.10-2.

Predicted tide height changes between Case Study 4 and existing conditions (Case Study 1) are up to a 1.5 inches decrease (level lower than existing conditions) on a low tide and 1.3 inches higher on a high tide on the Great Bay side of the bridges. Removal of all piers permits greater flow into and out of Great Bay.

At Pomeroy Cove the predicted heights are up to 0.2 inch lower (level lower than existing conditions) on a low tide and up to 0.3 inch higher on a high tide. At the junction of the Cocheco River and the Salmon Falls River the predicted heights are up to 0.1 inch lower on a low tide and up to 0.4 inch lower on a high tide. The greater flow into Great Bay slightly reduces the tidal range in the Upper Piscataqua.

CASE STUDY 5: Model Results with Combined Bridge Piers

This case study modeled the currents and tide heights with the existing Little Bay and General Sullivan Bridge piers combined, except for the northern most piers that are off set from each other; and therefore, left in place. The combined General Sullivan and Little Bay Bridge piers for the combined piers case study vary from about 141.1 feet long by 11.8 feet wide to 196.9 to 210.0 feet long by 16.4 feet wide.

In this case mesh elements were deleted to create the combined bridge piers and the mesh was renumbered.

Flood Tide Current. Maximum predicted flood currents vary from 9.2 feet per second to 1.8 feet per second in the vicinity of the bridge piers at the 45 locations (Table 4.10-1 and **Figure 4.10-11**)).

The differences between the flood tide current velocities modeled for existing conditions (Case Study 1) and the conditions specified in Case Study 5 can be summarized as follows. (It should be noted that locations 1 through 16 and 40 through 42 are upstream of location of the piers based on the direction of the flow on a flood tide.):

- Predicted current velocities with the combined piers are greater on the flood tide than the existing piers current velocities at the following locations 5 through 12, 19 through 22, 25, 30, 32, 34 through 37, 40, 41, 43 and 45.

- Predicted current velocities at locations 1 through 4, 13 through 18, 23, 24, 26 through 29, 31, 38, 39, 42, and 44 are less than predicted with the existing piers on a flood tide.

- The Predicted current velocity at location 33 on a flood tide is the same for the Combined Piers (Case Study 5) as for the existing conditions current velocity (Case Study 1).

The predicted current direction for a flood tide is such that the combined piers in Case Study 5 impede the flow in the northern area (locations 1 through 4) and in the southern area (locations 13 through 16); consequently, the velocities at these locations are less than the velocities for the existing conditions (Case Study 1). Because the flow direction in the center of the channel is aligned with the bridge piers the combined pier currents are greater than the existing conditions (locations 5 through 12).

The locations inside of the pier area (locations 19 through 22) have higher predicted current velocities in the combined pier configuration than with the existing conditions pier configuration because the piers are aligned with the current direction and the combined piers reduce the turbulence. Also the locations in this area on the northern edge and the southern edge have lower velocities than in Case Study 1 existing conditions (locations 17, 18 and 23).

The currents at the locations on the downstream side (Little Bay side) of the bridge pier area are not as well ordered as the upstream side currents and as a result the velocities are higher at locations 25, 30, 32, 34 through 37, 43 and 45. Current velocities are lower at locations 24, 26 through 29, 31, 38, 39 and 44. Turbulence created by the piers probably influences the pattern of the upstream current velocities in the area of the piers.

The predicted greatest change in magnitude of current velocity for the maximum flood tide modeled is +0.5 foot per second at location 8 and a -0.8 foot per second change in magnitude at location 23.

Ebb Tide Current. Maximum predicted ebb currents vary from 9.8 feet per second to 1.6 feet per second in the vicinity of the bridge piers. If location 22 is included then they vary from 13.7 to 1.6 feet per second; however, this change is probably an anomaly of the model and should be viewed as not representative. Location 22 has a sharp depth gradient in this area; therefore, the model is least stable in this area at the time of maximum flow on the ebb tide (Table 4.10-1 and **Figure 4.10-12**).

The predicted current velocities at the 45 locations in the area of the piers for an ebb tide condition provide the following information (It should be noted locations 24 through 39 and 43 through 45 are upstream of the piers based on the direction of the flow on an ebb tide.):

- Predicted current velocities with the combined piers is greater than the existing pier predicted current velocities on an ebb tide at the following locations 1 through 8, 10, 11, 17 through 19, 21 through 23, 32 through 38, 40, 41, 44, 45.

- Predicted current velocities with the combined piers is less than the existing piers on an ebb tide at the following locations 9, 12 through 16, 20, 24 through 31, 39, 42 and 43.

The predicted current flow direction (**Figure 4.10-12**) is such that the combined piers configuration creates lower current velocities because the piers are not aligned with the current direction in the northern half of the upstream area (locations 24 through 31 and 43) and as a result the current velocities for Case Study 5 are lower than for the existing piers configuration. The current velocities are higher in the southern half with the combined piers (locations 32 through 38). In this area the current flow direction is more closely aligned with the pier orientation so that current velocities are higher under Case Study 5 conditions than the current velocities in the existing conditions (Case Study 1). Current velocity is lower at location 39. Within the pier area the predicted current velocities are higher (locations 17 through 19 and 21 through 23) under Case Study 5 conditions than the current velocities in the existing conditions (Case Study 1), except at location 20 where the current velocities are lower than the existing conditions (Case Study 1).

Predicted current velocities again are not as well ordered on the downstream side of the piers with locations 1 through 8, 10, 11, 40 and 41 having higher predicted velocities and locations 9, 12 through 16 and 42 having lower predicted velocities under Case Study 5 conditions than the current velocities in the existing conditions (Case Study 1). Again these results are attributed to turbulence in the pier area in the existing condition current velocities.

The predicted greatest change in magnitude of velocity for the maximum ebb tide modeled is +0.5 foot per second at location 21 and a -0.4 foot per second change at location 24. Because of the sharp depth gradient at location 22, a higher positive change of 1.3 feet per second was modeled, but this change is probably an anomaly of the model.

Tidal Height. Maximum predicted tidal heights on the Great Bay side of the bridges on a high tide vary from 9.0 to 8.8 feet and the minimum heights on a low tide vary from 1.8 to 1.4 feet (Table 4.10-2).

Maximum predicted tidal heights at Pomeroy Cove and the junction of the Cocheco and Salmon Falls Rivers on a high tide vary from 9.1 to 9.0 feet and the minimum heights on a low tide vary from 1.2 to 1.0 feet (Table 4.10-2).

Predicted tide height changes are up to a 0.2 inch decrease (level lower than existing conditions) on a low tide and 0.2 inch higher on a high tide on the Great Bay side of the bridges. These results are attributed to this pier configuration permitting slightly more efficient flow into and out of Great Bay.

At Pomeroy Cove the predicted heights are up to 0.1 inch higher (level higher than existing conditions) on an low tide and up to 0.1 inch lower on a high tide. At the junction of the Cocheco River and the Salmon Falls River the predicted heights are up to up to 0.1 inch higher on a low tide and 0.1 inch lower on a high tide. These results are attributed to this pier configuration permitting slightly more efficient flow into and out of Great Bay and as a result creating a slightly lower tidal range in the Upper Piscataqua River.

CASE STUDY 6: Model Results with Hydraulic Alternate One Bridge Piers but General Sullivan Bridge Piers Removed

This case study modeled the currents and tide heights with the existing General Sullivan Bridge piers removed and the Little Bay Bridge piers modified to extend the length described in Case Study 2. The extended Little Bay Bridge piers for Alternative One vary from about 141.1 feet long by 11.8 feet wide to 147.6 feet long by 16.4 feet wide.

In this case the Case Study 2 Hydraulic Alternate One mesh was used but modified by adding mesh elements in the area of the General Sullivan Bridge piers and the modified mesh was renumbered.

Flood Tide Current. Maximum predicted flood current velocities vary from 9.1 feet per second to 1.6 feet per second in the vicinity of the bridge piers at the 45 locations (Table 4.10-1 **and Figure 4.10-3**).

The differences between the flood tide current velocities modeled for existing conditions (Case Study 1) and the conditions specified in Case Study 6 can be summarized as follows**.** (It should be noted that locations 1 through 16 and 40 through 42 are upstream of location of the piers based on the direction of the flow on a flood tide.):

- Predicted current velocities with this configuration of piers are greater on the flood tide at the following locations 5 through 12, 17, 19 through 22, 24 through 26, 30, 32, 34, 36, 38, 40 through 43 and 45.

- Predicted current velocities at locations 1 through 4, 13 through 16, 18, 23, 27 through 29, 31, 33, 35, 37, 39, and 44 are less than predicted with the existing piers on a flood tide.

The predicted current direction (**Figure 4.10-13**) for a flood tide is such that the configuration of piers in Case Study 6 impedes the flow in the northern area (locations 1 through 4) and in the southern area (locations 13 through 16) and as a result the current velocities at these locations are less than the velocities for the existing conditions (Case Study 1). Because the flow direction in the center of the channel is aligned with the bridge piers the lengthened piers with no General Sullivan piers velocities are greater than the existing conditions (locations 5 through 12). The locations inside of the pier area (locations 17, and 19 through 22) have higher predicted current velocities in this pier configuration than with the existing conditions pier configuration because the piers are aligned with the current direction and the removal of the General Sullivan piers reduces the turbulence. Locations 18 and 23 in this area have lower current velocities than the velocities in Case Study 1.

The current velocities at the locations on the downstream side (Little Bay side) of the bridge pier area are not as well ordered as the upstream side current velocities and as a result the velocities are higher at locations 24 though 26, 30, 32, 34, 36, 38, 43 and 45. Current velocities are lower at locations 27, 29, 31, 33, 35, 37, 39, and 44. Turbulence created by the piers probably influences the pattern of the current velocities in the locations downstream of the pier areas.

The predicted greatest change in magnitude of current velocity for the maximum flood tide modeled is +1.0 foot per second at location 32 and a -0.7 foot per second change at location 29.

Ebb Tide Current. Maximum predicted ebb current velocities vary from 9.7 feet per second to 1.3 feet per second in the vicinity of the bridge piers. If location 22 is included then they vary from 13.8 to 1.3 feet per second; however, this change is probably an anomaly of the model and should be viewed as not representative. Location 22 has a sharp depth gradient in this area; therefore, the model is least stable in this area at the time of maximum flow on the ebb tide (Table 4.10-1 and **Figure 4.10-14**).

The predicted current velocities at the 45 locations in the area of the piers for an ebb tide condition provide the following information (It should be noted locations 24 through 39 and 43 through 45 are upstream of the piers based on the direction of the flow on an ebb tide):

- Predicted current velocities with this configuration of piers is greater than the existing pier predicted current velocities on an ebb tide at locations 2, 3, 10, 11, 13, 15, 17, 21 through 23, 26, 28, 30, 32 through 41, 43 through 45.

- Predicted current velocities with this configuration of piers is less than the existing piers on an ebb tide at locations 1, 4 through 9, 12, 14, 16, 18 through 20, 24, 25, 27, 29, 31 and 42.

The predicted current flow direction (**Figure 4.10-14**) is such that the Hydraulic Alternate One piers with no General Sullivan Bridge Piers configuration creates lower flow because the piers are not aligned with the current direction in the northern half of the upstream area (locations 24 through 31) except for locations 26, 28, and 30 and as a result the current velocities are lower than for the existing piers configuration. The current velocities are higher in the southern half with the Hydraulic Alternate One piers with no General Sullivan Bridge Piers (locations 32 through 39). In this area the current flow direction is more closely aligned with the piers orientation so that current velocities are higher. Within the pier area the predicted current velocities are higher (locations 17, and 21 through 23) except at locations 18 through 20 where they are lower. The predicted current velocities are higher for this configuration than for the existing conditions piers at locations 17, 21 through 23 because of the reduced turbulence caused by removing the General Sullivan Bridge Piers.

Predicted current velocities again are not as well ordered on the downstream side of the piers with locations 2, 3, 10, 11, 13, 15, 40 and 41 having higher predicted velocities and locations 1, 4 though 9, 12, 14, 16 and 42 having lower predicted velocities. Again these results are attributed to turbulence in the pier area.

The predicted greatest change in magnitude of velocity for the maximum ebb tide modeled is +1.4 feet per second at location 34 and a -0.5 foot per second change at location 6.

Tidal Height. Maximum predicted tidal heights on the Great Bay side of the bridges on a high tide vary from 9.0 to 8.9 feet and the minimum heights on a low tide vary from 1.8 to 1.4 feet (Table 4.10-2).

Maximum predicted tidal heights at Pomeroy Cove and the junction of the Cocheco and Salmon Falls Rivers on a high tide vary from 9.1 to 9.0 feet and the minimum heights on a low tide vary from 1.2 to 1.0 feet (Table 4.10-2).

Predicted tide height changes are up to an 0.8 inch decrease (level lower than existing conditions) on a low tide and 0.7 inch higher on the Great Bay side of the bridges. These results are attributed to this pier configuration permitting slightly better flow into and out of Great Bay.

At Pomeroy Cove the predicted heights are up to 0.1 inch higher (level higher than existing conditions) on an low tide and up to 0.1 inch lower on a high tide. At the junction of the Cocheco River and the Salmon Falls River the predicted heights are up to up to 0.1 inch higher on a low tide and 0.2 inch lower on a high tide. These results are attributed to this pier configuration permitting slightly more efficient flow into and out of Great Bay and as a result creating a slightly lower tidal range in the Upper Piscataqua River.

4.10.2.4 Conclusions

Summary of Key Findings

Predicted current velocities are affected in the Bridge area by the pier configurations defined by Case Studies 2 through 6 when compared to the existing conditions (Case Study 1).

Maximum predicted flood current velocities range up to 9.2 feet per second (Case Study 5). Maximum predicted ebb current velocities range up to 9.9 feet per second (Case Studies 2 and 3).

Predicted tidal heights are affected in the Great Bay Estuarine System by the bridge pier configurations modeled in Case Studies 1 through 6. Tidal Height predicted highs range from 9.1 feet at Sandy Point (Case Study 4) to 8.8 feet at Durham Town Landing (Case Study 1). Tidal Height predicted lows range from 1.8 feet at Squamscot Marsh (Case Studies 1 through 6) to 1.3 feet at Pickering Brook and Adams Point (Case Study 4).

The case studies can be ranked by potential impact on the tidal range compared to the existing condition (Case Study 1) as follows (highest impact to lowest impact):

1. **Case Study Four: No Bridge Piers**
   a. Predicted high tide differences on the Great Bay side of the bridges: up to 1.3 inches higher at Squamscot Marsh. This equates to a 1.5 percent change in the high tide level when compared to the existing conditions.
   b. Predicted high tide differences in Pomeroy Cove and junction of the Cocheco and Salmon Falls River: up to 0.4 inch lower at the junction

of the Cocheco and Salmon Falls River. This equates to a 0.5 percent change.

c. Predicted low tide differences on the Great Bay side of the bridges: up to 1.5 inches decrease at the Durham Town Landing. This equates to a 1.9 percent change in the low tide level when compared to the existing conditions.

d. Predicted low tide differences Pomeroy Cove and junction of the Cocheco and Salmon Falls River: up to 1.6 inches higher at Pomeroy cove. This equates to a 0.2 percent change.

2. Case Study Six: Hydraulic Alternate One Bridge Piers but General Sullivan Bridge Piers Removed

a. Predicted high tide differences on the Great Bay side of the bridges: up to 0.8 inch higher at Squamscot Marsh and Pickering Brook. This equates to a 0.9 percent change in the tide level when compared to the existing conditions (Case Study 1).

b. Predicted high tide differences Pomeroy Cove and junction of the Cocheco and Salmon Falls Rivers up to 0.2 inch lower at the junction of the Cocheco and Salmon Falls Rivers. This equates to a 0.3 percent change.

c. Predicted low tide differences on the Great Bay side of the bridges: up to 0.8 inch decrease at Durham Town Landing. This equates to a 0.9 percent change in the low tide level when compared to the existing conditions (Case Study 1).

d. Predicted low tide differences Pomeroy Cove and junction of the Cocheco and Salmon Falls River: up to 0.1 inch higher at the junction of the Cocheco and Salmon Falls Rivers This equates to a 0.1 percent change.

3. Case Study Five: Combined Bridge Piers

a. Predicted high tide differences on the Great Bay side of the bridges: 0.2 inch higher at all locations. This equates to a 0.2 percent change in the high tide level when compared to the existing conditions (Case Study 1).

b. Predicted high tide differences at Pomeroy Cove and the junction of the Cocheco and Salmon Falls River: 0.1 inch lower at both locations. This equates to a 0.1 percent change.

c. Predicted low tide differences on the Great Bay side of the bridges: 0.2 inch decrease at all locations. This equates to a 0.3 percent change in the low tide level when compared to the existing conditions (Case Study 1).

d. Predicted low tide differences at Pomeroy Cove and the junction of the Cocheco and Salmon Falls River: 0.1 inch higher at both locations. This equates to a 0.1 percent change.

4. **Case Study Two: Hydraulic Alternative One Piers**

a. Predicted High Tide differences on the Great Bay side of the bridges: up to 0.1 inch higher at Pickering Brook. This equates to a 0.1 percent change in the high tide level when compared to the existing conditions (Case Study 1).

b. Predicted High Tide differences at Pomeroy Cove and the junction of the Cocheco and Salmon Falls Rivers: up to 0.1 inch lower at the junction of the Cocheco and Salmon Falls Rivers. This equates to a 0.1 percent change.

c. Predicted Low Tide differences on the Great Bay side of the bridges: up to 0.1 inch at all locations except Lubberland Creek. This equates to a 0.1 percent change in the low tide level when compared to the existing conditions (Case Study 1).

d. Predicted Low Tide differences at Pomeroy Cove and the junction of the Cocheco and Salmon Falls River: 0.1 inch higher at both locations. This equates to a 0.1 percent change.

5. **Case Study Three: Hydraulic Alternative Two Piers**

a. Predicted High Tide differences on the Great Bay side of the bridges: up to 0.1 inch higher at Pickering Brook. This equates to a 0.1 percent change in the high tide level when compared to the existing conditions (Case Study 1).

b. Predicted High Tide differences at Pomeroy Cove and the junction of the Cocheco and Salmon Falls Rivers: no change.

c. Predicted Low Tide differences on the Great Bay side of the bridges: up to 0.1 inch decrease at Squamscot Marsh. This equates to a 0.1 percent change in the low tide level when compared to the existing conditions (Case Study 1).

d. Predicted Low Tide differences at Pomeroy Cove and the junction of the Cocheco and Salmon Falls Rivers: up to 0.1 inch higher at the junction of the Cocheco and Salmon Falls Rivers. This equates to a 0.1 percent change.

The results of the model suggest that the proposed extension of the Little Bay Bridge piers towards the General Sullivan Bridge will have a very minor effect on tidal heights, current directions and velocities.

4.10.3 Direct Impacts to Tidal Habitats

Impacts to bottom habitats were quantified by combining information on existing bottom habitats with the footprints of the proposed bridge foundation including grading associated with the Hilton Park loop connector. Subtidal habitats will be most affected, but it is noted that the northernmost foundation (Pier #8) is in the intertidal zone (see **Figure 4.10-15**).

As discussed in Section 3.10, intertidal and subtidal habitats were classified based on geophysical bottom type and dominant plant and/or animal taxa present. Intertidal habitats were mapped using high resolution aerial imagery obtained in April 2004 and ground-truthed by field inspections. Six intertidal habitat types occurred in the vicinity of the bridges: salt marsh, mudflat, rockweed, rock/algal/abundant mussel, rock/algal/sparse mussel, and rock/algal/soft sediments (**Figure 4.10-15**). Subtidal habitats were mapped based on towed, underwater videography obtained in August 2004. Four types of subtidal habitats were mapped: kelp bed, macroalgal (non-kelp) bed, mussel reef, and other. No extractive sampling of any of the subtidal habitats was possible during the present study. Hence, existing published and unpublished ecological studies were used where necessary to supplement the video imagery to determine the dominant species present in each of the subtidal habitat types.

Based on the proposed expansion of the bridge piers, several analyses were developed to determine potential environmental effects, as discussed in detail below.

The most extensive information on the general ecology of the area under and near the bridges is the result of a series of field studies conducted during the 1970s by Arthur Mathieson, a phycologist at UNH and senior scientist at Jackson Estuarine Laboratory, and his colleagues. These studies focused on the plants and animals occurring on the bridge piers in the intertidal and shallow subtidal zones but included data on environmental conditions in other nearby areas. Mathieson, *et al*. (1983) provides a synthesis of these studies, as well as information from earlier research (Reynolds, 1971; Reynolds and Mathieson, 1975; Mathieson, *et al*. 1981). Table 4.10-3 below summarizes the dominant plant and animal taxa in the habitat types that will be replaced/lost by the new bridge piling foundations based on the present investigation as well as information in the historical studies by Mathieson and colleagues.

In addition to the habitats in Table 4.10-3, saltmarsh is also present, restricted to the intertidal zone, forming a narrow fringe in most areas near the bridges. It is dominated by cord grass (*Spartina* spp.) and includes other plants as well as invertebrates and fish. The following species can occur in salt marsh habitat in New Hampshire: Common plants - *Spartina alterniflora, Spartina patens, Carex* spp., *Distichlis spicata, Eleocharis* spp., *Juncus* spp., *Salicornia* spp., and *Scirpus* spp.; Common invertebrates – *Semibalanus balanoides, Geukensia demissa, Littorina littorea, Carcinus maenas*, and *Gammarus* spp.; Common fish - *Fundulus heteroclitus, Menidia menidia*, and *Gasterosteus* spp.

Table 4.10-4 summarizes the areal losses of each habitat type that will result from construction of the eight new bridge pier foundations. Seven habitat types will suffer direct loss due to being replaced by the new bridge pier foundations. A total of 22,295 square feet (0.5 acre) of bottom habitats will be lost. The data in this table were determined by calculating the area of each mapped habitat type within the total footprint of each of the proposed bridge pier foundation extension. It should be noted that all of the affected bottom habitats are predominantly hard bottoms, ranging from gravel to boulders in size (see Section 3.10). The entire area is a tidal rapid that regularly experiences tidal currents up to 10 feet per second on spring tides and represents a relatively rare coastal environment. It should also be noted that the plant and animal taxa listed in Table 4.10-3 represent only a small fraction of all species present in these habitats. All of the affected habitat types are ecologically quite diverse and apparently (based on numbers of epibenthic organisms observed) very productive.

4.10.4 Effects of Hydrodynamic Changes on Subtidal Habitats

Bottom habitat data was reviewed in light of the outputs from the hydrodynamic modeling portion of the study. As mentioned above, the Little Bay and General Sullivan bridges span an area that can be described as a tidal rapid. All tidal waters entering and leaving Great Bay, Little Bay, and their associated tributaries, pass through the constriction between Dover Point and Newington, resulting in unusually strong currents. This is a major environmental factor affecting the ecology of the area. The distributions of plants and animals in this area probably are determined in large measure by the tidal current patterns in combination with water depth and substrate type. Therefore, any changes in water flow conditions caused by bridge construction must be carefully considered.

The previous studies by Mathieson, *et al.* (1983) discussed above showed that several species distribution patterns were related to water current regime and/or interspecific interactions such as competition probably affected by water flows. For example, two algal genera, *Porphyra* and *Blidingia*, mainly were found in high-flow areas whereas rockweeds mainly occurred in areas with intermediate to low current velocities, and were stunted in high-flow areas. In some areas, the blue mussel (*Mytilus edulis*) displaced *Chondrus crispus* (Irish moss), but *Mytilus* apparently was removed by predators in other areas. Kelp (*Laminaria digitata*), a plant that typically occurs in open coastal waters, was noted in some shallow subtidal areas. The kelp beds under the bridges represent unusual habitats this far up the estuary.

Table 4.10-3
Dominant Plant and Animal Taxa

Habitat Type	Dominant Plant and Animal Taxa
Intertidal[1]	
Scattered rock/algae/soft sediment	*Ascophyllum nodosum, Fucus vesiculosus, Semibalanus balanoides*
Rock/algae/sparse mussel	*Ascophyllum nodosum, Fucus vesiculosus, Mytilus edulis*
Rock/algae/abundant mussel	*Ascophyllum nodosum, Fucus vesiculosus, Mytilus edulis*
Subtidal	
Rock/algae (non-kelp)	*Chondrus crispus, Asterias* spp., *Cancer* spp.
Rock/kelp	*Laminaria digitata, Chondrus crispus, Cancer* spp.
Mussel reef	*Mytilus edulis, Asterias* spp., *Cancer* spp.
Other (hydroids, seastars, crabs, etc)	Hydroidea, Porifiera, *Asterias* spp., *Cancer* spp.

Note:
1 There will be no direct impacts to mudflat, saltmarsh, or rockweed habitats, even though those were identified as occurring in the study area.

Based on field measurements by Mathieson, *et al.* (1983) at multiple locations and depths over several tidal cycles, maximum velocities of about 6 knots (9-10 feet per second) occurred on the flood tide with fastest flows in the deeper waters along the south (Newington) side. Velocities up to about 4 knots (6 feet per second) were recorded during ebb tides in the shallow subtidal areas along the north (Dover Point) side. Current flows in the area were complex and had a wide range of directional components and velocities during a tidal cycle.

These historical data compare well with the hydrodynamic modeling studies conducted as part of the present EIS. The study area is flood-dominated, with most of the flood flow occurring on the south side of the bridge spans and maximum flow velocities around bridge piers 6, 7 and 8. Most of the flood current flow is on the north side, with highest velocities occurring around piers 2, 3 and 4.

Increasing the footprints of the foundations and vertical components of the existing bridge piers will re-direct existing currents in a manner that will create additional resistance to the water flow in some areas, and decreased turbulence in other areas. Hence, the hydrodynamic model predicts a small change in tidal current velocities in the area near the bridge for the Build Alternatives (*i.e.,* Case Studies 5 and 6 in Section 4.10.2). Specifically, tidal velocities do not change more than 0.5 feet per second in any location, and the change is typically less than 0.3 feet per second. A decrease of this magnitude represents less than a 5 percent difference from existing flow and ebb maximum current velocities, and the general shapes of the flow patterns around the piers will remain similar to existing conditions.

Table 4.10-4
Subtidal and Intertidal Habitat Impacts (square feet)

		Proposed Bridge Pier Foundation (see Figure 4.10-15)										
Habitat Type[1]	Newington Abutment	1	2	3	4	5	6	7	8	Dover Abut.	Total (sq. ft.)	Class.[2]
Scat. rock/algae/soft sediment									20	485	505	E2RS2N
Rock/algae/sparse mussel	865								555		1,420	E2RS2M
Rock/algae/abundant mussel									1,190[3]	955	2,145	E2RF2M
Rock/algae (non-kelp)	3,695	2,075	1,655			1,935	140	2,200			11,700	E1AB1L
Rock/kelp		135					1,840				1,975	E1AB1L
Mussel reef				1,310							1,310	E1RF2L
Other (hydroids, seastars, crabs, etc)			540	765	1,935						3,240	E1RB2L
Totals:	4,560	2,210	2,195	2,075	1,935	1,935	1,980	2,200	1,765	1,440	22,295	

Notes:
1 Habitats mapped by the University of New Hampshire, Jackson Estuarine Lab, 2004.
2 See Figure 3.6-1 for a key to the Cowardin Classification System.
3 The NH Estuaries Project reports that the mussel bed in the vicinity of Pier 8 has been used since 1994 to monitor toxic contaminants in mussel tissue. The reported location of the mussel tissue sampling station (43.1197 N Lat/70.8273 W Long) is outside of the footprint of the expanded pier. See **Figure 4.10-15**.
4 There will be no direct impacts to mudflats or rockweed (intertidal) habitats.
5 There will be no direct impacts to sub- or intertidal habitats resulting from work on the Newington abutment.

The effects of water velocity on feeding, growth, and other biotic responses have not been studied for most of the species that dominate the benthic communities under the bridges. Hence, detailed predictions of how each species in the existing benthic communities will respond to the predicted changes in flow cannot be made. However, considering the relatively small magnitude of change that the hydrodynamic model predicts, it seems reasonable to expect most biotic changes will also be minimal. Wildish and Kristmanson (1997) and Peterson (2001) provide conceptual models of how water flow velocities affects individual growth rate of passive (*e.g.*, sponges, hydroids) and active (*e.g.*, bivalve mollusks) suspension feeders. Both show the typical inverted parabolic shape of the relationship between biotic responses (for plants and animals) to most environmental variables: at low velocities the two are positively related, then flatten out at moderate velocities, followed by a negative relation (inhibitory) at high velocities. It is possible that the predicted decreases in flow velocities might favor one species over another, but there is no way to predict how changes of such a small relative magnitude (less than 5 percent difference) would impact the existing benthic communities. It seems reasonable to conclude that the overall effects of changes in current velocities due to bridge construction will be negligible.

4.10.5 Effects of Tidal Height Changes

Similar to the minor ecological effects expected to result from changes in current speeds near the bridges, the potential effects of bridge construction on tidal elevations should be negligible. The model predicts the high and low tides to change by approximately 0.2 inch or less, depending on the pier design in the Little Bay and Great Bay. Relative to the total tidal range (approximately 9 feet), this is a trivial change. Additionally, the model demonstrates that this magnitude of change is less than the total change experienced in the estuary in the past. This is evident by examining the tidal range differences between Model Case Study 4 (no bridge piers, representative of conditions prior to the construction of the General Sullivan Bridge) and Case Study 1 (existing conditions).

4.10.6 Navigation

The Little Bay and General Sullivan Bridges span an important navigational channel, providing access from the Great Bay to the Piscataqua River and then to the open ocean. As previously discussed, the area where the bridges are located can be described as a tidal rapid. All tidal waters entering and leaving Great Bay, Little Bay, and their associated tributaries pass through the constriction between Dover Point and Bloody Point in Newington, resulting in unusually strong currents. Combined with the sixteen piers associated with the Little Bay Bridge and the General Sullivan Bridge, these currents create a difficult navigation problem to vessels which attempt passage through the area. Additionally, the poor condition of the General Sullivan Bridge has become a concern to boaters and safety agencies due to the potential hazards from falling material. The USCG, during previous permits issued for reconstruction of the Little Bay Bridge in the 1980s, recognized the obstacle presented by the abandoned General Sullivan Bridge and stipulated its removal if it is no longer used for transportation purposes.[102]

For purposes of this discussion, it is assumed that the two main bridge alternatives (Widen West/Rehabilitate and Widen West/Remove) combine into a single alternative, since both would require similar widening of the Little Bay Bridge piers. Removal of the General Sullivan Bridge piers, although it has not yet been determined feasible, would remove one obstacle from the navigational channel,

While modification of vertical clearances are often a concern for bridge projects, both bridge alternatives (Widen West/Rehabilitate and Widen

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102 Subsequent coordination with the USCG indicates that agency would have no objection to the bridge remaining in service, so long as it is adequately rehabilitated and maintained for a transportation use.

West/Remove) would maintain the existing limiting vertical clearances for the 100 ft. and 200 ft. (horizontal clearance) navigation corridors.[103]

Similarly, extension of bridge piers should have no substantial impact to navigation, since the piers will maintain existing alignments, and since ships attempting passage through the channel generally pass parallel to the existing piers. The proposed widening of the Little Bay Bridges will extend the existing pier footings and subfootings toward the General Sullivan Bridge. It is anticipated that the footings will be joined below the water level with the General Sullivan Bridge and the granite faced pier walls will either be joined together or a very small separation will occur between the two sets of walls. Although the resulting piers will be longer than the existing structures, they will not decrease the width of the navigational channel, the most important parameter to anyone attempting to navigate the area.
Since tidal currents have an important effect on navigation, results of the hydrodynamic model were reviewed to help determine if indirect impacts to navigation could result from changes to tidal currents. To accomplish this, the model was used to predict tidal current speeds and directions at 45 points in the immediate vicinity of the bridge (approximately 300 feet inland and seaward of the bridges).

The data indicate that current velocity maxima will increase by no more than 0.5 feet per second, with changes typically only 0.3 feet per second (see Section 4.10.2.4). These potential changes represent only a slight change from the estimated 10 feet per second maximum tidal current under existing conditions. The model predicts that current speeds will increase in some areas near the piers, while the speeds will decrease in other areas.

Additionally, the model predicts that current directions will not change substantially, at least at the scale that can be resolved by the model. However, based on experience with similar hydraulic situations, it is anticipated that the extension of the bridge piers would decrease turbulent flow in the immediate vicinity of the piers, a phenomena that would tend to increase navigation safety.

Taken together, the results of the hydrodynamic model suggest that changes in tidal currents at the bridges will have only modest effects on navigation, and should not create situations that are more hazardous than the conditions already present.

The reconstruction, removal, modification or replacement of the Little Bay and/or General Sullivan Bridges will be reviewed by the USCG. The project will ultimately require a permit from the USCG under its permitting

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103 See Figures 2.4-37 and 3.2-6 for the existing vertical clearances for the LBB and GSB.

authority pursuant to Section 9 of the Rivers and Harbors Act of 1899 and the General Bridge Act of 1946, and so impacts to navigation will be thoroughly studied. Under the General Bridge Act of 1946, the USCG is responsible to preserve the public right of navigation and to prevent interference with interstate or foreign commerce. The USCG will therefore review plans for the reconstructed bridge, identifying and analyzing any change to the horizontal or vertical clearances of the existing bridges. Their review will require that the bridges provide for the reasonable needs of navigation, as well as the reasonable needs of land traffic (*i.e.,* highway users).

4.10.7 Marine Sediment Entrainment During Pier Construction

Water quality impacts may occur during construction phases of the project since construction of temporary cofferdams and excavation associated with the bridge pier extension will disturb bottom sediments. In order to assess this potential impact, existing data sources were reviewed, including the ongoing water quality monitoring program conducted by the NHDES Shellfish Program (Nash 2005), and historical studies on sediment quality in the area (**Figure 4.10-16**; Jones 2000).

For the present analysis, one important consideration is the potential impacts of the construction on classification of the surrounding waters with respect to shellfish harvesting. NHDES is in the process of assessing the present classifications of these areas, and their ongoing program provides an extensive water quality database (Nash 2005). It will be important to work with NHDES and the USACOE during final design to ensure that construction impacts are held to acceptable levels.

Sediment samples from several sites in the vicinity of the present study area were taken from 1973-1994 and analyzed for various toxic pollutants, primarily heavy metals (Jones 2000). For the present analysis, data on the three metals summarized by Jones (2000) are presented (**Figure 4.10-16**). Of the available data, lead and chromium concentrations from Trickys Cove and chromium concentrations in Pomeroy Cove are relatively high, exceeding NOAA (1999) threshold levels. Jones (2000) discussed the fact that the Cocheco River has very high chromium concentrations due to historical tannery waste discharges, and it may have contributed to downstream sediment loadings. Regardless of the source(s) of existing pollutants, construction activities could potentially release metals (or other toxic pollutants) from existing sediments, or create new areas of scour such that pollutant loadings to the estuary are temporarily increased during construction. The existing database is not extensive for sediment quality. However, the data do suggest that a sediment sampling and analysis program should be conducted prior to construction in order to properly plan and mitigate this potential impact.

The sediment sampling and analysis program would typically occur in conjunction with the geotechnical investigations during the final design phase. Even if the sediments are determined to not pose a contamination risk, stringent requirements will be incorporated into the final design plans to require the selected contractor to minimize any movement of sediment beyond the work area. It is anticipated that all work on the bridge piers will be conducted behind sealed cofferdams, which will substantially limit the movement of suspended sediments. The NHDOT and FHWA will conduct regular inspections of the measures designed to minimize this risk. Additional measures will be developed if contaminants in the marine sediments exceed NOAA thresholds for ecological or human health risk. These requirements are typically a condition of the USACOE and NHDES Wetlands Bureau permits, as well as part of the 401 Water Quality Certificate that will be required for the project.

4.10.8 Essential Fish Habitat

The Great Bay estuary is designated as EFH for 17 species of fish in the vicinity of the Spaulding Turnpike Improvement project by the NMFS. However, many of these species are not actually present within the study area because suitable habitat is not present for one or more of these species' life stages. A detailed discussion of EFH habitat in the project area, including a consideration of possible effects to each of the 17 species, is presented in an EFH Assessment Report for this project (NHDOT 2006).

Construction activities in the water will consist of the construction of new piers for the widened bridge structure. The net impact of the project on EFH is expected to be relatively minor. Construction of the new piers for the widened Little Bay Bridges will cause direct impacts to benthic habitats on the Newington side of the project beneath the bridges, with minimal impacts to narrow sections of macroalgal and kelp bed habitats. On the Dover side, impacts from new pier construction, will affect a small amount of kelp, macroalgal, and rock/algal mussel bed habitats (see Table 4.10-4 for a summary). The effects on these habitats will be minimized through careful construction activities, which will lessen the disturbance outside of the extended pier footprints.

With the use of standard Best Management Practices (BMPs) for marine construction, no substantial water quality degradation of any EFH is expected. Any impact is likely to be limited to a temporary increase in turbidity and suspended solids. Because of substantial tidal exchange and normal river flows, water quality at the project site is expected to return quickly to its pre-disturbance condition.

Potential impacts to EFH were evaluated in a written EHF Assessment (NHDOT 2006) and in an EFH Assessment Worksheet prepared by the FHWA (see Appendix M). These documents concluded that, while the project will result in impacts to EFH, the adverse effect on EFH is not substantial. This determination was reviewed by the NMFS, which concurred that, because of the highly dynamic current and tide conditions at the project site, there should be minimal adverse effects to benthic fauna and flora and EFH.[104]

4.10.9 Anadromous Fish Passage

Passage through the mouth of the Little Bay at the proposed bridge pier location is critical to the movement of anadromous fish stocks seeking the spawning areas in tributaries of the Great Bay/Little Bay system including the Oyster, Lamprey, and Squamscott Rivers.

Bridge construction should have no substantial impacts to fish passage, since the piers will maintain existing alignments. The proposed widening of the Little Bay Bridges will extend the existing pier footings and sub-footings toward the General Sullivan Bridge. It is anticipated that the footings will be joined below the water level with the General Sullivan Bridge and the granite-faced pier walls will either be joined together or a very small separation will occur between the two sets of walls. Although the resulting piers will be longer than the existing structures, they will not decrease the width of the channel.

Since fish species may be affected by tidal currents, results of the hydrodynamic model (see Section 4.10.2) were reviewed to help determine if indirect impacts could result from changes to tidal currents. To accomplish this, the model was used to predict tidal current speeds and directions at 45 points in the immediate vicinity of the bridge (approximately 300 feet inland and seaward of the bridges).

The data indicate that current velocity maxima will increase by no more than 0.5 feet per second, with changes typically only 0.3 feet per second. These potential changes represent only a slight change from the estimated 10 feet per second maximum tidal current under existing conditions. The model predicts that current speeds will increase in some areas near the piers, while the speeds will decrease in other areas. Additionally, the model predicts that

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104 See Appendix M for a copy of the correspondence from Mike Johnson, NMFS, to Bill O'Donnell, FHWA, dated November 21, 2006

current directions will not change substantially, at least at the scale that can be resolved by the model. The results of the hydrodynamic model suggest that changes in tidal currents at the bridges will have no measurable permanent effects on fish passage, especially since these anadromous fish likely move into and out of the Great Bay during the corresponding in-coming or out-going tides.

Construction of the piers is not expected to cause any direct mortality of any finfish life stages that could simply swim away from the disturbance. However, species potentially present at the project site year round may be displaced from habitat they prefer.

However, it is possible that construction activities could have some effect of behavior of anadromous fish due to issues such as turbidity or acoustical impacts. The NHDOT and FHWA will coordinate the design, methods and anticipated schedule of the pier construction during the project's final design with NHF&GD's Durham office as well as with the USACOE, the USFWS, and the NMFS to reduce to the extent practicable, the potential temporary effects that construction activities may have on anadromous fish.

4.10.10 Tidal Buffer Zone Impacts

As discussed in Section 3.10, the NHDES has regulatory jurisdiction over all activities within 100 feet of the highest observable tideline per NH RSA 482-A, which is known as the Tidal Buffer Zone. The footprint of the Selected Alternative encroaches on the TBZ in four locations:

- At the Scammel Bridge and the nearby Bayview Park;
- At Pomeroy Cove;
- At the end of Dover Point, where the LBB and GSB abutments are located; and
- In Newington, where the Little Bay and General Sullivan Bridges meet grade.

Table 4.10-5 provides a summary of these impacts, which are shown graphically in **Figure 4.10-17**.

From Table 4.10-5, it is apparent that each of the alternatives impact approximately 5.0 acres of TBZ. All of the affected TBZ meets the definition of "developed upland" per NH Administrative Rule Env-Wt 101.26, *i.e.,* the majority of the area has been previously disturbed and is not in a natural state. These areas include features such as the existing Turnpike, US 4, and local roadways. Because no new areas will be converted from undeveloped buffer zone, it was determined that impacts to the tidal buffer zone would be negligible. Additionally, the NHDES, which has regulatory jurisdiction over activity in the tidal buffer zone, generally regards projects within the developed upland to be "minimum impact," which are not subject to mitigation.

Table 4.10-5
Tidal Buffer Zone Impacts (acres)

	Newington			Bridge		Dover	
				Widen West			
Location	Alternative 10A	Alternative 12A	Alternative 13	Rehabilitate GSB	Remove GSB	Alternative 2	Alternative 3
Scammell Bridge	---	---	---	---	---	1.1	1.1
Pomeroy Cove	---	---	---	---	---	2.0	2.0
Dover Point Bridge Abutments	---	---	---	0.9	0.9	---	---
Newington Bridge Abutments	---	---	---	1.0	1.0	---	---

4.10.11 Potential Effects from Shading

Section 2.4.8.4 discusses the numerous bridge options considered during the development of alternatives. The Selected Alternative involves widening the Little Bay Bridges to the west, with the rehabilitation of the General Sullivan Bridge for bicycle and pedestrian access. As depicted in **Figure 2.4-31** this proposed action would expand the width of the Little Bay Bridge deck (1589 feet long) from approximately 65 feet to a total of approximately 151 feet. This represents a substantial increase and has raised concerns about the effect the deck widening may have on aquatic resources. This concern was raised following publication of the DEIS, so the focus of this analysis is on the Selected Alternative only.

Generally, shading effects result from structures that are in close proximity to the surface of the wetland or surface water, which is not true in this case. Rather, the Little Bay Bridge deck is approximately 55 feet above mean sea level. However, since it is well understood that the availability of light is one of the main factors controlling the distribution of marine flora and fauna in this area (together with tidal velocities), a three-dimensional shade model was built to measure the differences between the existing and proposed conditions.

The shade model considered the actual height of the bridge, its existing and proposed width, and its actual location. Two dates of interest were modeled: the summer equinox (*i.e.*, the longest day of the year, June 21) and the winter solstice (*i.e.*, the shortest day of the year, December 22). The model predicted the total size of the shadow cast by the bridge deck under both the existing and proposed conditions. Table 4.10-6 summarizes these data.

Table 4.10-6
Shade Modeling of the Proposed Bridge Widening[1]

Date	Time	Exist. LBB Shadow (acres)	Exist. GSB Shadow (acres)	Total Existing Shadow (acres)	Prop. LBB New Shadow Acres[2]	Total Proposed Shadow (acres)
June 21	9:00 AM	2.3	1.0	3.3	3.8	7.1
June 21	12:00 PM	2.4	0.9	3.3	3.8	7.1
June 21	3:00 PM	2.4	0.9	3.3	2.7	6.0
June 21	6:00 PM	2.4	0.9	3.3	3.9	7.2
December 22	9:00 AM	2.4	1.0	3.5	3.8	7.3
December 22	12:00 PM	2.4	1.0	3.3	3.8	7.2
December 22	3:00 PM	2.4	0.9	3.3	3.8	7.1
December 22	6:00 PM[3]	0.0	0.0	0.0	0.0	0.0

Notes:
1 Data are from VHB, Microstation V8 Solar Study Tool analysis of LBB surface under existing and proposed conditions (Widen West Alternative).
2 This column shows the amount of shading created by the new, widened portions of the proposed LBB bridge.
3 Since the sun is below the horizon, no shadow is cast by the bridge.

These data show that the larger bridge will indeed cast a wider shadow. The existing shadow cast under the bridge is approximately 3.3 acres under most conditions (although this will vary depending on the time of day and the time of the year). Under the Widen West/Rehabilitate Alternative, the shadow will increase about 3.8 acres to a total size of more than 7 acres under most conditions.

However, nearly the entire shadow area is already subject to shadow effects. In fact, of the 7.2-acre shadow predicted for June 21 (summer equinox), only about 0.4 acre is new area not previously subject to shading from the existing bridge. That amount drops to less than 0.04 acre during the winter solstice on December 22.

It is also relevant to compare the amount of area that is now permanently shadowed by the existing bridge structures with the area that would be permanently shadowed by the expanded bridge cross-section. Under the existing conditions, there are no areas subject to a permanent shadow. The project would result in a modest increase under the proposed widened bridge. Specifically, this permanently shadowed area would be approximately 3.0 acres during the summer equinox (June 21) and about 0.1 acre under the winter solstice (December 22).

Predicting the biotic effect of these changes with any certainty is impossible, especially without long-term, extensive study. However, changes in the amount and duration of shading could result in a shift in plant and animal communities.

The area subject to "new shading" and the area subject to "permanent shading" are the most relevant indicators of the potential magnitude of biological effects of the change in shading. This is because the benthic (bottom-dwelling) and lotic (floating/swimming) flora and fauna within areas already experiencing some shading are likely to be adapted to this condition. Thus, shade-tolerant organisms are likely to represent a substantial portion of the biological community in areas that already experience some level of shading and are likely to become dominant in areas of permanent shadow.

The shading model indicates that nearly all of the area shaded by the proposed bridge is already subject to some level of shading. And, as noted above, substantial shading effects generally result only from structures that are in close proximity to the surface of the wetland or surface water, which is not true in this case. Taken together, these findings suggest that the overall effect of shading from the proposed bridge expansion on the biology of the Little Bay would be minor.

4.10.12 Mitigation

As discussed in the previous sections, overall impacts to marine resources are expected to be minor. For example, the hydrodynamic model demonstrates that the change in tidal heights for the Selected Alternative will be approximately 0.1 to 0.2 inches over a tidal range of approximately 7 to 8 feet. The biological effects of such a change are predicted to be negligible. Similarly, impacts to navigation, to the water quality in the Bay, to anadromous fish passage, to the tidal buffer zone and to the marine biota from the shading effects of the widened bridge are expected to be negligible to minor. There are a number of mitigation measures that will be used to minimize impacts even further:

- The expansion of the bridge piers will impact a total of approximately 0.5 acre of inter- and sub-tidal habitat. Mitigation for this impact is incorporated into the project mitigation package described in Section 4.6.5, Compensatory Wetland Mitigation.

- To minimize the potential for water quality impacts in the Bay and in the Piscataqua River, permanent stormwater treatment and detention systems will be constructed, as described in Section 4.9.7.

- NHDOT will evaluate the feasibility of constructing a closed drainage system on the widened LBB to minimize direct stormwater discharge to the Little Bay and Piscataqua River.

- A marine sediment sampling and analysis program will be conducted prior to construction of the expanded bridge piers to properly plan and mitigate potential impacts from suspension of contaminated marine sediments.

- Additional measures will be developed in consultation with state and federal resource agencies and other experts as needed if contaminants in the marine sediments exceed NOAA thresholds for ecological or human health risk.

- Stringent requirements will be incorporated into the final design plans for the bridge pier expansion to require the selected contractor to minimize any movement of sediment beyond the work area, even if sediments are determined to be free from contamination.

- It is anticipated that all work on the bridge piers will be conducted behind sealed cofferdams, which will substantially limit the movement of suspended sediments. NHDOT will conduct regular inspections of the measures designed to minimize this risk.

- Contractors will also be required to develop a SWPPP, which details all of the erosion control measures to be employed during construction, and which requires NHDOT approval. Frequent inspections of the pier construction site will be required to maintain compliance with permit conditions.

- To eliminate potential impacts to navigation, reconstruction of the LBB will maintain the existing limiting vertical clearances for the 100 ft and 200 ft navigation corridors (horizontal clearance) and the extension of bridge piers will maintain existing alignments.

- The plans for the reconstruction of the Little Bay and General Sullivan Bridges will be submitted to the USCG to address the reasonable needs of navigation, as well as the reasonable needs of land traffic (i.e., highway users), and to procure the necessary USCG permit.

- NHDOT will coordinate the design, methods and anticipated schedule of the pier construction during the project's final design with the NHF&GD as well as with the USACOE, the USFWS, and the NMFS to reduce, to the extent practicable, the potential temporary effects that construction activities may have on anadromous fish.

- NHDOT will coordinate with the NH Estuaries Project to locate and avoid impacts to the existing shellfish monitoring station located between Pier 8 of the Little Bay Bridges and the Dover shoreline.

4.11 Floodplains

4.11.1 Impact Methodology

The evaluation of floodplain impacts associated with the Build Alternatives uses information derived from the FEMA mapping for the study area. Floodplains (100-year frequency flood) were generated from FEMA FIS' and FIRMs for each community traversed by the highway corridor.

The floodplain and available floodway data were transcribed onto the corridor constraint mapping, as presented in **Figure 3.11-1**. Volumetric floodplain impacts were generated using an Average End Area Methodology which calculated the volume of cut and fill between the existing ground surface, the proposed ground surfaces for each alternative, and the floodplain elevation surface. Volumetric impacts were calculated using InRoads.[105] The impacts of detention basins on 100-year floodplains were not assessed because detention basins consist primarily of cuts into the floodplain that will attenuate flood elevations.

4.11.2 Build Alternatives

Newington Segment

There are no impacts to FEMA-mapped 100-year floodplain or floodway impacts associated with any of the Newington alternatives, as shown in Table 4.11-1.

Bridge Segment

Widening and rehabilitation of the Little Bay Bridges will result in 0.4 acre of impact to the 100-year floodplain along the shoreline at both the north and south ends of the bridges, the expanded bridge piers, and within the roadside ditch that extends to the south from Pomeroy Cove. The majority of this impact is from the expanded piers. The volumetric impact to the 100-year floodplain by this alternative is approximately 2.7 acre-feet. [106]

105 CADD Software (Bentley Systems, Inc.)
106 Floodway dimensions in the Little Bay, Bellamy River and the Piscataqua River have not been determined by FEMA. Therefore, calculation of floodway impacts are not possible.

Table 4.11-1
100-year Floodplain Impacts

	Newington			Bridge		Dover	
				Widen West			
	Alternative 10A	Alternative 12A	Alternative 13	Rehabilitate GSB	Remove GSB	Alternative 2	Alternative 3
Fill Volume (acre-feet)	0	0	0	2.7	2.7	1.5	1.2
Fill Area (acre)	0	0	0	0.4	0.4	1.5	0.8

Dover Segment

Impacts of the Dover alternatives on the 100-year floodplains amount to approximately 1.5 and 0.8 acres for Alternative 2 and Alternative 3, respectively. The volumetric impacts to the 100-year floodplain by Alternative 2 and Alternative 3 are 1.5 and 1.2 acre-feet, respectively.

Impacts to the 100-year floodplain occur in the vicinity of Pomeroy Cove as well as the Spur Road area.

4.11.3 No-Build Alternative

The No-Build Alternative would not result in any new impacts to floodplains or floodways within the study area.

4.11.4 Secondary Impacts

Secondary land use impacts associated with growth that may be stimulated by the Turnpike widening are described in Section 4.3. Based on the analysis discussed in Section 4.3, as much as 75 acres of floodplain within the study area may be impacted as a result of secondary growth.

However, the estimated impact, which is based on the assumption that future development would occur in a "spatially random" pattern, is a conservative estimate of future impacts on floodplains. Floodplains are very localized on the landscape because they primarily lie along flowing waters. In addition, for those communities that participate in the National Flood Insurance Program, construction in floodplains is regulated at the community level per FEMA rules. Hence, a reasonable assumption is that there will be minimal involvement of floodplains with any future growth above that experienced under the No-Build condition. Further, it can be assumed that impacts that are incurred by future development will be required to be appropriately mitigated by the project proponents. In conclusion, involvement of floodplains with any future growth will be regulated by existing federal and state regulations, as well as local laws and ordinances.

4.11.5 Mitigation

The floodplain impacts are considered minor in the context of the tremendous volume of Little Bay and will have a negligible effect on the base flood elevations in the area. Nevertheless, direct impacts to the 100-year floodplain have been minimized in the preliminary design developed to date, and will continue to be considered during final design by steepening highway embankments and/or utilizing retaining walls, where appropriate. In addition, the permanent preservation of several tracts of land in the watersheds of the project corridor as part of the wetland mitigation package will offer floodplain protection.

4.11.6 Floodplain Finding

All projects potentially impacting floodplains require an evaluation under Executive Order 11988, *Floodplain Management* (May 24, 1977). The regulation that sets forth the policy and procedures of this order is entitled Floodplain Management and Protection of Wetlands (44 CFR Part 9), which is under the authority of the FEMA. FHWA policies and procedures also cover the impact of projects on floodplains and floodways, and are found in *Location and Hydraulic Design of Encroachments on Floodplains* (23 CFR 650A).

This project has been carefully evaluated with respect to its effect on floodplains, practicable alternatives to such impacts and practicable mitigation measures as required under the provisions of Executive Order 11988, Floodplain Management and 23 CFR 650A.

The Selected Alternative would affect a total of 1.2 acres of 100-year floodplain (3.9 acre-feet). The majority of this impact is associated with the expansion of the bridge piers. The floodplain impacts are considered minor in the context of the tremendous volume of Little Bay and will have a negligible effect on the base flood elevations in the area.

An extensive hydrodynamic model was developed for this EIS to investigate the potential effects of the project on tidal conditions in the Little Bay/Great Bay estuary. The model predicted only minimal changes in tidal conditions as a result of the Selected Alternative (*i.e.*, the extension of the existing Little Bay Bridge piers). While the model predicts that the pier extension may change tidal maxima, the predicted changes are on the order of 0.1 to 0.2 inch, depending on the tidal condition and the location in the estuary. Similarly, current velocities and directions are expected to change only minimally. Therefore, it was concluded that hydrodynamic changes would not pose a measurable change in tidal flooding.

Although floodplain impacts are negligible, efforts to further reduce impacts will continue to be considered during final design by steepening highway embankments and/or utilizing retaining walls, where appropriate. In addition, the permanent preservation of several tracts of land in the watersheds of the project corridor, as part of the wetland mitigation package, will offer floodplain protection.

Based on the above considerations, it is determined that there is no practicable alternative to the proposed construction in floodplains and that the Selected Alternative includes all practicable measures to minimize harm to floodplains.

4.12 Groundwater Resources

4.12.1 Introduction

Groundwater resources within the study area consist of stratified-drift aquifers, and any identified municipal, community, and non-community public water supply wells. These groundwater resources are regulated under the New Hampshire Groundwater Protection Act, 1991 (NHGPA), which empowers local municipalities to regulate land uses in certain cases.

4.12.2 Impact Analysis Methodology

4.12.2.1 Stratified-Drift Aquifers

As presented in Section 3.4, much of the Dover portion of the study area is underlain by stratified-drift deposits. The NH GRANIT data indicate that the majority of this stratified-drift deposit is considered to have moderately low transmissivity values of 1,000 to 2,000 square feet per day. Transmissivity is measured in square feet per day and quantifies the ability of an aquifer to transmit water based on the permeability and depth of the material. Aquifer transmissivity values are generally grouped into following four categories ranging from the highest potential productivity to the lowest productivity: 4,000–8,000 sq ft/day; 2,000-4,000 sq ft/day; 1,000–2,000 sq ft/day; and 1–1,000 sq ft/day.

A small portion of this aquifer, directly north of Pomeroy Cove, is mapped as having higher transmissivity values of 2,000 to 4,000 and 4,000 to 8,000 sq. ft/day presumably due to a pocket of coarser grained deposits rather than an increased depth of saturated deposits. The westernmost portion of the Newington side of the study area including much of the land area within the Pease International Tradeport and an area extending just north of Arboretum Drive and then east to Woodbury Avenue is also mapped as stratified-drift deposits with a relatively low transmissivity value of less than 1,000 sq. feet per day. There are no known public water supply wells that are located within these stratified-drift deposits. The productive capabilities of these stratified-drift deposits for a future public water supply well are considered limited mostly due to the likelihood for salt water intrusion from nearby tidal waters and due to the extent of the existing commercial and industrial development that overlies these deposits.

The City of Portsmouth's water supply system services the commercial and industrial buildings within Newington. The municipal water mains also extend into residential areas along Nimble Hill Road but not all residents may have elected to connect to the Portsmouth water system and, therefore, would continue to utilize private wells for water supply. The commercial and residential buildings on the Dover side are serviced by the City of Dover municipal water supply system.

4.12.2.2 Public and Private Water Supply Wells

A review of NH GRANIT layers was conducted to determine the location of community and non-community supply wells within the study area, and any associated Wellhead Protection Areas (WHPAs). These electronic files of stratified-drift deposits and public water supply wells were merged with the project base map to create the water resources map **(Figure 3.12-1)**.

Community wells may consist of either municipal wells, wells serving multiple residences such as condominium complexes or major subdivisions, restaurants, day care centers, schools, office buildings, *etc.* According to the NHDES public well data base, there are no public supply wells located within the study area

There is one WHPA located within the Pease International Tradeport, that extends into the southern most section of the study area in Newington. The outer limits of the WHPA, as shown in **Figure 3.12-1** are about a 0.5 mile south and west of Arboretum Drive. The WHPA location is also upgradient of the project area and would not be affected by the proposed roadway improvements.

The NHDES database indicates that there are two private wells located off of Dover Point Road in Dover near the northeasterly limits of the project area and along the Piscataqua River, as depicted on **Figure 3.12-1.** These private wells are located outside the area where roadway improvements are proposed for Dover Point Road and would not be affected by the project**.** As mentioned earlier, although nearly the entire project area in both Newington and Dover is serviced by municipal water systems, it is possible that there are other private wells in the project area that have not been identified because they were not visible from field observations and/or they were installed prior to when NHDES began registering private wells (*i.e.*, approx. 1980) and including them in their database. Residents are not required to, and sometimes choose not to, connect to a municipal water system, if they have their own reliable private well. Data on public and private wells are supplied to NH GRANIT by the NHDES and were supplemented by field observations.[107]

4.12.3 Summary of Findings

4.12.3.1 Stratified-Drift Deposits

Table 4.12-1 presents a comparison of existing and new roadway area associated with the proposed Build Alternatives overlying stratified-drift deposits. Roadway areas within each of the various zones of transmissivity values mapped by the NH GRANIT data were evaluated. The new roadway area is based upon the Eight-Lane Alternative (*i.e.*, six travel lanes and an auxiliary lane in each direction between Exits 3 and 6) and includes the proposed mainline, ramp area and local road connector improvements.

Newington

On the Newington side, there is very little difference among the three Build Alternatives with the total new roadway area within stratified-drift deposits (less than 1000 square feet per day transmissivity) estimated to be approximately 4.0, 4.0 and 4.6 acres for Alternatives 10A, 12A and 13, respectively. Most of this new roadway area is centered around the proposed Woodbury Avenue Interchange.

Bridge

Both bridge segment alternatives, Widen West/Rehabilitate and Widen West/Remove, would require the addition of 1.2 acres of new impervious surface, all of it located in the Dover portion of this segment.

Dover

On the Dover side, there is very little difference between Alternatives 2 and 3 with respect to the amount of new roadway area within various transmissivity zones. Both alternatives would add another 4.4 acres of roadway area over the highest transmissivity deposits having a rating value

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107 The NHDES private well database is not a complete record of all private wells. Therefore, although not observed during field work, additional private wells may occur within the study area.

Table 4.12-1
Estimated Stratified-Drift Impacts (Acres)

	Transmissivity (square feet/day)				
	<1000	1000-2000	2000-4000	>4000	Total
Existing Impervious Area	210	68.0	10.6	5.0	293.6
Additional Impervious Area (Build Alts.)					
Newington Alternative 10A	4.0	---	---	---	4.0
Newington Alternative 12A	4.0	---	---	---	4.0
Newington Alternative 13	4.6	---	---	---	4.6
Bridge Segment	---	1.2	---	---	1.2
Dover Alternative 2	---	3.7	2.0	2.4	8.1
Dover Alternative 3	---	3.9	2.0	2.4	8.3

of greater than 2,000 square feet per day. This deposit is located between Pomeroy Cove and Dover Point Road and is estimated to have a total area of approximately 40 acres. An additional 3.7 or 3.9 acres of new impervious area would impact less productive stratified drift deposit (1,000 – 2,000 square feet per day) for Alternative 2 and 3, respectively.

4.12.3.2 Public and Private Water Supply Wells

According to the NHDES' public wells data, there are no public water supply wells located within the project area. A portion of a Wellhead Protection Area (WHPA), centered within the Pease International Tradeport, is located in the southernmost limits of the project area, but would not be affected by any of the proposed Build Alternatives.

The NHDES data base indicates that there are two private wells located off of Dover Point Road in Dover near the northeasterly limits of the project area and along the Piscataqua River, as depicted on **Figure 3.12-1.** These private wells are located outside the area where roadway improvements are proposed for Dover Point Road and would not be affected by the project.

4.12.4 Mitigation

An impact analysis was conducted to determine the potential net increase in impervious area that may result over the stratified-drift deposits as a result of the various project alternatives. The impervious area represents a concern as it may restrict the amount of rainfall that recharges back into the groundwater. To help reduce this potential impact, NHDOT will examine the use of infiltration technology during final design of the reconstructed drainage system. Such measures can be incorporated into the drainage design to allow stormwater to infiltrate back into the ground following treatment. These measures would compensate for any initial restriction to recharge caused by an increase in impervious area.

4.13 Air Quality

The air quality analysis presents the results of the local and regional air quality evaluation of the Spaulding Turnpike roadway improvements in Newington and Dover. The local evaluation presents a microscale analysis that evaluates the carbon monoxide hotspot impacts and the regional evaluation discusses the proposed project's compliance with Transportation Conformity. Information on current air quality conditions and attainment status is contained in Section 3.13.1, and technical information in support of this analysis is contained in Appendix H.

4.13.1 Alternatives

Air quality analyses were conducted for Alternatives 10A, 12A and 13 in Newington and Alternatives 2 and 3 in Dover as well as the No-Build condition. All of the alternatives will create new signalized intersections in the study area. The CO concentrations for existing conditions were calculated at some intersections that currently do not exist to provide a basis for comparison to the future build CO concentrations. The Selected Alternative is comprised of Alternative 13 in Newington and Alternative 3 in Dover. The air quality study ranked all of the signalized intersections in Alternatives 10A, 12A, 13, 2, and 3 based upon total traffic volumes and levels of service. The intersections with the highest traffic volumes and the intersections with the worst levels of service were selected for evaluation.

The air quality analysis included four intersections in Newington and three intersections in Dover (refer to **Figures 3.13-1 and 3.13-2**). These intersections are listed in Section 3.13.2.2. The air quality study assumes that if these intersections meet the NAAQS, then all other intersections, regardless of alternative, which will have lower volumes and better levels of service, can be assumed to also meet the NAAQS.

The microscale analysis used peak-hour traffic volumes. Vehicle speeds were developed based upon posted speed limits and travel speed observations made during peak traffic periods.

4.13.2 Project Impacts

The results of the microscale analysis demonstrate that all the CO concentrations for the 2013 No-Build, 2013 Build (opening year), 2025 No-Build, and 2025 Build conditions will be below the 1-hour and 8-hour CO NAAQS. Tables 4.13-1 and 4.13-2 present the Newington maximum predicted 1-hour and 8-hour CO concentrations, respectively, for the 2003 Existing, 2013 No-Build, 2013 Build, 2025 No-Build, and 2025 Build conditions. Tables 4.13-3 and 4.13-4 present the Dover maximum predicted 1-hour and 8-hour CO concentrations, respectively, for the 2003 Existing, 2013 No-Build, 2013 Build, 2025 No-Build, and 2025 Build conditions at the various intersections. The tables include those receptor locations that exhibited the highest CO concentrations for each quadrant of each intersection.

The results of the microscale analysis indicate that, under nearly all future No-Build conditions (2013 and 2025), the predicted CO concentrations at all receptor locations are below predicted concentrations for 2003 Existing Conditions. These lower CO concentrations can be attributed primarily to more efficient vehicles with enhanced emissions control technologies as mandated by the Federal Motor Vehicle Exhaust Emissions Control Program for new vehicles entering the fleet.

The results of the microscale analysis demonstrate that all of the CO concentrations for the future Build conditions (2013 and 2025) are below the NAAQS of 35 ppm and 9 ppm, respectively. The proposed project satisfies the SIP criteria for CO because all of the 2003, 2013, and 2025 No-Build and Build CO concentrations (both 1 hour and 8 hour values) in Newington and Dover are below the NAAQS of 35 ppm and 9 ppm, respectively.

4.13.3 Secondary Impacts

The air quality analysis calculated emissions for the existing (2003), estimated year of project completion (2013), and design year (2025). These emission estimates are based upon the traffic projections developed for the proposed project and its alternatives, which are discussed in Section 4.2. The secondary impacts associated with secondary growth for air quality, such as industrial sources, cannot be reasonably estimated in this EIS and are typically included in future emission estimates for the New Hampshire State Implementation Plan.

Table 4.13-1
Newington Predicted Maximum 1-Hour CO Concentrations (Parts Per Million)[1]

Receptor No. and Location[2, 3]	2003 Existing	2013 No-Build	2013 Alt. 10A Build	2013 Alt. 12A Build	2013 Alt. 13 Build	2025 No-Build	2025 Alt. 10A Build	2025 Alt. 12A Build	2025 Alt. 13 Build
Spaulding Turnpike Exit 3 Northbound Off ramp at Woodbury Avenue Extension									
1. Southeast Corner	5.5	4.7	4.1	4.1	3.1	4.8	4.3	4.3	3.2
2. Northeast Corner	4.2	3.7	3.8	3.8	3.7	3.7	4.1	4.1	3.8
3. Northwest Corner	4.8	4.2	3.7	3.7	3.6	4.2	4.0	4.0	3.6
4. Southwest Corner	7.8	6.5	3.9	3.9	3.9	6.8	4.4	4.4	4.1
Spaulding Turnpike Exit 3 Southbound Ramps at Woodbury Avenue Extension									
5. Northeast Corner	2.7	2.6	3.2	3.2	2.8	2.6	3.3	3.3	2.9
6. Northwest Corner	2.6	2.5	3.7	3.7	2.6	2.6	4.1	4.1	2.6
7. South Corner	2.7	2.6	3.3	3.3	2.6	2.6	3.3	3.3	2.7
Shattuck Way Connector at Woodbury Avenue Extension									
8. Southeast Corner	2.6	2.5	3.0	3.0	2.7	2.5	3.1	3.1	2.7
9. Northeast Corner	2.6	2.4	3.5	3.5	2.7	2.4	3.3	3.3	2.9
10. West Corner	2.5	2.3	3.3	3.3	2.7	2.4	3.4	3.4	2.7
Spaulding Turnpike Exit 3 Southbound Ramps at Woodbury Avenue Extension									
11. Northeast Corner	2.5	2.4	2.3	2.3	4.2	2.4	2.4	2.4	4.0
12. Northwest Corner	2.5	2.4	2.7	2.7	3.9	2.4	2.7	2.7	3.9
13. Southwest Corner	2.5	2.4	2.7	2.7	3.4	2.4	2.8	2.8	3.4
14. Southeast Corner	2.6	2.5	2.4	2.4	3.2	2.5	2.4	2.4	3.2
Spaulding Turnpike									
15. Right of Way	3.0	2.4	3.4	3.4	3.4	2.4	3.6	3.6	3.6

Source: Vanasse Hangen Brustlin, Inc.
1 The concentrations are expressed in parts per million (ppm) and include a 1-hour background concentration of 2.0 ppm. The 1-hour NAAQS for CO is 35 ppm. Concentrations were determined based on USEPA Guidance as discussed in Section 3.13.3.2.
2 The air quality study assumes that if these intersections meet the NAAQS, then all other intersections, regardless of alternative, which will have lower volumes and better levels of service, can be assumed to also meet the NAAQS.
3 See **Figure 3.13-3** for locations.

Table 4.13-2
Newington Predicted Maximum 8-Hour CO Concentrations (Parts Per Million)[1]

Receptor No. and Location[2, 3]	2003 Existing	2013 No-Build	2013 Alt. 10A Build	2013 Alt. 12A Build	2013 Alt. 13 Build	2025 No-Build	2025 Alt. 10A Build	2025 Alt. 12A Build	2025 Alt. 13 Build
Spaulding Turnpike Exit 3 Northbound Off Ramp at Woodbury Avenue Extension									
1. Southeast Corner	4.5	3.9	3.5	3.5	2.8	4.0	3.6	3.6	2.8
2. Northeast Corner	3.5	3.2	3.3	3.3	3.2	3.2	3.5	3.5	3.3
3. Northwest Corner	4.0	3.5	3.2	3.2	3.1	3.5	3.4	3.4	3.1
4. Southwest Corner	6.1	5.2	3.3	3.3	3.3	5.4	3.7	3.7	3.5
Spaulding Turnpike Exit 3 Southbound Ramps at Woodbury Avenue Extension									
5. Northeast Corner	2.5	2.4	2.8	2.8	2.6	2.4	2.9	2.9	2.6
6. Northwest Corner	2.4	2.4	3.2	3.2	2.4	2.4	3.5	3.5	2.4
7. South Corner	2.5	2.4	2.9	2.9	2.4	2.4	2.9	2.9	2.5
Shattuck Way Connector at Woodbury Avenue Extension									
8. Southeast Corner	2.4	2.4	2.7	2.7	2.5	2.4	2.8	2.8	2.5
9. Northeast Corner	2.4	2.3	3.1	3.1	2.5	2.3	2.9	2.9	2.6
10. West Corner	2.4	2.2	2.9	2.9	2.5	2.3	3.0	3.0	2.5
Spaulding Turnpike Exit 3 Southbound Ramps at Woodbury Avenue Extension									
11. Northeast Corner	2.4	2.3	2.2	2.2	3.5	2.3	2.3	2.3	3.4
12. Northwest Corner	2.4	2.3	2.5	2.5	3.3	2.3	2.5	2.5	3.3
13. Southwest Corner	2.4	2.3	2.5	2.5	3.0	2.3	2.6	2.6	3.0
14. Southeast Corner	2.4	2.4	2.3	2.3	2.8	2.4	2.3	2.3	2.8
Spaulding Turnpike									
15. Right of Way	2.7	2.3	3.0	3.0	3.0	2.3	3.1	3.1	3.1

Source: Vanasse Hangen Brustlin, Inc.

1 The concentrations are expressed in parts per million (ppm) and include an 8-hour background concentration of 2.0 ppm. The 8-hour NAAQS for CO is 9 ppm.

2 The air quality study assumes that if these intersections meet the NAAQS, then all other intersections, regardless of alternative, which will have lower volumes and better levels of service, can be assumed to also meet the NAAQS.

3 See **Figure 3.13-3** for locations.

Table 4.13-3
Dover Predicted Maximum 1-Hour CO Concentrations (Parts Per Million)[1]

Receptor No. and Location[2, 3]	2003 Existing	2013 No-Build	2013 Alt. 2 Build	2013 Alt. 3 Build	2025 No-Build	2025 Alt. 2 Build	2025 Alt. 3 Build
Dover Point Road at US 4							
1. Southeast Corner	3.8	3.5	4.1	4.1	3.5	4.9	4.9
2. North Corner	3.9	3.3	3.7	3.7	3.4	4.3	4.3
3. Southwest Corner	3.8	3.3	3.7	3.7	3.4	4.5	4.5
Spaulding Turnpike Exit 6 Northbound Off-ramp at US 4							
4. Southeast Corner	4.2	3.6	5.1	5.1	3.7	5.2	5.2
5. Northeast Corner	4.9	4.2	5.5	5.5	4.3	5.3	5.3
6. Northwest Corner	5.5	4.6	5.6	5.6	4.8	5.8	5.8
7. Southwest Corner	6.8	5.7	4.8	4.8	5.8	4.9	4.9
Spaulding Turnpike Exit 6 Southbound On-ramp at US 4							
8. Southeast Corner	3.7	3.3	3.7	3.7	3.4	3.9	3.9
9. North Corner	4.7	4.1	3.6	3.6	4.1	3.8	3.8
10. Southwest Corner	3.6	3.2	3.9	3.9	3.3	4.1	4.1
Spaulding Turnpike							
11. Right of Way	3.0	2.4	3.4	3.4	2.4	3.6	3.6

Source: Vanasse Hangen Brustlin, Inc.

1 The concentrations are expressed in parts per million (ppm) and include a 1-hour background concentration of 2.0 ppm. The 1-hour NAAQS for CO is 35 ppm.

2 The air quality study assumes that if these intersections meet the NAAQS, then all other intersections, regardless of alternative, which will have lower volumes and better levels of service, can be assumed to also meet the NAAQS.

3 See **Figure 3.13-4** for locations.

Table 4.13-4
Dover Predicted Maximum 8-Hour CO Concentrations (Parts Per Million)[1]

Receptor No. and Location[2, 3]	2003 Existing	2013 No-Build	2013 Alt. 2 Build	2013 Alt. 3 Build	2025 No-Build	2025 Alt. 2 Build	2025 Alt. 3 Build
Dover Point Road at US 4							
1. Southeast Corner	3.3	3.1	3.5	3.5	3.1	4.0	4.0
2. North Corner	3.3	2.9	3.2	3.2	3.0	3.6	3.6
3. Southwest Corner	3.3	2.9	3.2	3.2	3.0	3.8	3.8
Spaulding Turnpike Exit 6 Northbound Off Ramp at US 4							
4. Southeast Corner	3.5	3.1	4.2	4.2	3.2	4.2	4.2
5. Northeast Corner	4.0	3.5	4.5	4.5	3.6	4.3	4.3
6. Northwest Corner	4.5	3.8	4.5	4.5	4.0	4.7	4.7
7. Southwest Corner	5.4	4.6	4.0	4.0	4.7	4.0	4.0
Spaulding Turnpike Exit 6 Southbound On Ramp at US 4							
8. Southeast Corner	3.2	2.9	3.2	3.2	3.0	3.3	3.3
9. North Corner	3.9	3.5	3.1	3.1	3.5	3.3	3.3
10. Southwest Corner	3.1	2.8	3.3	3.3	2.9	3.5	3.5
Spaulding Turnpike							
11. Right of Way	2.7	2.3	3.0	3.0	2.3	3.1	3.1

Source: Vanasse Hangen Brustlin, Inc.
1 The concentrations are expressed in parts per million (ppm) and include an 8-hour background concentration of 2.0 ppm. The 8-hour NAAQS for CO is 9 ppm.
2 The air quality study assumes that if these intersections meet the NAAQS, then all other intersections, regardless of alternative, which will have lower volumes and better levels of service, can be assumed to also meet the NAAQS.
3 See **Figures 3.13-4** for locations.

4.13.4 Construction Impacts

The proposed roadway improvement to the Spaulding Turnpike may result in a temporary increase of emissions during construction. Emissions from the operation of construction equipment will include nitrogen oxides, sulfur oxides, carbon monoxide, and particulate matter. These emissions will be temporary and the locations at which they occur will be changing over time.

NHDOT will require the contractors, involved with the improvements to the Spaulding Turnpike, to include air pollution control devices on heavy diesel construction equipment in accordance with applicable state and federal laws at the time of construction. The merits and practicality of more stringent or voluntary specification measures will be considered through the final design process with input from the contracting community at large.

Mitigating fugitive dust emissions involves minimizing or eliminating its generation. Mitigation measures that will be used for construction include wetting and stabilization to suppress dust generation, cleaning paved roadways, and scheduling construction to minimize the amount and duration of exposed earth.

4.13.5 Transportation Conformity

USDOT and the USEPA have established conformity procedures to ensure that transportation projects are in compliance with SIPs. Conformity requires that proposed transportation projects be part of an MPO-adopted Transportation Improvement Program (TIP) for urbanized areas and the total emissions of all projects must meet the air quality budgets established in the SIPs. The proposed improvements to the Spaulding Turnpike must demonstrate that the regional emissions comply with the Transportation Conformity requirements. This project is included in the Fiscal Year 2005-2007 Transportation Improvement Program and Transportation Plan that includes a regional air quality conformity analysis; therefore, a separate mesoscale analysis will not be conducted for this EIS.

The proposed project satisfies the transportation conformity requirements because the proposed project's air quality emissions were evaluated as a future project in the NHDOT's State Transportation Improvement Program (STIP) for Fiscal Years 2007-2010, which was reviewed by USEPA and found to be in conformance by the US Department of Transportation.

The project-level air quality study consisted of a microscale modeling analysis that predicts CO levels at critical receptor locations along the project corridor. The microscale analysis was conducted according to USEPA guidelines. The results of the air quality analysis demonstrate that the proposed project will not interfere with the attainment or maintenance of the NAAQS for CO. These results are consistent with the study area's designation as attainment for CO.

4.13.6 Air Toxics

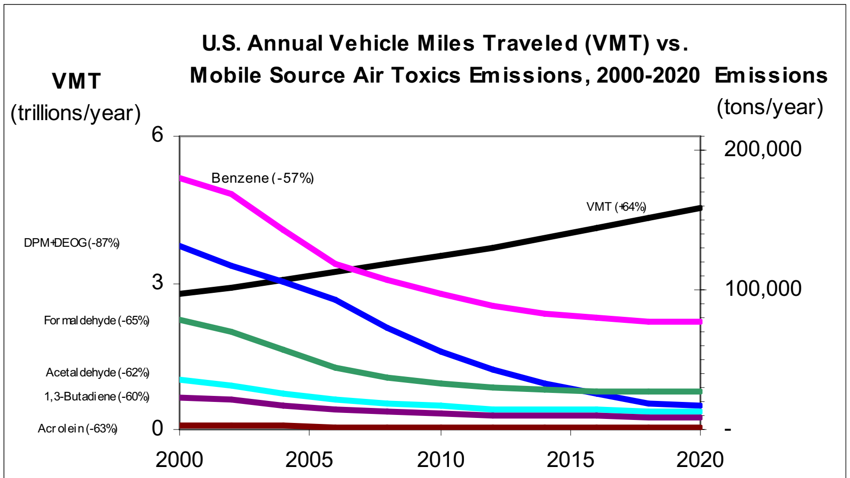
In addition to the criteria air pollutants for which there are National Ambient Air Quality Standards, USEPA also regulates air toxics. Most air toxics originate from human-made sources, including on-road mobile sources, non-road mobile sources (*e.g.*, airplanes), area sources (*e.g.*, dry cleaners) and stationary sources (*e.g.*, factories or refineries). The following discussion on air toxics is consistent with FHWA's 2006 MSAT interim guidance.

Mobile Source Air Toxics (MSATs) are a subset of the 188 air toxics defined by the Clean Air Act. The MSATs are compounds emitted from highway vehicles and non-road equipment. Some toxic compounds are present in fuel and are emitted to the air when the fuel evaporates or passes through the engine unburned. Other toxics are emitted from the incomplete combustion of fuels or as secondary combustion products. Metal air toxics also result from engine wear or from impurities in oil or gasoline.

The USEPA is the lead Federal agency for administering the Clean Air Act and has certain responsibilities regarding the health effects of MSATs. The USEPA issued a Final Rule on Controlling Emissions of Hazardous Air Pollutants from Mobile Sources [66 FR 17229 (March 29, 2001)]. This rule was issued under the authority in Section 202 of the Clean Air Act. In its rule, USEPA examined the impacts of existing and newly promulgated mobile source control programs, including its reformulated gasoline (RFG) program, its national low emission vehicle (NLEV) standards, its Tier 2 motor vehicle emissions standards and gasoline sulfur control requirements, and its proposed heavy duty engine and vehicle standards and on-highway diesel fuel sulfur control requirements. Between 2000 and 2020, even with a 64 percent increase in VMT (as projected by FHWA), these programs will reduce on-highway emissions of benzene, formaldehyde, 1,3-butadiene, and acetaldehyde by 57 percent to 65 percent, and will reduce on-highway diesel particulate matter (PM) emissions by 87 percent, as shown in Exhibit 4.13-1.

As a result, USEPA concluded that no further motor vehicle emissions standards or fuel standards were necessary to further control MSATs. The agency is preparing another rule under authority of CAA Section 202(l) that will address these issues and could make adjustments to the full 21 and the primary six MSATs.

Exhibit 4.13-1
Mobile Source Air Toxics Emissions



Notes: For on-road mobile sources. Emissions factors were generated using MOBILE6.2. MTBE proportion of market for oxygenates is held constant, at 50%. Gasoline RVP and oxygenate content are held constant. VMT: *Highway Statistics 2000*, Table VM-2 for 2000, analysis assumes annual growth rate of 2.5%. "DPM + DEOG" is based on MOBILE6.2-generated factors for elemental carbon, organic carbon and SO4 from diesel-powered vehicles, with the particle size cutoff set at 10.0 microns.

Available technical tools do not enable us to predict the project-specific health impacts of the emission changes associated with the alternatives in this FEIS. Due to these limitations, the following discussion is included in accordance with CEQ regulations [40 CFR 1502.22(b)] regarding incomplete or unavailable information:

Evaluating the environmental and health impacts from MSATs on a proposed highway project would involve several key elements, including emissions modeling, dispersion modeling in order to estimate ambient concentrations resulting from the estimated emissions, exposure modeling in order to estimate human exposure to the estimated concentrations, and then final determination of health impacts based on the estimated exposure. Each of these steps is encumbered by technical shortcomings or uncertain science that prevents a more complete determination of the MSAT health impacts of this project.

1. Emissions: The USEPA tools to estimate MSAT emissions from motor vehicles are not sensitive to key variables determining emissions of MSATs in the context of highway projects. While MOBILE 6.2 is used to predict emissions at a regional level, it has limited applicability at the project level. MOBILE 6.2 is a trip-based model; emission factors are projected based on a typical trip of 7.5 miles, and on average speeds for this typical trip. This means that MOBILE 6.2 does not have the ability to predict emission factors for a specific vehicle operating condition at a specific location at a specific time. Because of this limitation, MOBILE 6.2 can only approximate the operating speeds

and levels of congestion likely to be present on the largest-scale projects, and cannot adequately capture emissions effects of smaller projects. For particulate matter, the model results are not sensitive to average trip speed, although the other MSAT emission rates do change with changes in trip speed. Also, the emissions rates used in MOBILE 6.2 for both particulate matter and MSATs are based on a limited number of tests of mostly older-technology vehicles. Lastly, in its discussions of particulate matter under the conformity rule, USEPA has identified problems with MOBILE 6.2 as an obstacle to quantitative analysis. These deficiencies compromise the capability of MOBILE 6.2 to estimate MSAT emissions. MOBILE 6.2 is an adequate tool for projecting emissions trends, and performing relative analyses between alternatives for very large projects, but it is not sensitive enough to capture the effects of travel changes tied to smaller projects or to predict emissions near specific roadside locations.

2. Dispersion; The tools to predict how MSATs disperse are also limited. The USEPA's current regulatory models, CALINE3 and CAL3QHC, were developed and validated more than a decade ago for the purpose of predicting episodic concentrations of carbon monoxide to determine compliance with the NAAQS. The performance of dispersion models is more accurate for predicting maximum concentrations that can occur at some time at some location within a geographic area. This limitation makes it difficult to predict accurate exposure patterns at specific times at specific highway project locations across an urban area to assess potential health risk. The NCHRP is conducting research on best practices in applying models and other technical methods in the analysis of MSATs. This work also will focus on identifying appropriate methods of documenting and communicating MSAT impacts in the NEPA process and to the general public. Along with these general limitations of dispersion models, FHWA is also faced with a lack of monitoring data in most areas for use in establishing project-specific MSAT background concentrations.

3. Exposure Levels and Health Effects: Finally, even if emission levels and concentrations of MSATs could be accurately predicted, shortcomings in current techniques for exposure assessment and risk analysis preclude reaching meaningful conclusions about project-specific health impacts. Exposure assessments are difficult because it is difficult to accurately calculate annual concentrations of MSATs near roadways, and to determine the portion of a year that people are actually exposed to those concentrations at a specific location. These difficulties are magnified for 70-year cancer assessments, particularly because unsupportable assumptions would have to be made regarding changes in travel patterns and vehicle technology (which

> affects emissions rates) over a 70-year period. There are also considerable uncertainties associated with the existing estimates of toxicity of the various MSATs, because of factors such as low-dose extrapolation and translation of occupational exposure data to the general population. Because of these shortcomings, any calculated difference in health impacts between alternatives is likely to be much smaller than the uncertainties associated with calculating the impacts. Consequently, the results of such assessments would not be useful to decision-makers, who would need to weigh this information against other project impacts that are better suited for quantitative analysis.

Research into the health impacts of MSATs is ongoing. For different emission types, there are a variety of studies that show that some either are statistically associated with adverse health outcomes through epidemiological studies (frequently based on emissions levels found in occupational settings) or that animals demonstrate adverse health outcomes when exposed to large doses.

Exposure to toxics has been a focus of a number of USEPA efforts. Most notably, the agency conducted the National Air Toxics Assessment (NATA) in 1996 to evaluate modeled estimates of human exposure applicable to the county level. While not intended for use as a measure of or benchmark for local exposure, the modeled estimates in the NATA database best illustrate the levels of various toxics when aggregated to a national or State level.

The USEPA is in the process of assessing the risks of various kinds of exposures to these pollutants. The USEPA Integrated Risk Information System (IRIS) is a database of human health effects that may result from exposure to various substances found in the environment. The IRIS database is located at http://www.epa.gov/iris. The following toxicity information for the six prioritized MSATs, was taken from the IRIS database "Weight of Evidence Characterization" summaries. This information is taken verbatim from USEPA's IRIS database and represents the Agency's most current evaluations of the potential hazards and toxicology of these chemicals or mixtures.

- **Benzene** is characterized as a known human carcinogen.

- The potential carcinogenicity of **acrolein** cannot be determined because the existing data are inadequate for an assessment of human carcinogenic potential for either the oral or inhalation route of exposure.

- **Formaldehyde** is a probable human carcinogen, based on limited evidence in humans, and sufficient evidence in animals.

- **1,3-butadiene** is characterized as carcinogenic to humans by inhalation.

- **Acetaldehyde** is a probable human carcinogen based on increased incidence of nasal tumors in male and female rats and laryngeal tumors in male and female hamsters after inhalation exposure.

- **Diesel exhaust** (DE) is likely to be carcinogenic to humans by inhalation from environmental exposures. Diesel exhaust as reviewed in this document is the combination of diesel particulate matter and diesel exhaust organic gases.

- **Diesel exhaust** also represents chronic respiratory effects, possibly the primary non-cancer hazard from MSATs. Prolonged exposures may impair pulmonary function and could produce symptoms, such as cough, phlegm, and chronic bronchitis. Exposure relationships have not been developed from these studies.

As discussed above, technical shortcomings of emissions and dispersion models and uncertain science with respect to health effects prevent meaningful or reliable estimates of MSAT emissions and effects of this project. However, even though reliable methods do not exist to accurately estimate the health impacts of MSATs at the project level, it is possible to qualitatively assess the levels of future MSAT emissions under the project. Although a qualitative analysis cannot identify and measure health impacts from MSATs, it can give a basis for identifying and comparing the potential differences among MSAT emissions—if any—from the various alternatives. The qualitative assessment presented below is derived in part from a study conducted by the FHWA entitled *A Methodology for Evaluating Mobile Source Air Toxic Emissions Among Transportation Project Alternatives*, found at: *www.fhwa.dot.gov/environment/airtoxic/msatcompare/msatemissions.htm*

The 2025 AADT for the Spaulding Turnpike Improvements roadway segments ranged from 50,000 to 95,000 AADT. Using EPA's MOBILE 6.2 emissions model, FHWA has estimated that an AADT of 150,000 would be roughly equivalent to the Clean Air Act definition of a major Hazardous Air Pollutant (HAP) source, *i.e.* 25 tons per year (tpy) for all HAPs or 10 tpy for any single HAP. The AADTs for the Spaulding Turnpike Improvements roadway segments are substantially below these levels.

The EIS evaluated alternatives (potential actions), such as transportation improvements, new location highways, and improvements to existing highways. For each alternative in this FEIS, the amount of MSATs emitted would be proportional to the vehicle miles traveled, or VMT, assuming that other variables such as fleet mix are the same for each alternative. The VMT estimated for each of the Build Alternatives is higher than that for the No-Build Alternative, because the additional capacity increases the efficiency of the roadway and attracts rerouted trips from elsewhere in the transportation network. This increase in VMT would lead to higher MSAT emissions for the

Selected Alternative along the highway corridor. The emissions increase is offset somewhat by lower MSAT emission rates due to increased speeds. According to EPA's MOBILE 6 emissions model, emissions of all of the priority MSATs, except for diesel particulate matter, decrease as speed increases. The extent to which these speed-related emissions decrease will offset VMT-related emissions increase cannot be reliably projected due to the inherent deficiencies of technical models.

Because the estimated VMT under each of the Alternatives are nearly the same, it is expected there would be no appreciable difference in overall MSAT emissions among the various alternatives. Also, regardless of the alternative chosen, emissions will likely be lower than present levels in the design year as a result of USEPA's national control programs that are projected to reduce MSAT emissions by 57 to 87 percent between 2000 and 2020. Local conditions may differ from these national projections in terms of fleet mix and turnover, VMT growth rates, and local control measures. However, the magnitude of the EPA-projected reductions is so great (even after accounting for VMT growth) that MSAT emissions in the study area are likely to be lower in the future in nearly all cases.

The additional travel lanes contemplated as part of the project alternatives will have the effect of moving some traffic closer to nearby homes, schools and businesses; therefore, under each alternative there may be localized areas where ambient concentrations of MSATs could be higher under certain Build Alternatives than the No-Build Alternative. The localized increases in MSAT concentrations would likely be most pronounced along the Spaulding Turnpike/NH 16. However, as discussed above, the magnitude and the duration of these potential increases compared to the No-Build Alternative cannot be accurately quantified due to the inherent deficiencies of current models. In summary, when a highway is widened and minor new roadway segments are proposed, receptor locations will be closer, the localized level of MSAT emissions for the Build Alternatives could be higher relative to the No-Build Alternative, but this could be offset due to increases in speeds and reductions in congestion (which are associated with lower MSAT emissions). Also, MSATs will be lower in other locations when traffic shifts away from them. However, on a regional basis, EPA's vehicle and fuel regulations, coupled with fleet turnover, will over time cause substantial reductions that, in almost all cases, will cause region-wide MSAT levels to be substantially lower than today.

4.13.7 Conclusion

The air quality analysis demonstrates that this project is in compliance with the 1990 Clean Air Act Amendments and the New Hampshire State Implementation Plan. The results of the microscale analysis demonstrate that the proposed project will not create CO violations in locations where violations do not currently exist. In fact, the results demonstrate that no CO violations currently exist in the air quality study area. The microscale analysis also demonstrates that CO concentrations for the No-Build and Build Alternatives are all below the NAAQS standards for CO.

The proposed project also satisfies the transportation conformity requirements because it was included in the NHDOT's STIP for Fiscal Years 2007-2010.

In summary, the results of the air quality analysis demonstrate that the proposed project is in conformance with the SIP because:

- No new violation of the NAAQS will be created,
- No increase in the frequency or severity of any existing violations will occur, and
- No delay in attainment of any NAAQS standard will result.

4.14 Noise

The purpose of the noise analysis is to identify receptor locations, to predict existing and future highway noise levels, to determine project noise impacts, and to evaluate noise mitigation measures related to the Spaulding Turnpike improvement project. The noise analysis predicted existing and future sound levels for over two hundred receptor locations in the study area using traffic data, roadway geometry, and vehicle operating characteristics. These receptor locations included residential and commercial land uses. The analysis evaluated changes in sound levels among Existing, 2025 No-Build, and 2025 Build conditions.

4.14.1 2025 No-Build Condition

Under 2025 No-Build Conditions, the sound levels for receptor locations along the Spaulding Turnpike corridor are expected to be similar to the existing sound levels. This is the case because the highest sound levels are generated by the combination of traffic volumes, vehicle speeds, and truck percentages. Currently the Spaulding Turnpike is at capacity during the peak hours of the day. Traffic growth on the Turnpike under the existing roadway conditions can only occur in the form of peak spreading, which is to say that the Turnpike will operate at capacity for more hours of the day in the future. Without additional capacity to process more vehicles, peak sound levels are not expected to increase. As a result, the future peak sound levels are expected to be similar to the existing peak levels, although it is expected that peak sound levels will occur for longer periods of time in the future No-Build condition.

Table 4.14-1 summarizes the 2025 No-Build condition sound levels which will vary from 40 to 72 dBA.

4.14.2 Alternatives Evaluated

Noise analyses were conducted for Alternatives 10A, 12A and 13 in Newington and Alternatives 2 and 3 in Dover. The Selected Alternative is comprised of Alternative 13 in Newington and Alternative 3 in Dover. The Spaulding Turnpike will be widened to four lanes in each direction between Exits 3 and 6 (three basic highway lanes and one auxiliary lane in each direction), which represents the most conservative condition from a noise perspective. Alternatives 10A and 12A in Newington and Alternative 2 in Dover would result in sound levels similar to, or lower than, the Selected Alternative. Due to commuting trends, the Spaulding Turnpike's northbound and southbound travel lanes have different volume characteristics for morning and evening peak periods. Therefore, sound levels on the northbound side of the Turnpike were calculated using the weekday evening peak hour volumes and the sound levels on the southbound side of the Turnpike were calculated using the weekday morning peak hour volumes.

4.14.3 2025 Build Condition

The noise analysis established receptor locations based upon the "Activity Category" (land use) as described in the FHWA Noise Abatement Criteria (NAC), which is presented in Table 3.14-2. The predominant land use evaluated in the study area is residential, which is identified as being in Activity Category "B." As discussed in Section 4.14.2, sound levels under the 2025 Build Condition will also represent a worst-case condition for each receptor location. The 2025 Build Condition sound levels are projected to vary from 47 to 72 dBA, which represents up to a 7 dBA increase in sound levels when compared to Existing Conditions. This increase is due to the combination of higher peak period traffic volumes, higher speeds due to additional roadway capacity, and new roadway alignment.

The results of the noise analysis were compared to the NAC. As discussed in Section 3.14.2, NHDOT considers traffic noise impacts to occur when noise levels approach (within 1 dBA), are at, or exceed the FHWA NAC (67 dBA for Activity Category "B" (residences) and 72 dBA for Activity Category "C" (commercial uses)), or when future noise levels exceed existing noise levels by 15 dBA or more. The noise analysis results indicate that the receptor locations at Fox Run Road and Shattuck Way in Newington as well as receptor locations at Dover Point Road, Hilton Park, Wentworth Terrace, Cote Drive, Spur Road, and Homestead Lane in Dover would experience

Table 4.14-1
Existing and Predicted (2025) Noise Levels (dBA)

			Existing Conditions		2025-No-Build		2025 Build	
Receptor Number	**Activity Category Land Use**	**Receptor Location**	**Existing Levels**	**No. of Receptors that approach, are at, or exceed the NAC**	**Predicted Levels**	**No. of Receptors that approach, are at, or exceed the NAC**	**2025 Build**	**No. of Receptors that approach, are at, or exceed the NAC**
Area 1	Commercial/Church	Fox Run Road – Newington	58-**67**[1]	1	58-**67**[1]	1	60-**68**[1]	1
Area 2	Residential	Old Dover Road – Newington	51-59	0	52-60	0	54-65	0
Area 3	Residential	Patterson Lane – Newington	39-47	0	40-49	0	47-51	0
Area 4	Residential	Nimble Hill Road – Newington	52-54	0	56-58	0	56-60	0
Area 5	Residential	Shattuck Way – Newington	50-**68**[1]	1	52-**69**[1]	1	58-**69**[1]	1
Area 6	Residential	Bloody Point – Newington	53-57	0	55-58	0	58-62	0
Area 7	Recreation	Hilton Park – Dover	57-**67**[1]	1	60-**68**[1]	1	60-**68**[1]	1
Area 8	Residential	Wentworth Terrace – Dover	59-**71**[1]	12	62-**72**[1]	12	62-**72**[1]	15
Area 9	Residential	Dover Point Road/Hilton Park – Dover	55-**70**[1]	22	58-**71**[1]	22	60-**71**[1]	25
Area 10	Residential	Boston Harbor Road – Dover	54-63	0	56-63	0	56-63	0
Area 11	Residential	Cote Drive – Dover	49-**71**[1]	10	52-**72**[1]	10	51-**72**[1]	11
Area 12	Residential	Spur Rd / Bayview Park – Dover	40-56	0	42-58	0	48-60	0
Area 13[2]	Residential	Spur Rd / Clearwater Dr – Dover	44-**66**[1]	19	46-**66**[1]	19	49-**67**[1]	19
Area 14[2]	Residential	Homestead Lane/Pearson Dr – Dover	54-**68**[1]	15	55-**69**[1]	15	58-**70**[1]	15

Notes:
1 The sound level approaches, is at, or exceeds the FHWA noise abatement criterion.
2 Area includes receptors north of Dover Tolls.

noise impacts. While the proposed project would not result in substantial increases (15 dBA or more) in sound levels, the existing and future build condition sound levels exceeded the NAC. Table 4.14.-1 presents the sound levels for Existing, 2025 No-Build, and 2025 Build Conditions, and **Figures 4.14-1 and 4.14-2** show the locations of the impacted receptors.

4.14.4 Secondary Impacts

The noise analysis calculated sound levels associated with traffic for both the existing year (2003) and the design year (2025). These sound levels were based on the traffic projections developed for all roadway alternatives evaluated, which were discussed in Section 4.2. Noise mitigation measures (*i.e.*, noise barriers) were also developed based upon these projections to address projected noise impacts.

Secondary land use impacts associated with population and employment growth potentially stimulated by the project are presented in Section 4.3. However, noise impacts associated with this secondary growth cannot be reasonably estimated because the mix of commercial/industrial development, as well as its exact location cannot be reasonably estimated.

4.14.5 Mitigation

NHDOT and FHWA's guidelines require that noise mitigation measures be evaluated for the receptor locations where adverse noise impacts have been identified. These measures can include traffic management, alteration of horizontal and vertical alignment, acquisition of property to serve as a buffer zone, or construction of a noise barrier. For the proposed project, improvements to the vertical alignment and construction of noise barriers were evaluated as mitigation measures.

A noise barrier provides noise abatement by reducing the transmission of sound waves. This is accomplished by shielding receptor locations from the noise source. A noise barrier must be of sufficient length and height to block the line of sight of the roadway from the receptor locations. NHDOT and FHWA guidelines establish a procedure to determine if a noise barrier is feasible and reasonable. The feasibility of noise abatement measures is based upon engineering and acoustical attributes. The engineering considerations include the existing highway geometry, the location of cross streets and driveways, safety issues, and other environmental impacts. The noise abatement measures must also be able to provide substantial acoustical benefits. Every effort is made to attain a 10 dBA (or greater) insertion loss at first row receptors. (Insertion loss is defined as the amount of noise reduction provided by a noise barrier.) A majority of the first row receptors must get a minimum of a 5 dBA insertion loss for a noise barrier to be considered effective. The reasonableness of noise abatement measures is based first upon its cost-effectiveness and then by public support. The NHDOT criteria requires that every effort should be made to keep the cost under $30,000 per protected receptor. A protected receptor is one that receives a minimum of a 5 dBA insertion loss. A minimum of 75% of the first row property owners will need to support the installation of the barrier in order for it to be constructed.

Noise mitigation measures were evaluated for receptor locations that were predicted to have adverse noise impacts. Adverse noise impacts are defined as receptor locations with 2025 Build condition sound levels that approach within 1 dBA, are at, or exceed the FHWA Noise Abatement Criteria, which is 67 and 72 dBA for residential and commercial areas respectively; or when the future sound levels exceed the existing sound levels by 15 dBA. Appendix L contains a summary of the noise barrier evaluation.

The Selected Alternative will maintain the existing vertical alignment and implement noise barriers as mitigation measures. The following locations in Dover met the NHDOT criteria for reasonableness and feasibility and are proposed as noise mitigation measures:

- Dover Point Road area (Receptor Area 9)
- Wentworth Terrace and Cote Drive areas (Receptor Areas 8 and 11)
- Spur Rd and Clearwater Drive areas (Receptor Area 13)
- Homestead Lane and Pearson Drive areas (Receptor Area 14)

Table 4.14-2 presents the locations where noise mitigation measures are being proposed. The proposed noise barrier locations are presented in **Figures 4.14-3 and 4.14-4.**

The noise analyses indicated that residences at the northern end of the study area on Homestead Lane, Pineview Lane, and Spur Road will be impacted. By inspection it was clear that adjacent residences to the north would also have noise levels above the Noise Abatement Criteria (NAC), thus it was determined to be inappropriate to end the noise barrier at the study limits. Taking this into account, the potential noise impacts to these residences just north of the study area were evaluated as a part of this project. As a result, Noise Barriers #3 and #4 were extended north of the toll plaza providing protection to an additional 25 impacted residences.

The location of Barrier #3 (**Figure 4.14-4**) was determined after reviewing several options for the length and height of the barrier. Noise Barrier # 3 was not extended southward to the junction of Spur Road because this additional length would not be expected to provide a substantial reduction in noise for

Table 4.14-2
Potential Noise Mitigation Locations Based on 2025 Build Alternatives

Receptor Location Number	Receptor Location	Number of Residences that Approach, Are At, or Exceed the NAC	Number of Residences w/ 5 dBA or Greater Reduction	Noise Barrier Recommendation
Area 1	Fox Run Road – Newington	1	1	No
Area 2	Old Dover Road – Newington	0	0	N/A
Area 3	Patterson Lane – Newington	0	0	N/A
Area 4	Nimble Hill Road – Newington	0	0	N/A
Area 5	Shattuck Way – Newington	1	1	No
Area 6	Bloody Point – Newington	0	0	N/A
Area 7	Hilton Park – Dover	1	1	No
Area 8	Wentworth Terrace – Dover	15	16	Yes
Area 9	Dover Point Road/Hilton Park – Dover	25	40	Yes
Area 10	Boston Harbor Road – Dover	0	0	N/A
Area 11	Cote Drive – Dover	11	47	Yes
Area 12	Spur Rd / Bayview Park – Dover	0	0	N/A
Area 13	Spur Rd / Clearwater Dr – Dover	19	29	Yes
Area 14	Homestead Lane/Pearson Dr – Dover	15	35	Yes

Notes:
N/A Not applicable since location does not have noise levels that approach, are at, or exceed the FHWA noise abatement criteria.

the residences on the southern portion of Spur Road. This barrier, as proposed, is only about two hundred dollars below the cost criteria of $30,000 per benefited receptor. An extension of the barrier further south would push it well over the cost criteria as the number of residences with a 5 dBA reduction would not be increased. Additionally, a factor in this decision was that these residences on the southern portion of Spur Road are not expected to be impacted – which is to say that their projected noise levels are less than 66 dBA.

Noise barriers are not recommended at any of the Noise Sensitive Receptor Areas in Newington or at Areas 7, 10, and 12 in Dover. Of these locations, only Areas 1, 5, and 7 have impacted receptors. The NHDOT cost-effective index is not met for any of these areas as only one to two receptors per area would receive a benefit (5 dBA or greater) from the barrier. Because the cost-effective index is not met, noise barriers are not recommended for these areas. Cost-effective index calculations are provided in Appendix L.

4.14.6 Construction Noise Impacts

Noise impacts from construction activities are closely related to the phase of construction and the type and placement of construction equipment at the site. Table 4.14-3 shows a variety of construction equipment that may be deployed at various stages of highway construction. Typical noise levels from this equipment are also shown.

Construction activities would result in a substantial, but temporary, noise impact to receptors at various locations adjacent to proposed construction. Noise levels would vary depending on the type and number of pieces of equipment active at any one time. It is expected that noise levels exceeding 67 decibels could occur up to 500 feet away from construction activities. In general, construction noise would be restricted to daylight hours, although night construction will be likely given the need to maintain traffic in both directions much of the time during daylight hours.

In an effort to minimize construction noise, proposed noise barriers will be built as soon as possible so that they may provide a reduction in subsequent construction noise to the residences.
Bridge construction represents a source of higher noise levels due to pile driving, ledge removal, and other activities. Major bridge construction is planned for the following locations:

- Little Bay Bridges
- General Sullivan Bridge
- Exit 3 Interchange
- Exit 6 Interchange

4.14.7 Future Noise Levels for Planning Purposes

The noise analysis has developed data that may be useful to local officials in their planning efforts for future development along the Spaulding Turnpike corridor. In order to limit the creation of new noise impacts, local officials should consider the following: Along the Spaulding Turnpike corridor, residential development would ideally be located no closer than 300 feet from the edge of the travel lane, which represents the approximate distance to the 66 dBA noise contour. It should be noted that this distance varies along the corridor as traffic, topography and other geometric conditions change. Therefore, as a general rule new residential developments should be a minimum of 300 feet from the Turnpike so that the residents are not impacted by future highway noise. Additionally, new development close to the Turnpike is recommended to include noise abatement as an element of the proposed development.

Table 4.14-3
Construction Equipment Noise Emissions[1]

Equipment Type	Noise Levels (dBA @50FT)
Earthmoving	
Front Loader	84
Backhoe	84
Bulldozer	88
Tractor	84
Scraper	90
Grader	83
Truck	90
Paver	84
Vibrator	76
Materials Handling	
Concrete Mixer	83
Crane	82
Derrick	88
Stationary	
Pump	71
Generator	81
Compressor	89
Impact Devices	
Pile Driver	91
Pavement Breaker	89
Pneumatic Tool	80

Note:
1 Data from "Highway Construction Noise: Environmental Assessment and Abatement, Volume IV: User's Manual." Vanderbilt University, Nashville, TN. Report No. VTR-81-3, 1981.

4.15 Community Resources

4.15.1 Introduction

This section addresses potential impacts of the project on community resources like police and fire stations, libraries, public parks, recreation areas, and conservation lands. The location and description of these resources are included in Section 3.15.

Impacts to "significant public parks and recreation areas" require a full evaluation under Section 4(f) of the Department of Transportation Act of 1966 to demonstrate that there is no reasonable and prudent alternative to avoid impacts to the use of land from the property and that the action includes all possible planning to minimize harm to the property from such use. This required Section 4(f) Evaluation is presented in detail in Chapter 5 of this EIS.

4.15.2 Impact Analysis Methodology

Impacts on community resources were evaluated by overlaying the footprints of the various alternatives on project base maps containing the locations of such resources. The direct loss of property acreage or impacts on access, aesthetics, or key features were evaluated in this analysis.

4.15.3 Analysis Results

Newington Alternatives

The Newington School is the only community facility within the project area. This elementary school is located beyond the limits of the proposed improvements to Nimble Hill Road and hence will not be impacted by the project. The Newington Town Hall, Langdon Library and a cemetery are also located on Nimble Hill Road further to the west. The project will not impact these facilities.

No state or federal facilities on or adjacent to the Tradeport property will be affected by this project. Improvements to the Turnpike will, however, lead to better access by the public to these facilities.

The small, town-owned boat launch at the end of Patterson Lane will not be affected by any of the proposed Turnpike improvements.

Bridge Alternatives

The proximity of Hilton Park to both the Little Bay Bridges and the General Sullivan Bridge raises a concern about indirect impacts to this resource. Although substantial reconstruction of the Little Bay Bridges would occur under either of the two Bridge Alternatives, most of this work (approximately 400 square feet of impact is expected beyond the existing ROW and accounts for the structure partially suspended over the park and construction of the foundations) will be contained within existing ROW. Disruption (*e.g.* noise, dust, traffic) to normal recreational activity will likely result during construction. Temporary use of some park land is likely to be required during construction, although the location and extent of this possible impact will not be known until final design and construction sequencing.

Dover Alternatives

Two public parks are affected by the Dover alternatives. Impacts to Hilton Park are discussed under the bridge alternatives. Bayview Park, owned by the NHF&GD, which lies between Spur Road and the Bellamy River, will be impacted by proposed improvements to Spur Road. Alternative 3 affects approximately the same area of Bayview Park as Alternative 2 (0.4 acre). As discussed in Chapter 5, impacts to Bayview Park are unavoidable due to the geometry of the existing roadways and the need to make a local connection from Spur Road to Boston Harbor Road.

All of the Dover alternatives avoid impacting the NH Division of Motor Vehicles office and its parking lot located just west of the Turnpike on Boston Harbor Road.

4.15.4 Secondary Impacts

Projections of future population growth and development even under the No-Build Alternative will increase the demand on community facilities and resources in the vicinity of the project corridor. New facilities may have to be built to meet this demand and additional funding from public sources may be needed. This funding may have to come from an increase in taxes, user fees, or state or federal support.

The amount of additional growth predicted under the Build Alternative (*i.e.*, growth induced by the project) in the socio-economic study area is relatively minor (approximately 1,865 new residents) when compared to the predicted growth under the No-Build Alternative (approximately 50,450 new residents). Thus, the project-related secondary impacts on community facilities will be minor.

4.15.5 Mitigation

Direct impacts on Hilton Park have been avoided with proposed improvements occurring entirely within existing right-of-way. Handicap accessibility from the park to the rehabilitated General Sullivan Bridge will be provided by a ramp adjacent to the southbound lanes with both alternatives. Compared to existing conditions, safer access to the Park and to the eastern and western sides of Dover Point will be provided by the widening of the loop road. Additionally, NHDOT will work with NHDHR to develop and erect a sign that explains the history of the park and the GSB and significance of the park. Reasonable efforts will be made to minimize impacts to the park during construction, including preventing unnecessary disturbance of areas outside the existing right-of-way and maintaining safe access to the park.

In order to offset impacts to Bayview Park, NHDOT will continue to work with NHF&GD to provide improved access to the park. Pedestrians and bicyclists will also benefit from improved access as NHDOT intends to construct a sidewalk connecting the park to the Scammell Bridge and to Boston Harbor Road. Additionally, reasonable efforts will be made to minimize impacts to the park during construction, including preventing unnecessary disturbance of areas outside the authorized right-of-way, and maintaining safe access to the park for vehicles, pedestrians and bicyclists.

Based on further coordination with the NHF&GD following the Public Hearing, additional mitigation will include an increase in parking at the existing Bayview Park lot. Parking would be expanded from six to ten spaces by extending the parking area to the southwest. The larger lot will benefit users of the park, as well as anglers using the Scammell Bridge and the adjacent shoreline to fish.

4.16 Aesthetic and Visual Resources

Impacts related to aesthetics and visual quality involve changes in the viewshed from both the highway itself (user impacts) and to the highway from adjacent residences, streets and roads. In general, views from the highway will be affected by the presence of additional pavement or the loss of natural buffers between the highway and adjacent development. Similarly, views to the highway may be changed due to loss of natural screening or elevating the highway itself. Barriers, like soundwalls, may also block views from or towards the highway.

The following sections discuss visual impacts for the three sections of the project (Newington, Bridge, and Dover) and compare the changes to existing conditions or the No-Build Alternative.

4.16.1 Build Alternatives

Newington Alternatives

Visual impacts for any of the three Newington alternatives will be similar for travelers in both directions noticing the elimination of the naturally vegetated center median that exists today. The loss of the natural vegetation along the west side of the highway will also be very apparent with the construction of the new Woodbury Avenue Interchange. The latter change will be more dramatic under Alternatives 12A and 10A than under Alternative 13 since the interchange design is more compact under Alternative 13 as compared with the other two Alternatives.

With the Turnpike proposed in the center median between Exits 3 and 4, an opportunity to shield the Turnpike from the east and west vantage points exists through the preservation of some of the existing natural vegetation supplemented with additional plantings.

Views towards the highway from the east side will also change as the new infrastructure will appear more expansive due to new expanded interchange and the addition of a travel lane as well as turn lanes on Woodbury Avenue.

Traveling northward, just south of Little Bay Bridge, "gateway" views of the distant mountains and foreground bridges will be largely maintained.

Bridge Alternatives

Motorists passing over the expanded Little Bay Bridges in either direction will be less aware of traffic in the opposite direction with the addition of a full inside shoulder adjacent to the median barrier separating the opposing lanes of traffic. Riverscape views to the east towards the Piscataqua River will be generally unchanged with the exception of the view from the southbound direction which would be disrupted by the additional Turnpike width. Views of Little Bay to the west will be similarly affected, although preservation of the General Sullivan Bridge will maintain that historical structure with its visual appeal in the viewshed. Approaching Dover from the Little Bay Bridge, constructed noise barriers in the vicinity of Hilton Park and further northward will come into view shielding Pomeroy Cove.

Dover Alternatives

Visual impacts associated with either of the two Dover alternatives will be similar and primarily result from the slightly higher elevation of the new roadway and the presence of noise barriers along both sides of the highway. The noise barriers will create a wide tunnel-like view to the motorists either to the north or south between Hilton Park and Dover Point Road. Views towards the Turnpike from residences along either the western or eastern portions of Dover Point will be screened by the presence of these soundwalls.

4.16.2 No-Build Alternative

The No-Build Alternative would not result in any new impacts on aesthetics or visual quality since there would be no clearing of trees or earth removal necessary for new infrastructure, such as paved lanes, soundwalls, or median barriers. Traffic levels and hours of congestion will, however, continue to increase exacerbating the overall diminishing visual quality of the highway caused by congested and slow-moving traffic.

4.16.3 Secondary Impacts

Impacts associated with indirect and cumulative effects are described in Section 4.3. As discussed in these sections, the project is not expected to cause substantial indirect effects.

Over the last several decades, southern New Hampshire has experienced a shift from a rural and forested visual character to a more suburban character as housing and commercial development has converted previously undeveloped land. This change is no more apparent than along NH 16 through the project area. Growth along the NH 16 corridor has largely resulted in the congestion levels in the project area, burdening an outdated design, and adversely affecting safety. Due to the dynamics and attractiveness of the area, continued growth is expected whether the Turnpike is widened or not. The secondary growth directly attributable to this project is expected to have a minor incremental effect on this increased suburbanization and the consequent loss of the former agricultural and forested rural character that is taking place in southern New Hampshire.

4.16.4 Mitigation

Mitigative treatments will be developed at the final design stage. Measures to be studied will include:

- Landscape planting and natural revegetation of the cut and fill slopes for the mainline and at all interchanges and, as appropriate, at off-site park-and-ride facilities.

- Structural design and aesthetic considerations for drainage structures, bridges, noise barriers, *etc.* to enhance their visual appearance.

- Highway lighting at interchanges and park-and-ride facilities will be designed with “cut offs”(shields) or similar features to limit unwanted light where appropriate.

- Since areas that are visually impacted are also often impacted by noise, noise barriers will serve a dual purpose of blocking noise, as well as any undesirable view of the highway. Generally, landscaping amenities will be added in conjunction with the noise barriers, wherever practicable.

- Landscape screenings or privacy fences to minimize the visual impact of the highway and mitigate for the loss of existing vegetative screening will be considered and evaluated as part of the discussions with affected property owners during the project final design.

- Aesthetic considerations for noise barriers to enhance their appearance.

- Potential use of transparent materials in noise barriers at Pomeroy Cove to enable continued viewing of this aquatic resource.

4.17 Cultural Resources

4.17.1 Historic Resources

4.17.1.1 Impact Methodology

Based on numerous meetings of NHDHR, FHWA, and NHDOT beginning in June 2003 and extending through January 2006, determinations of eligibility and impact evaluations were made for all properties potentially eligible for the National Register of Historic Places. Consensus determinations were made in all cases. NHDHR/FHWA Determinations of Eligibility/Effect (36 CFR 800) forms are included in Appendix G. An Effect Memo was signed on February 9, 2005, and is also included in the Appendix.

Criteria of Effect and Adverse Effect were determined based on the Section 106 review process established by the National Historic Preservation Act of 1966 and outlined in 36 CFR 800.9, which defines the following:

No Effect: The undertaking will not affect any historic property.

Effect: The undertaking may alter National Register-qualifying characteristics and features of location, setting or use.

Adverse Effect: The undertaking may diminish the integrity of design, setting, materials, workmanship, feeling or association. Adverse effects include, but are not limited to:

- Physical destruction, damage, or alteration of all/part of the property,

- Isolation from or alteration of the character of the property's setting when that character contributes to the property's qualification for the National Register,

- Introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting,

- Neglect of a property resulting in its deterioration or destruction, or

- Transfer, lease, or sale of the property.

Otherwise adverse effects may be considered not adverse in the following circumstances:

- When the property is of value only for potential contribution to research, and when such value can be substantially preserved through appropriate research in accordance with professional standards and guidelines,

- When the undertaking is limited to rehabilitation of buildings and structures and is conducted in a manner that preserves the historical and architectural value of affected historic property through conforming with the Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings, or

- When the undertaking is limited to transfer, lease, or sale of a historic property, and adequate restrictions or conditions are included to ensure preservation of the property's notable historic features.

No Adverse Effect: The undertaking may affect one or more historic properties, but the effect will not be harmful to the National Register qualifying aspects of the property.

To determine potential impacts to historic structures, the footprint of each alternative was overlaid onto a map containing the locations of the listed or eligible historic properties. An impact was counted if the footprint of the alternative intersected any portion of the eligible property.

4.17.1.2 Build Alternatives

As discussed in the section above, highway projects can have a variety of effects on historic structures. In some cases, direct taking of structures is necessary in order to accommodate new infrastructure. And, even if the historic structures themselves are not directly impacted, they can still be adversely affected by altering the setting of the historic property in an adverse manner.

None of the proposed roadway alternatives impact any structures that are currently-listed on the National Register of Historic Places. However, all roadway alternatives have the potential to impact properties that have been determined to be eligible for listing, as discussed below.

Newington

In the Newington Segment, all alternatives (Alternatives 10A, 12A and 13) have the potential to affect the 18th century Isaac Dow House and the Beane Farm, located directly across from each other on Woodbury Avenue. These impacts result from the proposed expansion of the northern portions of Woodbury Avenue from two lanes to four lanes. The original conceptual layouts would result in the total acquisition of the Isaac Dow House. In consultation with NHDHR, alternative layouts were developed that allowed a reduction of impacts. Similarly, all three Newington alternatives would impact the Portsmouth Water Booster Station on the Pease Tradeport Property.

Even with design changes to minimize direct impacts, the NHSHPO determined, with the concurrence of the NHDOT and FHWA, that the project will have an adverse effect on the eligible properties in Newington: Beane Farm (NWN0204), Isaac Dow House (NWN0205), and the Portsmouth Water Booster Station (NWN0208).

Beane Farm

Adverse effects to the Beane Farm (NWN0204) include minor filling on the property, loss of mature trees, loss of view of existing hillcrest, and loss of its hilltop setting caused by the elimination of the crest resulting from the extension of Woodbury Avenue over the Spaulding Turnpike.

Isaac Dow House

Adverse effects to the Dow House (NWN0205) include removal of the stone retaining wall, minor slope impacts, and loss of shrubs.

Portsmouth Water Booster Station

Adverse effects to the Portsmouth Water Booster Station (NWN0228) occur through acquisition of a portion of the property for the construction of the Turnpike embankment.

Bridge Segment

Perhaps the most conspicuous historic structure within the study area is the General Sullivan Bridge, built from 1933 to 1935, which replaced the partially covered Boston and Maine railroad and highway bridge over Little Bay. In 1988, representatives from the NHDOT, the NHDHR, and the FHWA reviewed the General Sullivan Bridge, as part of the thematic review of continuous steel truss bridges in the state. After judging the bridge's historicity, technological significance and environmental quality, the committee deemed the bridge eligible for the National Register of Historic Places with a score of 28 points, ranking the bridge the second highest rated historic bridge in the state.

As discussed in Chapter 2, one of the two alternatives brought forward for further study in this EIS includes the removal of the General Sullivan Bridge. This proposal was motivated by a concern for the safety and aesthetic impact of the deteriorating structure on users of the Turnpike and the Little Bay below. Removal of the bridge would have an obvious and complete adverse effect on this resource. Like any other Section 4(f) resource, removal or rehabilitation of the General Sullivan Bridge can only be carried out after the determination is made that implementation of other alternatives would result in extraordinary costs, and/or social, economic, or environmental impacts (*i.e.,* Section 4(f) evaluation). In addition, the proposed project must include all possible planning to minimize harm to the historic bridge. After careful consideration of the alternatives and public input, a Selected Alternative was identified that would preserve the General Sullivan Bridge through its rehabilitation to a standard such that it could accommodate pedestrian and bicycle traffic.

Despite the decision to rehabilitate the General Sullivan Bridge, adverse effects to the Bridge were determined to result from certain elements of the Selected Alternative. These include the removal of the roadway and north embankment approach to the bridge and limited reconfiguration of the north abutment and wing wall to accommodate the widening of the connector road under the Little Bay Bridges. (See Appendix G, SHPO letter dated February 3, 2006 which supports the proposed treatment of the General Sullivan Bridge.)

Dover

Within Dover, both Alternatives 2 and 3 would result in adverse effects to the Ira Pinkham House (DOV0093), including a strip acquisition and the need to demolish the property's barn.

4.17.1.3 No-Build Alternative

The No-Build Alternative has no direct effect on historic resources.

4.17.1.4 Mitigation

If a project cannot be designed to avoid historic properties, then appropriate mitigation to reduce impacts must be provided. This mitigation can include further documentation of the adversely affected properties, including using HABS (Historic American Buildings Survey) or HAER (Historic American Engineering Record) standards; minimizing land acquisition and maximizing the distance between the highway corridor and the historic structure; providing access as necessary to maintain existing land uses; and providing landscaping and screening where appropriate to minimize visual and noise impacts; and public education about historic properties.

The following properties will receive mitigation to offset Section 106 and 4(f) impacts. Mitigation measures for this project are listed below on a property-by-property basis, with applicable alternatives identified. See also the Adverse Effect Memo in Appendix G, signed by NHDHR, FHWA, and NHDOT on February 9, 2006 for specific mitigation measures related to the Selected Alternative. (Properties which do not have Section 106 adverse effects may have Section 4(f) impacts. See Chapter 5 for a discussion of Section 4(f) impacts.)

Beane Farm (NWN0204)

Mitigation for impacts to the Beane Farm will include planting of new silver maples and lilacs on the property in consultation with the owner and their placement in relation to the power lines that avoids the need for future trimming.

Isaac Dow House (NWN0205)

Mitigation for this adverse effect will include replacement of the granite slab wall in-kind and appropriate landscaping with shrubs in consultation with the owner. Note that the NHDOT also minimized the right-of-way acquisition to reduce its impacts.

Portsmouth Water Booster Station (NWN0228)

Mitigation of the adverse effect to this property is accomplished by leaving a tree buffer between the Turnpike and the historic building and its documentation by completion of a Determination of Eligibility.

General Sullivan Bridge (DOV0158)

Mitigation for impacts to the Bridge will include its rehabilitation for use by pedestrians and bicycles and its continued use for fishing. Work on the bridges will be accomplished in a manner that will not impact the adjacent Hilton Park Picnic Shelter. Overall, the impact of the project on the General Sullivan Bridge will be beneficial.

Ira Pinkham House (DOV0093)

Mitigation for this property's impact will involve producing a state-level Historic American Building Survey for the dwelling, documentation of the barn's structure in the same document, preparation of preservation covenants for the house and barn, marketing the barn for relocation if structurally feasible, and marketing the dwelling, if the entire property is acquired.

4.17.2 Archaeological Resources

4.17.2.1 Impact Methodology

The National Environmental Policy Act and Section 106 of the NHPA require that Federal agencies assess the effects of a proposed project on archaeological resources that are identified in the Phase II level of investigation as eligible for the National Register of Historic Places. It further directs the agency to consider how project alternatives reduce the impact of those effects on archaeological properties. (See Section 3.17.3 for a description of archaeological phases.)

Evaluation of Build Alternatives was completed by correlating zones of archaeological resource sensitivity (**Figures 3.17-2 and 3.17-3**) with each alternative to ascertain any probable impact to known or potential archaeological resources. This entailed transcription of sensitivity zones onto individual alternative plans. Evaluation also included complete walkover inspection of all the proposed alternatives to observe conditions and confirm sensitivity assignments.

The design footprint of each alternative was used to identify the total amount of sensitive areas potentially impacted. Even though site boundaries are not yet defined, the impact area can provide information of the relative impacts among the alternatives. Impacts were analyzed for all segments. Typically, site boundaries are not identified until Phase II investigations, which have not yet been completed. Impacts to archaeological sites are described in the next section.

Following the completion of the FEIS and the Record of Decision, archaeological sites that may be affected by the Selected Alternative will be re-examined to determine the level of integrity of the identified sites and to complete most of the investigations through the Phase IB level. This site re-examination will likely reduce the number of impacted, potentially eligible archaeological sites.

A discussion of archaeological resource sensitivity for each alternative is presented below. Primarily, only zones of sensitivity are discussed in the following text and shown on accompanying figures. Other sections of each alternative do not exhibit sensitivity, typically because of extent of disturbance or pervasive conditions (*e.g.,* poor drainage, saturated soils, effects of repeated construction involving cutting and filling, steep slopes, or dense development).

4.17.2.2 Build Alternatives

All of the roadway and bridge alternatives impact areas of known or probable archaeological sensitivity to one degree or another. Table 4.17-1 and **Figures 4.17-1 through 4.17-7** summarize the amount of impact to each of the sensitive or probable areas identified during the Phase IA investigation. Impacts were calculated using GIS analysis to overlay the sensitivity mapping with the footprint of each of the alternatives.

Within Newington, a total of 29.6, 33.4, or 25.7 acres of sensitive areas would be impacted by Alternatives 10A, 12A, and 13, respectively. There are two primary differences among these alternatives. First, Alternative 13 avoids impact to Area 36 and minimizes impacts to Area 32. Alternatives 10A and 12A create impacts to these areas resulting from planned improvements to Shattuck Way. Second, the relatively more compact footprint of Alternative 13 minimizes impacts to Area 49a (11.6 acres) relative to Alternative 10A (13.4 acres) and Alternative 12A (14.7 acres) impacts.

Archaeologically, there is little differentiation between the two Bridge Alternatives, with 3.6 or 3.7 acres impacted for the Widen West/Rehabilitate and Widen West/Remove Alternatives, respectively. Both alternatives impact Area 21, the location of a brickyard which has been identified (27-ST-52), but the significance of which has not yet been determined.

Similarly, there is little differentiation between Dover Alternatives 2 and 3. Although the Selected Alternative (Alternative 3) impacts slightly more sensitive area (14.9 acres) than Alternative 2 (13.2 acres), **Figures 4.17-6** and **4.17-7** indicate that nearly all of this difference is attributable to the configuration of the Spur Road/Boston Harbor Road local connector. This is due to the fact that Alternative 3 maintains a southbound connection to the Turnpike, a feature that received strong support during public informational meetings throughout the project. Consequently, however, the layout of this alternative has greater impacts to Area 20 (9.4 acres) as compared to Alternative 2 (7.2 acres).

Below, more information is presented on the specific areas impacted by each alternative.

Newington Alternatives

Newington, Alternative 10A

The design for Newington Alternative 10A (**Figure 4.17-1**) primarily includes roadway improvements along the Spaulding Turnpike and interchanges, Shattuck Way, Nimble Hill Road, Woodbury Avenue, Arboretum Drive, and the Pease Spur Railroad.

Sensitive Areas

Portions of three areas exhibiting archaeological resource sensitivity are impacted by Alternative 10A, summarized as follows:

Area 32

- Location: Newington. Area 32 includes two lightly wooded sections within a zone of commercial development on the east side of the Spaulding Turnpike, bounded by Shattuck Way.
- Description: These areas represent remnants of wooded tracts which include terrace edges of Pickering Brook.
- Sensitivity Ranking: Sensitive.
- Thematic Context: The margin of Pickering Brook exhibits sensitivity for the occurrence of Native American remains. Elsewhere, the area borders the historic road to Bloody Point and has sensitivity for historic period land use and agriculture.

Area 33

- Location: Newington. Area 33 includes the wooded upper reaches of Pickering Brook and Dirty Gut.
- Description: Pickering Brook and its tributary, Dirty Gut, flow easterly from extensive wetlands into the Piscataqua River at Pickering's Cove. Remnants of the original landscape are found along the course of the stream and its headwater wetlands. It is anticipated that archaeological deposits, including artifacts or features associated with Native American occupation of Pickering Brook may be encountered. The zones potentially affected by Alternative 10A appear to be intact and are found within undisturbed woodlands.
- Sensitivity Ranking: Sensitive.
- Thematic Context: Margins of the stream and wetland are sensitive for the occurrence of Native American sites or components.

Area 58

- Location: Newington. Area 58 includes shoreline and stream margins on the west side of the Spaulding Turnpike.
- Description: This area is open and wooded land along the shoreline with a section along a stream on the north side of Nimble Hill Road.
- Sensitivity Ranking: Sensitive.

Table 4.17-1
Impacts to Potential Archaeologically Sensitive Areas (Acres)[1]

		Roadway Segment Newington			Bridge Segment Widen West		Roadway Segment Dover	
Area	Sensitivity Level[2]	Alt 10A	Alt 12A	Alt 13	Remove	Rehabilitate	Alt 2	Alt 3
3	Exhibits Sensitivity						0.8	0.7
4	Probable Sensitivity						0.04	0.04
6	Exhibits Sensitivity						3.5	3.3
11	Probable Sensitivity						0.5	0.5
12	Exhibits Sensitivity						0.1	0.01
13	Verified Sites						0.01	
14	Exhibits Sensitivity				1.7	1.6	0.9	0.9
16	Exhibits Sensitivity					0.2		
18	Probable Sensitivity				1.8	1.1		
19	Exhibits Sensitivity				0.1	0.1	0.2	0.1
20	Exhibits Sensitivity						7.2	9.4
21	Verified Sites				0.2	0.2		
30	Probable Sensitivity	8.3	7.8	7.3	1.7	1.7		
32	Exhibits Sensitivity	0.9	0.01	0.1				
33	Exhibits Sensitivity	5.6	5.3	5.2				
36	Exhibits Sensitivity		4.1					
37	Probable Sensitivity	0.4	0.4	0.5				
41	Probable Sensitivity	0.7	0.7	0.6				
45	Probable Sensitivity	0.01	0.01					
49a	Probable Sensitivity	13.4	14.7	11.6				
58	Exhibits Sensitivity	0.1	0.1	0.1				
62	Probable Sensitivity	0.3	0.3	0.3				
68	Verified Sites		0.03					
	TOTAL	29.6	33.4	25.7	5.5	4.9	13.2	14.9

Notes:
1 See Figures 4.17-1 through 4.17-7 for the location of impact areas.
2 Sensitivity categories are described in Section 3.17.2.

- Thematic Context: The shoreline and stream margins are sensitive for Native American resources. During archaeological fieldwork for the River Road Extension Project, a Native American site was discovered here and recorded as site 27-RK-410 (Bunker *et al*. 2005). This site was found not to be significant. Other sections are sensitive for historic period agriculture and land use. Folsom Farm in Newington in 1849 shows the location of farm buildings and fields. Other nineteenth century and topographic maps reflect that this was open land, used for agriculture.

Probable Sensitive Areas

Portions of six areas exhibiting probable archaeological resource sensitivity areas impacted by Alternative 10A are summarized below:

Area 30

- Location: Newington. Area 30 is the median of the Spaulding Turnpike.
- Description: This area is positioned between the northbound and southbound segments of the Spaulding Turnpike and was crossed by historic roads. The area exhibits evidence of clearing and cutting associated with highway placement but resources may be present beneath a veneer of fill.
- Sensitivity Ranking: Probable sensitivity.
- Thematic Context: Historic period agriculture and land use along historic roadway. Nineteenth century maps show the alignment of the historic roadway through the present-day median area. The B.S. Hoyt property is indicated on the map of 1892.

Area 37

- Location: Newington. Area 37 includes a height of land on the east side of Woodbury Avenue which has been developed for commercial use.
- Description: The location includes open and wooded sections of landscape with a veneer of modern impact associated with development of commercial properties and highway modifications.
- Sensitivity Ranking: Probable sensitivity.
- Thematic Context: Historic period agriculture and land use. Nineteenth century maps of Newington indicate that this area was open land until 1851 when several properties of the Dow family are shown.

Area 41

- Location: Newington. Area 41 is a small segment along Woodbury Avenue.
- Description: This area is lightly wooded with a veneer of impact from development and road modification.
- Sensitivity Ranking: Probable sensitivity.
- Thematic Context: Historic period land use. Nineteenth century maps reveal that residences were located along the margins of the Road to Bloody Point.

Area 45

- Location: Newington. Area 45 includes two zones along the west side of Woodbury Avenue.
- Description: These areas are lightly wooded with a veneer of impact from development and road modification.
- Sensitivity Ranking: Probable sensitivity.
- Thematic Context: Historic period land use. Nineteenth century maps reveal that residences were located along the margins of the Road to Bloody Point.

Area 49a

- Location: Newington. Area 49a includes an extensive area on the western side of the Spaulding Turnpike.
- Description: This area is wooded, with extensive evidence of modification from logging, as well as widespread land use associated with military activities. It is intersected by roads and areas of disturbance and is drained by small streams.
- Sensitivity Ranking: Probable Sensitivity.
- Thematic Context: Nineteenth century and topographic maps indicate that most of this area was undeveloped in historic times. Although the area underwent limited utilization in historic times, it may retain sensitivity for Native American resources.

Area 62

- Location: Newington. Area 62 is Nimble Hill Road.
- Description: Nimble Hill Road overlays a portion of the Road to Bloody Point and provides connection to the center of Newington village.
- Sensitivity Ranking: Probable sensitivity along margins.
- Thematic Context: Historic roads.

Newington, Alternative 12A

The Newington Alternative 12A (**Figure 4.17-2**) design primarily includes roadway improvements along the Spaulding Turnpike and interchanges, Shattuck Way, Nimble Hill Road, Woodbury Avenue, Arboretum Drive, Patterson Lane, and the Pease Spur Railroad, along with proposed railroad improvements at the eastern end of Patterson Lane.

Verified Site

Area 68

- Location: Newington. Area 68, the Downing family cemetery, is located south of the abandoned Newington drive-in theater on the west side of the Spaulding Turnpike.
- Description: The Downing family cemetery, part of a property owned by the G-6 Corporation, is located "in a wooded area next to a dry-laid stone fence, which likely served as the southern property line of the former John Downing farm" (Shepard-Rabadam 2005). Later in the 1950s, part of the farm was transformed into a one-screen, 400-car drive-in theater. Six unearthed marble headstones, largely illegible due to environmental factors, lean against the trees and fence and provide evidence that the integrity of the site has been compromised. The relationships between the stones and burial locations are unknown (Shepard-Rabadam 2005). Other headstones may remain below the ground surface. Richard Downing, who may have been John's 25-year-old brother who died in 1851, is one of the family members buried in the cemetery. Ann Elizabeth Downing, John's daughter (b. 1853) who died at 16 months, is also buried here. In addition, several of John's grandchildren, including two of Jacob and Mary (John's eldest daughter) Ames infant and toddler children (4 year old Mary Ellen Childs Ames and 2 year old Ann E. Ames), were buried in the family cemetery in 1845.
- Sensitivity Ranking: Confirmed site.
- Thematic Context: Burial Practices. The Newington Historical Society map of graveyards and archeological sites depicts the location of this cemetery adjacent to the drive in.

Sensitive Areas

Alternative 12A would impact many of the same sensitive areas as Alternative 10A. Specifically, Areas 32, 33 and 58 would be impacted. Additionally, Alternative 12A impacts Area 36, which is described below.

Area 36

- Location: Newington. Area 36 includes the Rollins Farm area of Newington and adjacent shoreline.
- Description: This area is characterized as open fields, woodlands and undeveloped shoreline. A small stream drains into the Piscataqua River in this area. Open fields and woodlands which exhibit sensitivity for the occurrence of the Portsmouth and Dover railroad, and the Rollins rail station as well as historic period settlement, land use and agricultural practices, relative to Rollins Farm. It is anticipated that archaeological

remains, including artifacts and deposits related to historic land clearing, farming, domestic life, the Rollins Farm and railroad station may be encountered in these zones. It is also anticipated that archaeological deposits, including artifacts or features associated with Native American occupation of the immediate shoreline and stream drainages may also be encountered. The zones potentially affected by Alternative 12A appear to be intact and are found within agricultural fields and undisturbed woodlands.

- Sensitivity Ranking: Sensitive.
- Thematic Context: The shoreline and stream margins exhibit sensitivity for Native American site presence. Overall this area is sensitive for historic period agriculture and land use. In addition, a section of the Portsmouth and Dover Railroad and the Rollins station are located here.

Probable Sensitive Areas

Alternative 12A would impact many of the same probable sensitive areas as Alternatives 10A. Specifically, the following areas would be impacted: Areas 30, 37, 41, 45, 49a, and 62.

Alternative 13

Newington Alternative 13 (the Selected Alternative, **Figure 4.17-3**) primarily includes roadway improvements along the Spaulding Turnpike and interchanges, Shattuck Way, Nimble Hill Road, Woodbury Avenue, and Arboretum Drive. It is expected that archaeological remains, including artifacts and deposits related to historic land clearing, farming, domestic life, brick making or early settlement, may be encountered in specific areas within this alternative. It is expected that archaeological deposits, including artifacts or features associated with Native American occupation of the margins, terraces, and wetlands adjacent to Pickering Brook and its tributary Dirty Gut, may also be encountered. The zones potentially affected by Alternative 13 appear to be intact and are found within residential yards, along historic period roadways, or in undisturbed woodlands.
Alternative 13 impacts the following areas:

- Sensitive Areas: Areas 32, 33, 58
- Probable Sensitive Areas: Areas 30, 37, 41, 49a, 62

All of these areas were previously described.

Bridge Alternatives

Two Bridge Segment Alternatives are being discussed, the Widen West/Rehabilitation Alternative and the Widen West/Bridge Removal Alternative (**Figures 4.17-4 and 4.17-5,** respectively). Both include improvements at the shoreline in Dover and Newington, and have nearly identical footprints.

Both Bridge Segment Alternatives propose new infrastructure that will affect areas deemed sensitive for numerous archaeological resources. Sensitivity is assigned for Native American sites, particularly for the period of contact with first European settlers. Sensitivity for Euro-American historic period resources includes the first settlement by the Hilton fishermen in 1623, residences, agriculture and land use, Hilton Hall hotel, the Portsmouth and Dover Railroad with a station, ferry landings, wharves, and brickyards. The earliest maps of North America indicate the Hilton settlement, as does the 1670 Map of the Piscataqua. This location is highlighted in later maps, including the 1912 composite Map of Dover. All nineteenth and twentieth century maps, property plans and topographic maps show an intricate overlay of structures and features here including the railroad, Dover Point Station, Pinkham's wharf, ferry landings, the hotel, residences, and brickyards. The 1834, 1856, and 1871 maps indicate brickyards in the vicinity. Twentieth century maps show park development. While portions of the landscape appear to lack integrity, cultural resources may exist below a veneer of visible surface disturbance and/or fill.

Verified Sites

One verified site will be impacted by the bridge construction. Both bridge alternatives would impact Area 21.

Area 21

- Location: Dover. Area 21 is located at the southernmost tip of Dover Point, beneath the Little Bay Bridge.
- Description: This area appears to have undergone extreme impact from highway and bridge construction; however brick is visible along the shoreline within areas of riprap.
- Sensitivity Ranking: Verified site. Determination of Eligibility is needed. This brickyard site, situated beneath the General Sullivan and Little Bay Bridge at the tip of Dover Point, was identified during the current survey as a previously recorded site (27-ST-57). Some areas of the shoreline may be relatively intact beneath a layer of fill. Due to the early settlement history of this area, it is deemed archaeologically sensitive.
- Thematic Context: Brick-making

Sensitive Areas

Both Bridge Alternatives will impact Sensitive Areas 14 and 19, while only the Widen West/Rehabilitate Alternative will impact Area 16.

Area 14

- Location: Dover. Area 14 includes a residential area on western side of Dover Point, along both sides of Boston Harbor Road, west of the Spaulding Turnpike.
- Description: This area contains open yards of a residential neighborhood and lots with commercial development. Yards and wooded sections extend to the shoreline of Little Bay.
- Sensitivity Ranking: Sensitive. Open yards of a residential area between Dover Point Road and the Spaulding Turnpike, exhibit sensitivity for historic period settlement, land use and agricultural practices.
- Thematic Context: Native American sensitivity may occur along the shoreline and in wooded sections.

Area 16

- Location: Dover. Area 16 consists of a portion of Hilton Park, located on the west side of the Spaulding Turnpike. This area is only impacted by the Widen West/Rehabilitate Alternative.
- Description: This area is within an open park landscape, including both wooded sections and light residential development.
- Sensitivity Ranking: Sensitive.
- Thematic Context: Native American site sensitivity is assigned to shoreline areas within the park and adjacent neighborhood. Other sensitivity includes historic period first settlement, brickyards, and agriculture, with continuation into twentieth century poultry farming. The composite Map of Dover in 1912 indicates that a store, residences and the Pascataqua House were located here and that ferry landings were located in the vicinity. The map of 1871 indicates the presence of a series of brickyards which extended along the tip of Dover Point. Other nineteenth century maps show that the area was continuously occupied by the Pinkham family, known brick-makers. Topographic maps reveal that residential development began to become denser by 1941. Twentieth century property maps reveal numerous residences, roadways, a windmill and other features including the Fannie E. King hen house and chicken fence. The poultry farm included an open parcel which corresponds with today's open park landscape.

Area 19

- Location: Dover. Area 19 is located on the east side of the Spaulding Turnpike within a residential neighborhood along Wentworth Terrace.
- Description: This is a residential neighborhood with yards and wooded areas that extend to the shoreline of Piscataqua River.

- Sensitivity Ranking: Sensitive.
- Thematic Context: Native American site sensitivity is assigned to the shoreline. Historic sensitivity includes first settlement, and historic period agricultural use. The Portsmouth and Dover Railroad passed along the edge of this area and once crossed Pomeroy Cove. Over time, the portion of the cove lying west of the tracks filled in, so that it now is nearly invisible as a natural feature.

Probable Sensitive Areas

Both Bridge Alternatives impact Probable Sensitive Areas 18 and 30. Area 30 was previously described under Alternative 10A.

Area 18

- Location: Dover. Area 18 consists of a portion of Hilton Park, located on the east side of the Spaulding Turnpike.
- Description: The area includes an extent of Hilton Park along the eastern shoreline of Dover Point. Here, the landscape has been modified by many past events, including construction of the Portsmouth and Dover Railroad, numerous streets, the Spaulding Turnpike, and park access roads, facilities and utilities.
- Sensitivity Ranking: Probable sensitivity with verified site. A brickyard was identified during the current survey as a previously recorded site (27-ST-56). It is located on the shoreline between the docking wharf and boat launch area along the southeast tip of Dover Point. A scatter of common red brick and glass fragments is evident for approximately 100 meters.
- Thematic Context: The area exhibits sensitivity for numerous archeological resources below a veneer of visible surface disturbance. Sensitivity is assigned for Native American sites, particularly for the period of contact with first European settlers. Sensitivity for Euro-American historic period resources includes the first settlement by the Hilton fishermen in 1623, residences, agriculture and land use, Hilton Hall hotel, the Portsmouth and Dover Railroad with a station, ferry landings, wharves, and brickyards.

Dover Alternatives

Alternative 2

The Alternative 2 (**Figure 4.17-6**). The design primarily includes roadway improvements along the Spaulding Turnpike, US 4, Dover Point Road, Boston Harbor Road and Spur Road and at the interchange. It is expected that archaeological remains, including artifacts and deposits related to historic land clearing, farming, domestic life, brick-making or early settlement, may be encountered in specific areas within this alternative. It is anticipated that archaeological deposits, including artifacts or features associated with Native American occupation of the immediate shoreline and tip of Dover Point may also be encountered. The zones potentially affected by the Dover alternatives appear to be intact and are found within residential yards, along historic period roadways, or in undisturbed woodlands.

Verified Site

One verified site would be impacted by Alternative 2:

Area 13

- Location: Dover. Area 13 includes a section of shoreline on Redding Point south of the Scammell Bridge abutment.
- Description: This location includes an extent of shoreline within a wooded parcel bounded by residences and roadways. The area has been slightly impacted by road construction activity, including placement of trenches and stockpiling of materials. Brick is visible along eroding surfaces of the shoreline.
- Sensitivity Ranking: Verified site. This site was identified as a previously recorded site (27-ST-54) during the current survey.
- Thematic Context: Brick-making. The 1912 composite Map of Dover indicates that this corresponds to the general location of an unnamed brickyard.

Sensitive Areas

Portions of areas exhibiting archaeological resource sensitivity, which are impacted by Alternative 2 include Areas 3, 6, 12, 14, 19 and 20. Areas 14 and 19 were previously described under the Bridge Alternatives.

Area 3

- Location: Dover. Area 3 includes undeveloped wooded areas on west side of Dover Point Road.
- Description: This area includes wooded parcels bounded by developed areas.
- Sensitivity Ranking: Sensitive.
- Thematic Context: Historic period agricultural land use. The 1912 Composite Map of Dover indicates that the landscape in the locale was wooded and was used as an ox pasture in 1652.

Area 6

- Location: Dover. Area 6 includes a residential area on the east side of Dover Point Road.
- Description: This area is a residential neighborhood with wooded yards extending to the shoreline of the river.
- Sensitivity Ranking: Sensitive.
- Thematic Context: Native American sensitivity along the shoreline, and sensitivity for first settlement period, historic period agricultural use, brickyards and industrial land uses. The 1912 composite Map of Dover indicates that High Street, now called Dover Point Road, was established in 1633. This map also shows many structures and industries in this sector of the project area including: the Fisk Brick Plant; the railroad grade of the Portland and Dover Railroad; Captain Millet's Ship Yard (1720-1764); the Millet apple tree (1720-1913); a boat yard; Clements' tannery (*ca*. 1655); a brewery (*ca*. 1640); and a series of residences along High Street and Fore River Lane.

Area 12

- Location: Dover. Area 12 includes the Redding Point area between Scammell Bridge and the Dover Point Toll Booth of the Spaulding Turnpike.
- Description: This is a wooded section, which extends along the Bellamy River (formerly the Back River) between Back Cove and Redding Point Cove. The area has witnessed little to no development in both historic and modern times.
- Sensitivity Ranking: Sensitive.
- Thematic Context: Native American sensitivity along the shoreline and margins of small, intermittent streams. Elsewhere, there is sensitivity for historic period land use, agriculture and brick yards.

Area 20

Wooded sections within US 4 and Spaulding Turnpike interchange which exhibit sensitivity for historic period settlement, land use and agricultural practices.

- Location: Dover. Area 20 includes the US 4 and Spaulding Turnpike interchange.
- Description: This is an elevated wooded area, which overlooks the Bellamy River and Redding Point.
- Sensitivity Ranking: Sensitive.

- Thematic Context: The area is assigned sensitivity for historic period agriculture and land use. Nineteenth century maps and topographic maps show that the area was open space, intersected by railroad and highway placement.

Probable Sensitive Areas

Portions of two areas exhibiting archaeological resource sensitivity are impacted by Alternative 2, including:

Area 4

- Location: Dover. Area 4 is contained within Exit 6 of Spaulding Turnpike
- Description: This area has been cleared and modified for highway construction. Isolated wooded zones are positioned within the area.
- Sensitivity Ranking: Probable Sensitivity in wooded zones; no sensitivity elsewhere.
- Thematic Context: First settlement and historic period agricultural land use. The 1912 composite Map of Dover indicates that this area was known as "Captain's Hill" and was occupied by Captain Thomas Wiggin (*ca*. 1633) and Captain Thomas Wiggin, Jr. (*ca.* 1660). The 1912 composite map also indicates that the Portsmouth & Dover Railroad and Hilton Station were located to the west of this area, in the Spaulding Turnpike corridor.

Area 11

- Location: Dover. Area 11 is a residential area on west side of Spur Road along shoreline of Bellamy River.
- Description: This includes a densely developed and modified residential area, along the shoreline, interspersed with wooded zones.
- Sensitivity Ranking: Probable sensitivity.
- Thematic Context: Native American sensitivity is assigned to the shoreline and stream which flows from the Hall's spring area. Wooded zones may retain sensitivity for first settlement and historic period agricultural land use. The 1912 composite Map of Dover indicates that this area was primarily woodland with the occurrence of Hall's Slip (*ca*. 1633) on the Bellamy River

Alternative 3

Dover Alternative 3 impacts Areas 3, 4, 6, 11, 12, 14, 19 and 20. This Alternative (**Figure 4.17-7**) has impacts that are very similar to Alternative 2. There are two differences worth noting, however. First, Alternative 3 avoids impact to Area 13, a verified brick-making site associated with the shoreline of Redding Point, just southeast of the Scammell Bridge in Dover. Secondly, Alternative 3 has more impact to Area 20 (sensitive for historic period agriculture) than Alternative 2. These inspected areas are previously described.

4.17.2.3 No-Build

The No-Build Alternative will not affect identified archaeological sites or sensitivity areas since new construction would not occur.

4.17.2.4 Further Investigations and Potential Mitigation

The Phase I-A archaeological investigation revealed that known and likely archaeological resources exist in the project area, although many areas have been subjected to extensive disturbance. A team composed of historical, industrial, nautical and pre-contact archeologists, have identified the portions of the project area that are archaeologically sensitive for pre-contact Native American and/or historic European American archaeological resources.

After the Record of Decision, it is recommended that Phase I-B archaeological investigation be undertaken in the sensitivity areas that are impacted by the Selected Alternative in compliance with May 2004 Phase I-B guidelines for fieldwork and report writing defined by the Bureau of Environment, NHDOT.

Further archaeological resources survey or mitigation is recommended for any sites and areas impacted by the Selected Alternative as follows:

- Continued study is recommended at the impacted verified site (Area 21 shown in red on **Figures 3.17-2** and **3.17-3**) to determine its eligibility status for the National Register of Historic Places. This would follow a Phase II survey strategy as recommended by NHDOT Guidelines. This would entail continued field investigation and research to evaluate site integrity, establish period of occupation, function, cultural affiliation and associated context, and to more closely define site boundaries within the project area. Field examination would involve a combined strategy of excavation using 0.5 by 0.5 m tests with 1 by 1 m units and trenches as well as mapping of visible features. This would be accompanied by detailed archival research and comparative study to address whether the data collected from the site and its associated features will augment our understanding of the contexts relative to the site.

- There are several verified sites adjacent to the Selected Alternative, which should not be impacted by construction. They include Areas 23, 46 and 74 in Newington, and Areas 9 and 13 in Dover (shown in red on **Figures 3.17-2 and 3.17-3**). Temporary construction fencing will be installed between these sites and the work zone. To assure accurate placement of the fencing, the boundaries of some of the sites may require definition through Phase I-B testing.

- Continued study is recommended at known sensitive areas that are impacted by the Selected Alternative (identified above and shown in purple on **Figures 3.17-2** and **3.17-3**) for the occurrence of archaeological resources to discover site presence. Survey is also recommended at areas that exhibit probable sensitivity (shown in yellow on **Figures 3.17-2** and **3.17-3**) to determine the extent of previous disturbance as well as site presence. This would follow a Phase I-B survey strategy as recommended by the NHDOT Guidelines. This would entail initial soil coring to assess disturbance along the preferred corridor which may be followed by field testing of areas identified as sensitive during Phase I-A through excavation of 0.5 x 0.5 m shovel tests to define approximate horizontal and vertical boundaries, identify stratigraphy and components, and assess site integrity. This would be accompanied by more detailed research on associated context and qualities of individual sites.

No further survey is recommended in areas lacking integrity (shown in white on **Figures 3.17-2** and **3.17-3**). No further survey is recommended for verified sites that have previously been determined to be not eligible for the National Register of Historic Places (shown in green on **Figures 3.17-2** and **3.17-3**).

The determination of effects (DOE) and any required Section 4(f) analysis of these archaeological sites could not be completed prior to the completion of this Final EIS because site significance has not been determined and site boundaries have not been identified. Because of the time-consuming nature of archaeological investigations, Phase II is not completed until the final design stage once the Selected Alternative is confirmed and the FEIS is completed.

Once the additional studies are completed to the Phase II level for those sites along the Selected Alternative, the level of effect for those sites found to be eligible for the National Register can be determined. Some sites may require mitigation, depending on the area of impact by the project. At least three approaches to the mitigation of these archaeological resources are possible.

A decision of the importance of preservation-in-place versus data recovery will need to be made. If preservation in-place is found to be necessary, then a change in design or location will be made, where feasible and prudent, to satisfy Section 4(f). In some cases, the location of the corridor may be moved slightly or work adjacent to the site may be modified so that the site will not be impacted by the Selected Alternative. Preservation-in-place preserves the site for future archaeological study when it may address new research needs that may not be currently identified. If preservation-in-place is not required and data recovery becomes the appropriate form of mitigation, then Section 4(f) does not apply to the resource. The second form of mitigation then involves the recovery of the information that the site may yield under National Register Criterion D by implementing a data recovery plan under a Phase III investigation. Thirdly, in a few cases, previously identified archaeological sites in the vicinity of, but not impacted by, the alignment and of a similar age, type, function, and composition may provide similar or superior data to address research questions identified for the significant site impacted by the Selected Alternative. In this instance, the mitigation would consist of this previously identified site being excavated using a data recovery program. While this form of mitigation needs to be completed prior to the completion of the project, its excavation can continue while work commences within the corridor. Whether archaeological information is gained through the excavation of the site within the corridor or an alternative site, information would be distributed to the public through such venues as site reports, public lectures, school programs, interpretive brochures, and, depending on the nature of the site, public visitation during investigations.

4.18 Potential Petroleum, Hazardous Materials and Solid Waste

4.18.1 Impact Methodology

Based on the corridor-level assessment of potential petroleum and hazardous material sites, an impact related to petroleum and hazardous material releases or solid waste site is determined to exist if a proposed alternative has the potential to encounter such a site or a building demolition is required. When an impact is identified, specific procedures may be implemented to define the nature and extent of that impact as it relates to a specified alternative. In general, an identified impact for a contaminated site or potential building demolition does not necessarily indicate that a certain alternative is less desirable. Contaminated properties or building demolition can usually be managed efficiently and cost-effectively during right-of-way acquisition and construction phases.

4.18.2 Potential Project Impacts and Mitigation

4.18.2.1 Potential Petroleum, Hazardous Material and Solid Waste Sites

Table 4.18-1 summarizes the contamination sites that could impact the various alternatives related to petroleum or hazardous material releases or to solid waste sites. All contamination sites within the study area are included in the table below and were selected based on field reconnaissance and current property usage.

The list of sites below and their associated properties represents the potential for encountering contamination under the various project alternatives. The steps that will occur to further evaluate these areas include the following:

- Perform site specific Initial Site Assessments (ISAs) for the remaining properties that are included within the Selected Alternative.

- Based on the ISA results, perform Preliminary Site Investigations (PSIs). The properties that are currently being monitored for contamination (Groundwater Management Permits or GMPs) may require further sampling and analysis but will likely not likely require a full PSI.

The proposed wetland mitigation sites were also evaluated at a corridor level. Based on this preliminary evaluation, a complete ISA is recommended for the Railway Brook restoration site and may be needed for the Watson property.

In addition to the database searches conducted as part of the EIS process, a Risk Assessment Survey for Contamination and Appraisal of Land (RASCAL) will also be performed for the properties within the proposed project area. NHDOT has designed the RASCAL system of hand-held computer data collection and web-based data management to catalogue potential hazardous materials issues on prospective and currently owned properties. Additional sites requiring ISAs or PSIs may be identified during the RASCAL Survey.

Initial Site Assessments will be performed for those properties that could pose a risk related to potential contamination if encountered along one or more of the alternatives. An ISA represents the first step in a sequential process to determine if a property might be contaminated. Typically, an ISA fully documents historic releases that have already been identified, as well as potential sources that could contribute to contamination (*i.e.*, underground tanks, floor drains, and fill areas).

Table 4.18-1
Summary of Potential Petroleum, Hazardous Material, and Solid Waste Sites

Address	Town	Description	Alternatives Impacted	Figure ID#
Wentworth Terrace	Dover	Pumping Station	2, 3	4
Fox Run Mall	Newington	Retail Store	10A, 12A, 13	7
Old Dover Road	Newington	--	10A, 12A, 13	22
Old Dover Road	Newington	Power Company	10A, 12A, 13	24
Old Dover Road	Newington	Building Materials	10A, 12A, 13	25
Old Dover Road	Newington	Contractor	10A, 12A, 13	26
Patterson Lane	Newington	--	10A, 12A, 13	27
Patterson Lane	Newington	--	13	28[1]
Nimble Hill Road	Newington	--	10A, 12A, 13	31
River Road (Formerly)	Newington	Pool Company	10A, 12A, 13	34
River Road (Formerly)	Newington	Energy Company	13	35[1]
River Road (Formerly)	Newington	Auto Shop	10A, 12A, 13	37
Spaulding Turnpike	Newington	Former Country Store	10A, 12A, 13	38
Spaulding Turnpike	Newington	Tractor-trailer Truck Spill	10A, 12A, 13	39
Spaulding Turnpike	Newington	Service Station	10A, 12A, 13	43
Woodbury Avenue	Newington	Retail Store	10A, 12A, 13	50
Spaulding Turnpike	Newington	Sediment Disposal Area	10A, 12A, 13	52

Note:
1 Sites 28 and 35 may be impacted by future Pease Spur reconstruction, but would not be directly affected by Alternative 13.

Following completion of the ISA, and if determined to be warranted, the next step would be to perform Preliminary Site Investigations (PSIs). PSIs include subsurface investigations to determine the nature and extent of the contamination. Subsurface investigation typically includes the excavation of test pits, soil borings, and the installation of groundwater monitoring wells. Soil and groundwater samples collected during the PSI are analyzed by a laboratory to determine if contaminant levels require remediation in accordance with NHDES regulations.

In the event contamination is identified during PSIs, the following scenarios are possible:

- Contamination is limited to groundwater that does not warrant remediation and the groundwater will not be encountered during construction.
- Contamination is limited to soil that does not warrant remediation and the contaminated soil will not be encountered during construction.
- The identified contaminated soil or groundwater requires remediation by NHDOT following property acquisition.

- The identified contaminated groundwater will not be encountered during construction and assessment/remediation is ongoing by the existing property owner as part of an existing Groundwater Management Zone (GMZ) permit.

- Limits of solid waste will be categorized. Removal, or consolidation of solid waste on-site will be performed in consultation with NHDES.

- If contaminated materials are expected to be encountered during construction, appropriate worker health and safety provisions and waste management provisions will be identified. Provisions may include health and safety plans (HASPs) and soil/groundwater management plans for excavation and on/off-site management of waste materials. All work will be performed in accordance with applicable NHDES regulations and NHDES-approved remedial action plans.

4.18.2.2 Building Demolition

Prior to any scheduled building demolition, a comprehensive building audit will be performed to identify and quantify all regulated building materials and special wastes. Buildings that may require demolition are summarized in Table 4.18-2. Materials and wastes that may be inventoried include the following:

- Asbestos
- Lead-based paint
- Polychlorinated biphenyls (PCBs) within fluorescent light ballasts
- Electrical transformers that may contain PCB dielectric oil
- Mercury-containing fluorescent light bulbs
- Mercury thermostats
- Miscellaneous containers of oil or hazardous materials
- Refrigerants (air conditioners, refrigerators)
- Hydraulic lifts
- Above-ground storage tanks
- Underground storage tanks

The scope of each audit will vary depending on building type, age, and current use. Audits for residential buildings will likely be limited to asbestos and lead paint audits, while those for commercial buildings will include a more comprehensive audit for other regulated materials. Based on the findings of the building audits, abatement plans will be prepared to address the removal of all regulated building materials. An audit for asbestos and lead-based paint should also be performed for any bridges or utilities to be impacted by the project.

Table 4.18-2
Building Demolition

Site	Location	Alternative(s)
Residential Duplex	Shattuck Way, Newington	10A
General Sullivan Bridge	Spans Little Bay, Newington and Dover	Widen West/Remove
K9 Kaos (Barn)	Dover Point Road, Dover	2 and 3
Adaptations Unlimited (Retail Building)	Dover Point Road, Dover	2 and 3

The presence of lead-based paint (LBP) coated building components that will be demolished triggers certain requirements for worker exposure to lead during demolition and proper management of the LBP waste stream. Additionally, the rehabilitation of the General Sullivan Bridge will likely require removal of LBP.

The Resource Conservation Recovery Act (RCRA) regulates the disposal of lead-painted components. If a specific building component or demolition debris waste pile leaches lead at concentrations greater than five milligrams per liter (> 5 mg/L), the waste is characterized as hazardous waste in accordance with RCRA. Therefore, the exterior wood siding and window components with known LBP are typically segregated during demolition and disposed of as hazardous waste. Based on screening results, other identified non-metal LBP-painted building components (*e.g.,* interior LBP-painted doors, moldings, casings, walls, *etc.*) may not require segregation from the general construction and demolition waste stream. Additionally, exposure assessments (air monitoring) must be performed on employees engaged in demolition work that may disturb lead paint. Such work will be conducted by properly trained workers using appropriate worker protection and engineering controls.

Removal of LBP from the General Sullivan Bridge during its rehabilitation should not create any substantial environmental or human health risk since the NHDOT has many years of experience in dealing with this issue. NHDOT has comprehensive procedures for handling this type of work. Most notably, bridge contractors are required to fully enclose the bridge during any work involving LBP removal and provide the material and execution requirements for the installation and use of containment systems for the paint removal. Implementation of an Environmental Protection Plan for the protection of the public and the environment from exposure to harmful levels of dust, paint debris, and lead and other toxic metals that may be present in the paint being removed or repaired is also required. This includes all means and methods necessary for the containment, collection and removal of old paint chips, corrosion residues, spent abrasives and newly applied paint. Worker protection and waste handling are also stipulated in the Environmental Protection Plan. Daily assessments of visible emissions and releases, as well as air, soils, and water testing/analysis are required.

Miscellaneous containers of oil and hazardous materials will also be removed prior to demolition. These materials will not be commingled with the general building demolition waste stream. Tank closure assessments will be performed following the removal of every underground storage tank. The assessments will determine if contamination is present and whether remediation is required.

4.19 Energy Impacts

Energy, in the form of diesel and gasoline fuels, will be required to construct any of the Build Alternatives. The No-Build Alternative would not involve this large expenditure of energy, although the condition of the existing bridges and highway pavement is deteriorating, and continued maintenance will require more intensive energy-dependent work efforts over time.

Since the project will improve the flow of traffic through the corridor, future vehicular energy requirements under the Build Alternatives will be less due to more efficient traffic flow along the highway. Conversely, energy requirements will be higher with the No-Build Alternative because of less efficient traffic flow with extended periods of congestion.

With the additional lanes and wider bridges associated with any of the Build Alternatives, a greater expenditure of energy as compared to current levels will be needed for routine maintenance activities. These fuel-requiring activities include plowing, sanding, mowing, bridge and drainage system maintenance, and roadway surface repairs. However, because the new roadway surface and bridges will incorporate the latest technology in design and materials, the facility is expected to require less maintenance on a per lane-mile basis in the future.

4.20 Construction Impacts

4.20.1 Effects

Impacts caused by construction activities will occur with any of the alternatives, except the No-Build. Construction impacts will be short-term, however, and would vary little among the Build Alternatives. Construction activities may result in temporary adverse impacts, with the two primary pollutant sources during construction being construction equipment and exposed soils in unvegetated areas.

Air pollutants emitted from diesel and gasoline powered construction equipment will include oxides of nitrogen and sulfur, carbon monoxide, and particulate matter. Emissions from construction equipment may result in elevated ambient concentrations within the immediate vicinity of construction operations for short periods of time, but are not expected to have a substantial impact.

Particulate matter (dust) will be emitted as a result of grubbing, grading, excavating, hauling, and blasting operations. Dust emitted during most construction activities will be controlled by wetting unpaved areas in the construction zone, covering loads on all open trucks, and seeding all unvegetated areas as soon as practicable. These methods will be employed during construction.

Activities associated with construction will likely require blasting of bedrock material in some areas and extensive grading. The grading will include the stripping of existing vegetation, followed by major excavation and filling. This construction will result in nearly complete reworking and/or removal of surficial and subsoils along the sides of highway. Exposure of previously vegetated soils could lead to erosion, if not properly controlled.

Temporary impacts to surface waters are possible due to construction-related activities that cause siltation and erosion. Also the introduction of additional heavy metals, nutrients and petroleum-based pollutants from paved surfaces may impact surface waters.

Best management practices will be employed to limit erosion and sedimentation from the site. These protocols will be established under federal and state guidelines prior to construction activities. Water quality swales and basins will be constructed to effectively treat an increased percentage of paved surface area over existing conditions. Vegetative buffers will be maintained between basins and remaining unimpacted wetland areas where possible.

The following mitigation section describes mitigation components incorporated in the project design to minimize or eliminate construction-related impacts to off-site surface waters, and to compensate for impacted wetlands.

4.20.2 Mitigation

To mitigate potential sedimentation impacts by construction, a well-defined drainage and erosion control program, including BMPs, will be developed and implemented. Construction schedules will require that areas stripped of vegetation be limited in size and either surfaced or vegetated as quickly as possible after initial exposure. During the construction period, temporary erosion check dams will be installed in appropriate locations. With proper diversions of flow, installation of silt retention basins, and carefully scheduled construction activities to limit soil exposure, erosion during construction should be minimized. BMPs for fertilizer application during construction will also be followed. In addition, mechanisms to avoid and control chemical leaks and spills from construction equipment will be instituted. NHDOT will ensure that all of these measures are properly installed and maintained throughout construction to ensure their maximum functionality and effectiveness. Additional details can be found in *NHDOT's Standard Specifications for Road and Bridge Construction, Section 699, Temporary Project Water Pollution Control (Soil Erosion)*. It is recognized that the project is located in a sensitive area from a water quality perspective. Careful attention will be focused during the final design and construction phases to appropriately address this issue.

Human presence and associated construction noise at new location areas may repel some species of wildlife from the edge of the right-of-way. Animals tend to habituate to constant noise (Busnel 1978), but loud, sudden sounds will be commonplace during construction. The loud noises associated with construction also could mask territorial vocalizations of bird species near the construction, interfering at least temporarily with breeding. Amphibians, which breed more commonly at dusk or night, are less likely to be affected by the noise.

Construction activities will result in substantial, but temporary, noise impacts to sensitive receptors at various locations along the project's length. Noise levels in the vicinity of construction activities will vary widely depending on the type and number of pieces of construction equipment active at any one time (Table 4.14-3).

It is expected that noise levels exceeding 67 decibels could occur up to 500 feet away from construction activities. Construction noise will, in some areas, be occurring near residences presently experiencing lower noise levels. Where possible, proposed noise barriers (refer to Section 4.14-6) will be constructed prior to reconstructing and widening the highway. In general, construction will be accomplished during daylight hours, although periodic night-time construction should be expected given the traffic volumes during daylight hours and the need to maintain traffic at these times.

Construction will create increased truck traffic on secondary roads. Access to the Turnpike will be maintained although unavoidable delays will occur. Temporary delays will be experienced getting on and off the Turnpike and along the mainline as bridges are under construction, traffic is shifted temporarily from one side to the other, equipment is moved around, and materials delivered. NHDOT will continue to coordinate with local and state emergency response personnel to develop efficient incident management procedures and protocols. Intelligent Transportation System technologies will be deployed to more efficiently manage traffic, enhance incident management during construction, and provide real-time traveler information. A detailed Traffic Control Plan, to include incident management procedures, will be instituted to reduce traffic-related, short-term disruptions and minimize construction zone delays. The plan will include the requirement to maintain two lanes of traffic in both directions along the mainline for normal construction activities, and during high volume traffic periods. Businesses and their customers may experience some inconvenience due primarily to construction activities along their frontage on secondary highways in interchange areas. Construction activities will be coordinated with property owners to ensure that reasonable access to properties is maintained. Temporary signing and other issues related to the temporary relocation of access points, caused by construction activities, will be appropriately addressed on an individual basis.

Some short-term visual impacts will also occur during construction as land clearing and earth-moving occurs. Additionally, some views will also be disrupted by the presence of temporary construction or access roads that may be needed.

4.21 Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

Current congestion along the Spaulding Turnpike impedes the free flow of traffic traveling both north and south through the corridor, as well as the traffic accessing or traveling through the various interchanges. Transportation improvements, like the proposed one, are identified through the regional planning commissions and local officials, as well as NHDOT, and are based upon a comprehensive planning process. This planning considers present and future transportation needs within the context of present and anticipated future land-use development. Local short-term impacts and the use of resources by the project are thus determined to be consistent with the maintenance and enhancement of the long-term productivity for the state as a whole before a highway project is approved.

The types of impacts for all the Build Alternatives in the project corridor would be similar. Most short-term impacts will be associated with construction: noise, temporary impacts to air quality, disturbance of soils, potential sedimentation (temporarily reducing water quality and affecting aquatic communities), potential traffic delays, and temporary visual impacts. Erosion and sedimentation will be minimized during construction through the use of BMPs to avoid impacts to aquatic communities. Other impacts would cease after construction. In comparison, short-term benefits of construction will include additional employment and an additional source of revenue to the local service industry. Increased local spending during construction will also benefit the economy of the communities in the corridor.

Socio-economic impacts are detailed in Section 4.3. As discussed there, Alternative 10A will include the loss of a single residence in Newington and both Alternatives 2 and 3 will impact two businesses in Dover. The value of some residences may be affected by the Turnpike widening and other modifications to the infrastructure and there will be some loss of tax revenue due to right-of-way (ROW) acquisitions necessary for the Turnpike widening and interchange modifications. Some of the necessary ROW acquisition may impact land planned for future development, both residential and commercial. These economic impacts will be largely compensated for in the long term by improved access within the region. Depending on the Alternative, the loss of the residence in Newington and/or two businesses in Dover may have a minor temporary impact on the communities, but this impact can be absorbed because, there are adequate residential and commercial properties for sale or lease in the project corridor to accommodate those displaced.

With regards to long-term impacts on natural resources, only minor impacts to forest and natural land will result. This change does incrementally reduce the rural or suburban ambience and appeal of the area. The permanent loss of habitat will also result in some reduction in the animal populations currently living within the project corridor. However, this latter effect will be offset by the habitats created for both fish and wildlife in the Railway Brook restoration area, as well as by the permanent protection of habitats in areas purchased for preservation purposes. The potential loss of historic structures is also mitigated since the project has been designed to avoid substantial impacts to these resources. Note that a main feature of the Selected Alternative is the rehabilitation of the General Sullivan Bridge, among the most well-known historic landmarks on New Hampshire's seacoast.

4.22 Irreversible and Irretrievable Resource Commitment

Implementation of the project will involve a commitment of a range of natural, physical, human, and fiscal resources. Land used in the construction of the proposed facility is considered an irreversible commitment during the time period that the land is used for a highway facility. However, if a greater need arises in the future for use of the land or if the highway facility is no longer needed, the land can be converted to another use. At present, there is no reason to believe such a conversion will ever be necessary or desirable.

Considerable amounts of fossil fuels, labor, and highway construction materials such as cement, aggregate, and bituminous material will be expended. Additionally, large amounts of labor and natural resources will be used in the fabrication and preparation of construction materials. These materials are generally not retrievable. However, they are not in short supply and their use will not have an adverse effect upon continued availability of these resources. Any construction will also require a substantial one-time expenditure of both state and federal funds, which are not retrievable.

The decision to commit these resources is based on the concept that residents in the immediate area, region, and state will benefit by the improved quality of service, which is expected to outweigh the commitment of these resources.

5

Section 4(f) Evaluation

5.1 Introduction

Under Section 4(f) of the Department of Transportation Act as amended by the Federal-Aid Highway Act of 1968 (Public Law 90-495, 49 USC 1653), the Secretary of Transportation shall not approve any program or project which "requires the use of any publicly owned land from a public park, recreation area, or wildlife and waterfowl refuge of national, state, or local significance as so determined by federal, state, or local officials having jurisdiction thereof, or any land from a historic site of national, state or local significance as so determined by such officials unless (1) there is no feasible and prudent alternative to the use of such land, and (2) such program includes all possible planning to minimize harm to such park, recreation area, wildlife and waterfowl refuge, or historic site resulting from such use."

This combined Environmental Impact Statement (EIS) and Section 4(f) Evaluation provides the required documentation to demonstrate that there is no prudent and feasible alternative to affecting recreational or historic 4(f) resources. This evaluation also outlines the coordination that has occurred and the measures proposed to minimize harm to these resources.

5.2 Description of Selected Alternative

NHDOT, in planning this project, examined a large number of multimodal and highway improvement alternatives. After an initial screening, seven Build Alternatives were selected as a "reasonable range of alternatives." Alternatives included the No-Build Alternative; TSM measures; infrastructure improvements such as widening the Spaulding Turnpike and Little Bay Bridges, park-and-ride lots, expanded bus and rail service in the corridor, enhanced ride-sharing opportunities and commuter incentive programs, as well as employer-based measures to encourage people to not drive alone. (For detailed descriptions, see Sections 2.3 through 2.6.)

The NHDOT's Selected Alternative involves a combination of transportation infrastructure improvements and strategies for the 3.5-mile study corridor as follows:

- Rehabilitate/Widen the Little Bay Bridges (LBB) to eight lanes (three general purpose lanes plus an auxiliary lane in each direction) maintaining the existing easterly edge of the bridge and widening entirely to the west.

  - The three general purpose lanes plus an auxiliary lane in each direction (*i.e.,* eight lanes in total) on the Turnpike would extend between Exits 3 and 6. Six lanes in total would extend south of Exit 3 to match into the existing cross-section of the Turnpike at Exit 1, and would extend north through Exit 6 to the Dover toll plaza.
  - The existing profile of the Little Bay Bridges (suitable for 60 mph design criteria) would be maintained, as would the existing vertical clearance over the channel.
  - The bridge rehabilitation would involve replacing the existing bridge decks, modifying the steel girders to upgrade the pin and hanger connections, repainting the steel girders, and seismically retrofitting the existing pier columns.

- Rehabilitate the General Sullivan Bridge (GSB) to a six-ton loading capacity to continue to function as a pedestrian/bicycle/recreational facility and to accommodate emergency response and maintenance vehicles from Newington.

  - The GSB is a historic landmark structure. It is the second highest rated historic bridge in the state (as recognized by NHDHR and FHWA), eligible for the National Register of Historic Places, and identified as a highly valued Section 4(f) resource.
  - The GSB is currently an important bike/pedestrian connection across Little Bay and is used for fishing and other recreational activity. These transportation connections and recreational activities will be more pleasurable on the GSB in comparison to the use of a multi-use path attached to the widened Little Bay Bridges, which will carry a large volume of vehicles at highway speed.
  - Retaining the GSB as part of the Selected Alternative requires the removal of the GSB's northerly approach embankment and wingwalls to facilitate the proposed reconstruction of a local access connector under the LBB. The existing concrete wingwall along the approach embankment would be removed essentially exposing the back of the GSB abutment. With the removal of the northerly approach embankment, a new 280-foot long pedestrian/bike path including a 155-foot pedestrian/bicycle structure is proposed that

would connect the northerly end of the GSB with the local access road sidewalk and with Hilton Park.

- The estimated cost to rehabilitate the GSB to a six-ton capacity is approximately $26.0 million. The rehabilitation would involve the complete replacement of the deck and supporting structural system (*i.e.* floor beams and stringers), other miscellaneous repairs to the structural steel to arrest future corrosion, cleaning and painting the entire structure, and repairing the substructure (patching spalls and repointing the masonry). A seismic retrofit to primarily prevent the potential collapse of the structure will include at a minimum, a bearing retrofit. The net additional cost to the project of rehabilitating the GSB is estimated to be approximately $10.9 million, or approximately 4.8 percent of total project costs. This net additional cost takes into account $5.7 million that would be required if the structure were to be removed and $9.4 million that would be required to replace the recreational connection across the Bay with a 16-foot wide multi-use path attached to the Little Bay Bridges. This does not take into account the cost of the necessary mitigation should the GSB be removed, which would further reduce the net cost difference.

- Alternative 3 in Dover
  - This Alternative provides a full service interchange at Exit 6 and improves both system and local connectivity for the neighborhoods on both sides of the Turnpike and US 4, and for travelers heading easterly on US 4 towards Dover and northerly on the Turnpike.
  - The proximity of the signalized diamond-type interchange at Exit 6 necessitates the closing of the Cote Drive on-ramp to the Turnpike.
  - A two-lane northbound off-ramp widening to provide dual left and right turn lanes at its intersection with US 4 is proposed to handle the heavy volume of traffic exiting the northbound Turnpike at Exit 6.
  - A new two-way bridge (replacing the existing westbound only bridge) would be constructed to carry US 4 over the Turnpike.
  - Signals would be installed at the northbound ramps and at the southbound on-ramp. A third signal could potentially be required at the Dover Point Road intersection to provide safe egress for the neighborhood.
  - A bridge would be constructed to carry US 4 over a new local connector roadway between Spur Road and Boston Harbor Road. This grade-separated facility provides a local connection for the neighborhoods north and south of US 4 and eliminates the need for a

traffic signal at the Boston Harbor Road/ US 4 intersection, where turns would be restricted to right turns in and out only. A short on-ramp from this local connector to the southbound on-ramp from US 4 would maintain convenient access from the Dover Point neighborhoods and Hilton Park, while reducing some of the traffic demand at the Boston Harbor Road/ US 4 intersection.

- The Exit 5 off and on-ramps would be discontinued. The proximity of these ramps to the reconfigured Exit 6 would create traffic operational and safety problems. In addition, upgrading the geometry of the Exit 5 interchange to current standards would impact Hilton Park and the Wentworth Terrace neighborhood. Access to the park and Wentworth Terrace will be provided *via* a new two-way local connector road traversing under the Little Bay Bridges adjacent to the channel. A section of Hilton Drive extending north from the existing ramps to the existing pump station will be retained to create a loop road for trucks and other vehicles to move easily exiting the Wentworth Terrace neighborhood.
- An underpass utilizing the existing traveled way beneath the Little Bay Bridges is proposed to connect the east and west sides of Hilton Park and the residential neighborhoods. The existing roadway would be widened to accommodate two-way travel at a design speed of 20 mph. This underpass location provides the benefit of utilizing an existing grade-separated crossing as opposed to locating a grade-separated crossing further north, which would necessitate elevating the Turnpike and increasing noise and aesthetic concerns for the surrounding properties. The existing east-west pedestrian and bicycle connection at this location will be maintained.
- New sidewalks are proposed along the west side of Dover Point Road between Hilton Park and the existing sidewalk opposite the Division of Motor Vehicles (DMV) property; along the north side of Spur Road between the Bayview Park parking area and the Scammell Bridge; along the west side of the connector road between Spur Road and Boston Harbor Road; along the new two-way connector beneath the Little Bay Bridge and along Hilton Drive connecting to the reconstructed walkway along Pomeroy Cove.
- This alternative avoids impacts to Pomeroy Cove and minimizes impacts to wetlands and private property to the extent practicable. Approximately 8.3 acres of impacts to wetlands are estimated. No homes or full acquisitions of residential properties are required. Two businesses (a barn, which houses a dog kennel, will be physically impacted by the Turnpike widening and a bath/kitchen retail business where the rear portion of the building is impacted) will need to be acquired. Retaining walls, ranging from 6 to 14 feet in height, are proposed along the west side of the Turnpike to reduce

slope impacts on the properties between the Turnpike and Dover Point Road. Retaining walls, ranging from 16 to 18 feet in height, are proposed along the east side of the Turnpike to avoid impacts to Pomeroy Cove and to limit slope impacts on the properties in the Dover Point Road/Cote Drive neighborhood. The existing bicycle/pedestrian path abutting Pomeroy Cove and connecting Hilton Park and Wentworth Terrace to Dover Point Road would be maintained.

- Sound barriers are proposed on both the east and west sides of the Turnpike between the LBB and Exit 6, and also extending north of the Dover Tolls, which will mitigate for the elevated noise levels. Sound barriers are also proposed on both the east and west sides of the Turnpike north of Exit 6.

- Alternative 13 in Newington
  - This alternative provides a reconfigured full service interchange at Exit 3 (Woodbury Avenue), a northern access into the Tradeport, and maintains on and off-ramps to provide full access at Nimble Hill Road and Shattuck Way at Exit 4.
  - This alternative also eliminates the ramps at Exit 2 (rerouting traffic to Exit 3), and includes provisions for a future Railroad Spur over the Turnpike into the Pease Tradeport should the need arise. Right-of-way and easements will be procured as part of the project and a portion of the railroad bridge's pier foundation will be constructed within the median of the Turnpike.
  - Sidewalks will be provided on both sides of Woodbury Avenue between Fox Run Road and Exit 3. The sidewalk on the north side of the roadway will be extended through the interchange, across the Turnpike and into the Tradeport on Arboretum Drive.
  - The ExxonMobil gas station/convenience store will continue to operate at its current location. However, access to the station from the Nimble Hill Road ramps will be limited to right turns into and right turns exiting the existing driveway. A local roadway, which would provide access to the gas station, Thermo Electron, and one other parcel (with existing direct access to the Turnpike) is proposed. This local roadway could also provide access to the former drive-in property *via* the roadbed of the existing southbound Turnpike (once discontinued) should that property be developed in the future.
  - Woodbury Avenue would be reconstructed to extend the two existing lanes in each direction with a center-raised median from the Fox Run Road intersection through the Exit 3 interchange area. A reduced cross-section is proposed in front of the Isaac Dow house

and Beane Farm property to minimize impacts to these two historic resources.

- In conjunction with the Interim Safety Improvement project, this alternative improves local connectivity by providing a direct connection (via Shattuck Way) between the east and west sides of the Turnpike, and provides a local connection between Woodbury Avenue and the Tradeport.
- Bridge work will include the construction of a 3-span structure to carry Woodbury Avenue over the Turnpike, and widening and rehabilitation of the structure carrying the Turnpike over Shattuck Way.
- Two signals are proposed, one each at the intersection of the northbound and southbound Exit 3 ramps with Woodbury Avenue.

5.3 Description of Section 4(f) Resources

Section 4(f) Resources associated with this project include historical properties that are eligible for listing in the National Register of Historic Places and public parklands.

During project planning, sixteen historic properties and two small historic districts were identified in the project study area as being eligible for listing in the Register (see Section 3.17.2, Table 3.17-1, and Figure 3.17-1). A total of five of these historic properties are impacted by one or more of the alternatives as listed:

- Isaac Dow House, Newington;
- Beane Farm, Newington;
- Portsmouth Water Booster Station, Newington;
- General Sullivan Bridge, Newington and Dover; and
- Ira Pinkham House, Dover.

A full description of each of these properties is provided in Sections 3.17-2 and 4.17-1.

In addition to these historic properties, two public parks are impacted by the project. Both are located in Dover:

- Bayview Park, owned by the NHF&GD, located on Royals Cove at the confluence of the Bellamy River and Little Bay; and
- Hilton Park, owned by the NHDOT, located at the southern end of Dover Point on both sides of the Turnpike.

A description of these parks can be found in Section 3.15, Community Resources.

The determination of effects (DOE) and the Section 4(f) analysis of archaeological sites will not be completed until after the issuance of the ROD because site significance has not yet been determined and site boundaries have not been identified. However, NHDOT has identified areas of archaeological sensitivity and known sites in Phase I-A. Because of the time-consuming nature of archaeological investigations, testing, DOE, and data recovery (Phases I-B, II, and III) are not usually completed until the final design stage when the Selected Alternative is confirmed and the FEIS is completed. Because site significance has not been determined and site extent is not yet verified, a 4(f) analysis, if needed, cannot be completed at this time (see Section 4.17.2.4).

Note that impacts on archaeological resources only create a Section 4(f) impact when the archaeological resources are best served by preservation in-place for future study rather than data-recovery.

5.4 Impacts on Section 4(f) Properties

Table 5.4-1 and **Figures 5.4-1** through **5.4-5** depict the impacts to Section 4(f) resources for each of the alternatives considered in this Final EIS. Because many of the alternatives are so similar, there are typically only small differences in the level of impact from one alternative to another.

Because no impacts on 4(f) properties are expected to result from TSM or TDM elements of the Selected Alternative, the discussion in this section focuses on impacts associated with highway and bridge widening (*i.e.*, Build Alternatives). Table 5.4-1 summarizes impacts to each property.

For purposes of calculating Section 4(f) impacts, the total area of new permanent right-of-way on a given property was determined. Additionally, slope impacts were defined as the total area outside of the proposed permanent right-of-way that would be subject to grading. Temporary construction easements are not considered a Section 4(f) impact, subject to certain conditions as enumerated at 23 CFR 771.135(p)(7), noted below.

- The duration of any construction easement will be temporary, *i.e.*, less than the time needed for construction of the project, and there will be no change in ownership of the land;

- The scope of the work will be minor, *i.e.*, both the nature and the magnitude of the changes to the resource resulting from the temporary use of the land are minimal;

- There are no anticipated permanent adverse physical impacts, nor will there be interference with the activities or purpose of the resource, on either a temporary or permanent basis;

- The land being used must be fully restored, *i.e.*, the resource must be returned to a condition which is at least as good as that which existed prior to the project; and

- Documented agreement, concurring with the above conditions, is needed from the Officials having jurisdiction over the resource.

5.4.1 Historic Properties

5.4.1.1 Beane Farm (NWN0204)

The Beane Farm (see **Figure 5.4-2**) sits close to the edge of the existing right-of-way on Woodbury Avenue in Newington. Adverse effects include minor filling on the property, loss of mature trees, loss of view of existing hillcrest, and loss of its hilltop setting caused by the elimination of the crest resulting from the widening and extension of Woodbury Avenue over the Spaulding Turnpike. No new right-of-way from this site would be required for any of the Newington Alternatives. However, slight grading impacts would be unavoidable. Alternatives 10A and 12A would both require approximately 8,475 square feet of slope impact, while Alternative 13 would decrease this impact to approximately 4,450 square feet.

5.4.1.2 Isaac Dow House (NWN0205)

Adverse effects to the Dow House (NWN0205) include removal of the stone retaining wall, minor slope impacts, and loss of shrubs due to the widening and extension of Woodbury Avenue over the Turnpike (see **Figure 5.4-2**). Alternatives 10A and 12A would not require new right-of-way from the property, but would result in approximately 525 square feet of slope fill on the northwest corner of the property. Alternative 13 would result in slightly less impact (435 square feet) since the vertical alignment of Woodbury Avenue is different.

Table 5.4-1
Impacts to 4(f) Resources (Square Feet)

	Total Size (Ac)	Alternative 10A		Alternative 12A		Alternative 13		Widen & Remove		Widen & Rehabilitate		Alternative 2		Alternative 3	
		ROW	Slope	ROW	Slope	ROW	Slope	ROW	Slope	ROW	Slope	ROW	Slope	ROW	Slope
Historic Property															
Beane Farm	3.8	0	8,475	0	8,475	0	4,450	---	---	---	---	---	---	---	---
Isaac Dow House	0.3	0	525	0	525	0	435	---	---	---	---	---	---	---	---
Portsmouth Water Booster Station	2.4	25,600	275	31,175	0	33,125	400	---	---	---	---	---	---	---	---
General Sullivan Bridge	N/A[1]	---	---	---	---	---	---	Remove	27,975	Rehabilitate	25,600	---	---	---	---
Ira Pinkham House	0.8	---	---	---	---	---	---	7,350	0	7,350	0	---	---	---	---
Recreational Properties															
Hilton Park[2]	9.2	---	---	---	---	---	---	0	400	0	400	---	---	---	---
Bayview Park	25.4	---	---	---	---	---	---	---	---	---	---	16,800	1,850	14,325	4,900

Notes:
1 Since the General Sullivan Bridge is a structure (1,600 feet long), not a property, property size is not applicable.
2 Although project design has been modified to avoid direct impacts to Hilton Park, it will be temporarily affected during construction.

5.4.1.3 Portsmouth Water Booster Station (NWN0228)

New right-of-way on the property of the Portsmouth Water Booster Station will be required for all three Newington Alternatives, and all three will require regrading on the property to maintain the design profile of the re-constructed Turnpike (see **Figure 5.4-1**). In the case of this property, however, the three alternatives vary in the level of impact. Alternatives 10A and 12A would require approximately 25,600 square feet and 31,175 square feet, respectively of new right-of-way. Alternative 13, the Selected Alternative, increases this acquisition to approximately 33,125 square feet. Additional slope easements for grading and clearing beyond the new right-of-way boundary will be required for Alternative 10A (275 square feet) and Alternative 13 (400 square feet).

5.4.1.4 General Sullivan Bridge (DOV0158)

Perhaps the most conspicuous historic structure within the study area is the General Sullivan Bridge, built from 1933 to 1935, which replaced the covered Boston and Maine railroad and highway bridge over Little Bay.

Section 2.4 discusses the numerous bridge options considered during the development of alternatives. During the preliminary screening of alternatives in 2003 and 2004, it was determined that only two main bridge alternatives warranted full consideration in this EIS:

- Widen the Little Bay Bridges to the west, with the rehabilitation of the General Sullivan Bridge for bicycle and pedestrian access, *i.e.,* the "Selected Alternative" or the "Widen West/Rehabilitate Alternative"; and
- Widen the Little Bay Bridges to the west, accommodating bicycles and pedestrians on the widened bridge, and Remove the General Sullivan Bridge, *i.e.,* the "Widen West/Remove Alternative."

The proposal to remove the GSB was motivated by a concern for the safety and aesthetic impact of the deteriorating structure on users of the Turnpike and the Little Bay below. However, removal of the bridge would have an obvious and complete Section 4(f) and Section 106 impact on this resource.

Like any other 4(f) resource, removal or rehabilitation of the General Sullivan Bridge can only be carried out after the determination is made that there is no feasible and prudent alternative to the use of the Section 4(f) resource and that all possible planning to minimize harm has been included. In practice, this determination considers whether avoiding the impact would result in extraordinary costs, and/or social, economic, or environmental impacts. In addition, the proposed project must include all possible planning to minimize harm to the historic bridge under Section 106 of the NHPA and Section 4(f). After careful consideration of the study results, coordination with SHPO, and public input, a Selected Alternative was identified that would preserve the General Sullivan Bridge through its rehabilitation to a standard such that it could accommodate pedestrian and bicycle traffic, recreational use, as well as emergency and maintenance vehicles.

Despite the decision to rehabilitate the General Sullivan Bridge, adverse effects to the Bridge (per Section 106) were determined to result from certain elements of the Selected Alternative. These include the removal of the roadway and north embankment approach to the bridge and limited reconfiguration of the north abutment and wingwall to accommodate the widening of the Hilton Park connector road under the Little Bay Bridges (LBB). The existing concrete backwall (28 feet in width) and wingwalls (66 feet in length) along the approach embankment would be removed, essentially exposing the back of the GSB abutment. With the removal of the northerly approach embankment, a new 280-foot long pedestrian/bike path, including a 155-foot pedestrian/bicycle bridge structure, is proposed that would connect the northerly end of the GSB with the local access road, sidewalk and with Hilton Park. NHDHR affirms that the rehabilitation of the GSB greatly outweighs the technical finding of "adverse effect" and renders the adverse effect determination insignificant. (See letter dated February 3, 2006 in Appendix G). See **Figure 5.4-3** for a view of the modifications of the GSB under both the Widen West/Rehabilitate and the Widen West/Remove Alternatives.

5.4.1.5 Ira Pinkham House (DOV0093)

Within Dover, both Alternatives 2 and 3 would both result in adverse effects to the Ira Pinkham House (DOV0093), including acquisition of a portion of the property that encompasses the barn (**see Figure 5.4-4**). Although the property is located in Dover, it is located within the "Bridge Segment," meaning that the Bridge Alternatives and not the Dover Alternatives determine the effects on the property (see **Figure 2.4-16** for a depiction of the design segments). Both Bridge Segment alternatives would have identical effects, requiring new right-of-way and grading impacts, as well as demolition of the barn structure on this property.

5.4.2 Public Parks and Recreation

Section 4(f) impacts may occur as a result of the project on Hilton Park and Bayview Park, as discussed below.

5.4.2.1 Hilton Park

Hilton Park (see **Figure 5.4-4**) is discussed in Sections 3.15, 3.17, 4.15, and 4.17. The park is one of the more popular recreational resources in the Seacoast region. Because of its proximity to the existing Turnpike, the Park was identified as a critical issue early in project planning. The park is located within the "Bridge Segment" of the study area (see **Figure 2.4-16**).

Neither the Widen West/Rehabilitate nor the Widen West/Remove Alternatives will require acquisition of new right-of-way. There will be minor grading outside of the existing Turnpike right-of-way to perpetuate the existing driveway connection to Dover Point Road and for construction of a pedestrian/bicycle path. Although the park is already owned by the NHDOT, care was taken to avoid these types of impacts.

However, both alternatives would require the construction of a new ramp structure to allow pedestrian/bicycle access to the GSB or the LBB, depending on the alternatives. Portions of this ramp will be cantilevered on a structure over the park, and approximately two pier foundations that support the structure over the park will be required. Approximately 400 square feet of impact is expected and accounts for the structure partially suspended over the park and the construction of the foundations, both of which represent a "use" under Section 4(f). **Figure 5.4-3** illustrates a minor difference between the alternatives with regard to the location of this ramp.

The proximity of Hilton Park to both the Little Bay Bridges and the General Sullivan Bridge raises a concern about indirect impacts to this resource. Disruption (*e.g.*, noise, dust, traffic) to normal recreational activity will likely result during construction. Temporary utilization of some park land is likely to be required during construction, although the location and extent of this potential impact will not be known until final design and construction sequencing are developed. Note that such temporary use does not constitute a "use" under Section 4(f) regulations since the following conditions are met:

- The duration of any construction easement will be temporary, *i.e.*, less than the time needed for construction of the project, and there will be no change in ownership of the Hilton Park land;

- The scope of the work will be minor, *i.e.,* both the nature and the magnitude of the changes to Hilton Park resulting from the temporary use of the land are minimal;

- There are no anticipated permanent adverse physical impacts, nor will there be interference with the activities or purpose of the Park, on either a temporary or permanent basis;

- The land being used will be fully restored and returned to its pre-existing condition or better; and

- NHDOT owns the park and, as the project proponent, agrees to the above conditions.

5.4.2.2. Bayview Park

Impacts to Bayview Park are required to reconfigure the US 4/Spur Road/Boston Harbor Road intersection (see **Figure 5.4-5**). This intersection is one of the key elements of the project, since it is currently an area that is substantially congested during the morning peak hour. Dover Alternative 2 would require approximately 16,800 square feet of new right-of-way and an additional 1,850 square feet of slope impact to allow for the realignment of Spur Road. Alternative 3, the Selected Alternative, will reduce the right-of-way impact to 14,325 square feet with an additional 4,900 square feet of slope impact, while still accommodating a local connection between Spur Road and Boston Harbor Road.

5.5 Avoidance[108]

Consideration was given in the planning process to shifting the alignments of alternatives to avoid Section 4(f) impacts. All alternatives avoid Section 4(f) impacts to the majority of the historic properties in the study area. Given the existing location of the Turnpike and the presence of adjacent Section 4(f) resources, there are no feasible and prudent alternatives that avoid such resources (see Table 5.4-1). The only alternative that avoids Section 4(f) resources is the No-Build Alternative, which does not meet the purpose and need of the project (see Section 1.4).

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108 Much of the information in this section of the DEIS has been moved to Section 5.6 of this FEIS.

5.6 Measures to Minimize Harm[109]

Minimization of harm entails both design modifications that lessen the impact on Section 4(f) resources and mitigation measures that compensate for residual impacts. For example, minor modifications to the roadway layout may be made to minimize the amount of grading or new right-of-way. If a project cannot be designed to avoid historic properties, then appropriate mitigation to reduce impacts must be provided. This mitigation can include further documentation of the adversely affected properties, including using HABS (Historic American Buildings Survey) or HAER (Historic American Engineering Record) standards; minimizing land acquisition and maximizing the distance between the highway corridor and the historic structure or recreational properties; providing access as necessary to maintain existing land uses; and providing landscaping and screening where appropriate to minimize visual and noise impacts.

5.6.1 Design Modifications

Specific design modifications that were made to minimize harm to the impacted properties are as follow:

- Initial concepts, which would have required the demolition of the Isaac Dow House, were refined to eliminate this impact. Early concepts specified a four-lane roadway cross-section, which would have been 92 feet wide, including median, shoulders and sidewalks. Upon identification of the Isaac Dow House as a historic resource (located opposite the historic Beane Farm), designers reconsidered the proposed cross-section, reducing its width to 76 feet in order to prevent acquisition of the property.

- Woodbury Avenue would be reconstructed to extend the two existing lanes in each direction with a center-raised median from the Fox Run Road intersection through the Exit 3 interchange area. A reduced cross-section is proposed in front of the Isaac Dow House and Beane Farm property to minimize impacts to these two historic resources.

- The bridge and roadway design adjacent to Hilton Park was revised during multiple iterations to reduce any right-of-way taking or grading.

- The design near Hilton Park incorporates retaining walls where necessary on the western side of the Turnpike to minimize grading

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109 Portions of this section of the FEIS were contained in Section 5.5 of the DEIS.

impacts, in addition to cantilevering the pedestrian and bicycle path over the ground.

- The recommendation to advance the Westerly Widening alternatives (towards the General Sullivan Bridge) was made specifically to minimize the impacts to Hilton Park (and tidal wetlands).

- The General Sullivan Bridge, in addition to being the second highest rated historic bridge in the state, is currently an important bicycle/pedestrian connection across Little Bay and is used for fishing and other recreational activity. The decision to rehabilitate the General Sullivan Bridge and preserve this valued historic resource, rather than the alternative of removing it, was largely based on the historic significance to the state and the fact that these transportation connections and recreational activities will be more pleasurable on the General Sullivan Bridge in comparison to the use of a multi-use path attached to the widened Little Bay Bridges, which will carry high volumes of vehicles at highway speed.

- Impacts to Bayview Park are unavoidable due to the fact that a key element of the project is to create a safer and more efficient local connection from Spur Road to Boston Harbor Road. This is accomplished either by: 1) retaining the fully signalized intersection but shifting it approximately 125 feet to the east of its current location to improve traffic operations (Alternative 2); or 2) shortening the eastern shift to 100 feet, eliminating the wider signalized intersection for a smaller intersection ("right in–right out" at Spur Road), and constructing a grade-separated connection between Spur Road and Boston Harbor Road approximately 600 feet east of the existing intersection (Alternative 3).

- Existing roadway geometry and infrastructure constraints require both alternatives to shift Spur Road slightly to the north in order to improve its curve radius at its intersection with US 4. Alternative 3 impacts to the park are reduced due to the fact that the intersection is shifted 25 feet to the west as compared to Alternative 2, and therefore impacts a smaller portion of the Park's southern boundary. Additionally, since the intersection under Alternative 3 will be "right in, right out" only, the overall footprint of the intersection is smaller than a fully signalized intersection. Note that both alternatives have slight impacts to the existing parking area at the park while maintaining such public access to the park. Mitigation measures are described in Section 5.6.2 below.

5.6.2 Mitigation Measures

5.6.2.1 Historic Properties

Beane Farm (NWN0204)

Mitigation for impacts to the Beane Farm will include planting of new silver maples and lilacs on the property in consultation with the owner and their placement in relation to the power lines to avoid the need for future trimming.

Isaac Dow House (NWN0205)

Mitigation for this adverse effect will include replacement of the granite slab wall in-kind and appropriate landscaping with shrubs in consultation with the owner. Note that the NHDOT also minimized the right-of-way acquisition to reduce its impacts.

Portsmouth Water Booster Station (NWN0228)

Mitigation of the adverse effect to this property is accomplished by leaving a tree buffer between the Turnpike and the historic structures and by its documentation within its Determination of Eligibility.

General Sullivan Bridge (DOV0158)

Mitigation for impacts to the Bridge will include its rehabilitation for use by pedestrians and bicycles and its continued use for fishing. Work on the bridges will be accomplished in a manner that will not impact the adjacent Hilton Park Picnic Shelter. Overall, the impact of the project on the General Sullivan Bridge will be beneficial.

Ira Pinkham House (DOV0093)

Mitigation for this property taking will involve producing a state-level Historic American Building Survey for the dwelling, documentation of the barn's structure in the same document, preparation of preservation covenants for the house and barn, marketing the barn for relocation if structurally feasible, and marketing the dwelling if the property is acquired in total.

5.6.2.2 Public Parks and Recreation

Hilton Park

Although impacts to Hilton Park are very minor, NHDOT will work with NHDHR to develop and erect a sign that explains the history of the GSB and significance of the park. Additionally, reasonable efforts will be made to minimize impacts to the park during construction, including preventing unnecessary disturbance of areas outside the existing right-of-way, and maintaining safe access to the park.

Bayview Park

In order to offset impacts to Bayview Park, NHDOT will continue to work with NHF&GD to provide improved access to the park. Pedestrians and bicyclists will also benefit from improved access as NHDOT intends to construct a sidewalk connecting the park to the Scammell Bridge and to Boston Harbor Road. Additionally, reasonable efforts will be made to minimize impacts to the park during construction, including preventing unnecessary disturbance of areas outside the authorized right-of-way, and maintaining safe access to the park for vehicles, pedestrians and bicyclists.

Based on further coordination with the NHF&GD following the Public Hearing, additional mitigation will include an increase in parking at the existing Bayview Park lot. Parking would be expanded from six to ten spaces, by extending the parking area to the southwest. The larger lot will benefit users of the park, as well as anglers using the Scammell Bridge and the adjacent shoreline to fish.

5.7 Coordination

Meetings were held among the New Hampshire Division of Historical Resources (NHDHR), the Federal Highway Administration (FHWA), and the New Hampshire Department of Transportation (NHDOT) throughout the course of the project. Determinations of National Register Eligibility were made at meetings on February 9 and 13, and March 9 and 23, 2005, and Determinations of Effect were made by consensus on January 5 and January 12, 2006. An Effect Memo was signed on February 9, 2006 (see Appendix G). A full list of coordination meetings with NHDHR can be found in Chapter 8.

Additionally, NHDOT coordinated with the NHF&GD regarding recreation opportunities at Hilton Park. This coordination included sharing information on environmental and cultural resources to facilitate NHF&GD's consideration of improved full-tide boating access at Hilton Park. NHDOT also coordinated with the NHF&GD regarding potential impacts to Bayview

Park, which led to an agreement to mitigate impacts to the park by increasing angler parking.

As required by Section 4(f), the FHWA provided a copy of the Draft EIS and Section 4(f) Evaluation to the USDOI for comment. Based on their review of the documents, the USDOI concurred that there are no feasible and prudent alternatives to the Selected Alternative, and agreed to the measures proposed to minimize harm to 4(f) resources. (See Volume 4, Letter F-5.)

5.8 Summary Statement

Based upon the above considerations, it was concluded that there are no feasible and prudent alternatives to the use of land from Section 4(f) properties, and the proposed action includes all planning to minimize harm to these properties resulting from such use.

6

List of Preparers

6.1 List of Preparers including their Responsibilities and Qualifications

New Hampshire Department of Transportation

Name /Title: Mr. Christopher Waszczuk, P.E., Chief Project Manager

Qualifications: B.S., Civil Engineering, University of Massachusetts, Amherst.
Twenty years experience in project management and bridge and highway engineering design.

Responsibilities: Overall project coordination and management.

Name /Title: Mr. Michael Dugas, P.E., Supervisor, Preliminary Design

Qualifications: B.S., Civil Engineering, Virginia Tech.
Seventeen years experience in transportation engineering.

Responsibilities: Roadway engineering design review.

Name /Title: Mr. Marc Laurin, Senior Environmental Manager, Bureau of Environment

Qualifications: B.A., Biology, Potsdam State University of New York.
Sixteen years experience in environmental impact assessment and document preparation with specialized training in wetlands analysis.

Responsibilities: Principal reviewer of environmental analyses.

Name /Title:	Dr. Joyce McKay, Historian, Bureau of Environment
Qualifications:	B.A., Anthropology, Indiana University; M.A., History Museum Studies, Cooperstown Graduate Programs (SUNY – Oneonta); Ph.D., Anthropology, with specialization in historical archeology, Brown University. Thirty years experience in historic building management, archaeological survey, and Section 106 and 4(f) coordination.
Responsibilities:	Historical and archaeological review.

Name /Title:	Mr. Charles Hood, Chief, Project Development Section, Bureau of Environment
Qualifications:	B.S., Forestry, University of New Hampshire. Thirty-one years experience in environmental impact assessment and document preparation, with specialized training in noise analysis.
Responsibilities:	Reviewed air quality and noise analyses.

Name/Title:	Mr. Russell A. St. Pierre, Senior Environmental Manager
Qualifications:	A.A.S., Forestry, Paul Smith College; B.S., Computer Science, Franklin Pierce College. Eleven years of experience in environmental impact evaluation and document preparation with specialized training in air quality analysis and noise analysis.
Responsibilities:	Reviewed air quality and noise sections.

Name/Title:	Dr. Subramanian N. Sharma, Traffic Research Engineer
Qualifications:	Ph.D., Civil Engineering, University of Massachusetts – Amherst. Fifteen years experience in transportation planning and traffic analysis.
Responsibilities:	Reviewed traffic modelling section.

Federal Highway Administration

Name /Title: Mr. William O'Donnell, P.E., Environmental Program Manager

Qualifications: B.S., Civil Engineering, Northeastern University.
Forty years experience with additional training in air and noise analyses, water quality, ecological impacts, historic and archaeological preservation, and hazardous materials studies.

Responsibilities: Principal reviewer of highway design concepts and EIS preparation.

Name /Title: Mr. Harry Kinter, Special Programs Manager

Qualifications: B.A., History, Pennsylvania State University;
M.A., History, Indiana University of Pennsylvania.
Thirty-two years experience including specialized training in appraisal, relocation assistance, administration and management, historic and archaeological preservation, hazardous materials studies, social impacts, aesthetic impacts, and landscaping.

Responsibilities: Reviewed cultural resources and hazardous materials sections.

Vanasse Hangen Brustlin, Inc.

Name /Title: Mr. Francis O'Callaghan, P.E., Executive Vice President

Qualifications: B.S., Civil Engineering, Merrimack College;
M.C.P., Community Planning, University of Rhode Island.
Thirty years experience in transportation planning, traffic operations and preliminary design of roadway projects.

Responsibilities: Consultant Team Manager. Overall supervision of the alternatives development and the Environmental Impact Statement preparation.

Name /Title: Mr. Peter Walker, Director, Environmental Services

Qualifications: B.A., Biology and Environmental Studies, Williams College;
M.S., Biology, University of Vermont.
Certified Wetland Scientist (NH).
Sixteen years experience in environmental science and impact analysis.

Responsibilities: Overall supervision of environmental analysis and the preparation of the Environmental Impact Statement.

Name /Title: Mr. Bruce Tasker, P.E., Director, Highway Engineering

Qualifications: A.S., Civil Technology, Wentworth Institute;
B.S., Civil Engineering, New England College.
Thirty years experience in preliminary and final design.

Responsibilities: Highway Design Team Manager. Overall supervision of corridor design development.

Name /Title: Ms. Robin Bousa, Senior Transportation Engineer

Qualifications: B.S., Civil Engineering, University of Lowell.
Twenty years experience in transportation planning, traffic operations, and traffic impact assessment.

Responsibilities: Oversaw traffic operations evaluation.

Name /Title: Mr. Steve Johnson, P.E., Senior Bridge Engineer

Qualifications: B.S., Civil Engineering, Iowa State University.
Twenty-four years of experience in design of bridges and structures.

Responsibilities: Oversaw development of bridge alternatives as well as associated engineering and cost analysis.

Name /Title: Dr. William J. Barry, Senior Environmental Scientist

Qualifications: B.S., Biological Sciences, Cornell University;
Ph.D., Zoology, Michigan State University with emphasis in ecology and animal behavior. Certified Wildlife Biologist and Certified Wetland Scientist (NH).
Twenty years experience as an environmental consultant.

Responsibilities: Supervised natural resource impact analyses. Authored wildlife impact assessment.

Name /Title: Mr. David Wilcock, P.E., Senior Rail and Transit Engineer

Qualifications: B.S., Civil Engineering, Northeastern University.
Twenty-two years experience in studies examining the feasibility and operations of railway and bus transportation systems.

Responsibilities: Oversaw development of multi-modal options, including bus and rail alternatives.

Name /Title: Mr. Howard Muise, Senior Transportation Planner

Qualifications: B.A., Liberal Arts, Northeastern University;
M.S.P., Transportation Planning, Florida State University.
Twenty-five years experience in transportation planning, traffic impact studies, and travel demand projections.

Responsibilities: Oversaw development of ridership estimates for bus, rail, and HOV alternatives.

Name /Title: Mr. Kevin McMaster, G.I.S.P., Senior Environ. GIS Analyst

Qualifications: B.S., Environmental Science, University of Toronto;
M.S., Geography, specializing in GIS, University of Western Ontario.
Seven years of experience in environmental monitoring, spatial data analysis, remote sensing, cartography, 3-D modeling and visualization.

Responsibilities: Developed environmental impact analysis mapping for natural resources such as wetlands, farmlands, floodplains, and wildlife habitat.

Name /Title: Mr. Thomas Wholley, Air and Noise Specialist

Qualifications: B.S., Civil Engineering, Lowell Technological Institute.
Twenty-seven years experience in preparing and reviewing air quality and noise analyses.

Responsibilities: Performed air quality and noise modeling, including development of noise mitigation recommendations.

Name/Title: Mr. Robert Swierk, AICP/Senior Transportation Planner

Qualifications: B.S., Geological and Environmental Science, Stanford University;
M.S., Transportation Engineering, University of California.
Seven years experience in the transportation planning field.

Responsibilities: Assisted in the development of multi-modal options, including bus and rail alternatives.

Name/Title: Mr. William R. Arcieri, Senior Water Resource Scientist

Qualifications: B.S., Hydrology, University of New Hampshire;
M.S., Water Resources, University of Rhode Island.
Twenty years experience in the assessment of water quality impacts associated with stormwater and non-point pollution sources.

Responsibilities: Performed surface and groundwater impact analyses and authored same sections of the EIS.

Name /Title: Mr. Jacob Tinus, CWS, Senior Environmental Scientist

Qualifications: B.S., Biology, University of New York at Potsdam.
M.S., Environmental Resource Management and Administration, Antioch/New England Graduate School, Keene, New Hampshire.
Six years experience in wetland and natural resource assessment and permitting of transportation and land development projects.

Responsibilities: Oversaw natural resource fieldwork, including wetlands identification, function and value assessments and wetlands mitigation site assessments. Authored wetlands and vernal pool descriptions and impact sections.

Name /Title: Mr. Peter Steckler, Environmental Scientist

Qualifications: B.S., Environmental Science/Conservation Biology, University of Vermont.
Five years experience with special focus in aquatic resources and GIS Analysis, including biological assessment experience in wetland delineation, water quality monitoring, and fisheries management.

Responsibilities: Assisted with development of GIS database and impacts analysis. Completed natural resource assessment field work for wetlands and stream.

Name /Title: Ms. Rita Walsh, Senior Preservation Planner

Qualifications: B.A., Historic Preservation, University of Michigan; M.S., Historic Preservation, University of Vermont. Twenty years experience in cultural resource compliance and historic preservation studies.

Responsibilities: Reviewed and co-authored cultural resource analyses.

RKG Associates

Name /Title: Mr. Jimmy E. Hicks, Executive Vice President

Qualifications: B.A., Economics and Political Science, Old Dominion University; Master of Urban and Regional Planning, Virginia Tech.
Thirty years experience in the assessment of transportation, economic development, land use, and economic impacts at all levels of government.

Responsibilities: Performed socio-economic impacts analysis, including determination of indirect and cumulative economic effects.

Name /Title: Mr. Michael Casino, Project Manager

Qualifications: B.S., Community Planning and Environmental Conservation, University of New Hampshire.
Twenty years experience in land use planning and economics, including preparation of environmental documentation meeting NEPA requirements for transportation and other infrastructure projects.

Responsibilities: Assisted with socio-economic impacts analysis.

University of New Hampshire

Name /Title: Dr. Raymond Grizzle, Ph.D., Associate Research Professor

Qualifications: B.S. , Biology, Florida State University;
M.S., Biology, University of Central Florida;
Ph.D., Department of Biological Sciences, Ecology Program, Rutgers University.
Expert in benthic marine ecology, including basic and applied ecology of invertebrates, including those living in estuarine and shallow continental shelf habitats.

Responsibilities: Oversaw mapping of marine benthic habitats.
Contributed to assessment of impacts to marine habitats.

Name/Title: Dr. Barbaros Cellikol, Ph.D., Professor and Chair, Mechanical Engineering Department

Qualifications: B.A., Physics and Math, Elon University;
M.S., Physics, Stevens Institute of Technology;
Ph.D., Physics, University of New Hampshire

Dr. Cellikol is an expert in the fields of statics, strength, kinematics, dynamics, and vibration of mechanical systems, with more than 32 years of teaching and research.

Responsibilities: Oversaw development of the Little Bay/Great Bay hydrodynamic model.

Name /Title: Mr. Jon P. Scott, P.E., Research Engineer, University of New Hampshire

Qualifications: B.S., Engineering, United States Naval Academy;
M.S., Mechanical Engineering, University of New Hampshire.
Ten years experience in computer modeling of estuaries and lakes.

Responsibilities: Developed hydrodynamic model of the existing conditions in Little Bay, as well as tidal conditions under various alternative bridge alternatives.

Victoria Bunker, Inc.

Name /Title: Dr. Victoria Bunker, Ph.D, Principal Archaeologist

Qualifications: B.A., University of New Hampshire;
M.A., Tufts University;
Ph.D., Archaeology, Boston University.

Thirty years experience as a prehistoric sites archeologist. Twenty-five years experience in conducting cultural resource review and impact analysis.

Responsibilities: Developed Phase 1A and 1B archaeological investigations. Co-Authored Archaeological Resources portions of the EIS.

Preservation Company

Name /Title: Ms. Lynne Monroe, Architectural Historian

Qualifications: B.F.A., University of Pennsylvania.
Advanced study in Historic Preservation at Boston University.
Twenty-five years experience in historic preservation.
Experience in historic architectural surveys and National Register nominations.

Responsibilities: Oversaw completion of historic structures surveys, authored historic resources section.

7

List of Agencies, Organizations and Persons to Whom Copies of the Draft and/or Final Environmental Impact Statement Were Sent

7.1 Federal Agencies

Director, Office of Environmental Policy and Compliance
US Department of the Interior
Main Interior Building, MS 2340
1849 C Street, NW
Washington, DC 20240

US Environmental Protection Agency
Office of Federal Activities
Ariel Rio Building (South Oval Lobby),
EIS Filing Section, Mail Code 2252-A
1200 Pennsylvania, NW
Washington, DC 20460

US Environmental Protection Agency, Region I
1 Congress Street, Suite 1100
Boston MA 02114-2023

US Army Corps of Engineers
Environmental Analysis Branch
New England District
696 Virginia Road
Concord, MA 01742-2751

Exec. Director, Advisory Council on Historic Preservation
Office of Planning and Review
Old P. O. Bldg., Suite 809
1100 Pennsylvania Avenue, NW
Washington, DC 20004

Office of the Secretary
Department of Agriculture
Room 200A
14th and Independence Avenue, SW
Washington, DC 20250

Regional Director – Region I
Federal Emergency Mgmt. Agency
J.W. McCormack P.O. & Court House
Boston, MA 02109

Regional Administrator -- Region I
Dept. of Housing & Urban Development
John F. Kennedy Building
Boston, MA 02203

US Army Corps of Engineers
Regulatory Branch
696 Virginia Road
Concord, MA 01742-2751

Director, New England Region
Federal Aviation Administration
12 New England Executive Park
Burlington, MA 01803

Federal Energy Regulatory Comm.
Environmental Evaluation Branch
888 First Street, NE
Washington, DC 20426

Federal Railroad Administration
7th Floor, MS 20
1120 Vermont Avenue, NW
Washington, DC 20590

Regional Administrator
Federal Transit Administration
DOT Transportation Systems Center
Kendall Square
Cambridge, MA 02142-1093

Director, Office of Policy & Strategic Planning
National Oceanic & Atmospheric Admin.
US Dept. of Commerce – Room 5805
14th and Constitution Avenue, NW
Washington, DC 20230

Regional Director
Northeastern Region
National Marine Fisheries Svcs
1 Blackburn Drive
Gloucester, MA 01930

John McDonald
First Coast Guard District
408 Atlantic Avenue – Room 613
Boston, MA 02210

Division of NEPA Affairs
Department of Energy
Room 4 G 064
1000 Independence Avenue, SW
Washington, DC 20585

Field Office Supervisor
US Fish & Wildlife Service
70 Commercial Street, Suite 300
Concord, NH 03301-5087

US Department of Interior
Geological Survey
NH/VT District
361 Commerce Way
Pembroke, NH 03275

Susan J. Hoey, Acting District Conservationist
District Conservationist
Natural Resources Conservation Service
Epping Service Center
Telly's Plaza, 243 Calef Highway
Epping, NH 03042-2326

Mary Currier, Executive Director
Rockingham County Conservation District
110 North Road
Brentwood, NH 03833-6614

Tessa M. Chadwick
State Conservationist
Natural Resource Conservation Service
Federal Building, 2 Madbury Road
Durham, NH 03824-7581

Gary Kassof
Chief, Bridge Branch
First Coast Guard District
One South Street
Battery Park Building
New York, NY 10004-5073

7.2 State Agencies

The Honorable John Lynch
Office of the Governor
Room 208–214, State House
Concord, NH 03301

Executive Councilor Beverly Hollingworth
107 North Main Street
Room 207, State House
Concord, NH 03301

Executive Councilor John Shea
107 North Main Street
Room 207, State House
Concord, NH 03301

Executive Councilor Raymond J. Wieczorek
107 North Main Street
Room 207, State House
Concord, NH 03301

Executive Councilor Raymond S. Burton
107 North Main Street
Room 207, State House
Concord, NH 03301

Executive Councilor Debora Pignatelli
107 North Main Street
Room 207, State House
Concord, NH 03301

Executive Councilor Ruth L. Griffin
Chair, Special Committee
479 Richards Avenue
Portsmouth, NH 03801

Executive Councilor Peter J. Spaulding
Member, Special Committee
386 Gage Hill Road
Hopkinton, NH 03229

US Senator John E. Sununu
1750 Elm Street
Manchester, NH 03104

US Senator Judd Gregg
Norris Cotton Federal Building
Manchester, NH 03103

US Representative Paul Hodes, II
United States House of Representatives
506 Cannon House Office Building
Washington, DC 20515

US Representative Carol Shea-Porter
104 Washington Street
Dover, NH 03820

Allison McLean, Director
NH Dept. of Resources & Economic Development
Parks and Recreation Division
172 Pembroke Road
Concord, NH 03301

Amy Ignatius, Director
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Additionally, excerpts from the DEIS and FEIS relating to indirect and cumulative effects were sent to all 33 communities in the socio-economic study area.

7.3 Others (Including Local and Regional Organizations)

City of Dover
-- Mayor
-- City Council
-- City Manager
-- Planning Director
-- Conservation Commission
-- City Library
-- Historical Society

Town of Newington
-- Board of Selectmen
-- Planning Board
-- Conservation Commission
-- Town Library
-- Historic District Commission

Cliff Sinnott, Executive Director
Rockingham Planning Commission
156 Water Street
Exeter, NH 03833

Audubon Society of New Hampshire
3 Silk Farm Road
Concord, NH 03301

City of Portsmouth
-- Mayor
-- City Council
-- City Manager
-- Planning Board
-- Conservation Commission
-- City Library
-- Historic District Commission

Cynthia Copeland, AICP, Executive Director
Strafford Regional Planning Commission
2 Ridge Street, Suite 4
Dover, New Hampshire 03820-2505

Society for the Protection of NH Forests
54 Portsmouth Street
Concord, NH 03301

The Nature Conservancy
New Hampshire Chapter
22 Bridge Street, 4th Floor
Concord, NH 03301

Conservation Law Foundation
Concord Advocacy Center
27 North Main Street
Concord, NH 03301-4930

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Rockingham Planning Commission
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Mr. Sandy Hislop
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Mr. Jim Campbell
Town Planner
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Mr. Rad Nichols
Executive Director
COAST
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Dover, NH 03820

Mr. Peter Hamelin
President
Portsmouth Chamber of Commerce
PO Box 239
Portsmouth, NH 03803-0239

Mr. Rick Card
Greater Dover Chamber of Commerce
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Dover, NH 03821

Mr. Jack Newick
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8

Comments and Coordination

8.1 Advisory Task Force Meetings

An Advisory Task Force (ATF) was established early in the project process to provide a forum for the local communities to be closely involved with the technical review and progression of the EIS. The ATF is comprised of a total of fifteen members. These members represent the general public, local officials, State and Federal agencies, and interested stakeholders including local residents, regional planning commissions, chambers of commerce, local transit providers, the Pease Development Authority, and the Great Bay Estuarine Research Reserve. The dates, locations and topics of these ATF meetings were:

Meeting No.	Date/Location	Topics
Meeting 1	Wednesday, April 30, 2003 Newington Town Hall	Kick-Off Meeting; Role of ATF and Scope of Project.
Meeting 2	Wednesday, July 30, 2003 Dover City Hall	Update of Environmental Resource Inventories and Traffic Data Collection; Presentation of Preliminary Findings of the Seacoast Travel Survey; Review of Issues identified at the June 25, 2003 Scoping Meeting; Update of Status of the Regional Travel Demand Model; Review of the Potential Range of Alternatives to be considered in the DEIS; Review of Project Purpose and Need Statement; and Review of Toll-Related Issues.
Meeting 3	Wednesday, October 29, 2003 Newington Town Hall	Reviewed and Finalized Project Purpose and Need Statement; Update of Environmental Resource Inventories; Review of Preliminary Bridge Investigations; Update of Regional Travel Demand Model and Findings from Seacoast Travel Survey; Summary of Study Area Safety and Traffic Deficiencies and Issues; Review of the Study Area's Transit and Rail Systems; Summary of Socio-Economic characteristics of the Study Area with respect to Journey-to-Work Data; Update of the Intelligent Transportation System (ITS) Plan and Incident Management Initiatives for the Study Area and Region; Summary of the Draft Ten Year Transportation Improvement Program as it relates to the Newington-Dover Project; Discussion of Funding Near-Term Improvements to address current Safety and Traffic Operational Problems,; and Discussion of a Long-Term Vision for the Study Area.

Meeting 4	Wednesday, January 28, 2004 Dover City Hall	Update on the Regional Travel Demand Model; Preliminary Summary Review of the Scoping Report (to be distributed in March 2004); Discussion of Navigation-Related Issues; Discussion of the Historical Significance of the General Sullivan Bridge; Preliminary Discussion of Short-Term TSM-Type Improvement Alternatives; Discussion of Potential Park-and-Ride Sites; and Discussion of a Long Term Vision for the Study Area.
Meeting 5	Wednesday, March 31, 2004 Newington Town Hall	Review of Bridge Characteristics and Conditions; Review of Preliminary Bridge, Turnpike and Interchange Conceptual Alternatives; Review of Short-Term TSM-Type Alternatives; Unanimous ATF Endorsement for Implementation of the TSM Measures; Review of Long-Term Interchange Alternatives in Dover and Newington; Unanimous ATF Endorsement of Alternative 3 in Dover to be advanced for Further Analysis in Phase 3 (DEIS); and ATF Consensus to drop Alternative 7 in Newington from Further Consideration.
Meeting 6	Wednesday, April 28, 2004 Newington Town Hall	Reviewed Bridge Navigation and Permitting Issues, and the History, Reuse Alternatives and Issues related to the General Sullivan Bridge; Review of Bridge and Roadway Conceptual Alternatives, Potential Impacts and Cost Estimates; Discussion and Visualization of Level of Service for varying traffic conditions along the Spaulding Turnpike; Unanimous ATF endorsement of advancing three bridge alternatives – Rehabilitation and Widening of the Little Bay Bridges (LBB) with the General Sullivan Bridge (GSB) rehabilitated, Rehabilitation and Widening of the LBB with the GSB removed, and Replacement of the LBB with the GSB removed; Unanimous ATF endorsement of advancing roadway Alternatives 2 and 3 in Dover and Alternatives 10 and 11 in Newington for further study in Phase 3 (DEIS).
Meeting 7	Wednesday, June 23, 2004 Dover City Hall	Review of Preliminary Ridership Estimates of TDM Alternatives including Rail, Bus, HOV and Reversible Lanes, and Employer-based Programs; Review of Preliminary Screening of Impacts and Costs associated with Conceptual Bridge and Roadway Alternatives; Presentation and Discussion of Study Team's Recommended Range of Alternatives to be advanced to Phase 3 (DEIS) Analysis; Unanimous ATF endorsement of the Recommended Range of Alternatives to carry forward. These Alternatives included: Bridge – Westerly widening of the LBB with retention of the GSB, westerly widening of the LBB with a new multi-use path on the widened bridge and removal of the GSB, and construction of a new bridge to the west of the LBB with a multi-use path and removal of the GSB; Roadway – Alternatives 2 and 3 in Dover, and Alternatives 10, 11 and 12 in Newington; Transportation System Management – Dover TSM1, Dover TSM2, Interim Safety Plan (Newington) and Newington TSM Exit 3, Southbound, and Exits 3 – 4, Northbound; and Travel Demand Management – Expansion of the *Downeaster* Rail Services, preservation of the Pease rail spur connection, expansion of intercity bus service between Rochester, Portsmouth and Boston, expansion of express bus service between Rochester and Portsmouth, expansion of local bus service, and employer-based measures.

Meeting 8	Wednesday, August 25, 2004 Newington Town Hall	Review and response to comments and questions from Public Information Meetings of 6/30/04 and 7/01/04; Review and discussion of refined ridership estimates associated with Rail, Bus, HOV and other TDM Alternatives; Review, refinement and comparison of impacts and costs associated with the range of alternatives; and Review of Project Schedule.
Meeting 9	Wednesday, January 12, 2005 Dover City Hall	Review of Rationale Report including updated information on cross-sections, traffic and transit ridership, and a summary of the alternatives recommended for further study; Review of the modified cross-section of Woodbury Avenue to reduce potential impacts to the historic Isaac Dow House and Beane Farm; Review of preliminary analysis of six and eight-lane options combining various bridge, transit, employer-based TDM and HOV options.
Meeting 10	Wednesday, February 23, 2005 Newington Town Hall	Review of six and eight-lane options combining various bridge, transit, employer-based TDM and HOV options; ATF dismisses non-transit and HOV combination alternatives noting little community support; Review and discussion of issues and rationales for both rehabilitating and removing the GSB; Review and discussion of Turnpike profile alternatives.
Meeting 11	Wednesday, March 30, 2005 Dover City Hall	Discussion of ACOE, USEPA, SRPC and City of Dover review comments on the Rationale Report; Traffic simulations and comparison of future traffic operations under the six and eight-lane Turnpike options; Review of design criteria, and discussion and concurrence by the ATF that the existing LBB profile is not a safety problem and not the major factor in peak hour congestion; Review and discussion of peak hour shoulder use; ATF dismisses the new bridge (off line) alternative due to impacts, costs, and 4(f) considerations; Remaining options include eight-lane widening/rehabilitation of LBB with transit, TDM and rehabilitation of GSB, eight-lane widening/rehabilitation of LBB with transit, TDM and removal of the GSB, six-lane widening/rehabilitation of LBB with transit, TDM, rehabilitation of GSB, and utilization of a borrow (zipper) lane, and six-lane widening/rehabilitation of LBB with transit, TDM, rehabilitation of GSB, and peak hour shoulder use.
Meeting 12	Wednesday, May 4, 2005 Newington Town Hall	Review of development and refinement of alternatives in Newington and in Dover. FHWA notes safety concerns and their lack of support for six-lane options utilizing either a borrow lane or peak hour shoulder use as long term solutions to address project purpose and need.
Meeting 13	Wednesday, July 6, 2005 Newington Town Hall	Review of feedback from public information meetings (May 18 and May 19, 2005); Discussion and review of alternatives refinement (Alternative 10 modified to Alternative 10A and Alternative 12 modified to Alternative 12A) including Alternative 13 conceived by Newington officials; review and discussion of preliminary noise impact analysis.
Meeting 14	Wednesday, August 24, 2005 Dover City Hall	Review of the Dover Alternatives, including Hilton Park Connector; Discussion of Socio-economic Impacts, including Indirect and Cumulative Impacts; Initial discussion of wetlands mitigation ideas.

Meeting 15	Wednesday, October 26, 2005 Newington Town Hall	Review of the suggested Preferred Alternative; Review of revised Spur Road extension/Boston Harbor Road connector, including new Boston Harbor Road southbound on ramp; Discussion of noise analysis and proposed noise barrier locations; discussion of wetlands mitigation parcels, restoration of Railway Brook.
Meeting 16	Wednesday, January 18, 2006 Dover City Hall	Review of feedback from public information meetings (November 7 and November 9, 2005); Review of support for the suggested Preferred Alternative; Review and discussion of potential new sidewalk along Dover Point Road; Review of the summary of impacts associated with the suggested Preferred Alternative; Review and discussion of the updated wetlands mitigation package; and Discussion of the project schedule and potential locations for holding the Public Hearing.
Meeting 17	Thursday, July 26, 2007 Newington Town Hall	Review of project status and update of FEIS schedule; Review of Public Hearing and DEIS comments; Update of project cost of the Selected Alternative.

8.2 Resource Agency/SHPO Meetings

Following the official Notice of Intent to prepare an EIS, a Scoping Meeting was held on June 25, 2003. The public, as well as, local, state, and federal agencies were invited to attend. Since that initial Scoping Meeting, thirty-one agency meetings have been held as part of regular coordination to provide an opportunity for the agencies to review the development and screening of project alternatives and to comment on environmental issues ("Resource Agency Meetings") or cultural resources ("SHPO Meetings"). These meetings are typically held at NHDOT headquarters in Concord. Some of these agency meetings were held in Newington and Dover with the intent of providing a more convenient forum for members of the public or local officials who wanted to attend, and an opportunity for agency staff to observe areas of concern within the study area. Typical attendees of the Resource Agency Meetings include the USEPA, USACOE, USFWS, NMFS, NHDES, including its Coastal Program, and NHF&GD. SHPO meetings also occur on a regular basis and are attended by several staff members from the NHDHR, NHDOT, and FHWA to discuss cultural resource issues.

Listed below are each of the agency meetings held during the development of the EIS. The 31 meetings include seventeen Resource Agency Meetings and fourteen SHPO Meetings (identified as such in the "topics" column of the table).

Meeting No.	Date/Location	Topics
Phase I **Project Scoping/Data Collection/Issue Identification**		
Meeting 1	Wednesday, April 16, 2003 NHDOT Headquarters, Concord, NH	Introduction to the project for the natural resource agencies, including the project schedule and preparation for upcoming Scoping Meeting.
Meeting 2	Wednesday, July 16, 2003 NHDOT Headquarters, Concord, NH	Review of feedback and comments received during the Scoping Meeting and comments on project Purpose and Need Statement.
Meeting 3	Wednesday, August 20, 2003 NHDOT Headquarters, Concord, NH	Review of project and discussion of socio-economic and secondary effects. Meeting with USEPA, ACOE, NHDES.
Meeting 4	Thursday, September 11, 2003 NHDOT Headquarters, Concord, NH	SHPO coordination meeting to provide project overview, including EIS schedule and approach to historical and archaeological field studies.
Meeting 5	Tuesday, October 7, 2003 Newington and Dover	Combined natural and SHPO meeting to field visit to review the project corridor including natural resources and historic properties.

Phase II
Conceptual Alternatives Development and Screening

Meeting 6	Thursday, April 1, 2004 NHDOT Headquarters, Concord, NH	SHPO coordination meeting to discuss progress and preliminary findings of surveys to identify historic structures in the project corridor.
Meeting 7	Wednesday, April 21, 2004 NHDOT Headquarters, Concord, NH	Review of preliminary alternatives and screening methodology.
Meeting 8	Thursday, June 10, 2004 NHDOT Headquarters, Concord, NH	SHPO coordination meeting to discuss preliminary results of Phase 1A archaeological investigations.
Meeting 9	Wednesday, June 23, 2004 NHDOT Headquarters, Concord, NH	Review of ridership, LOS, TDM, TSM, bridge and roadway alternatives.
Meeting 10	Friday, July 16, 2004 NHDOT Headquarters, Concord, NH	SHPO coordination meeting to discuss historic structures and environmental screening methodology.
Meeting 11	Thursday, August 5, 2004 Newington Town Hall	Further review of alternatives including TDM, LOS, and a 3-Lane Concept. Discussion of environmental screening of alternatives, including a draft constraints matrix. Presentation of the Alternatives recommended for further study in the Draft EIS.
Meeting 12	Thursday, August 5, 2004 Newington and Dover	Field review of natural resources of Little Bay, Hilton Point and other areas within the project corridor.
Meeting 13	Thursday, August 5, 2004 NHDOT Headquarters, Concord, NH	SHPO coordination meeting to review progress of the historic structures survey.

Phase III

Meeting 14	Thursday, January 6, 2005 NHDOT Headquarters, Concord, NH	SHPO coordination meeting to review the preliminary design of the widening of Woodbury Avenue in front of the Beane Farm and the Isaac Dow House in which impacts were minimized; Discussion of landscaping and the composition of the Dow House retaining wall.
Meeting 15	Thursday, January 19, 2005 NHDOT Headquarters, Concord, NH	Reviewed alternatives recommended for further study; preliminary review of six- vs. eight-lane impacts.
Meeting 16	Tuesday, February 22, 2005 NHDOT Headquarters, Concord, NH	SHPO coordination meeting to discuss the Dover Railroad line, the Pease Spur line, the alternatives that remove or rehabilitate the General Sullivan Bridge, and minimization of impacts to Hilton Park.
Meeting 17	Thursday, April 7, 2005 NHDOT Headquarters, Concord, NH	SHPO coordination meeting to discuss the requests for more information by DHR and more specifically of the Pease Spur line's relationship to the AFB.
Meeting 18	Wednesday, April 20, 2005 NHDOT Headquarters, Concord, NH	Review the six- vs. eight- lane impacts; review of combination alternatives including TDM and HOV lanes and zipper lane concept.

Meeting 19	Thursday, July 7, 2005 NHDOT Headquarters, Concord, NH	SHPO coordination meeting to discuss the newly developed Alternative 13 and comparison with previously discussed alternatives.
Meeting 20	Thursday, July 20, 2005 NHDOT Headquarters, Concord, NH	Discussed Newington Alternatives 10A, 12A, and 13 and Dover Alternatives 2 and 3; Estimated project related wetland impacts; Discussed NHDOT approach to compensatory mitigation and preliminary list of potential compensatory mitigation parcels.
Meeting 21	Thursday, August 11, 2005 NHDOT Headquarters, Concord, NH	Review secondary impacts evaluation and results with USEPA, NHDES, RPC, and SRPC.
Meeting 22	Wednesday, August 17, 2005 NHDOT Headquarters, Concord, NH	Review results of mitigation screening. Discussed Blackwater Brook & Bellamy River parcels in Dover and Railway Brook in Newington.
Meeting 23	Tuesday, September 13, 2005 Newington & Dover Field Review	Field Review to review mitigation parcels in Newington and Dover.
Meeting 24	Tuesday, October 4, 2005 Newington Field Review	Additional field review of mitigation parcels in Newington.
Meeting 25	Wednesday, November 2, 2005 NHDOT Headquarters, Concord, NH	Discussion of preliminary wetlands mitigation recommendations, including Blackwater Brook preservation, Railway Brook restoration/preservation and Drive-in restoration/preservation.
Meeting 26	Thursday, December 8, 2005 NHDOT Headquarters, Concord, NH	SHPO coordination meeting to discuss the determination of effects to eligible properties, Discussion of the boundaries of the eligible properties and mitigation of impacted resources within the project area. The effects to Hilton Park and the GSB were tabled for a future meeting as eligibility, integrity and boundary issues needed to be resolved.
Meeting 27	Wednesday, December 14, 2005 NHDOT Headquarters, Concord, NH	Review Preferred Alternative and mitigation components and to brief agencies on Tuttle Farm as a potential mitigation site.
Meeting 28	Thursday, January 5, and 12, 2006 NHDOT Headquarters, Concord, NH	SHPO coordination meeting to discuss the effects to the GSB and Hilton Park. For the GSB Rehabilitation Alternative, the effects will be mitigated by the proposed rehabilitation. (Subsequently, at a Determination of Eligibility meeting held on January 11, 2006, Hilton Park was determined to not be eligible.)
Meeting 29	Tuesday, February 21, 2006 NHDOT Headquarters, Concord, NH	SHPO coordination meeting to review Tuttle Farm field assessment and revised mitigation package, including Tuttle Farm, Railway Brook Restoration and the Watson Property in Newington.
Meeting 30	Wednesday, March 2, 2006 NHDOT Headquarters, Concord, NH	SHPO coordination meeting to discuss the mitigation required for the GSB Removal Alternative.
Meeting 31	Wednesday, April 5, 2006 Newington and Dover	Field review of mitigation proposal, including the Tuttle Farm (Dover), the Watson Property (Newington) and the Knight Brook area (Newington).

Meeting 32	Wednesday, March 21, 2007 NHDOT Headquarters, Concord, NH	Discussion of progress on mitigation package, including Tuttle Farm, Tsimekles Property, and restoration of Railway Brook. General consensus on recommended mitigation package reached.
Meeting 33	Thursday, September 6, 2007 NHDOT Headquarters, Concord, NH	SHPO coordination meeting to discuss project status, including reaffirming that rehabilitation of the GSB is included in the Selected Alternative. Discussion of change in project funding based on revised draft 10-year plan and upcoming GACIT meetings.

8.3 Local Public Officials and Public Informational Meetings

As part of the EIS process, informational meetings were regularly held with officials and the general public in the communities affected by the project. The dates, location, and topics were as follows:

Meeting No.	Date/Location	Topics
Meeting 1	Wednesday, June 25, 2003 Newington Town Hall	Project /NEPA Scoping Meeting – Roles of Federal Lead Agency and Cooperating Agency Roles; Project Background; Project Purpose and Need; Study Area; Sensitive Environmental Issues; Reasonable Range of Alternatives; Project Phases and Schedule; and Solicitation and Response to Public Input.
Meeting 2	Wednesday, November 12, 2003 Dover City Hall	Reviewed project's Scope, Study Area, and Purpose and Need. Reviewed the existing study area traffic conditions, crash data, and environmental resources. Described the preliminary bridge findings contrasting the Little Bay Bridges with the General Sullivan Bridge. Described the calibration and update of the Seacoast Travel Demand Model. Summarized the Reasonable Range of Alternatives under consideration. Described the Project Process, Schedule, and Public Participation. Solicited and Responded to Public Input and Comments.
Meeting 3	Wednesday, June 30, 2004 Dover City Hall	Reviewed Project Purpose and Need, Project Process and Schedule, and Project Background. Described Alternatives Conceptualized; Reviewed Preliminary Constraints/Impacts Matrix of Alternatives; Presented Range of Alternatives recommended for further study; Solicited and Responded to Public Input.
Meeting 4	Thursday, July 1, 2004 Newington Town Hall	Reviewed Project Purpose and Need, Project Process and Schedule, and Project Background. Described Alternatives Conceptualized; Reviewed Preliminary Constraints/Impacts Matrix of Alternatives; Presented Range of Alternatives recommended for further study; Solicited and Responded to Public Input.
Meeting 5	Wednesday, May 18, 2005 Dover City Hall	Review of Project Purpose and Need, NEPA/EIS Process and Schedule; Review of Study Area and Background Information on Traffic and Safety Conditions, Travel Demands and Environmental Resources; Review of the Development of Alternatives and the Evaluation of Combined Alternatives; Review of Preliminary Noise Impact Analysis; Solicited and Responded to Public Input.
Meeting 6	Thursday, May 19, 2005 Newington Town Hall	Review of Project Purpose and Need, NEPA/EIS Process and Schedule; Review of Study Area and Background Information on Traffic and Safety Conditions, Travel Demands and Environmental Resources; Review of the Development of Alternatives and the Evaluation of Combined Alternatives; Review of Preliminary Noise Impact Analysis; Solicited and

		Responded to Public Input.
Meeting 7	Wednesday, October 5, 2005 Dover City Hall	Review of Dover Alternatives, Hilton Park Local Connector Alternatives, and LBB Cross -Sections; Review of Project NEPA/EIS Process and Project Schedule; Solicited and Responded to City Council and Public Input.
Meeting 8	Monday, November 7, 2005 Dover City Hall	Reviewed suggested Preferred Alternative, including Newington Alternative 13, Dover Alternative 3, and Bridge Widen & Rehabilitate GSB; Reviewed all recommended TSM, TDM, Bus and Transit alternatives; Presented noise impact analysis and proposed mitigation; reviewed proposed wetland mitigation package including Blackwater Brook preservation, Railway Brook restoration/preservation, Drive-in restoration/preservation.
Meeting 9	Wednesday, November 9, 2005 Newington Town Hall	Reviewed suggested Preferred Alternative, including Newington Alternative 13, Dover Alternative 3, and Bridge Widen & Rehabilitate GSB; Reviewed all recommended TSM, TDM, Bus and Transit alternatives; Presented noise impact analysis and proposed mitigation; reviewed proposed wetland mitigation package including Blackwater Brook preservation, Railway Brook restoration/preservation, Drive-in restoration/preservation.
Meeting 10	Wednesday, April 26, 2006 Dover City Hall	Seacoast MPO Meeting. Reviewed suggested Preferred Alternative, including Newington Alternative 13, Dover Alternative 3, and Bridge Widen & Rehabilitate GSB; Reviewed all recommended TSM, TDM, Bus and Transit alternatives; Presented noise impact analysis and proposed mitigation; reviewed proposed wetland mitigation package including Blackwater Brook preservation, Railway Brook restoration/preservation, Drive-in restoration/preservation.

8.4 Public Hearing

After circulation of the DEIS, a Joint Public Hearing involving the NHDOT, USACOE, NHDES-Wetlands Bureau, and FHWA, and overseen by a Special Committee appointed by the Governor and Executive Council, was held on September 21, 2006 at the St. Thomas Aquinas High School in Dover. The Special Committee, comprised of three of the Executive Councilors, or their designees, subsequently determined on August 22, 2007, the occasion for the layout of the highway in accordance with RSA 230:45 in order for the NHDOT to advance the project. Comments on the preferred project alternative, DEIS and related issues were received at the Hearing. A summary of the hearing comments is contained in Volume 4 of the FEIS, including the NHDOT's formal response to comments which are presented in the Report of the Commissioner.

8.5 Comments on the DEIS

Written comments on the DEIS were received for a 90-day period following distribution of the document. These comments were received from Federal and State agencies, local officials, regional planning agencies and organizations, private organizations and citizens. All of these comments and the official response to each of them are provided in a separate Volume 4 of this FEIS.

9

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10

Subject Index and Acronym List

10.1 Subject Index

Page(s)

10.2 Acronyms

AADT	Average Annual Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ACHP	Advisory Council on Historic Preservation
ADT	Average Daily Traffic
AFB	Air Force Base
ASNH	Audubon Society of New Hampshire
AST	Above-ground Storage Tank
ATF	Advisory Task Force
AWDT	Average Weekday Daily Traffic
B&MC	Boston & Maine Corporation
BG	Block Group
BMPs	Best Management Practices
BRT	Bus Rapid Transit
CAAA	1990 Clean Air Act Amendments
CBSA	Core Based Statistical Area
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, Liability Act
CMAQ	Congestion Mitigation and Air Quality
CNG	Compressed Natural Gas
CO	Carbon Monoxide
COAST	Cooperative Alliance for Seacoast Transportation
CSR	Conway Scenic Railroad
dBA	A-weighted decibels (noise levels)
DDHV	Directional Design Hourly Volumes
DE	Diesel Exhaust
DEIS	Draft Environmental Impact Statement
DGPS	Differential Global Positioning System

DHV	Design Hourly Volume
DMV	Division of Motor Vehicles
DOE	Determination of Eligibility/Effects
DOT	Department of Transportation
ED	Extended Detention
EFH	Essential Fish Habitat
EJ	Environmental Justice
EM	Electromagnetic Geophysical Survey
FAA	Federal Aviation Administration
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FHWA	US Department of Transportation, Federal Highway Administration
FPPA	Farmland Protection Policy Act
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GIS	Geographic Information System
GRS	Guilford Rail System
HABS	Historical American Buildings Survey
HAER	Historic American Engineering Record
HOV	High Occupancy Vehicles
HUD	Housing and Urban Development
IRIS	USEPA Integrated Risk Information System
ISA	Initial Site Assessment
JEL	Jackson Estuarine Laboratory
LEDPA	Least Environmentally Damaging Practicable Alternative
LCIP	Land Conservation Investment Program
LMA	Labor Market Area
LBP	Lead-Based Paint
LOS	Level of Service
LRT	Light Rail Transit
LWCF	Land and Water Conservation Fund
MBTA	Massachusetts Bay Transportation Authority

MPO	Seacoast Metropolitan Planning Organization
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer System
MSA	Magnuson-Stevens Act
MSAT	Mobile Source Air Toxics
NAAQS	National Ambient Air Quality Standards
NAC	Noise Abatement Criteria
NATA	National Air Toxics Assessment (1996)
NCHRP	National Cooperative Highway Research Program
NECTA	New England City and Town Areas
NEPA	Natural Environmental Policy Act
NGDC	National Geodetic Data Center
NHARD	New Hampshire Air Resources Division
NHCP	New Hampshire Coastal Program
NHDES	New Hampshire Department of Environmental Services
NHDHR	New Hampshire Division of Historical Resources
NHDOS	New Hampshire Department of Safety
NHDOT	New Hampshire Department of Transportation
NHDRED	New Hampshire Department of Resources and Economic Development
NHEP	New Hampshire Estuaries Program
NHES	New Hampshire Employment Security
NHF&GD	New Hampshire Fish and Game Department
NHN	New Hampshire Northcoast Railroad
NHNHB	New Hampshire Natural Heritage Bureau
NHOEP	New Hampshire Office of Energy and Planning
NHPA	National Historic Preservation Act
NHS	National Highway System
NHWB	New Hampshire Wetlands Bureau
NLEVS	National Low Emission Vehicle Standards
NMFS	National Marine Fisheries Service
NNEPRA	Northern New England Passenger Rail Authority
NOAA	National Oceanic and Atmospheric Administration

NRCS	Natural Resource Conservation Service
NOx	Nitric Oxide and Nitrogen Dioxide
NPS	National Park Service
NRCS	Natural Resource Conservation Service
NWI	National Wetlands Inventory
OHM	Oil and/or Hazardous Materials
OMB	Office of Management and Budget
PDA	Pease Development Authority
PM	Particulate Matter
PMSA	Primary Metropolitan Statistical Area
PSI	Preliminary Site Investigation
RCRA	Resource Conservation and Recovery Act
REMI	Regional Economic Models, Inc.
RFG	Reformulated Gasoline
ROD	Record of Decision
ROW	Right-of-Way
RPC	Rockingham Planning Commission
RSA	Revised Statutes Annotated
RWIS	Road Weather Information System
SABR	Seacoast Area Bicycle Routes
SCS	Soil Conservation Service (currently NRCS)
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SOV	Single Occupant Vehicle
SPUI	Single-Point Urban Interchange
SRC	Strafford Rivers Conservancy
SRPC	Strafford Regional Planning Commission
SSD	Stopping Sight Distance
STIP	Statewide Transportation Improvement Program
STRY	Springfield Terminal Railway
SWPPP	Stormwater Pollution Preservation Plan
TDM	Travel Demand Management

TIP	Transportation Improvement Program
TMA	Transportation Management Association
TMO	Transportation Management Organization
TSM	Transportation System Management
UA	Urbanized Area
UNH	University of New Hampshire
USACOE	US Army Corps of Engineers
USCG	US Coast Guard
USDA	US Department of Agriculture
USDOI	US Department of the Interior
USDOT	US Department of Transportation
USEPA	US Environmental Protection Agency
USFS	US Forest Service
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
UST	Underground Storage Tank
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compounds
VPD	Vehicles Per Day
VPH	Vehicles Per Hour
W&P	Woods & Poole Economics, Inc.
WHPA	Wellhead Protection Area

11

Project Commitments

The following commitments have been made by NHDOT and FHWA to address or mitigate possible impacts associated with the Selected Alternative. See Chapters 4 and 5 for additional discussion and details.

A. Transportation and Highway Design

1. Relative to commercial vehicles accessing and exiting the Wentworth Terrace neighborhood and Hilton Drive, the proposed improvements to Hilton Drive in the vicinity of Wentworth Terrace and Hilton Park (including the local connector roadway traversing under the Turnpike and adjacent to the channel) will be designed to accommodate tractor-trailer trucks. Also, as suggested, a portion of Hilton Drive extending north from the existing ramps to the pump station will be retained to create a loop road for trucks to more easily exit the neighborhood.

2. The General Sullivan Bridge, an historic bridge eligible for the National Register of Historic Places, will be rehabilitated to a six-ton loading capacity to continue to function as a pedestrian/bicycle/recreational facility and to accommodate emergency response and maintenance vehicles from Newington.

3. The Exit 6 proposed improvements at the US 4/Spur Road, Spur Road/local connector, and local connector/Boston Harbor Road intersections will be designed to safely and efficiently accommodate heavy commercial vehicles including tractor-trailer trucks.

4. In Dover, new sidewalks will be constructed in the following locations:

   - Along the west side of Dover Point Road, between Hilton Park and the existing sidewalk located opposite the Division of Motor Vehicles (DMV) property;
   - Along the north side of Spur Road between the Bayview Park parking area and the Scammell Bridge;

- Along the west side of the connector road between Spur Road and Boston Harbor Road and along the west side of Dover Point Road;
- Along the new two-way connector beneath the Little Bay Bridges as described above; and
- Along Hilton Drive connecting to the reconstructed walkway along Pomeroy Cove.

Sidewalk construction is contingent on the City of Dover agreeing to accept maintenance responsibilities (both winter and summer maintenance) for the sidewalk in accordance with its accepted policies and practices as mandated in RSA 231:92-a. A municipal agreement between the City and the NHDOT documenting maintenance responsibilities will need to be executed prior to these sidewalks being incorporated into the project.

5. As part of the project in Dover, the NHDOT proposes to build minimum 4-foot wide shoulder areas, which will accommodate bicycles, along the reconstructed segments of Dover Point Road, US 4, Spur Road, Hilton Drive, along the new two-way connector beneath the Little Bay Bridges, and along Hilton Drive connecting to the reconstructed walkway along Pomeroy Cove.

6. Retaining walls, ranging from 4 to 14 feet in height, will be constructed along the west side of the Turnpike to reduce slope impacts on the properties between the Turnpike and Dover Point Road.

7. Retaining walls, ranging from 4 to 18 feet in height, will be constructed along the east side of the Turnpike to avoid impacts to Pomeroy Cove and to limit slope impacts on the properties in the Dover Point Road/Cote Drive neighborhood.

8. The existing bicycle/pedestrian path abutting Pomeroy Cove and connecting Hilton Park and Wentworth Terrace to Dover Point Road will be maintained.

9. The two existing driveways that presently service parcel N031 (Exxon/Mobil gas station/convenience store in Newington) will be maintained. The present driveway on Nimble Hill Road will have direct access to and from the Turnpike on-ramp, but will be restricted to right turns in and out. The second driveway will have a direct connection to the new local connector road that is proposed south of the gas station.

10. A local roadway, which would provide access to the gas station, Thermo Electron, and one other parcel (with existing direct access to the Turnpike) will be constructed as part of the project. This local roadway could also provide access to the former drive-in property *via* the roadbed of the existing southbound Turnpike if that property is developed in the future.

11. In Newington, new or reconstructed sidewalks will be included in the project on both sides of Woodbury Avenue between Fox Run Road and Exit 3. The sidewalk on the north side of the roadway will be extended through the interchange, across the Turnpike and into the Tradeport on Arboretum Drive.

    Sidewalk construction is contingent on the Town of Newington agreeing to accept maintenance responsibilities (both winter and summer maintenance) for the sidewalk in accordance with its accepted policies and practices as mandated in RSA 231:92-a. A municipal agreement between the Town and the NHDOT documenting maintenance responsibilities will need to be executed prior to the sidewalks being incorporated into the project.

12. Roadside shoulder areas (4 to 5 feet wide) to accommodate bicyclists are proposed in Newington within the limits of the project along Woodbury Avenue, the bridge over the Turnpike within the Exit 3 Interchange area, and along the reconstructed sections of Arboretum Drive.

13. The project will include provisions for a future Railroad Spur over the Turnpike into the Pease Tradeport. Right-of-way and easements will be procured as part of the project and a portion of the railroad bridge's pier foundation will be constructed within the median of the Turnpike. An agreement between the NHDOT and the PDA (with concurrence from FHWA if federal funds are to be used) will also be secured as part of the project to outline a shared cost arrangement should the rail spur be constructed in the future.

14. In addition to the already completed Transportation System Management provisions identified in the FEIS, NHDOT will implement short-term relief prior to the project at Exit 6 by re-striping the Exit 6 southbound on-ramp area to create two through lanes on the Turnpike and a one-lane on-ramp from US 4, as well as closing the existing access ramp from Boston Harbor Road.

15. Early implementation of these Travel Demand Management actions will also provide greater options to study area commuters during construction:

    - A new park-and-ride facility consisting of 416 spaces is under construction at the Exit 9 area in Dover. The facility is a separate project under the CMAQ program. Construction is scheduled to be completed in 2008 and will complement the COAST express bus service and Dover's planned downtown transit loop service.
    - A park-and-ride facility consisting of approximately 200 spaces will be pursued at the Exit 13 area in Rochester either under the CMAQ program or as part of the Rochester 10620H project (currently planned to advertise in 2008).
    - A park-and-ride facility consisting of approximately 30 to 50 spaces will be pursued for the US 4/NH 125 intersection area in Lee to accommodate

travelers using US 4 eastbound. The NHDOT also recommends advancement of this project under the CMAQ program.

16. To improve bus service in the seacoast area and reduce peak hour headways to provide a more attractive and reliable mass transit mode of travel, three bus alternatives will be advanced with capital investments and consideration of operating subsidies up to a maximum of five years. The items could be accomplished through the CMAQ program or with project-related funds and are intended to mitigate for the potential increased levels of congestion during construction and overall dependency on SOV travel in the region.

    - Bus Alternative 1, involving expanded intercity service for Rochester, Dover, Portsmouth and Boston to serve the commuter market.
    - Bus Alternative 2, involving expanding the planned COAST express bus service among Rochester, Dover, and Portsmouth to reduce headways during the peak period for the planned express commuter bus service.
    - Bus Alternative 3, involving improving connectivity and headways for three existing bus routes: COAST Route 2 service between Rochester and Portsmouth; Wildcat Transit Route 4 service between Durham and Portsmouth; and COAST Tradeport Trolley services which connects these two routes with the Tradeport.

17. NHDOT has provided support for expansion of the *Downeaster* service through a joint-sponsored CMAQ project (total cost $6.0 million) by the Maine DOT, NHDOT and NNEPRA for Rail Alternative 1C, which funded track and siding improvements in Maine and New Hampshire to allow NNEPRA to operate a fifth weekday roundtrip between Portland and Boston beginning in August 2007.

18. To support the promotion of employer-based measures to encourage travel other than by SOV, NHDOT will support funding for the seacoast area TMA, Seacoast Commuter Options, to help supplement the service for a maximum period of five years. This extension of funding could be accomplished through the CMAQ program or with project-related funds.

B. Socio-Economic Resources

1. Property requiring acquisition will be appraised utilizing techniques recognized and accepted by the appraising profession and in conformity with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended, and applicable to New Hampshire State Law.

2. Completed appraisals will be reviewed by an independent appraiser to ensure that requirements of condemnation law and acceptable appraisal methods are met.

3. Two businesses will be acquired under the Selected Alternative. The displaced businesses are eligible for relocation benefits, which include:

   - Fair market value for acquired property
   - Relocation advisory assistance services
   - Payments for actual reasonable moving
   - Business re-establishment costs

C. Wetland Resources

1. Compensation for unavoidable losses of wetlands and other natural resources will include a combination of restoration/enhancement and preservation.

2. NHDOT and FHWA will collaborate with the affected communities and the state and federal resource agencies, as well as area conservation organizations such as the SRC and TNC, to protect approximately 150 – 250 acres at three sites in Dover and Newington, described below.

   Preferred Preservation Properties:

   - **Tuttle Farm, Dover** – In response to the property owner's request, NHDOT, in partnership with the City of Dover, has expedited the acquisition of a conservation easement on the Tuttle Farmstead to permanently preserve the 120-acre farm. The preservation was consummated on January 29, 2007 with the conservation easements executed and property rights on 109.1 acres transferred to the City, the NHDOT, and the SRC.
   - **Watson Property, Newington** – This 35-acre parcel would protect upland forest and tidal wetlands adjacent to Little Bay at Trickys Cove precluding further coastal development.

   - **Blackwater Brook Preserve, Dover** – NHDOT and FHWA will continue to work with the City to permanently protect a large portion of the 105-acre Tsimekles property in the Blackwater Brook watershed. If an agreement to acquire a large portion of the Tsimekles parcel is not reached, NHDOT and FHWA will work to acquire 30 to 40 acres of one or more of the several other parcels in the Blackwater Brook area that are deemed worthy of preservation and permanent protection.

   Alternative Preservation Properties:

   - Knight Brook Riparian Corridor, Newington - If negotiation for an easement on the Watson Property is not successful, then NHDOT will pursue preservation of approximately 60 to 70 acres in the Knight Brook area. More than 100 acres in this area have been identified as appropriate for preservation. These parcels lie adjacent to the recently-preserved Frink Farm and would provide additional expansion of a large contiguous area of preserved land extending to Fox Point.

3. NHDOT and FHWA will work with the affected communities and the state and federal resource agencies to determine the conditions of the conservation easement and easement interest holders for the Watson Property, as well as any parcel protected in the Blackwater Brook area or Knights Brook area.

4. NHDOT and FHWA will collaborate with the Town of Newington, the Pease Development Authority and the state and federal resource agencies to restore approximately 3,100 linear feet of Railway Brook (Restoration Alternative A), a portion of a heavily impacted perennial stream on the property of the Pease International Tradeport. This mitigation measure will include restoration and expansion of floodplain wetlands adjacent to the stream within an approximately 300-foot wide corridor. The restored riparian corridor, including adjacent upland buffer, would be preserved by establishment of a permanent conservation easement.

D. Drainage and Water Quality

1. In Newington, at least five extended-detention basins or other appropriate BMPs will be designed for stormwater treatment, with three of the basins in the lower Pickering Brook watershed.

2. Numerous grassed swales will also be used to treat runoff from various roadway sections especially around the proposed Woodbury Avenue Interchange area.

3. As part of the project's final design, NHDOT will closely review and evaluate the existing drainage conditions on Dover Point. Careful attention will be exercised to identify drainage-related issues along the Turnpike on Dover Point and not exacerbate the deficient conditions. This will include properly graded and constructed ditches and other drainage appurtenances to prevent the ponding of water adjacent to private property to the degree practicable.

4. In Dover, at least three extended-detention basins or other appropriate BMPs will be constructed to receive and treat runoff from much of both the existing and new roadway areas. Numerous grass swales will also be included to treat smaller sections of roadway that cannot be directed to the extended-detention basins.

5. A pollutant loading analysis using Schueler's Simple Method (Schueler 1987), or another method approved by the NHDES, will be completed during the preliminary stage of the final design. If needed, additional or revised BMPs, such as gravel wetlands, will be included to ensure to the maximum extent practicable that the project results in no net increase in estimated pollutant loading relative to existing conditions.

6. NHDOT will evaluate the feasibility of constructing a closed drainage system on the widened LBB to minimize direct stormwater discharge to the Little Bay and Piscataqua River.

7. NHDOT will continue to investigate various measures and technologies as a means of reducing overall salt use in the project corridor.

8. To minimize the potential for water quality impacts during construction, the NHDOT will require construction contractors to provide detailed erosion control plans including contingency measures and periodic turbidity monitoring of the site discharge during wet weather events.

9. Contractors will also be required to develop a SWPPP, which requires NHDOT approval. Frequent inspections of construction sites will be required to maintain compliance with permit conditions.

E. Navigation

1. Reconstruction of the LBB will maintain the existing limiting vertical clearances for the 100 ft and 200 ft navigation corridors (horizontal clearance) and the extension of bridge piers will maintain existing alignments to eliminate potential impacts to navigation.

2. The plans for the reconstruction of the Little Bay and General Sullivan Bridges will be submitted to the USCG to address the reasonable needs of navigation, as well as the reasonable needs of land traffic (*i.e.,* highway users), and to procure the necessary USCG permit.

F. Marine Resources

1. A sediment sampling and analysis program will be conducted prior to construction in order to properly plan and mitigate potential impacts from suspension of contaminated sediments.

2. Additional measures will be developed in consultation with state and federal resource agencies and other experts as needed if contaminants in the marine sediments exceed NOAA thresholds for ecological or human health risk.

3. Stringent requirements will be incorporated into the final design plans to require the selected contractor to minimize any movement of sediment beyond the work area, even if sediments are determined to be free from contamination.

4. It is anticipated that all work on the bridge piers will be conducted behind sealed cofferdams, which will substantially limit the movement of suspended sediments. The NHDOT will conduct regular inspections of the measures designed to minimize this risk.

5. The NHDOT will coordinate the design, methods and anticipated schedule of the pier construction during the project's final design with the NHF&GD as well as with the USACOE, the USFWS, and the NMFS to reduce, to the extent practicable, the potential temporary effects that construction activities may have on anadromous fish.

6. NHDOT will coordinate with the NH Estuaries Project to locate and avoid impacts to the existing shellfish monitoring station located between Pier 8 of the Little Bay Bridges and the Dover shoreline.

G. Floodplains

1. Measures to minimize or eliminate direct impacts to the 100-year floodplain will continue to be considered during final design by steepening highway embankments and/or utilizing retaining walls, where appropriate.

2. NHDOT has and will continue to coordinate the project with both Dover and Newington and will seek to further minimize floodplain impacts during the project's final design, to the extent practicable.

H. Groundwater

1. To help reduce potential impacts to groundwater recharge, NHDOT will examine the use of infiltration technology during final design of the reconstructed drainage system. Such measures would be incorporated into the drainage design to allow stormwater to infiltrate back into the ground following treatment.

I. Noise

1. The Selected Alternative will generally maintain the existing vertical alignment to minimize noise impacts.

2. If desired by a 75% majority of the benefited first row property owners, four large noise barriers will be constructed in Dover in the following locations:

   - Dover Point Road area (Noise Barrier #1, 4,100 feet long, 14 feet high)
   - Wentworth Terrace and Cote Drive areas (Noise Barrier #2, 4,200 feet long, 14 feet high)
   - Spur Road and Clearwater Drive areas (Noise Barrier #3, 3,600 feet long, 12 feet high)
   - Homestead Lane and Pearson Drive areas (Noise Barrier #4, 3,700 feet long, 14 feet high)

Additional meetings with the benefited property owners will be held to discuss the noise barriers and ascertain whether the barriers are desired or not. In accordance with NHDOT's Policy and Procedural Guidelines, a minimum of 75% of the first row property owners will need to support the installation of the barrier in order for it to be constructed.

3. The Spur Road/Clearwater Drive barrier and the Homestead Lane/Pearson Drive barrier will extend north of the toll plaza to provide abatement to an additional 25 residences.

4. In an effort to minimize construction noise, proposed noise barriers will be built as soon as practicable so that they may provide a reduction in subsequent construction noise to the residences.

5. During neighborhood meetings, more detailed information on the type, height, special features, and length of the noise barriers will be discussed and input gathered for consideration in the final design of the barriers where determined feasible.

6. NHDOT will strive to design the noise barriers to be as low as possible while still achieving the necessary noise reductions, and will consider various architectural treatments and landscaping during the final design phase to mitigate the visual impact of the barriers.

7. As part of the project's final design effort, NHDOT will investigate the merits and feasibility of utilizing "quiet pavement" or "porous pavement" to reduce to effect of tire noise throughout the project area.

J. Recreational Resources

Hilton Park

1. Continued access from the park to the rehabilitated General Sullivan Bridge will be provided by an ADA-compliant ramp located in the western portion of Hilton Park.

2. Safer access to the Park and to the eastern and western sides of Dover Point will be provided by the widening of the existing single-lane loop road.

3. NHDOT will work with NHDHR to develop and erect an informational sign that explains the history and significance of the park and the General Sullivan Bridge.

4. Reasonable efforts will be made to minimize impacts to the park during construction, including preventing unnecessary disturbance of areas outside the existing right-of-way and maintaining safe access to the park.

5. NHDOT will continue to coordinate with the NHF&GD and NHDRED to determine whether improvements to the boating infrastructure at Hilton Park could be accomplished concurrently with the Little Bay Bridge and Turnpike Expansion project.

Bayview Park

1. NHDOT will provide improved access to Bayview Park. Pedestrians and bicyclists will benefit from improved access as NHDOT intends to construct a sidewalk connecting the park to the Scammell Bridge and to Boston Harbor Road.

2. The existing parking lot will be expanded from six to ten spaces by extending the parking area to the southwest to benefit users of the park, as well as anglers using the Scammell Bridge and adjacent shoreline to fish.

3. Reasonable efforts will be made to minimize impacts to the park during construction, including preventing unnecessary disturbance of areas outside the authorized right-of-way, and maintaining safe access to the park for vehicles, pedestrians and bicyclists.

K. Visual Resources

1. Landscaping and design treatments will be developed at the final design stage to minimize the aesthetic impact of the proposed action. Measures to be studied will include:

   - Minimization of tree clearing and setback areas to the extent practicable.
   - Planting of new trees in select locations to mitigate for the mature trees that will be lost due to construction.
   - Landscape planting and natural revegetation of the cut and fill slopes for the mainline and at all interchanges and, as appropriate, at off-site park-and-ride facilities.
   - Structural design and aesthetic considerations for drainage structures, bridges, noise barriers, *etc.* to enhance their visual appearance.
   - Highway lighting at interchanges and park-and-ride facilities will be designed with "cut offs"(shields) or similar features to limit unwanted light where appropriate.
   - Landscaping amenities will be considered in conjunction with the noise barriers, wherever practicable.
   - Landscape screenings or privacy fences to minimize the visual impact of the highway and mitigate for the loss of existing vegetative screening will be considered and evaluated as part of the discussions with affected property owners during the project final design.
   - Potential use of transparent materials in noise barriers at Pomeroy Cove to enable continued viewing of this aquatic resource.

2. NHDOT proposes to plant evergreen trees alongside US 4 to shield the pocket neighborhood on Boston Harbor Road from headlight glare and the increased

elevation of US 4. The evergreen trees will over time help to obscure the highway.

L. Cultural Resources

Historical Structures

1. A reduced cross-section for Woodbury Avenue will be constructed in front of the Isaac Dow house (NWN0205) and Beane Farm (NWN0204) property to minimize impacts to these two historic resources.

2. Mitigation for impacts to the Beane Farm will include planting of new silver maples and lilacs on the property in consultation with the owner and their placement in relation to the power lines to avoid the need for future trimming.

3. Mitigation for the Isaac Dow House will include replacement of the granite slab wall in-kind and appropriate landscaping with shrubs in consultation with the owner.

4. Mitigation for the adverse effect to the Portsmouth Water Booster Station (NWN0228) will be accomplished by leaving a tree buffer between the Turnpike and the historic structures and by its documentation within its Determination of Eligibility.

5. Mitigation for impacts to the General Sullivan Bridge (DOV0158) will include its rehabilitation for use by pedestrians and bicyclists and its continued use for fishing.

6. Work on the bridges will be accomplished in a manner that will not impact the adjacent Hilton Park Picnic Shelter.

7. Mitigation for the property taking at the Ira Pinkham House (DOV0093) will involve producing a state-level Historic American Building Survey for the dwelling, documentation of the barn's structure in the same document, preparation of preservation covenants for the house and barn, marketing the barn for relocation if structurally feasible, and marketing the dwelling if the property is acquired in total.

8. NHDOT will continue to work with the Town of Newington to develop an agreement to transfer the historic former railroad station on Bloody Point and the land immediately surrounding the building to the Town.

Archaeological Resources

1. NHDOT will initiate Phase I-B archaeological investigations in the sensitivity areas that are impacted by the Selected Alternative, as discussed in Section 4.17, in

compliance with May 2004 Phase I-B guidelines for fieldwork and report writing defined by the Bureau of Environment, NHDOT Guidelines.

2. Continued study will be conducted at the impacted verified site on the southern tip of Dover Point (Area 21) to determine its eligibility status for the National Register of Historic Places following a Phase II survey strategy as recommended by NHDOT Guidelines.

3. Temporary construction fencing will be installed between all unimpacted verified sites and the work zone, including at Areas 23, 46 and 74 in Newington, and Areas 9 and 13 in Dover. If needed to ensure accurate placement of the fencing, the boundaries of these sites will be defined through Phase I-B testing.

4. Mitigation for all impacted verified sites will be developed in consultation with NHDHR and other interested parties following completion of Phase II studies. Mitigation may include the following, depending on the site:

   - Preservation in-place may be necessary, requiring a change in design or location, where feasible and prudent, to satisfy Section 4(f). In some cases, the location of the corridor may be moved slightly or work adjacent to the site may be modified so that the site will not be impacted by the Selected Alternative.
   - If preservation in-place is determined unnecessary, then recovery of the information from the site will be accomplished by implementing a data recovery plan under a Phase III investigation.
   - In a few cases, excavation using a data recovery plan may be conducted on a previously identified unimpacted archaeological site in the vicinity of the alignment and of a similar age, type, function, and composition. This form of mitigation would be completed prior to the completion of the project. However, its excavation can continue while work commences within the corridor.

5. Where archaeological information is gained through the excavation of sites associated with this project, NHDOT will assist in distributing information to the public through such venues as site reports, public lectures, school programs, interpretive brochures, and, depending on the nature of the site, public visitation during investigations.

M. Petroleum, Hazardous Materials and Solid Waste

1. Initial Site Assessments (ISAs) will be performed for those properties that could pose a risk related to potential contamination if encountered along the Selected Alternative.

2. Following completion of the ISA, and if determined to be warranted, NHDOT will perform a Preliminary Site Investigation (PSI) to determine if contaminant levels require remediation in accordance with NHDES regulations.

3. If necessary, NHDOT will coordinate with the NHDES to develop an appropriate remedial action plan for any acquired property determined to contain hazardous materials warranting clean up.

4. If contaminated materials are expected to be encountered during construction, appropriate worker health and safety provisions and waste management provisions will be identified. Provisions may include health and safety plans (HASPs) and soil/groundwater management plans for excavation and on/off-site management of waste materials. All work will be performed in accordance with applicable NHDES regulations and NHDES-approved remedial action plans.

5. Prior to any scheduled building, utility or bridge demolition or reconstruction, a comprehensive environmental audit will be performed on the structure to identify and quantify all regulated building materials and special wastes. Materials and wastes that will be inventoried include the following:

   - Asbestos
   - Lead-based paint (LBP)
   - Polychlorinated biphenyls (PCBs) within fluorescent light ballasts
   - Electrical transformers that may contain PCB dielectric oil
   - Mercury-containing fluorescent light bulbs
   - Mercury thermostats
   - Miscellaneous containers of oil or hazardous materials
   - Refrigerants (air conditioners, refrigerators)
   - Hydraulic lifts
   - Above-ground storage tanks
   - Underground storage tanks

6. Based on the findings of the environmental audits, abatement plans will be prepared to address the removal of all regulated building materials as needed.

7. Exposure assessments (air monitoring) will be performed on employees engaged in demolition work that may disturb lead paint or other hazardous substances. Such work will be conducted by properly trained workers using appropriate worker protection and engineering controls.

8. Bridge contractors will be required to fully enclose the General Sullivan Bridge during any work involving LBP removal and provide the material and execution requirements for the installation and use of containment systems for the paint removal.

9. Implementation of an Environmental Protection Plan for the protection of the public and the environment from exposure to harmful levels of dust, paint debris, and lead and other toxic metals that may be present in the paint being removed or repaired will also be required for the reconstruction of the bridges.

N. Construction Impacts

1. To mitigate potential sedimentation impacts by construction, a SWPPP containing a well-defined drainage and erosion control program, including BMPs, will be developed and implemented following *NHDOT's Standard Specifications for Road and Bridge Construction, Section 699, Temporary Project Water Pollution Control (Soil Erosion)*.

2. The drainage and erosion control program will require that areas stripped of vegetation be limited in size and either surfaced or vegetated as quickly as possible after initial exposure. Other measures such as silt fencing, temporary settling basins, temporary erosion check dams and other measures will be installed in appropriate locations.

3. BMPs for fertilizer application during construction be followed to limit potential water quality impacts.

4. Mechanisms and procedures to avoid and control chemical leaks and spills from construction equipment will be instituted.

5. NHDOT will ensure that all erosion control measures are properly installed and maintained throughout construction to ensure their maximum functionality and effectiveness.

6. In general, construction will be accomplished during daylight hours, although periodic night-time construction should be expected given the traffic volumes during daylight hours and the need to maintain traffic at these times.

7. NHDOT will continue to coordinate with local and state emergency response personnel to develop efficient incident management procedures and protocols during construction. A detailed Traffic Control Plan, to include incident management procedures, will be instituted to reduce traffic-related, short-term disruptions and minimize construction zone delays.

8. The Traffic Control Plan will include the requirement to maintain two lanes of traffic in both directions along the mainline for normal construction activities, and during high volume traffic periods.

9. Construction activities will be coordinated with property owners to ensure that reasonable access to properties is maintained. Temporary signing and other issues related to the temporary relocation of access points, caused by construction activities, will be appropriately addressed on an individual basis.

10. Intelligent Transportation Systems, such as Smart Workzone Technologies, will be employed to more efficiently manage traffic/travel demand and enhance incident management. Specific Incident Management procedures and protocols will be incorporated into the contract documents and specifications.

11. NHDOT will require the contractors, involved with the improvements to the Spaulding Turnpike, to include air pollution control devices on heavy diesel construction equipment in accordance with applicable state and federal laws at the time of construction. The merits and practicality of more stringent or voluntary specification measures will be considered through the final design process with input from the contracting community at large.

12. Mitigation measures for fugitive dust emissions will be used for construction including wetting and stabilization to suppress dust generation, cleaning paved roadways, and scheduling construction to minimize the amount and duration of exposed earth.

O. Utility Impacts

1. During the project's final design, NHDOT will closely coordinate the project with Town Officials concerning municipal utilities and with the private utility companies concerning their facilities in the project area. Efforts will be initiated to verify the location of existing facilities, to identify potential areas of conflict and the utility relocations necessary to accomplish the proposed construction, and to accommodate requests for concurrent municipal or private utility improvements.

2. Where appropriate, the affected municipalities will be given the option to include utility work, at the municipality's expense, in the construction contract. Any property rights or additional right-of-way required for the utility work would be the responsibility of the Town.

3. NHDOT will work closely with Granite State Gas to limit the extent of relocations to only those that are reasonable and prudent.


VHB
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