I-93 EXIT 4A

SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT/SECTION 4(F) EVALUATION

VOLUME I: MAIN TEXT

NHDOT Project Number: 13065
Federal Project Number: IM-0931(201)
FHWA EIS # FHWA-NH-EIS-07-01-DS

OCTOBER 2018

Federal Highway Administration (FHWA)
New Hampshire Department of Transportation (NHDOT)
Town of Londonderry
Town of Derry

U.S. Department of Transportation
Federal Highway Administration

New Hampshire DOT Department of Transportation

FHWA-NH-EIS-07-01-DS

Derry-Londonderry
IM-0931(201)
13065
I-93 Exit 4A
Rockingham County, New Hampshire

Supplemental Draft Environmental Impact Statement
Submitted Pursuant to 42 U.S.C. 4332(2)(c) and
49 U.S.C. 303, 16 U.S.C. 470(f), 33 U.S.C. 1334
by the
U.S. Department of Transportation Federal Highway Administration,
New Hampshire Department of Transportation,
Town of Derry, and Town of Londonderry

Cooperating Agencies

U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, New Hampshire Department of Environmental Services, and New Hampshire Division of Historical Resources

The following persons may be contacted for additional information concerning this document.

Mr. Jamison Sikora
Environmental Program Manager
Federal Highway Administration
53 Pleasant Street, Suite 2200
Concord, New Hampshire 03301
(603) 410-4870
Jamie.sikora@dot.gov

Mr. Keith Cota
Project Manager
New Hampshire Department of Transportation
7 Hazen Drive
Concord, New Hampshire 03302
(603) 271-1615
Keith.Cota@dot.nh.gov

Abstract: The proposed project is located in the Towns of Derry and Londonderry and involves construction of a new interchange (known as Exit 4A) with Interstate 93. The purpose of this project includes: providing for the safe and efficient movement of people, goods, and services between I-93 and the towns served by NH Route 102, specifically Derry and Londonderry; providing an alternative route to the Interstate system for traffic using NH Route 102 to and from the east; providing improved Interstate access for commercial and industrially zoned lands near NH Route 28; and enhancing and promoting the economic vitality of the downtown Derry area. This Supplemental Draft Environmental Impact Statement (SDEIS) serves as a supplement to the July 2007 DEIS. This SDEIS considers updated information to confirm the underlying conditions and assumptions supporting the purpose and need, the reasonable range of alternatives; and to assess the environmental effects of the Project and the alternatives. Based on this SDEIS, FHWA, with input from state and federal agencies; state, town, and local officials; and the public, will choose a Proposed Action. NHDOT and FHWA anticipate completing the NEPA environmental review process by issuing a Combined FEIS and Record of Decision.

____
Federal Highway Administration
Date: _______________
Patrick Bauer
New Hampshire Division Administrator

____
New Hampshire Department of Transportation
Date: _______________
Peter Stamnas
Director of Project Development

____
Town of Derry
Date: _______________
David Caron
Town Administrator for Derry

____
Town of Londonderry
Date: _______________
Kevin Smith
Town Manager of Londonderry

I-93 EXIT 4A
SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT/SECTION 4(F) EVALUATION

VOLUME I

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

Prepared by:

Fuss & O'Neill, Louis Berger, and Normandeau

October 2018

NHDOT Project Number: 13065
Federal Project Number: IM-0931(201)

This page intentionally left blank.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

[*Figures are included in Volume II of this SDEIS]*

LIST OF APPENDICES

[*Appendices are included in Volume III of this SDEIS]*

1.0 INTRODUCTION

The Towns of Derry and Londonderry, New Hampshire (the Towns), and the New Hampshire Department of Transportation (NHDOT), in cooperation with the Federal Highway Administration (FHWA), prepared this Supplemental Draft Environmental Impact Statement (SDEIS) for the Interstate 93 (I-93) Exit 4A Project (Project). The Project is located in the Towns and includes construction of a new interchange with I-93 (known as Exit 4A) and other transportation improvements to reduce congestion and improve safety along State Route 102 (NH 102), from I-93 easterly through downtown Derry, and to promote economic vitality in the Derry/Londonderry area.

This SDEIS has been prepared in accordance with the requirements of the National Environmental Policy Act (NEPA; Public Law 91-190, 42 United States Code [USC] 4321–4347 as amended) and the regulations of the Council on Environmental Quality (CEQ; 40 Code of Federal Regulations [CFR] 1500–1508), as well as applicable FHWA regulations (23 CFR Part 771; 23 USC 138) and guidance (FHWA, 1987).[1] This SDEIS contains three volumes: Volume I contains all text and tables, Volume II contains all figures, and Volume III contains all appendices. Volume I is organized as follows:

- Chapter 1. Introduction
- Chapter 2. Purpose and Need
- Chapter 3. Alternatives Analysis
- Chapter 4. Affected Environment and Environmental Consequences
- Chapter 5. Indirect Effects and Cumulative Impacts
- Chapter 6. Other Topics
- Chapter 7. Section 4(f) Resources
- Chapter 8. Public Involvement and Agency Coordination
- Chapter 9. SDEIS Distribution List
- Chapter 10. List of Preparers
- Chapter 11. Acronyms
- Chapter 12. References

1.1 Project History

The I-93 Exit 4A Project dates back to 1985 when the Town of Derry first approached NHDOT regarding the possibility of obtaining funding for a new I-93 interchange. The Southern NH Regional Planning Commission (SNHPC) conducted a transportation study for Derry later that year to evaluate alternatives to relieve traffic congestion along NH 102 in downtown Derry. Based on the results of that study, the Derry Town Council endorsed a new interchange

[1] The referenced regulations and other documentation form the basic guidance requirements in preparing NEPA documents. Subsequent sections of this SDEIS include discussion of additional pertinent regulations, guidance, and Presidential Executive Orders and their applicability to resource impacts.

alternative. In May 1987, the NH Legislature passed empowering legislation that directed NHDOT "…to cooperate with the Towns of Derry and Londonderry in the development of an acceptable design for a new exit to I-93 between existing Exits 4 and 5 to serve the Towns of Derry and Londonderry." Funding for the Project was to be provided by the Towns, and it was required that the Project meet current NHDOT highway design standards. Following the passage of this legislation, the Towns initiated preliminary planning and engineering in June 1987.

In 1988, the Towns submitted an application for approval of a break in the limited access right-of-way (ROW) for a new interchange on I-93 between existing Exits 4 and 5 to NHDOT and FHWA. FHWA approved this application in 1991, subject to several conditions, including the condition that the Project would need to meet NEPA requirements. FHWA later determined that an Environmental Impact Statement (EIS) must be completed for the Project. Additionally, FHWA approved only easterly access from the interchange. Although the potential for access to the west had to be considered in the planning process, it required its own independent approval process for any future consideration.

In 1996, State Senate Bill 581 was drafted to eliminate the exclusive Town funding requirement. Senate Bill 581 became unnecessary when State House Bill 1025 passed in 1996. House Bill 1025 endorsed NHDOT's 10-year plan, which included this Project and made it eligible for the use of state or federal funding.

After Derry and Londonderry each approved $5 million in bond authorization for the Project in 1997, the formal EIS process began in 1998, and the Notice of Intent was published in the Federal Register on June 12, 1998 (Vol. 63 No. 113). The environmental document, public involvement, and preliminary design analysis process began with the formal scoping process on June 30, 1998. Twenty-two meetings then solicited input from federal, state, and town officials and the public. The meeting groups included the Citizens Advisory Technical Committee (CATF) and Technical Advisory Committee (TAC), which comprised Town representatives, regional and state planners and engineers, and the public. A major purpose of the early public involvement was to obtain input on identifying a reasonable range of alternatives for the Project.

At each step of the environmental review process, meetings were held with natural, cultural, and socioeconomic resource agency staff members. Proposed alternative alignments and associated impacts were discussed, and input was received from agency members to ensure concurrence with federal and state permitting authorities. Site walks of the remaining alternatives and potential mitigation sites were held with the resource agencies on March 1, 2000; May 23, 2006; and June 15, 2006. The Project was also presented at U.S. Environmental Protection Agency (EPA) headquarters in Boston, Massachusetts, on February 27, 2003, at its secondary impact workshop.

Based on input received from the resource agencies in January 2003, FHWA suggested that the Towns perform additional socioeconomic-related studies. Because of financial considerations required for studying additional topics of concern, the Towns paused the Project in February 2003. In June 2005, the Towns recommenced the EIS review process. Because of the delay in the review process, field and database constraints information, as well as traffic information for the Project, was updated to reflect 2005 conditions.

In March 2006, at a meeting with federal, state, and town officials, a comprehensive summary was presented and discussed comparing the advantages and disadvantages of the alternatives under consideration. The Towns subsequently selected Alternative A as their preferred alternative, a new Exit 4A interchange located approximately 1 mile north of Exit 4. The resource agencies concurred with the selection of the preferred alternative. The Draft EIS (DEIS) was then developed in anticipation of an upcoming public hearing. The Notice of Availability of the DEIS was published in the Federal Register on August 3, 2007 (Vol. 72, No. 149).

The 2007 DEIS publication was followed by a joint NHDOT, New Hampshire Department of Environmental Services (NHDES), and U.S. Army Corps of Engineers (USACE) public hearing held on September 12, 2007, at the Derry Municipal Center. On March 3, 2008, a necessity meeting was held at the Derry Municipal Center to update the special committee members on comments received at the September 12, 2007, public hearing and to review the Towns' responses. At the conclusion of that meeting, the special committee voted unanimously to approve the necessity of the Project.

Between March 2008 and December 2010, work progressed on addressing comments received on the DEIS. These efforts were initially limited to collecting one year of stream monitoring data for chlorides and performing a vernal pool field study in the spring of 2009. Between 2009 and 2011, work included development of a preliminary draft Final EIS (FEIS) and further development of mitigation for wetland and vernal pool impacts. Funding issues then put completion of the FEIS on hold.

In October 2015, Governor Maggie Hassan directed NHDOT to accelerate the Project and prioritize it for inclusion in the state's Ten-Year Transportation Improvement Plan for 2017–2026. NHDOT and the Towns subsequently entered into an agreement under which NHDOT will provide administrative oversight for the completion of the environmental review process and transition the Project to NHDOT for final design and construction.

Because significant time has elapsed since the 2007 DEIS, FHWA requested preparation of an SDEIS in accordance with NEPA (see Section 1.3 for additional details). The revised Notice of Intent for the SDEIS was published in the Federal Register on December 8, 2016 (Vol. 81, No. 236). This SDEIS provides a comprehensive reevaluation of the Project, considering changes in environmental regulatory requirements, existing conditions, expected future conditions, and Project design.

1.2 Project Study Area

The study area defined for the initial screening of alternatives encompassed approximately 26 square miles within western portions of Derry and eastern Londonderry in western Rockingham County, NH (Figure 1.2-1). A large study area was necessary at that stage of the Project to consider a wide range of potential alternatives for meeting the Project's purpose and need. The 26-square-mile study area was concurred with by the federal and state regulatory/resource agencies at an agency scoping meeting on July 30, 1998 and also used for the 2007 DEIS. For this SDEIS, the study area for each resource was redefined to focus data collection and reporting on existing conditions to the area where there is the potential for direct impacts from the five Build Alternatives (A, B, C, D, and F). Chapter 4 contains the rationale for each of the updated resource study areas. Finally, a larger, five-town study area is used to identify potential indirect effects and cumulative impacts related to the Project (see Chapters 5 and 6).[2]

1.3 Requirements Met by This Supplemental Draft Environmental Impact Statement

NEPA requires a supplemental EIS when changes in the proposed action or new circumstances would result in significant environmental impacts not evaluated in the previous DEIS or FEIS (23 CFR 771.13). The purpose of this SDEIS is to provide an up-to-date assessment of the I-93 Exit 4A Project that considers changes in alternatives design (through updated preliminary engineering studies), changes in the existing environment, changes in environmental regulations, and other “significant new circumstances or information relevant to environmental concerns have a bearing on the proposed action or its impacts” (40 CFR 1502.9 (c)(1)). New circumstances affecting the Project include, but are not limited to: the final design for the ongoing widening of the I-93 mainline in the Project area; approved developer plans for a new, mixed-use development on both the east and west sides of I-93 (Woodmont Commons); the chloride total maximum daily load (TMDL) for the Beaver Brook watershed, Chloride Reduction Implementation Plan and reissuance of the Municipal Separate Storm Sewer System (MS4) general permit; and updated demographic projections affecting future travel demand.

Pursuant to CEQ and FHWA regulations, the SDEIS is subject to the same distribution and public review requirements as the previously published DEIS, except that scoping is not required (23 CFR 771.130(d)).

Because significant time has elapsed since the 2007 DEIS, FHWA requested documentation of updated studies in the SDEIS in accordance with NEPA. Updated studies and associated documentation began in June 2016 to document changes in baseline conditions. This SDEIS considers the updated information to confirm the underlying conditions and assumptions supporting the purpose and need, and range of alternatives; and to assess the environmental effects of the Project and reasonable alternatives. Updated information includes, but is not limited to, traffic, socioeconomic projections, land development proposals in the Project area, and changes in environmental resources and regulatory requirements. After the SDEIS is completed and a preferred alternative is presented at a public hearing, FHWA, with input from state and federal agencies; state, town, and local officials; and the public, will choose a Proposed Action. NHDOT and FHWA anticipate completing the NEPA environmental review process by issuing a Combined FEIS and Record of Decision (ROD).

[2] The limits of the economic study area were agreed upon in consultation with state and federal agency staff at a meeting held on August 25, 2005. Given that there are no major changes in the basic alignment of the alternatives under consideration since the 2007 DEIS, the previously agreed on study area remains reasonable for this SDEIS.

2.0 PURPOSE AND NEED

Taking into consideration agency and public input, the purpose and need for the Project was identified early in Project planning. As noted in Appendix A, for purposes of meeting the guidelines of the USACE Highway Methodology (USACE, 1993), the basic purpose of the Project is to reduce congestion and improve safety along NH 102 from I-93 easterly through downtown Derry and to promote economic vitality in the Derry-Londonderry area. This Project purpose statement was used throughout the planning process for the identification, evaluation, and screening of potential alternatives (CLD, 2000; CLD, 2001).

2.1 Purpose

The purpose of this Project includes:

- providing for the safe and efficient movement of people, goods, and services between I-93 and the towns served by NH 102, specifically Derry and Londonderry, that are immediately adjacent to I-93 Exit 4;
- providing an alternative route to the Interstate system for traffic using NH 102 to and from the east, thus removing a large volume of through traffic from the heavily congested downtown Derry street network;
- providing improved Interstate access for commercial and industrially zoned lands near State Route 28 (NH 28) in both Derry and Londonderry, thus allowing for the planned and orderly development of such lands to further locally defined economic development goals and tax base diversification; and
- enhancing and promoting the economic vitality of the downtown Derry area, presently characterized by traffic congestion and decreasing vehicular and pedestrian safety, by separating local, destination-oriented traffic from through traffic destined for the Interstate system.

2.2 Need

The Towns of Derry and Londonderry, working with FHWA, NHDOT, and CATF,[3] identified several factors demonstrating the need for transportation improvements within the study area, including traffic congestion in downtown Derry, economic vitality, and safety. Each of these aspects of the Project need is discussed below taking into account changes in traffic data and economic development opportunities since the 2007 DEIS.

2.2.1 Traffic Congestion in and around Downtown Derry

NH 102, known as Broadway, is the principal east-west roadway through both Derry and Londonderry and serves as the major route for traffic accessing I-93 via Exit 4. The section of NH 102 passing through downtown Derry serves as its “main street.” The “downtown” area begins at the NH 102/Fordway intersection and progresses easterly to the NH 102/NH 28

[3] The Citizens Advisory Technical Committee (CATF) was formed to offer opportunities for stakeholders to provide input into the Project planning process. The CATF included local officials, interested citizens, and federal and state agency staff. Chapter 11 includes a list of the CATF members and a summary of the highlights of Project meetings, including the scoping meetings.

intersection (Figure 2.2-1). It is currently a two-lane road from I-93 easterly through the downtown area, with several traffic signals and numerous intersections with side streets, on-street parallel parking, and a steady flow of pedestrian traffic. As a result of these complicating and often conflicting functions, downtown Derry experiences considerable congestion as locally oriented traffic intermingles with Interstate-bound through traffic.

Although operating near capacity, the updated traffic analyses conducted for 2015 existing conditions and the 2040 No Build condition generally show acceptable peak hour Level of Service (LOS) D at the major intersections along NH 102 through downtown Derry, including the NH 102/NH 28 (Crystal Ave/Birch Street) intersection. Traffic volumes in downtown Derry are projected to increase by approximately 15 percent between 2015 and 2040. Larger traffic increases and higher levels of congestion (LOS E or F) are not projected for Derry because of the availability of alternative routes to disperse traffic. The existing two-lane road is not capable of handling higher volumes without traffic flow breaking down. Therefore, traffic avoids the downtown NH 102 corridor, diverting to other local roads such as Folsom Road and Londonderry Road as alternative access routes to Exit 4. This situation has been observed on Folsom Road where traffic has increased from about 8,700 to 11,768 annual average daily traffic (AADT) between 1998 and 2015.

The traffic diversions to local roads to avoid NH 102 result in congestion issues in additional portions of Derry, such as the intersection of North High Street and Ash Street Extension, which is projected to operate at LOS F in the AM and PM peak hours in 2040. As traffic diverts around NH 102 to points easterly, it increases traffic on local streets not designed for high through-traffic volumes. Table 2.2-1 provides a summary of existing and 2040 No Build annual average weekday traffic (AAWDT) along key corridors in the study area (see Figure 2.2-1 for road segment locations).

In addition to congestion in Derry, the Exit 4 interchange is projected to experience congestion issues by 2040, even with the improvements made by the ongoing I-93 widening project and intersection spot improvements proposed by Woodmont Commons. Specifically, the following intersections in the Exit 4 area would operate at LOS E or F in the 2040 No Build condition:

- NH 102 and Gilcreast Road in AM and PM Peak Hour
- NH 102 and I-93 Exit 4 Southbound Off-Ramp in PM Peak Hour
- NH 102 and I-93 Exit 4 Northbound On- and Off-Ramp in AM and PM Peak Hour
- NH 102 and St. Charles Street/Londonderry Road in PM Peak Hour

The I-93 Exit 4 southbound off-ramp to NH 102 is also projected to operate at LOS F in the 2040 PM peak hour.

Table 2.2-1. Summary of 2015 and 2040 No Build Average Annual Weekday Traffic on NH 102 and Roadways Used to Bypass NH 102

Roadway Segment	Adjusted 2015 AAWDT	2040 No Build AAWDT	2015 to 2040 Increase	Percent Increase
NH 102, East of Griffin Street	16,400	18,958	2,558	13%
NH 102, West of Abbot Street	14,350	19,217	4,867	25%
NH 102, at Derry/Chester Town Line	8,200	9,671	1,471	15%
Folsom Road, West of NH 28	11,768	13,839	2,071	15%
Tsienneto Road, West of NH 102	5,394	8,636	3,242	38%
Tsienneto Road East of Pinkerton Street	14,637	19,457	4,820	25%
Ash Street at Londonderry Town Line	6,765	15,716	8,951	57%

2.2.2 Economic Vitality

Economic development issues and opportunities in Derry and Londonderry are discussed in the following sections for each Town. In Derry, constraints related to through traffic are a concern to the accessibility of business downtown. In Londonderry, a large tract of undeveloped land on the east side of I-93 currently has poor highway access and is the subject of the Town's Woodmont Commons Planned Unit Development (PUD) Master Plan to attract regionally significant business opportunities.

Derry

Economic vitality is essential for the Derry downtown area to remain the center of community activity, a clear priority identified in the Derry Master Plan. The 2010 Derry Master Plan notes "The town is also continuing to pursue the I-93 Exit 4A Project which is designed to relieve traffic on NH 102 and promote the safe and efficient movement of people, goods and services. Businesses in downtown Derry will benefit from the completion of the I-93 Exit 4A Project through the reduction of traffic and related congestion and improved accessibility" (Town of Derry, 2010).

Results from the community survey conducted as part of the 2010 Master Plan show that residents of Derry support attracting new businesses and industries to Derry. New businesses with the most support are office development, light industrial, an industrial park, and downtown revitalization. One of the recommendations of the Master Plan is to "continue to research the benefits, challenges and feasibility of Exit 4A." The Master Plan notes the following potential benefits for Derry:

- A direct access route to I-93 for commercial and industrial areas of town
- A bypass for the downtown, which will alleviate some of the current traffic problems and enhance the downtown area
- More connections to existing commercial and industrial areas and opening them up for more development

The Master Plan acknowledges that the existing heavy traffic on NH 102 influences the quality of the downtown area and the businesses located there. Traffic congestion creates a less pedestrian-friendly downtown and likely results in some drivers seeking alternative shopping opportunities and traffic routes. The Master Plan notes several actions that could be implemented to improve conditions for pedestrians and promote a business-friendly environment downtown. Many of the actions recommended in the Derry Master Plan will require alleviation of downtown traffic congestion. The Master Plan states that "Businesses in downtown Derry will benefit from the completion of the I-93 Exit 4A Project through the reduction of traffic and related congestion and improved accessibility." Further economic benefits to both Derry and Londonderry could also be realized by providing access to the existing industrial-zoned land adjacent to the east side of I-93 between Exits 4 and 5.

In 2015, the Exit 4 southbound off-ramp was operating at or near capacity (LOS D) in the AM peak hour and failing (LOS F) in the PM peak hour. The northbound on- and off-ramp was operating at LOS E in the AM peak hour and LOS F in the PM peak hour. This has consequences to the economic well-being of Derry because the Exit 4 interchange currently provides the only direct access between the Interstate and most of Derry's developed area. Although further improvements to the Exit 4 interchange are being constructed as part of the I-93 widening project, traffic congestion and associated safety issues along NH 102 in downtown Derry will continue, as described later in this SDEIS.

Londonderry

Large tracts of undeveloped land are adjacent to the east side of I-93 between Exits 4 and 5, the attractiveness of which for commercial or industrial development would be greatly enhanced by a direct connection to I-93. The proximity of the Manchester-Boston Regional Airport to this area also adds to the development potential of this land. As noted in the *Land Use Scenarios Technical Report* (see Appendix B), a new exit would provide accessibility to existing undeveloped land, thereby enhancing the development potential. The net effect of these development activities would likely be a number of new, high-paying jobs and increased tax revenue for both towns.

Since the 2007 DEIS, additional local planning efforts have further defined the development opportunities near I-93 in Londonderry. In 2013, the Town of Londonderry approved the Woodmont Commons PUD Master Plan covering approximately 630 acres bordering the east and west sides of I-93. The Master Plan envisions a mixed-use urban village being developed in several phases over 20 years, which would support diversification of the tax base. Portions of development on the west side of I-93 are under construction, with completion expected in 2020 (Woodmont Commons Phase I). The Master Plan restricts the quantity and type of development allowed on both the east and west sides of I-93 if Exit 4A is not constructed to limit traffic impacts of development. On the east side of I-93, specifically, coordination conducted during the evaluation for the *Land Use Scenarios Technical Report* (Appendix B) found that a predominately residential development pattern would occur in a No Build scenario (approximately 330 units) as opposed to a mixed residential-commercial pattern. The provision of new Interstate access to the east side of I-93 would allow for substantially higher intensity and combination of development, nearly 700,000 gross square feet (gsf) of commercial and 420,000 gsf of institutional uses based on the land use study (Woodmont Planning Team, 2011).

2.2.3 Safety

Although, as part of the ongoing I-93 widening project the Exit 4 interchange is being reconstructed to handle the projected design-year traffic flows easterly into Derry, the primary design intent is to address the north-south travel demands of the I-93 corridor and not the east-west demands along NH 102. The section of NH 102 that runs easterly into downtown Derry from Exit 4 will continue to have an insufficient number of lanes, especially at the intersections, to handle existing and future peak traffic flows. These peaks are especially high during the heavy evening commuting periods when both through traffic and traffic accessing local businesses are sharing the same roadway. Because the existing road has insufficient lanes to handle the peak traffic volumes, the traffic backs up into the interchange area, which results in increased safety hazards for the traveling public. Several intersections with higher crash rates based on analysis of 2013–2015 crash data are located along NH 102 in the study area, including at Gilcreast Road, Garden Lane/Hampton Drive, and the I-93 Exit 4 Northbound Ramps.

Between 2010 and 2014, there were 716 crashes in the Exit 4A study area, including 240 crashes along NH 102 between Exit 4 and Tsienneto Road (NHDOT, 2010–2014). Of the total, approximately 24 percent resulted in an injury or fatality. If traffic using NH 102 to the east could be moved away from the interchange area more efficiently, traffic congestion at the ramp intersections could be reduced and traffic flow improved, resulting in a more orderly and safer flow of traffic through the intersections, as well as elsewhere along NH 102.

The congestion in downtown Derry results in some vehicles seeking alternative routes, many of which result in additional traffic through residential neighborhoods, representing an additional safety concern. On Broadway itself, the congestion results in increased conflicts between through traffic, turning traffic, parked cars, pedestrians, and bicyclists.

3.0 ALTERNATIVES ANALYSIS

This chapter provides an analysis of the various alternatives identified that could satisfy the Project's purpose and need. 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. A summary of the environmental consequences of each alternative is also provided, and the preferred alternative is identified. Many of the details regarding the screening process are described in the Rationale Report (CLD, 2000) and Scoping and Rationale Report (CLD, 2001) previously prepared for this Project.

3.1 Project Scoping

Scoping involves the identification of the issues and range of alternatives to be considered in the DEIS. As outlined in the 2007 DEIS, scoping was achieved through meetings, telephone calls, and correspondence with federal, state, and local agencies and officials, with additional input from a CATF and the general public. In addition, two formal scoping meetings were held during the daytime and evening on July 30, 1998, which included representatives from the Office of the Governor of NH, U.S. Congressmen, State Senators and Representatives, Derry Town Council, Londonderry Town Council, Towns of Derry and Londonderry, Derry Development and Preservation Corporation, CATF, Derry Conservation Commission, Derry Citizens Commission, citizens of Derry, Derry MS Corporation, SNHPC, NHDOT, EPA, the U.S. Fish and Wildlife Service (USFWS), and local newspapers.

At the scoping meetings, the Project's purpose and need were discussed, as well as the limits of the Project study area, issues associated with access routes extending to the west of I-93, the public involvement process, anticipated additional future meetings, and an explanation of the steps required as part of the NEPA process. Also discussed were the potential areas of impacts and the reasonable range of alternatives to be studied in the DEIS. The scoping meeting also provided opportunities for federal and state agency representatives, local groups, and public officials to provide guidance on issues salient to the DEIS study. Following are some of the issues identified during this early stage of the process:

- Westerly access
- Need for the Project, including the separate traffic and economic development components
- Coordination with I-93 widening project
- Construction costs
- Prime wetlands
- Transportation demand management studies
- Statewide traffic model
- Secondary impacts
- Parks, recreation areas, and historic properties
- Section 6(f) properties

- Secondary road improvements
- Project funding
- Traffic growth

Additional issues were identified and considered throughout the screening of Project alternatives.

3.2 Development of Conceptual Corridors

Early in Project planning, a number of conceptual corridors for a new interchange location and connecting roadways were identified. Each corridor was evaluated based on engineering, environmental, cultural, topographic, and socioeconomic constraints. The following resources or issues were considered: water resources, including prime wetlands and 100-year floodplains; wildlife resources; existing land use and zoning; prime farmlands and orchards; hazardous materials sites; steep slopes; tax map data; historic and archaeological resources; and Section 4(f) resources.

As noted in the 2007 DEIS, a 300-foot corridor width was used to represent the potential physical characteristics associated with a new location alternative and for the initial screening of alternatives from an environmental impact standpoint. This width was based on the likely required cross-section of the proposed roadway needed to serve projected traffic volumes, as well as the design criteria outlined in the 2007 DEIS. These preliminary design criteria used to develop potential highway alternatives, as well as upgrade options for existing highways, are based on American Association of State Highway and Transportation Officials (AASHTO) policy and the NHDOT Highway Design Manual (NHDOT, 2007).

3.3 Alternative Corridors Considered

Conceptual corridor alternatives considered during the screening process for the 2007 DEIS include (1) upgrade existing roadways, (2) new I-93 interchange/connector road options, and (3) combinations of 1 and 2.

3.3.1 Upgrade Existing Roadway Facilities

This alternative consists of improving existing roadway facilities rather than constructing new facilities on new locations. Consideration was given to satisfying the purpose and need for the Project by upgrading NH 102 and certain other existing roads where traffic analysis indicated a need for improvements. Improvements would include substantial highway and traffic control measures to eliminate or reduce existing deficiencies.

3.3.2 New Location Alternatives

These alternatives consist of the construction of a new interchange on I-93 with connecting roads to major arterials to the east. The intent of the environmental review of the study area west of I-93 was to consider the implications of a future westerly extension with a proposed new interchange, and to consider an adjustment of the interchange location if it would better suit a future westerly extension. Therefore, by mapping environmental constraints between I-93 and NH 128, potential new interchange locations were located in positions that did not preclude construction of a future westerly connection. However, any westerly connection to a proposed new interchange would not meet the stated purpose and need of this study and would require an approval action from FHWA and NHDOT, and an independent environmental document pursuant to NEPA. The major arterials potentially affected by a new location alternative would include portions of NH 28 and/or NH 28 Bypass. The connecting roads could use portions of existing ROW, when feasible, or be on new locations. Combinations of alternatives were also considered.

3.3.3 Combinations of Alternatives

Combinations of alternatives were evaluated for their ability to meet the Project purpose and need. For example, combinations of new corridors, links, and a new I-93 interchange location, as well as upgrade alternatives with other improvements to existing roadways, were also evaluated.

3.4 Alternative Corridor Screening

The 2007 DEIS provides a detailed description of the identification of conceptual alternative corridors, their initial screening, and the resulting alternative corridors. The corridors were then screened in two phases to develop the five Build Alternatives considered in this SDEIS.

Initially, 24 corridors, including four possible interchange locations, were proposed for possible study. After discussion with CATF, TAC, and resource agencies, the number of possible combinations of links expanded to an investigation of 47 corridors. These 47 initial alternative corridors were screened for predetermined environmental and cultural resource impacts through a geographic information systems (GIS) analysis and the evaluation of projected traffic usage and benefit. The October 7, 1999, CATF meeting condensed the number of alternatives from 47 corridors to 11. Six of the 11 alternatives included access to I-93 from the west, while the other alternatives included only alternatives that provided access to the points east of I-93. The 2007 DEIS provides the rationale for screening out 36 of the original 47 conceptual corridors.

The 11 remaining alternative corridors were presented and discussed at a TAC meeting held on October 26, 1999, marking the start of the final screening process. As noted in the 2007 DEIS, the initial 47 corridors were rescreened, and an alternative was eliminated if it exceeded several of the following, newly established impact thresholds:

- Wetlands – 10 acres
- Prime wetlands – 1 acre
- Wildlife habitat – 20 acres
- Hazardous waste sites – 10 sites
- Land use/economy – moderately or seriously incompatible
- Potential displacements – 50 buildings
- Historic resources – 10 buildings and/or serious impacts on the Derry Village Historic District

Based on these thresholds, seven of the 11 alternative corridors were eliminated; however, three alternatives that had previously been eliminated were brought back into the analysis because the thresholds were not exceeded. The TAC determined that the following seven alternatives as outlined in the 2007 DEIS would remain for further consideration and screening in stage two of the final screening process.[4]

- Alternative Corridor 9 (Segments A, C, C', D, K' [Upgrade] – From NH 128 to NH 28 to Ross' Corner to Tsienneto Road to NH 102)
- Alternative Corridor 10 (Segments C, C', D, K' [Upgrade] – From I-93 to Exit 5 to NH 28 to Ross' Corner to Tsienneto Road to NH 102)
- Alternative Corridor 16 (Segments H', D', D, K' – From I-93 to the power line corridor to NH 28 to Ross' Corner to Tsienneto Road to NH 102)
- Alternative Corridor 22 (Segments L', L, B' [New Location] – From I-93 to the power line corridor to NH 102 to north of Beaver Lake)
- Alternative Corridor 24 (Segments L', K, K' – From I-93 to Madden Road to Ross' Corner to Tsienneto Road to NH 102)
- Alternative Corridor 32 (Segments I', D', D, K' – From I-93 to the power line corridor to NH 28 to Ross' Corner to Tsienneto Road to NH 102)
- Alternative Corridor 37 (Segments N, O, O' [Upgrade] – NH 102 Upgrade from I-93 to north of Beaver Lake)

Stage two of the final screening process involved re-running the SNHPC traffic model and considering the impacts of each segment within the seven alternatives. After re-running the SNHPC traffic model, the seven remaining alternatives were discussed with the TAC at a meeting on November 15, 1999. Based on these modeling results, it was determined that an upgrade of NH 28 would not effectively reduce the amount of traffic along NH 102. Therefore, Alternatives 9 and 10 were eliminated.

At this meeting, it was also determined that a segment of Alternative 22 (Segment B') would substantially alter the character of two historic agricultural areas (English Range and Chester Road). As a result, Segment B' was modified, and the resulting modified Alternative 22 was retained for analysis, while the original Alternative 22 was eliminated.

In addition, the TAC agreed to eliminate Alternative 16 because it lacked a feasible future western alternative. It was also agreed that Alternative 32 should remain due to the lack of substantial impacts represented in the matrix and that a modified Alternative 32, in addition to the original Alternative 32, would be studied. Alternative 32 Modified consists of Segment I', continuing to Segment D', and then to Segment D, Segment L, Segment B', and finally to Segment B.

Five alternatives remained after the screening process was completed:[5]

- Alternative Corridor 22 Modified (Segments L', L, B', B [New Location] – From I-93 to the power line corridor to Tsienneto Road to the intersection with NH 102). This alternative was renamed Alternative A.

[4] These corridors are shown on Figure 2.4-1 of the 2007 DEIS.
[5] These corridors are shown on Figure 2.4-2 of the 2007 DEIS.

- Alternative Corridor 24 (Segments L', K, K' – From I-93 to Madden Road to Ross' Corner to Tsienneto Road to NH 102). This alternative was renamed Alternative B.
- Alternative Corridor 32 (Segments I', D', D, K' – From I-93 to the power line corridor to NH 28 to Ross' Corner to Tsienneto Road to NH 102). This alternative was renamed Alternative C.
- Alternative Corridor 32 Modified (Segments I', D', D, L, B', B – From I-93 to the power line corridor to NH 28 to Ashleigh Drive to the power line corridor to Tsienneto Road to the intersection with NH 102). This alternative was renamed Alternative D.
- Alternative Corridor 37 (Segments N, O, O' – Minor upgrade of NH 102 from I-93 to north of Beaver Lake). This alternative was renamed Alternative F.

Regarding Alternative F, although initial planning efforts included Segments N, O, and O' in Alternative Corridor 37, the subsequent analysis of traffic volumes for NH 102 east of NH 28 Bypass noted that the existing road design was adequate to accommodate the Project traffic volumes. As a result, Segments O and O' were no longer included as part of this alternative, leaving only Segment N.

3.5 Identification of the Reasonable Range of Alternatives

The next step in the screening process involved the determination of a reasonable range of alternatives that could satisfy the purpose and need of the Project. At a regulatory/resource agency meeting held on November 17, 1999, USACE stated that its basic Project purpose that would satisfy its Highway Methodology process was "*To improve the safety and efficiency of traffic flow along NH 102 in the vicinity of Derry and Londonderry and to provide improved interstate access for commercial and industrially zoned lands in both Derry and Londonderry*" (Appendix A).

In 2006, a letter from USACE affirmed the basic purpose of the Project as follows: "*to reduce congestion and improve safety along NH 102 from I-93 easterly through downtown Derry, and to promote economic vitality in the Derry-Londonderry area*." As noted in the 2007 DEIS, the reasonable range of alternatives includes Build Alternatives A, B, C, D, and F.

By letter dated December 12, 2005, USACE formally acknowledged, for purposes of its Section 404 permitting, these alignments as constituting the reasonable range of alternatives, along with the No Build Alternative. Under NEPA requirements, the No Build Alternative must be reviewed and considered as an alternative to provide a means of comparison against other alternatives analyzed as part of this Project.

3.6 Description of the Alternatives Evaluated in This SDEIS

Section 3.6.1 describes the No Build Alternative, and Section 3.6.2 describes the Build Alternatives A, B, C, D, and F. In addition, Section 3.6.3 evaluates the Transportation Systems Management (TSM) and Transportation Demand Management (TDM) Alternatives. Appendix C provides the Interchange Justification Report prepared in compliance with Title 23, USC, Highways Section 111 (23 USC §111) and FHWA's May 2017 Policy on Access to the Interstate System (FHWA, 2017a). The intent of this policy is to "preserve and enhance the Interstate

System to meet the needs of the 21st Century by assuring that it provides the highest level of service in terms of safety and mobility" (FHWA, 2017a).

3.6.1 No Build Alternative

The No Build Alternative assumes that no major new construction would occur except for projects that are already planned and programmed. Table 3.6-1 lists the planned and programmed transportation projects included in the traffic model for the No Build Alternative. In addition, as noted in the *Land Use Scenarios Technical Report* (Appendix B), known developments and background population and employment growth projected through 2040 are included in the No Build Alternative.

Table 3.6-1. Projects Included in the No Build Alternative

Community	Project	Project No.	Part of Regional Transportation Plan
Bedford	NH 101—Widen NH 101 to 5 Lanes from NH 114 up to Wallace Road	13953	
Bedford	NH 101—Widen NH 101 to 5 Lanes from Wallace Road up to Amherst TL		Yes
Bedford	US 3—Widen US 3 to 5 Lanes from Hawthorne Drive North to Manchester Airport Access Road	40664	
Bedford-Manchester	F.E.E. Turnpike—Improvement to Bedford Mainline Toll Plaza to Institute Open Road Tolling	16100	
Nashua-Manchester-Bedford	F.E.E. Turnpike—Widen existing 2-Lane Sections of the Turnpike to a 3-Lane Typical From Exit 8 in Nashua to I-293 in Bedford	13761	
Chester	NH 102—NH 102/North Pond Road Intersection Improvements		Yes
Hooksett	US 3/NH 28—Widen US 3/NH 28 to 5 Lanes from Martins Ferry Road to West Alice Avenue	29611	
Hooksett	US 3/NH 28—Construct Southern Segment of US 3/NH 28 Alternate Bypass		Yes
Hooksett	US 3/NH 28—Construct Northern Segment of US 3/NH 28 Alternate Bypass		Yes
Hooksett	Widen US 3/NH 28 to five Lanes from Legends Drive to Hunt Street		Yes
Hooksett	Hackett Hill Road—Reconstruct intersection of NH 3A/Hackett Hill Road	14950	
Hooksett	NH 3A—Reconstruct and Widen from Commerce Road North to Goonan Road	24862	
Londonderry	NH 28—Widening NH 28 from NH 128 to Page Road		Yes

Community	Project	Project No.	Part of Regional Transportation Plan
Londonderry	NH 102—Widen NH 102 to 4 Lanes from Hudson Town Line to NH 128[a]—Lower Corridor		Yes
Londonderry	NH 102—Widen NH 102 to 5 Lanes from I-93 East to Londonderry Road—Upper Corridor		Yes
Londonderry	NH 102—Widen NH 102 to 6 Lanes from I-93 to NH 128[a]—Central Corridor		Yes
Londonderry	Intersection Improvements at NH 28/NH 128 for Safety and Traffic Flow		Yes
Manchester	I-293—Reconstruction of Exit 4 on I-293		Yes
Manchester	I-293—Reconstruction and Widening of Exit 6 (Amoskeag)	16099A	
Manchester	I-293—Reconstruct Exit 7	16099B	
Salem-Manchester	I-93—Reconstruct and Widen Mainline, Environmental Impact Study and Final Design From Mass S/L in Salem to I-293 in Manchester. Capacity Improvements, Reconstruction, and Widening from North of Exit 3 to I-293	10418C	
Salem-Manchester	I-93—Northbound and Southbound Mainline Weigh Station to Kendall	14633B	
Salem-Manchester	I-93—Exit 4 Ramps, Northbound and Southbound Mainline, NH 102 Approach Work	14633D	
Salem-Manchester	I-93—Northbound and Southbound Mainline, Exit 5 to I-293 Split (Londonderry & Manchester)	14633H	
Salem-Manchester	I-93—Northbound and Southbound Mainline, Exit 4 and 5 (Londonderry)	14633I	
Salem-Manchester	I-93—Exit 1 to Exit 5—Construct 4th Lane Northbound and Southbound	14633J	
Salem-Manchester	I-93—Final Design and ROW for I-93 Salem to Manchester	10418X	
Windham	NH 111—Corridor Improvements Within Town Center (Construction not in 10-year plan)	40663	
Windham	NH 28—Intersection NH 28/Roulston Road Improvements	40665	

Source: FY 2017–2020 Transportation Improvement Program, FY 2017–2026 Ten-Year Transportation Improvement Plan, and 2017–2040 SNHPC Regional Transportation Plan.

3.6.2 Build Alternatives

Alternative A

Alternative A includes a corridor that is approximately 3.2 miles in length between the new, proposed I-93 Exit 4A interchange and eastern Derry. There would be approximately 1 mile of roadway construction on a new alignment and 2.2 miles of existing roadway reconstruction. It would originate from the southern I-93 Exit 4A interchange location and travel southeast along new alignment through a wooded area to Folsom Road, near its intersection with North High Street and Madden Road. This alternative would continue to follow Folsom Road to Ross' Corner (Manchester Road/NH 28) and continue on Tsienneto Road across NH 28 Bypass to its intersection with NH 102, adjacent to Beaver Lake. Alternative A is shown on Figures 3.6-1 and 3.6-2. Specific improvements are outlined as follows:

I-93 Exit 4A to Ross' Corner

The section would contain a minimum of five lanes with additional lanes at intersections as required, mostly new construction.

Ross' Corner Reconstruction

Ross' Corner would require an additional eastbound through, left-turn lane and right-turn lane and an additional westbound through-lane to handle the traffic added by Alternative A. The intersection of Tsienneto Road and Pinkerton Street would also require additional through-lanes and would be signalized. The close proximity of NH 102 and Pinkerton Street will require that the signals are coordinated.

Tsienneto Road from Ross' Corner to NH 28 Bypass

The portion is an existing three-lane roadway (one lane in each direction with a middle turn lane) that would not be altered by the Project.

NH 28 Bypass/Tsienneto Road Intersection Reconstruction

This intersection would also require an additional through-lane in each direction on Tsienneto Road.

Tsienneto Road from NH 28 Bypass to NH 102

No work is proposed along a 1,600-foot long gap section from the NH 28 Bypass approach widening to Barkland Drive. Beginning at Barkland Drive, improvements extend easterly for 3,200 feet to NH 102. Improvements will involve construction of 11-foot lanes with 4-foot wide shoulders (5 feet adjacent to sidewalks), modification of horizontal and vertical curves to bring the alignments into conformance with design standards, and collection of stormwater with the provision of treatment at outfalls wherever feasible.

Tsienneto Road/NH 102/North Shore Road Intersection Reconstruction

This intersection would need to be signalized, with added through lanes in both directions on NH 102, and an added left turn lanes at the Tsienneto and North Shore Road intersections. The close proximity of North Shore Road and Tsienneto Road will require that the signals are coordinated.

The left turn lane on NH 102 would be extended to the north to also provide for left turns into English Range Road.

Alternative B

The Alternative B corridor is approximately 3.4 miles in length between the new, proposed I-93 Exit 4A interchange and eastern Derry. With the exception of an 800-foot long section of Ashleigh Drive that will be reconstructed, the remaining 3.2-mile corridor would consist of roadway construction on new alignment. It would originate from a new southern I-93 Exit 4A interchange and travel northeast along a new alignment through a wooded area to the intersection of Ashleigh Drive and NH 28. From this intersection, this alternative would extend northeast towards the intersection of London Road and NH 28 Bypass and then continue on new alignment to the intersection of Tsienneto Road and NH 102. Alternative B is shown on Figures 3.6-3 and 3.6-4. Specific improvements would be as follows:

I-93 Exit 4A to Ashleigh Drive/NH 28 Intersection

The section leading from the new, southern I-93 Exit 4A interchange to the intersection of Ashleigh Drive and NH 28 would contain five lanes of mostly new construction.

Ashleigh Drive/NH 28 Intersection Reconstruction

The new through roadway connecting from the west traveling east would consist of two through lanes, two exclusive right-turn lanes and a left-turn lane. Ashleigh Drive from the east traveling west would change from a through-left and exclusive right turn to an exclusive left turn, two through lanes and an exclusive right-turn lane. NH 28 north would require an additional left-turn lane.

Corridor from NH 28 to NH 28 Bypass

The portion would follow a new alignment along Ashleigh Drive to the power line ROW, then along the power line ROW to the NH 28 Bypass. This section would consist of one through lane in each direction and a median lane to accommodate left turns into existing commercial driveways and the remaining section of Ashleigh Drive. This median area would be available to accommodate left turns into future Corridor access points allowed between the aforementioned Ashleigh Drive intersection and NH 28 Bypass.

NH 28 Bypass Intersection Construction

A new signalized intersection would be constructed with all four approaches containing a left-turn lane. The southbound approach would contain a right-turn lane, and the remaining approaches would contain shared through/right-turn lanes.

Corridor from NH 28 Bypass to NH 102

This section would follow the power line ROW, then head southeast through a wooded section to intersect with Tsienneto Road and NH 102. It would contain two lanes.

Corridor/Tsienneto Road Reconfiguration

Tsienneto Road would be reconfigured to connect to the Corridor Road as a "T" shaped intersection. Exclusive left- and right-turn lanes would be provided on Tsienneto Road.

Corridor/NH 102/North Shore Road Intersection

This intersection would need to be signalized, with added through lanes in both directions on NH 102, and added left-turn lanes at the Corridor and North Shore Road intersections. The proximity of North Shore Road and Tsienneto Road requires coordinating the signals. The left-turn lane on NH 102 would be extended to the north to also provide for left turns into English Range Road.

Alternative C

The Alternative C corridor is approximately 3.7 miles in length between the new, proposed I-93 Exit 4A interchange and eastern Derry. Approximately 2.9 miles of corridor would be on new alignment, while approximately 0.8 mile would reconstruct existing roadways. The alternative would start from a new northern I-93 Exit 4A interchange and travel east approximately 0.7 mile along a power line ROW to NH 28. Following NH 28 south to the intersection of Ashleigh Drive, it would follow the same alignment as Alternative B to the intersection of Tsienneto Road and NH 102. Alternative C is shown on Figures 3.6-5 through 3.6-7. Specific improvements would be as follows:

I-93 Exit 4A to NH 28 Intersection

The section leading from the northern I-93 Exit 4A interchange option to the intersection with NH 28 of Ashleigh Drive and NH 28 would contain five lanes. Between Exit 4A and Scobie Pond Road, there would be new roadway construction that would tie into NH 28, an existing five-lane roadway.

Corridor/NH 28 Intersection Reconfiguration

NH 28 would be reconfigured to connect into the Corridor Road in a "T" shape signalized intersection. Single left- and right-turn lanes would be provided on southbound NH 28. On the Corridor Road, two through lanes and an exclusive left-turn lane into NH 28 would be provided traveling south. Two through lanes and an exclusive right-turn lane would be provided traveling northbound on NH 28 at the intersection.

NH 28 to Ashleigh Drive Intersection

The section would contain five lanes. Just south of the new NH 28 intersection, the new roadway construction would tie into existing NH 28. NH 28 currently consists of a two-lane roadway south to its intersection with Scobie Pond Road. From Scobie Pond Road to Ashleigh Drive, it consists of a five-lane section (two through lanes in each direction and a center-turn lane).

Ashleigh Drive/NH 28 Intersection

No changes to this intersection would be required.

Corridor from NH 28 to NH 28 Bypass

This portion would be the same as Alternative B.

NH 28 Bypass Intersection Construction

This intersection would be the same as Alternative B.

Corridor from NH 28 Bypass to Tsienneto Road

This portion would be the same as Alternative B.

Corridor/NH 102/North Shore Road Intersection Reconstruction

This portion would be the same as Alternative B.

Alternative D

The Alternative D corridor is approximately 3.9 miles in length between the new, proposed I-93 Exit 4A interchange and eastern Derry. Within this corridor, approximately 0.8 mile would be on new alignment, and 3.1 miles of existing roadways would be reconstructed. The alternative would commence from a new northern I-93 Exit 4A interchange and travel east approximately 0.7 mile along a power line ROW to NH 28. Following NH 28 south to Ross' Corner, the corridor would then follow the same path as Alternative A to the intersection of Tsienneto Road and NH 102. Alternative D is shown on Figures 3.6-8 through 3.6-10. Specific improvements would be as follows:

I-93 Exit 4A to Ashleigh Drive Intersection Reconstruction

This portion would be the same as Alternative C.

NH 28/Ashleigh Drive Intersection

On the NH 28 northbound approach, an exclusive right-turn lane would be provided.

NH 28 to Folsom Road/Tsienneto Road Intersection

No changes to the existing five-*lane section would be required.*

NH 28/Folsom Road/Tsienneto Road Intersection Reconstruction

On NH 28 southbound, a second through and left-turn lane would be provided. Eastbound on Folsom Road, a second through-lane would be provided and westbound on Tsienneto Road a second right-turn lane would be provided. The intersection of Tsienneto Road and Pinkerton Street would also require additional through-lanes on Tsienneto Road and require signalization. The proximity of NH 28 and Pinkerton Street requires coordinating the signals.

Tsienneto Road from Ross' Corner to NH 28 Bypass

This portion would be the same as Alternative A.

NH 28 Bypass/Tsienneto Road Intersection Reconstruction

This intersection would be the same as Alternative A.

Tsienneto Road from NH 28 Bypass to NH 102

This portion would be the same as Alternative A.

Tsienneto Road/NH 102/North Shore Road Intersection Reconstruction

This intersection would be the same as Alternative A.

Alternative F

Alternative F focuses all improvements along the existing NH 102 corridor between Exit 4 at I-93 and downtown Derry. A two-way center left-turn lane would be constructed from Londonderry Road to Crystal Avenue/Birch Street (NH 28). The majority of existing on-street parking spaces would be lost to accommodate the center-turn lane. Alternative F is shown on Figures 3.6-11 and 3.6-12. Additional improvements included in the study area would be as follows:

NH 102/Londonderry Road/St. Charles Street

There would be improvements to three approaches. The eastbound and westbound NH 102 approaches would include a new, left-turn lane and an additional through-lane. The southbound approach would include an extension to the existing right-turn lane. The signal would be upgraded to operate with the new lane geometry.

NH 102/Fordway/Madden Hill Road

Two approaches would be improved. The NH 102 eastbound approach would include a new right-turn lane, and the Fordway northbound approach would include a new left-turn lane. The signal would be upgraded to operate the new lane geometry. Also, there would be a three-lane cross-section along NH 102 from Valley Street, west of Fordway, and between Fordway and Crystal Avenue/Birch Street (NH 28).

NH 102/NH 28 (Crystal Avenue/Birch Street) Intersection Reconstruction

On NH 102 eastbound a new right turn lane and westbound a new through lane would be provided. On Birch Street northbound, a second left turn lane would be provided. The NH 102 approach widening from the east ends 500 feet east of the Birch Street/Crystal Avenue intersection. From the beginning of this approach widening, the work extends 4,200 feet to an ending point 100 feet before the Derry Rotary. No work on the rotary is included. Work includes one lane in each direction, shoulders on both sides and a sidewalk on the north side. On the south side, sidewalk would extend east for 1,700 feet, to a point 200 feet west of Hood Road that intersects on the north side of NH 102.

3.6.3 Other Alternatives

This section discusses other alternatives considered previously during alternatives screening and reconsidered during this SDEIS process. These alternatives would not meet the purpose and need and therefore are not analyzed in detail in the remainder of this SDEIS.

Transportation Systems Management

Potential TSM projects in the study area include signalizing intersections that have poor LOS, adding turning lanes to intersections, and coordinating adjacent signalized intersections. These and other similar improvements could ease the flow of traffic and improve the LOS at specific locations in the area but would not have a substantial effect on overall traffic volumes. Therefore, downtown Derry traffic issues, the diversion of traffic to local routes to avoid NH 102, and related safety issues would not be addressed by a TSM alternative. In addition, such an alternative would not have the potential to encourage economic vitality in Derry and Londonderry. However, TSM measures are incorporated into all five Build Alternatives through intersection improvements and signal timing changes to make the system work more efficiently.

Transportation Demand Management

The TDM alternative concept includes measures to improve efficiency of the existing transportation system by changing traveler behavior. This concept does not typically involve major capital improvements. TDM efforts include methods to traffic demand during peak periods by developing park-and-ride lots and ride-share programs (e.g., carpools or vanpools), encouraging flex-time work programs with employers and compressed work week schedules, and encouraging alternative modes of transportation such as bicycling and bussing.

Park-and-ride facilities situated at I-93 Exit 4 and Exit 5 serve express service to Boston. These facilities most likely attract residents from the east side of Derry because that is the closest access to a transit option serving Boston. Creating a new park-and-ride facility on the east side of Derry may reduce a small portion of peak hour traffic by capturing the trips; however, the bus companies intentionally operate along the I-93 corridor and serve facilities at the interchanges to minimize lost travel time. It would be difficult for the bus companies to agree to travel 2 miles off the I-93 corridor (4 miles round trip) to service a new park-and-ride facility near the NH 28 Bypass and NH 102 intersection. This extra travel time would most likely impact bus ridership north of Derry and add new bus traffic to downtown Derry.

Local bus service currently is offered through a specialty shuttle operation that operates as an on-call service. If the shuttle trips were to operate on a fixed schedule to serve the existing park-and-ride facilities in Londonderry, that might help reduce the pass-through vehicle trips in downtown Derry and replace them with frequent transit trips. However, it is unlikely that fixed shuttle service could operate through Derry because the land use density is not conducive to fixed route bus service. If the traffic analysis zones (TAZs) representing the corridor through downtown Derry were combined, the forecasted 2040 housing and population would equate to an average of 2.1 dwelling units per acre and 3.1 jobs per acre. The minimum recommended density requirements to operate a bus through a corridor is between 5–10 dwelling units per acre and between 2–5 jobs per acre (FTA, 2014). The forecasted dwelling unit densities are below and the forecasted job densities are equal to the minimum recommended density. In addition, due to the rural nature of the area, the users of this operation would likely be limited to commuters destined to Boston or Woodmont Commons, the largest employment areas accessible by the service. Therefore, the potential to offer much downtown Derry through-traffic relief would be minimal.

Other transit options include Uber and Lyft services, which operate as a taxi or carpool service if more than one passenger shares a trip. Any reduction in vehicle trips through downtown Derry would be minimal because the land use density is not conducive to a high volume of carpools. TDM will not be evaluated further in this SDEIS.

3.7 Comparison of Alternatives

The following sections provide a summary of environmental considerations, Project costs, and traffic for each Build Alternative as well as the identification of and rationale for the preferred alternative.

3.7.1 Summary of Impacts

Table 3.7-1 presents environmental considerations used to evaluate the alternatives. Chapter 4 (Affected Environment and Environmental Consequences) of this SDEIS presents a detailed discussion of the impacts associated with the Build Alternatives and the No Build Alternative. In addition, as noted in Table 3.7-1, the effect on 2040 traffic volumes in downtown Derry and the potential for economic development were used to consider how well the alternatives meet the purpose and need for the proposed Project. Finally, Project costs were also considered in the identification of a preferred alternative.

Table 3.7-1. Comparison of Build Alternatives

Resource	Impact Calculation	Alternative					
		No Build	A	B	C	D	F
Purpose and Need	Change in 2040 traffic through downtown Derry (NH 102) compared to 2040 No Build Conditions: NH 102 East of Griffin Street	2040 AAWDT: 18958	-19%	-24%	-22%	-8%	+18%
	Incremental increase in employment in Derry and Londonderry[a]	Derry: 10,479 Londonderry: 20,875	Derry: 346 Londonderry: 4,335	Derry: 346 Londonderry: 4,335	Derry: 0 Londonderry: 0	Derry: 0 Londonderry: 0	Derry: 0 Londonderry: 0
General	Length of roadway (miles)		5.96	5.59	6.25	6.21	2.44
	Additional lane miles[b]		9.1	12.6	12.0	8.1	1.8
	Construction Costs		$38,800,000	$37,800,000	$34,700,000	$35,400,000	$4,300,000
	Transmission Line Relocation Costs[c]		$850,000	$3,530,000	$7,560,000	$4,930,000	$0
Socioeconomic Conditions[d]	Potential residential total acquisitions (number)		13	19	13	0	0
	Potential business displacements (number)		25	11	2	2	16
	Potential commercial total acquisitions (number)		4	2	4	4	2
	Total area of ROW taking (acres)		41.45	52.81	53.35	43.2	1.17
Noise[e]	Single-Family (Number of impacted receptors)	66	83	60	56	67	66
	Multi-Family/Apartment (Number of impacted receptors)	41	44	33	34	38	42
	Community Facility/Park (Number of impacted receptors)	10	11	8	9	10	11
	Commercial w/outdoor use (Number of impacted receptors)	0	0	0	0	0	1
	Total Noise Impacts	133	138	101	99	115	120
Soils	Total area of disturbance (acres)		75.16	78.69	89.91	93.18	21.51
Contaminated Properties and Hazardous Materials	Known hazardous sites (number) within ASTM search radii		23	18	17	27	41
	Potential hazardous sites (number) within ASTM search radii		28	24	32	56	78
Surface Waters and Water Quality	New stream crossings (number)		4	6	0	0	1
	Existing stream crossings (number)		5	2	4	6	3
	Linear feet stream impacts		1,268	1,341	562	557	153
	Square feet stream impacts		9,658	20,524	16,202	16,171	2,060
	Lane-miles for chloride loading		7.6	11.1	10.6	8.3	1.3
Wetlands and Vernal Pools	Non-prime Non-vernal pool Wetlands (acres)		2.31	8.85	8.40	3.60	0.00
	Prime wetlands (acres)		0.03	0.06	0.06	0.03	0.00
	Vernal pools (acres)		1.12	1.09	0.27	0.29	0.00
	Wetlands total (acres)		3.46	10.00	8.73	3.92	0.00
	Vernal pools (number)		7	8	3	4	0
Groundwater	Aquifers, surface area of impacts, 0-1000 sq ft/day (acres)		23.17	13.56	32.67	37.66	19.15

Resource	Impact Calculation	Alternative					
		No Build	A	B	C	D	F
	Aquifers, surface area of impacts, 1000-2000 sq ft/day (acres)		0.00	0.00	0.00	0.00	0.16
	Public wellhead protection areas (number)		6	5	5	7	0
	Wellhead protection areas (new impervious, acres)		0.16	1.16	1.16	0.16	0
	Private wells (number)		0	2	2	0	0
	Private wells (number within 150 ft)		21	16	14	18	4
Floodplains	Floodway (acres)		0.15	0.20	0.45	0.45	0.06
	100-year floodplain (acres)		0.45	0.90	1.87	1.84	0.31
	500-year floodplain (acres)		0.57	0.89	0.20	0.43	3.01
Plant Communities and Wildlife	WAP supporting landscapes (acres)		15.37	22.49	8.69	1.85	0.00
	WAP highest ranked wildlife habitat in biological region (acres)		0.00	0.00	0.17	0.17	0.00
Threatened and Endangered Species	State-listed rare plant and animal occurrences (number)		1	2	2	1	0
Cultural Resources	Archaeological Resources		No impacts to known sites. Low probability of unknown resources.	No impacts to known sites. Low probability of unknown resources.	No impacts to known sites. Low probability of unknown resources.	No impacts to known sites. Low probability of unknown resources.	No impacts to known sites. Low probability of unknown resources.
	Historic Resources[6]		No adverse effects to NHRP-eligible resources.	No adverse effects to NHRP-eligible resources.	Adverse effect on the Reed Paige Clark Homestead properties (LON0114)	Adverse effect on the Reed Paige Clark Homestead properties (LON0114)	Adverse effect upon historic resources through the Broadway Historic District (Area B)
Parks, Recreation, and Conservation Lands	Parks and Conservation Lands (name, area)		Rider Fields (0.02 acre)	Rider Fields (0.96 acre)	Rockingham Road Conservation Site (0.035 acre) Dumont Conservation Site (0.048 acre) Rider Fields (0.96 acre)	Rockingham Road Conservation Site (0.035 acre) Dumont Conservation Site (0.048 acre) Rider Fields (0.02 acre)	Hoodkroft Golf Course (0.180 acre)
	Trails and Bicycle Paths (name)		Derry Rail Trail (Planned)	Derry Rail Trail (Planned)	Londonderry Rail Trail (Paved) Londonderry Rail Trail (Unpaved)	Londonderry Rail Trail (Paved) Londonderry Rail Trail (Unpaved)	Rail Trail / Path (On-Road Bicycle Route)

a The employment numbers for Build Alternatives are incremental and would be added to the projected employment under the No Build Scenario.
b Additional lane miles have not been used for chloride application purposes.
c The values for Alternative A are based on an alternative comparison level design to determine the preferred alternative. Once Alternative A was identified as the preferred alternative, the design was advanced further and refined in response to a more detailed design approach.
d The value of the residential relocations and business displacements will be evaluated.
e Noise results shown account for I-93 widening barriers, except sections of barriers in conflict with the alternatives. Results do not include barrier modifications proposed for the Exit 4A Project.
f Historic resources impacts based on NHDOT recommendations. SHPO concurrence is pending.

3.7.2 Description of and Rationale for the Preferred Alternative

To best address the traffic, economic, and safety issues, the Towns, NHDOT, and FHWA identified a preferred alternative. This preferred alternative, identified as Alternative A in this SDEIS, would include the following features:

- Construction of a new diamond interchange, located approximately 1 mile north of existing Exit 4, that would receive and direct traffic to the east side of I-93.
- Construction of approximately 1 mile of new roadway. This roadway would travel across currently undeveloped land to Folsom Road near its intersection with North High Street. This new roadway would be 72 feet wide from side to side, and would include four travel lanes that would be 11 feet-wide, with an 18-foot median to accommodate turn lanes with raised islands, and 5-foot shoulders.
- Reconstruction and improvements to approximately 1.6 miles of existing roadway, including sections of North High Street, Folsom Road, and Tsienneto Road, as well as sections of Franklin Street Extension, NH 28, Pinkerton Street, NH 28 Bypass, and NH 102. The specific improvements for each roadway segment are described in Section 3.6.2, but will generally include the addition of turning lanes, through-traffic lanes, traffic signals, and minor changes in roadway geometry.

Alternative A was selected as the preferred alternative based on the results of engineering, environmental, and socioeconomic studies (see Table 3.7-1 and Chapter 4). Advantages of Alternative A compared to the other Build Alternatives include lowest cost, including utilities; least acreage for ROW acquisitions; least area of stream impacts; lowest wetland impacts of the alternatives that meet the purpose and need; and no impact on Wildlife Action Plan (WAP) highest ranked habitat.

The No Build Alternative and Alternative F do not meet the purpose and need of the Project. Although Alternative D would result in a modest decrease in traffic in downtown Derry (8 percent), it would not contribute to economic development. It would also impact 16,171 square feet of streams (compared to 9,658 square feet of streams impacted by Alternative A). Alternative C would decrease the downtown Derry traffic the most (22 percent reduction); however, it would not contribute to economic development. It would also impact 16,202 square feet of streams and is the most costly of the Build Alternatives ($42,260,000). Although Alternatives A and B both satisfy the traffic and economic development needs of the proposed Project, Alternative A more closely follows existing roads than Alternative B, and Alternative A has considerably less impact on streams, wetlands, wildlife habitat, and open space than Alternative B.

4.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

This chapter presents the affected environment and the direct effects (environmental consequences) anticipated from the Proposed Project. For each topic, an introduction (including an overview of applicable regulations), data collection and analysis methodology, existing conditions (affected environment), and impacts are presented for the No Build and Build Alternatives. Indirect effects and cumulative impacts are discussed in Chapter 5.

4.1.1 Resources Dismissed From Further Analysis

Based on a review of the 2007 DEIS, the following resources are dismissed from further analysis for this SDEIS: federal/state river and coastal zone management programs and farmland.

Federal/State River and Coastal Zone Management Programs

Under the Wild and Scenic Rivers Act of 1968 (Public Law 92-542, 16 USC 1271), the National Park Service (NPS) is responsible for reviewing federal actions that may adversely impact rivers that are designated or currently under study for inclusion in the National Wild and Scenic Rivers system or rivers that are listed in the National Rivers Inventory. None of the waterbodies near the Build Alternatives are designated or currently under study for inclusion in the National Wild and Scenic Rivers system or are listed in the National Rivers Inventory; therefore, no impacts would occur as a result of the Proposed Project.

In 1988, the NH Legislature passed the Rivers Management and Protection Act (RSA 483), which regulates the quantity and quality of in-stream flow along certain protected rivers or along segments of protected rivers that are designated as Natural, Rural, Rural-Community, or Community Rivers. The NH Rivers Management Protection Program reviews federal, state, or local permits for any project that would affect a designated section of a river. No rivers near the Proposed Project are currently listed as designated rivers in the Rivers Management Protection Program system.

The Proposed Project lies outside the limits of the Coastal Zone management area; therefore, no impacts would occur on this resource, regardless of the alternative selected.

Farmland

The Farmland Protection Policy Act of 1984 (FPPA) (Section 1539-1549, Public Law 97-98, 95 Statute 1341-1344 [7 U.S.C. 4201 et seq.]) requires that federal agencies assess the effect of converting existing or potential farmland areas to areas of non-agricultural use. Specifically, the FPPA directs federal agencies to identify the effect of a federally funded project on farmland; consider alternatives that minimize impacts on farmlands; and ensure that the project is compatible, to the extent practicable, with local, state, or federal programs that protect farmlands. For this Project, impacts on farmland soils were assessed by overlaying the Build Alternatives on maps depicting soil series identified by the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), as having the characteristics of Prime Farmlands or Farmlands of Statewide or Local Importance. The FHWA Technical Advisory document

T6640.8A (October 30, 1987) further directs assessment of impacts on farmlands as part of the NEPA process for all transportation projects.

The majority of the footprints for Build Alternatives A, B, C, D, and F are located almost entirely within Urbanized Areas as defined by the U.S. Census Bureau. The only Build Alternatives that include areas outside designated Urban Areas are Alternatives C and D. These two Alternatives have a small portion of NH 28 in Londonderry, located outside the Urban Area, but are also not in proximity to any Prime or Unique Farmlands or Farmlands of Statewide or Local Importance. All other portions of the Build Alternatives would be within mapped Urban Areas. Those farmland areas that are within these Urbanized Areas are not protected under the FPPA. Therefore, no farmland impacts would be anticipated as a result of implementing any of the Build Alternatives. A copy of the completed Farmland Conversion Impact Rating Form AD 1006 is provided in Appendix D. NRCS responded on February 27, 2006, and determined that no further action will be required under the FPPA regardless of the Build Alternative selected.

Additional coordination with NRCS was undertaken in July 2018. The farmland conversion impact rating for corridor type projects was updated for each Build Alternative, and the relative value of each alternative corridor is 34 or less. Additionally, because Alternative A does not include any land that is prime, statewide, or locally important farmland, it is not subject to the FPPA.

4.1.2 Study Area

The study area defined for the initial screening of alternatives encompassed approximately 26 square miles within western portions of Derry and eastern Londonderry in western Rockingham County, NH (Figure 4.1-1). A large study area was necessary at that stage of the project in order to consider a wide range of potential alternatives for meeting the purpose and need. The 26-square-mile study area was also used for the 2007 DEIS and concurred with by the federal and state regulatory/resource agencies at an agency Scoping Meeting on July 30, 1998. For this SDEIS, the study area for each resource has been redefined to focus data collection and reporting on existing conditions to the area where there is the potential for direct impacts from the five Build Alternatives (A, B, C, D, and F). The rationale for each of the updated resource study areas is described in the appropriate resource sections. Finally, a larger, five-town study area has been used to identify potential indirect effects and cumulative impacts related to the Proposed Project (see Chapter 5).[6]

4.2 Traffic and Transportation

4.2.1 Affected Environment

Existing Access to Interstate 93

I-93 is a north-south highway, which connects Interstate 91 near St. Johnsbury, Vermont, to Interstate 95 in Canton, Massachusetts, and is a major link in the Interstate system and an important part of the National Highway System. The highway passes through the Towns of

[6] The limits of the economic study area were agreed upon in consultation with state and federal agency staff at a meeting held on August 25, 2005. Given that there are no major changes in the basic alignment of the alternatives under consideration since the 2007 DEIS, the previously agreed on study area remains reasonable for this SDEIS.

Derry and Londonderry, nearly bisecting the study area. Primary access to both Towns is via NH 102 (Exit 4) and NH 28 (Exit 5), both located in Londonderry and approximately 3.6 miles apart.

The Exit 4 interchange provides full directional access between I-93 and NH 102. To the east and west of the interchange, NH 102 provides access to the central business districts of Derry and Londonderry, respectively. To the west in Londonderry, NH 102 intersects NH 128, a two-lane, north-south highway, approximately two miles west of I-93, near the western boundary of the study area. To the east, in Derry, NH 102 intersects NH 28, a two- to four-lane, north-south highway approximately 1.1 miles east of I-93 and NH 28 Bypass, a two-lane, north-south highway, at the Derry Traffic Circle 2.1 miles east of I-93.

The Exit 5 interchange provides full directional access between I-93 and NH 28, and is located approximately 3.6 miles north of Exit 4. To the west in Londonderry, NH 28 intersects NH 128 1.3 miles west of I-93. To the east and south, NH 28 passes through the intersection with Folsom Road and Tsienneto Road (known locally as Ross' Corner), three miles south of Exit 5, and crosses NH 102 in downtown Derry.

Figure 4.2-1 shows the I-93 Exit 4 and Exit 5 interchanges.

Existing Roadway Network

I-93, as noted above, is a north-south oriented, full access control roadway. It has a posted speed limit of 65 miles per hour (mph) through the study area and four travel lanes, two in each direction. The average daily traffic (ADT) in 2015 was approximately 35,000 vehicles in each direction or 71,000 total vehicles per day, and NHDOT functionally classifies it as a principal arterial, Interstate (NHDOT, 2016a; 2017a). Two interchanges exist in the study area serving NH 102 (Exit 4) and NH 28 (Exit 5).

NHDOT is in the process of upgrading I-93 from four to eight lanes between Salem, New Hampshire, at the Massachusetts border and Manchester, New Hampshire, ending at Exit 6 at the I-293 interchange, more than 3 miles north of Exit 5. Exit 5 reconstruction was completed in 2014. Exit 4 reconstruction is currently ongoing with anticipated completion in fall 2020 (NHDOT, 2017b). Widening the I-93 mainline to six lanes is currently ongoing between Exits 4 and 5 with anticipated completion in fall 2019. Final construction of the fourth lane in each direction (eight lanes total) will be achieved with a separate project in the NHDOT Ten-Year Plan with anticipated completion in fall 2020 (NHDOT, 2017b). The No Build and all Build Alternatives under study for the Exit 4A Project assume completion of the I-93 widening project.

NH 102, also known as Nashua Road in Londonderry and Broadway in Derry, is a northeast-southwest oriented roadway with partial access control west of I-93 and no access control east of I-93 connecting Nashua to Chester, New Hampshire. It has a posted speed limit of 30 mph through the study area and has four travel lanes, two in each direction from the I-93 interchange and west. To the east, it has two travel lanes, one in each direction. The ADT in 2014 was approximately 18,000 total vehicles per day, and NHDOT functionally classifies it as an urban principal arterial—other (NHDOT, 2016c; 2017a). The roadway travels through a more urban environment to the east of I-93, extending through downtown Derry.

NH 28 is a north-south oriented roadway connecting Massachusetts to Manchester, New Hampshire with partial access control in the vicinity of the Exit 5 interchange. It has a posted speed limit of 30 mph through the study area. There are four travel lanes in the vicinity of the I-93 Exit 5 interchange (two lanes in each direction). To the south, it has two travel lanes, one in each direction, with the exception of a section from Ashleigh Drive to Ross' Corner within which there are four lanes. The ADT in 2014 was approximately 16,000 total vehicles per day, and NHDOT functionally classifies it as an urban minor arterial (NHDOT, 2016b; 2017a).

NH 28 Bypass is a north-south route that enters Derry to the north from Auburn and terminates at its junction with NH 28. This roadway is classified as a minor arterial. The Average Annual Weekday Traffic (AAWDT) in 2016 was approximately 12,250 total vehicles per day, and NHDOT functionally classifies it as a minor arterial (NHDOT, 2017a).

Tsienneto Road is an east-west road that travels through Derry to the north of NH 102 between NH 28 and NH 102 crossing NH 28 Bypass. It has a posted speed limit of 30 mph. The section west of NH 28 Bypass is a three-lane roadway, and the section east of NH 28 Bypass is a two-lane roadway. The AAWDT in 2016 was approximately 15,585 total vehicles per day, and NHDOT functionally classifies it as a minor arterial (NHDOT, 2017a).

Folsom Road is an east-west two-lane road that travels through Derry to the north of NH 102 between NH 28 and Madden Road. It has a posted speed limit of 30 mph. The AAWDT in 2016 was approximately 12,070 total vehicles per day, and NHDOT functionally classifies it as a collector (NHDOT, 2017a).

Ross' Corner is a major intersection of five roadways in northwestern Derry. The roadways are NH 28 (known as Crystal Avenue to the south and Manchester Road to the north), Tsienneto Road from the east, Folsom Road from the west, and Pinkerton Street from the southeast. Minor intersection and signal modifications to Ross' Corner were completed in 1999.

Pinkerton Street is an east-west two-lane road that travels through Derry between Tsienneto and NH 28 Bypass. It has a posted speed limit of 30 mph. The AAWDT in 2016 was approximately 10,722 total vehicles per day, and NHDOT functionally classifies it as a minor arterial (NHDOT, 2017a).

Londonderry Road is a north-south two-lane local road in Londonderry that travels between NH 102 and Ash Street. It has a posted speed limit of 35 mph.

Franklin Street is a north-south local road in western Derry that serves residences and some businesses. It connects NH 102 in downtown Derry to Folsom Road. An extension of Franklin Street (known as Franklin Street Extension) extends to the north of Folsom Road and connects to B Street. It carries a low amount of traffic (<2,000 vehicles per day).

Linlew Drive is an east-west local two-lane road in Derry that connects NH 28 to NH 28 Bypass. It has a posted speed limit of 30 mph.

Ashleigh Drive is a road that leads to a cul-de-sac in Derry from an intersection with NH 28. Because this road could become part of the proposed Alternatives, it is included in this study.

Multimodal Transportation Facilities

Transit Services and Park and Rides

In the study area, there are three bus routes and two park-and-ride lots serviced by the buses. Bus operations include Boston Express, Concord Coach Lines, and Cooperative Alliance for Regional Transportation.

Boston Express operates express bus service between Concord, New Hampshire, and Boston, Massachusetts. Two bus stops in the study area are North Londonderry, located in the Exit 5 park and ride lot, off NH 28 and Londonderry at Exit 4, located in the park and ride lot, off NH 102. Buses either service one stop, then express to Boston during the AM peak period, but stop at both Londonderry stops on the return trip. A total of nine inbound buses operate during the AM peak period (6:00 a.m.–9:00 a.m.) from either stop, and 12 buses operate in the return direction during the PM peak period (4:00 p.m.–7:00 p.m.) (Boston Express, 2016).

Concord Coach Lines operates express bus service between northern New Hampshire and Boston, Massachusetts. One bus stop in the study area is North Londonderry at Exit 5, located in the park and ride lot, off NH 28. A total of six southbound buses operate over the course of the day, and five northbound buses operate during the course of the day (Concord Coach Lines, 2017).

Cooperative Alliance for Regional Transportation is a specialty shuttle service that serves the study area by providing on-call rides and scheduled local shuttle routes to shopping and medical services. The routes can include deviations to accommodate patron requests (CART, n.d.). The shuttle service also serves the two park and rides located near I-93 at Exit 4 in Londonderry and Exit 5 in North Londonderry. Both are served by buses.

Londonderry Exit 4 Park and Ride is operated by Boston Express, and Boston Express is the only bus that services the facility. It contains 452 parking spaces and provides a bus shelter and bicycle rack (NHGov, 2017a).

North Londonderry Park and Ride is operated by Boston Express and is served by Boston Express and Concord Coach Lines. It contains 728 parking spaces and provides a bus shelter and bicycle rack (NHGov, 2017b).

New Hampshire does not have a high occupancy vehicle lane in the state.

Rail Service

The former Manchester & Lawrence (M&L) Railroad line, which passes between Manchester, New Hampshire, and Lawrence, Massachusetts through Salem, Windham, Derry, and Londonderry, has been discontinued and abandoned. Limited freight service previously available along the line between Salem and Lawrence was discontinued circa 1999. Within its town limits, Derry owns the M&L ROW, affording opportunities for use as a recreational trail. NHDOT also holds an easement that prevents any development within 30 feet of the former railroad ROW.

In Londonderry, NHDOT owns most of the M&L ROW. A section near the Londonderry/Derry town line is privately owned. Also, for its expansion, the Manchester-Boston Regional Airport purchased a section of the M&L ROW from the Boston & Maine Railroad line.

Bicycle and Pedestrian Facilities

With the abandonment of local rail lines and recent increased interest in outdoor recreational activities, state, regional, and local agencies have been actively pursuing the development of recreational trails in the region to encourage alternative modes of transportation and to provide corridors for recreation. This is evident within the study area, and several of these efforts are described in the following sections.

Planning Efforts

NHDOT developed the NH Statewide Bicycle and Pedestrian Plan in 1995 (updated in 2000) (NHDOT, 2000) as an element of the state's long-range statewide transportation plan. This plan outlined specific bicycle/pedestrian-related goals and objectives for the state and established planning and design criteria for bicycle facilities. NHDOT has also prepared regional bicycle maps showing bike routes within the state.

The NH State Trails Plan (Rizzo Associates, 2005) identified abandoned railroad corridors and other facilities that could be used for bicycle and pedestrian paths. The Plan also provides guidelines for developing trails. This Plan and the Salem to Concord Bikeway Feasibility Study (Rizzo Associates, 2003) identify the former M&L rail bed as a likely trail through the region.

The Town of Derry also produced a plan for bikeways and paths. With funds available through the Federal Intermodal Surface Transportation Efficiency Act and Transportation Equity Act for the 21st Century, the planned facilities would link various sections of town and promote safe passage of persons using these facilities.

Londonderry's Master Plan indicates that trail systems are needed for recreation and educational purposes. The Town has identified this issue as a "priority recreation resource." The Town is connected to the statewide network of bicycle trails created in the above-mentioned Southern New Hampshire Planning Commission (SNHPC) master plan.

Local Recreational Trails/Paths

Bicycle and multi-use trails within the study area are discussed in Section 4.19 and include the following:

- Old Trolley Line Trail
- Londonderry Rail Trail
- Rail Trail Path
- Derry Rail Trail
- Derry Bicycle Path
- Rider Fields Trail

Airports

The Manchester-Boston Regional Airport, located outside and northwest of the study area, influences the transportation infrastructure of the study area, as its social and economic implications are felt on a regional scale. The Airport provides passenger and freight services and is vital to the NH economy. It attracts passengers from Maine, Vermont, and Massachusetts, in addition to NH. No other airports are located in the immediate vicinity of the study area.

Traffic Data

The study area for the Project was established and agreed upon during development of the 2007 DEIS, and encompasses the expected extent of the roadway network that would likely be influenced by the introduction of a new I-93 interchange and associated connector roadways. An updated inventory of the key area roadways and intersections was conducted to ensure that the traffic modeling and subsequent analyses reflect existing conditions.

The various contracts for the I-93 widening project affecting the study area also needed to be considered. The Exit 5 improvements are already in place, and the Exit 4 interchange is being reconstructed now as part of Contract 14633-D. The widening of the mainline I-93 to four lanes between Exits 4 and 5 will also be completed as part of this existing contract.

Traffic Counts

As discussed in Appendix A, *Traffic Technical Report*, The traffic counting program was developed for the project, based on the key roadway segments and intersections in the study area, to assist in the development of 2015 base AAWDT volumes for use in the traffic model calibration. Most of these locations were counted in 2005 as part of the preparation of the original 2007 DEIS document. This effort was coordinated with the annual traffic counting programs conducted by both the NHDOT and SNHPC within the study area, and the new data collected in May and June of 2016 while school was still in session. Some of these locations had already been counted in 2014 or 2015 (NHDOT, 2016a, 2016b, 2016c).

The Automatic Traffic Recorder (ATR) counts were taken for a 3- to 5-day period. An ATR is a count obtained from placing black tubes across the road that record each time two vehicle axles cross the tube. A listing of the locations is included below and shown in Figure 2 of Appendix A.

- Interstate Locations (15 ATRs):
  - A. I-93 Exit 4—NB and SB on- and off-ramps (five ramps)
  - B. I-93 Exit 5—NB and SB on- and off-ramps (four ramps)
  - C. I-93 NB and SB south of Exit 4 (two mainlines)
  - D. I-93 NB and SB between Exits 4 and 5 (two mainlines)
  - E. I-93 NB and SB north of Exit 5 (two mainlines)
- State Highways/Local Streets (21 ATRs):
  1. Crystal Avenue (NH 28), south of Tsienneto Road
  2. Folsom Road, west of NH 28
  3. Pinkerton Street, east of Tsienneto Road
  4. Tsienneto Road, west of NH 102
  5. Tsienneto Road, east of Pinkerton Street
  6. Chester Road (NH 102), east of NH 28 Bypass (Sylvestri Circle)
  7. North Main Street (NH 28 Bypass), north of Pinkerton Street (Academy Drive)
  8. North Main Street (NH 28 Bypass), north of Tsienneto Road
  9. South Main Street (NH 28 Bypass), south of Thornton Street
  10. NH 102, east of Griffin Street
  11. NH 102, west of Abbot Street
  12. Fordway, over Beaver Brook
  13. Franklin Street, north of Folsom Road

14. Ash Street at Londonderry Town line
15. Crystal Avenue (NH 28), S of Rollins
16. NH 102, east of Hampton Drive
17. NH 102, at Derry Town line
18. NH 28, at Derry/Londonderry Town line
19. NH 28, north of Liberty Drive
20. Gilcreast Road, north of NH 102
21. Ash Street, east of Londonderry Road

In addition, intersection turning movement counts were obtained during AM and PM peak periods covering 19 intersections within the study area. These include the original 17 intersections from the 2007 DEIS plus two new ones to cover the east end of the study area.

Development of 2015 AAWDT Base Volumes

The primary tool used to forecast the future 2040 volumes was the SNHPC travel demand model. Prior to using the model all traffic count data must be consistent from the same base year. Because the counts were obtained from multiple years, they were adjusted to create a 2015 base year balanced network using the following three processes.

- The counts were adjusted based on the count season to allow for seasonal traffic fluctuations and represent a more typical October or April time period.
- The counts were adjusted to correct for the number of axles that triggered the counter to record a vehicle. Large trucks with more than two axles were counted as two or even three separate vehicles because the counter is programmed to record a vehicle every two axles that cross a sensor or tube.
- The counts were increased or decreased following a growth factor calculated separately for I-93 mainline and all other roadways (including the I-93 ramps). The I-93 mainline applied a 1.1 percent growth per year based on comparing multiple years of data for a counter on I-93, and all other roadways applied a 2.5 percent growth per year rate based on comparing multiple years of data for a counter on NH 28. Counts were increased or decreased by the appropriate rate depending on whether the counts were before 2015 or after 2015 (no adjustment was applied to 2015 counts).

In addition to creating the 2015 daily traffic volumes, the turning movement volumes obtained at the 19 intersections were used to develop the percentage of the daily volume equal to AM and PM peak hour volumes. The same percentage is applied to the future 2040 volumes produced by travel demand model to create 2040 peak hour volumes for each alternative. All traffic analysis required peak hour volumes to ascertain the intersection and freeway operations and queuing. Table 4.2-1 contains traffic count summary for I-93.

Table 4.2-2 contains the traffic count summary for roadways serving Londonderry and Derry.

Table 4.2-1. Traffic Count Summary—Interstate 93

Location		Raw Count	Adjusted 2015 Count
		Vehicles per year (AAWDT)	
A	Exit 4 NB Off-ramp	10,249	9,993
	Exit 4 NB On-ramp	10,303	10,045
	Exit 4 SB Off-ramp	9,862	9,615
	Exit 4 SB On-ramp—EB to SB	5,310	5,177
	Exit 4 SB On-ramp—WB to SB	4,767	4,648
	Exit 4 NB Off-ramp	10,249	9,993
	Exit 4 NB On-ramp	10,303	10,045
	Exit 4 SB Off-ramp	9,862	9,615
B	Exit 5 NB Off-ramp	5,745	5,601
	Exit 5 NB On-ramp	9,580	9,341
	Exit 5 SB Off-ramp	9,520	9,282
	Exit 5 SB On-ramp	5,645	5,504
C	I-93, South of Exit 4—NB		35,578
	I-93, South of Exit 4—SB	71,000	35,574
D	I-93, between Exits 4 and 5—NB		35,578
	I-93, between Exits 4 and 5—SB	71,000	35,574
E	I-93, North of Exit 5—NB		40,250
	I-93, North of Exit 5—SB	76,000	40,889

Table 4.2-2. Traffic Count Summary—Roadways serving Londonderry and Derry

Location		Raw Count	Adjusted 2015 Count
		Vehicles per year (AAWDT)	
1	Crystal Avenue (NH 28), south of Tsienneto Road	15,585	15,195
2	Folsom Road, west of NH 28	12,070	11,768
3	Pinkerton Street, east of Tsienneto Road	10,722	10,454
4	Tsienneto Road, west of NH 102	5,532	5,394
5	Tsienneto Road, east of Pinkerton Street	15,012	14,637
6	Chester Road (NH 102), east of NH 28 Bypass (Sylvestri Circle)	7,456	7,270
7	North Main Street (NH 28 Bypass), north of Pinkerton Street (Academy Drive)	8,615	8,400
8	North Main Street (NH 28 Bypass), north of Tsienneto Road	12,250	11,944
9	South Main Street (NH 28 Bypass), south of Thornton Street	14,341	13,982
10	NH 102, east of Griffin Street	16,000	16,400
11	NH 102, west of Abbot Street	14,000	14,350
12	Fordway, over Beaver Brook	5,200	5,330
13	Franklin Street, north of Folsom Road	1,800	1,845
14	Ash Street at Londonderry Town line	6,600	6,765
15	Crystal Avenue (NH 28), S of Rollins	13,000	13,000
16	NH 102, east of Hampton Drive	32,000	32,000
17	NH 102, at Derry Town line	22,656	22,090
18	NH 28, at Derry/Londonderry Town line	17,324	16,891
19	NH 28, north of Liberty Drive	13,000	13,000
20	Gilcreast Road, north of NH 102	10,070	9,818
21	Ash Street, east of Londonderry Road	6,900	6,900

Operational and Queuing Analysis Tools

The study analyzed the study area intersections using Synchro™ Traffic Signal Coordination Software. Two analyses were performed for traffic, including an intersection capacity analysis and an intersection queueing analysis. The intersection capacity analysis used the Synchro™ software tool and various input values as described in the following sections to determine the LOS or driver perception of an intersection's operation. The intersection queuing analysis used the Synchro™ tool to determine different levels of queuing or the length that vehicles may back up at an intersection.

Level of Service

Traffic congestion is expressed by the term Level of Service (LOS), as defined by the Highway Capacity Manual. LOS is a letter code ranging from "A" for excellent conditions to "F" for failure conditions. The conditions defining the LOS for roadways are summarized as follows.

LOS A
Represents the best operating condition, where traffic stream is considered free-flow.

LOS B
Represents reasonably free-flow conditions. The ability to maneuver is only slightly restricted. Effects of minor incidents are still easily absorbed.

LOS C
Represents speeds at or near free-low conditions. The freedom to maneuver is noticeably restricted. Queues may form.

LOS D
Represents traffic operations approaching unstable flow. Speeds decline slightly with increasing flows. Road density increases more quickly. The freedom to maneuver is more noticeably limited. Minor incidents cause queuing.

LOS E
Represents operation that is near or at capacity. There are no usable gaps in the traffic stream. Operations are extremely volatile. Any disruption causes queuing.

LOS F
Represents a breakdown in flow. Queues form behind breakdown points. The demand is greater than capacity.

LOS is the primary measure of traffic operations for both signalized and unsignalized intersections. LOS is a standard performance measure developed by the transportation profession to quantify driver perception for such elements as travel time, number of stops, total amount of stopped delay, and impediments caused by other vehicles. LOS provides a scale that is intended to match motorists' perception of how a transportation facility operates and to provide a scale to compare different facilities.

Signalized Intersection Level of Service

The LOS for signalized intersections is based on the HCM 2000 method and requires inputs to determine an accurate LOS (TRB, 2000). HCM 2010 or HCM 6 methods were not followed because the signal timings and phasing were not HCM 2010/ HCM 6 compliant, for example, signal timings included pedestrian-only phases.

Primary inputs include the following: vehicular volumes, pedestrian volumes, traffic signal timings, roadway geometry, speed limits, truck percentages, and peak hour factor (the measure of vehicle 15-minute flow rate). The average vehicle control delay, measured in seconds per vehicle, is calculated using these parameters and represents the average extra delay in seconds per vehicle caused by the presence of a traffic control device or traffic signal, including the time required to decelerate, stop, and accelerate. The LOS can be characterized for the entire intersection, each intersection approach, and each lane group. Signalized intersections that exceed a delay of 55 seconds have LOS E and those with a delay of 80 seconds or more have LOS F. Table 4.2-3 shows the average control delay and corresponding LOS for signalized intersections.

Table 4.2-3. Signalized Intersection Control Delay and LOS Thresholds—HCM 2000 Method

LOS	Average Control Delay (seconds/vehicle)	Description
A	Less than or equal to 10	Stable conditions
B	>10–20	
C	>20–35	
D	>35–55	
E	>55–80	Unstable conditions
F	More than 80	Above capacity and unstable conditions

Source: TRB (2000)

To determine the LOS of an intersection, the critical input values were entered into the analysis software (Synchro™), and the average vehicle delay (seconds per vehicle) was calculated. Based on the average vehicle delay, the LOS was determined for all movements (left, through, and right), approaches, and the intersection as a whole.

Unsignalized Intersection Levels of Service

The LOS for unsignalized intersections (i.e., STOP-controlled intersections) is based on the Highway Capacity Manual 2000 method and requires the same inputs as a signalized intersection (TRB, 2000). The average vehicle control delay, in seconds per vehicle, is calculated following the Highway Capacity Manual 2000 procedures and represents the average delay caused by the presence of a stop sign and the time required to decelerate, stop, and accelerate. The LOS for a two-way, STOP-controlled (TWSC) intersection (i.e., unsignalized intersection) is determined for each minor-street movement or shared movement as well as the major-street left turns. LOS F is assigned if the movement’s control delay exceeds 50 seconds. Table 4.2-4 shows the average control delay and corresponding LOS for unsignalized intersections. The worst LOS at one-way, STOP-controlled, and TWSC intersections represents the delay for the minor approach only.

Table 4.2-4. Unsignalized intersection control delay and LOS thresholds—HCM 2000 Method

LOS	Average Control Delay (seconds/vehicle)	Description
A	Less than or equal to 10	Stable conditions
B	>10-15	
C	>15-25	
D	>25-35	
E	>35-50	Unstable conditions
F	More than 50	Above capacity and unstable conditions

Source: TRB (2010)

Freeway Operations Analysis

The LOS for freeway facilities is based on the HCM 2010 method and requires inputs to determine an accurate LOS. Primary inputs include:

- vehicular volumes
- roadway geometry
- speed limits
- truck percentages
- peak hour factor

Freeway facilities are evaluated based on the density of vehicles. The higher the density the slower the vehicles travel and the worse the operations. Based on the vehicle density, the HCM provides LOS equivalents to represent the driver's perception of the facility operation. Table 4.2-5 shows the density and corresponding LOS for signalized intersections.

Table 4.2-5. HCM Freeway Facility Level of Service

LOS	Freeway Merge and Diverge Facilities	Description
	Density (passenger cars/ mile/ lane)	
A	0-10	Passing operation
B	>10-20	
C	>20-28	
D	>28-35	
E	>35	Unstable conditions
F	Demand Exceeds Capacity	Above capacity and unstable conditions

Source: TRB (2010)

The study analyzed the I-93 freeway facilities using Highway Capacity Software (HCS) 2010. Analyses were performed for ramp merge and diverge facilities. The HCS relied on various input values to determine the LOS or driver perception of a freeway segment's operation.

Existing Conditions Traffic Analysis Results

Based on the freeway operations analysis, all facilities operate at LOS D or better in 2015 during the AM and PM peak periods. Table 4.2-6 contains the freeway operation summary and Appendix A contains the detailed assessment.

Based on the signalized intersection operations analysis, one signalized intersection operated overall at LOS F during the PM peak hour at Ross' Corner (Intersection #11). All other intersections operated overall during the AM and PM peak hour at LOS D or better.

Based on the unsignalized intersection operations analysis, seven unsignalized intersections had at least one Stop-sign controlled approach operating at LOS F. These included the following locations:

- NH 102/Londonderry Road (Intersection #5) during both peak periods
- North High Street/Ash Street Extension (Intersection #8) during the PM peak hour
- Tsienneto Road/Pinkerton Street (Intersection #12) during both peak periods
- NH 28/Scobie Pond Road (Intersection #15) during both peak periods
- NH 102/NH 28 Bypass/East Derry Road (Intersection #16) during both peak periods
- NH 28 Bypass/Pinkerton/Nesmith (Intersection #17) during both peak periods
- NH 102/Tsienneto Road (Intersection #19) during the PM peak hour

Figure 4.2-2 shows the existing conditions LOS results. Table 4.2-7 contains the intersection operations summary. More detailed operations and queueing analysis as well as an assessment of downtown Derry congestions is contained in Appendix A.

Table 4.2-6. Existing Condition Freeway Analysis

Location		Facility Type	Time Period	LOS
A	I-93 Northbound to NH 102	Diverge	AM	B
			PM	D
	NH 102 to I-93 Northbound	Merge	AM	B
			PM	C
	I-93 Southbound to NH 102	Diverge	AM	C
			PM	C
	NH 102 Westbound to I-93 Southbound	Merge	AM	B
			PM	B
	NH 102 Eastbound to I-93 Southbound	Merge	AM	C
			PM	B
B	I-93 Northbound to NH 28	Diverge	AM	C
			PM	C
	NH 28 to I-93 Northbound	Merge	AM	D
			PM	D
	I-93 Southbound to NH 28	Diverge	AM	D
			PM	D
	NH 28 to I-93 Southbound	Merge	AM	C
			PM	C
C	I-93 South of Exit 4 – Northbound	Mainline	AM	B
			PM	D
	I-93 South of Exit 4—Southbound		AM	C
			PM	D
D	I-93 between Exits 4 and 5 – Northbound	Mainline	AM	C
			PM	C

<table>
<tr><th colspan="2">Location</th><th>Facility Type</th><th>Time Period</th><th>LOS</th></tr>
<tr><td rowspan="2"></td><td rowspan="2">I-93 between Exits 4 and 5 – Southbound</td><td rowspan="2"></td><td>AM</td><td>B</td></tr>
<tr><td>PM</td><td>B</td></tr>
<tr><td rowspan="4">E</td><td rowspan="2">I-93 North of Exit 5 – Northbound</td><td rowspan="4">Mainline</td><td>AM</td><td>C</td></tr>
<tr><td>PM</td><td>D</td></tr>
<tr><td rowspan="2">I-93 North of Exit 5 – Southbound</td><td>AM</td><td>D</td></tr>
<tr><td>PM</td><td>C</td></tr>
</table>

Table 4.2-7. Existing Condition Intersection Analysis

Location		AM Peak Hour		PM Peak Hour	
		Average Delay	LOS	Average Delay	LOS
1	Exit 4 SB Off-Ramp/NH 102	7.0	A	15.2	B
2	Exit 4 NB Off-Ramp/NH 102	28.4	C	25.3	C
3	Exit 5 SB Off-Ramp/NH 28	20.3	C	19.6	B
4	Exit 5 NB Off-Ramp/NH 28	14.1	B	15.1	B
5	NH 102/Londonderry Road[a]	43.0	F	79.8	F
6	NH 102/Fordway	25.7	C	33.0	C
7	NH Routes 102/28	39.9	D	39.9	D
8	North High Street/Ash Street Extension[a]	15.4	C	123.5	F
9	North High Street/Madden Road[a]	18.7	C	27.2	D
10	North High/Folsom/Franklin Streets[a]	14.2	B	23.7	C
11	Ross' Corner (Folsom/NH 28)	37.1	D	47.4	D
12	Tsienneto Road/Pinkerton Street[a]	154.3	F	282.3	F
13	NH 28/Linlew Drive	13.3	B	18.9	B
14	NH 28/Ashleigh Drive	16.9	B	24.0	C
15	NH 28/Scobie Pond Road[a]	143.2	F	[b]	F
16	NH 102/NH 28 Bypass/East Derry Road[a]	96.6	F	240.0	F
17	NH 28 Bypass/Pinkerton/Nesmith[a]	296.3	F	76.5	F
18	NH 28 Bypass/Tsienneto Road	36.5	D	35.4	D
19	NH 102/Tsienneto Road[a]	19.3	C	60.9	F

a Unsignalized intersections do not have an overall LOS; worst-case approach LOS reported.
b HCM 2000 calculation exceeds 300 seconds.

Crash Data

Crash data from the NH Department of Safety covering the last five full calendar years were obtained within the limits of the study area, bounded by I-93 to the west, NH 102 to the south, NH Routes 28 and 28 Bypass north of Tsienneto Road to the north, and the Tsienneto Road/NH 102 intersection to the east. The records were assigned to specific roadway segments or individual intersections if sufficient locational information was available. In some cases these identifiers overlapped, so the sum of the segment and intersection crashes is more than the total.

A total of 716 crashes were identified within the project area within the five-year time span, with only one fatality (a single-car incident in 2014 on NH 102 in Londonderry). Approximately 24 percent of the crashes were injury or fatality, with just under 87 percent of these occurring on the major roadways. NH Routes 102 and 28 combined for 2/3 of the total reported crashes (48 per year) and Interstate 93 accounting for 19 percent (25 per year). On an individual basis, the traffic circle at NH 28 Bypass and NH 102 had the most reported crashes, averaging almost 5 per year. Detailed NHDOT crash data from 2010 to 2014 for roadways and major intersections in the study area is provided in Appendix A.

4.2.2 Environmental Consequences

This section compares the No Build Alternative to the five proposed Build Alternatives to assess their impacts on traffic and downtown Derry pedestrian safety. The primary tool used to evaluate the potential effects of the No Build and Build Alternatives was SNHPC's travel demand model. Appendix A, *Traffic Technical Report*, provides detailed assumptions regarding the traffic projections.

No Build Alternative

The No Build Alternative represents the future conditions in the Project design year of 2040 if all planned roadway improvements are implemented, Woodmont Commons is partially built out, and other background growth would follow the demographic projections as described in Chapter 5, *Indirect Effects and Cumulative Impacts*. I-93 Exit 4A would not occur, and downtown Derry would continue to experience traffic issues.

Table 3.6-1 in Section 3.6.1 provides a list of the projects included in the No Build Alternative. Based on Appendix A, Table 7, there would be a reduction in trips on north-south roadways such as NH 28 Bypass, NH 28, and Fordway under the No Build Alternative. The widening of I-93 to four lanes each way would provide more north-south capacity. Comparing the existing traffic volumes to those anticipated under the No Build Alternative shows the following volume changes:

- Mainline volumes on I-93 would increase between 64 and 68 percent, which would result in a 2.5 percent annual growth rate.
- Ramp volumes at Exit 4 would increase between 95 and 125 percent.
- Ramp volumes at Exit 5 would grow between 45 and 50 percent.
- Volume would increase along NH 102 west of Exit 4.

Woodmont Commons would contribute to these volume increases at Exit 4, and background growth projected reflected in the demographic projections in Chapter 5 would contribute to the growth in traffic along I-93 and surrounding roadway network. The volume changes reflect a shift from north-south roadways paralleling I-93 to I-93 and not east-west roadways serving downtown Derry and Londonderry. Under the No Build Alternative, freeway conditions would not improve at Exit 4 as the I-93 northbound on-ramp from NH 102 would continue to queue into NH 102, 13 study area intersection operations would operate under failing condition (LOS E or F), and 6 study area intersections would operate at acceptable conditions. Therefore, this alternative would have adverse impacts on the freeway operations and adverse impacts (13 failing versus 6 passing) on the study area intersections.

Figure 4.2-3 shows the No Build Alternative LOS results. The No Build intersection and freeway operations summaries are contained in the comparison tables under each alternative. Appendix A contains detailed assessments of No Build Alternative conditions.

Build Alternatives

Alternative A

Under Alternative A, there would be a reduction in trips on east-west roadways including NH 102 and NH 28 (Appendix A, Table 7). The creation of a new parallel route to NH 102 would create a shift in traffic patterns through downtown Derry. Comparing the No Build Alternative to Alternative A shows the following volume changes:

- Mainline volumes on I-93 between Exits 4 and 4A would decrease an average of 3 percent and between Exits 4A and 5 would increase an average of 10 percent.
- Volumes along NH 102 east of Exit 4 would decrease by 28 percent.
- Volumes along NH 28 east of Exit 5 would decrease by 21 percent.
- Volumes would increase along NH 102 west of Exit 4.

Based on the analysis under Alternative A compared to the No Build Alternative, all freeway facilities would operate at LOS D or better. Ten intersections would improve from LOS E or F to LOS B through D or improve from LOS F to LOS E. Four intersections would degrade from LOS B through D to LOS E or LOS F. All new intersections and freeway facilities created under Alternative A would operate at LOS D or better. Figure 4.2-4 shows the Alternative A LOS results. Table 4.2-8 provides a comparison between the No Build and Alternative A freeway analysis. Table 4.2-9 provides a comparison between the No Build and Alternative A intersection analysis. Appendix A contains the detailed freeway and intersection analysis.

Table 4.2-8. Comparison between No Build and Alternative A Freeway Analysis

Location		Facility Type	Time Period	No Build LOS	Alternative A LOS
A	I-93 Northbound to NH 102	Diverge	AM	A	A
			PM	B	B
	NH 102 to I-93 Northbound	Merge	AM	C	B
			PM	C	C
	I-93 Southbound to NH 102	Diverge	AM	C	C
			PM	F	A
	NH 102 Westbound to I-93 Southbound	Merge	AM	B	B
			PM	B	A
	NH 102 Eastbound to I-93 Southbound	Merge	AM	C	C
			PM	B	B
B	I-93 Northbound to NH 28	Diverge	AM	C	C
			PM	C	D
	NH 28 to I-93 Northbound	Merge	AM	C	C
			PM	C	C
	I-93 Southbound to NH 28	Diverge	AM	D	C
			PM	D	C
	NH 28 to I-93 Southbound	Merge	AM	C	C
			PM	C	B
C	I-93 South of Exit 4—Northbound	Mainline	AM	B	B
			PM	C	C
	I-93 South of Exit 4—Southbound		AM	C	C
			PM	B	B
D	I-93 between Exits 4 and 5—Northbound	Mainline	AM	B	C[a]
			PM	C	C[a]
	I-93 between Exits 4 and 5—Southbound		AM	C	D[a]
			PM	C	D[a]
E	I-93 North of Exit 5—Northbound	Mainline	AM	C	C
			PM	C	C
	I-93 North of Exit 5—Southbound		AM	C	C
			PM	C	C

Note: Green shading represents improving from operating at a failing LOS to operating at an acceptable LOS.

[a] Represents the worst-case LOS between Exits 4 and 4A or Exits 4A and 5.

Table 4.2-9. Comparison between No Build and Alternative A Intersections Analysis

Location		No Build		Alternative A	
		AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
1	Exit 4 SB Off-Ramp/NH 102	D	F	C	**D**
2	Exit 4 NB Off-Ramp/NH 102	E	F	E	F
3	Exit 5 SB Off-Ramp/NH 28	E	C	**D**	C
4	Exit 5 NB Off-Ramp/NH 28	D	D	**E**	D
5	NH 102/Londonderry Road	B	E	B	**B**
6	NH 102/Fordway	C	D	C	D
7	NH Routes 102/28	D	D	**E**	D
8	North High Street/Ash Street Extension[a]	F	F	**C**	F
9	N High/ Madden (NB) Connector Road/ N High St (Alt A)[b]	D	F	C	**D**
10	North High/Folsom/Franklin Streets[b]	B	D	B	C
11	Ross' Corner (Folsom/NH 28)	F	E	**C**	**C**
12	Tsienneto Road/Pinkerton Street[b]	C	F	B	**B**
13	NH 28/Linlew Drive	B	B	B	C
14	NH 28/Ashleigh Drive	B	C	B	C
15	NH 28/Scobie Pond Road[a]	F	D	**B**	C
16	NH 102/NH 28 Bypass/East Derry Road[c]	D	F	**F**	**E**
17	NH 28 Bypass/Pinkerton/Nesmith[a]	A	A	**F**	**F**
18	NH 28 Bypass/Tsienneto Road	E	F	**C**	**C**
19	NH 102/Tsienneto Road[b]	C	F	A	**B**
20	Exit 4A SB off ramp/Connector Road	N/A	N/A	D	C
21	Exit 4A NB off ramp/Connector Road	N/A	N/A	C	B
27	NH 102/English Range Road[a]	N/A	N/A	C	D

Note: Green shading represents improving from operating at a failing LOS to operating at an acceptable LOS; red shading indicates moving from an acceptable LOS to a failing LOS.
[a] Unsignalized intersection do not have an overall LOS; worst-case approach LOS reported.
[b] Unsignalized intersection under No Build and signalized intersection under Alternative A.
[c] Roundabout analysis based on HCM 6 procedure.

The creation of a new parallel route to NH 102 in conjunction with the induced effect of a fully built-out Woodmont Commons would substantially contribute to changes in the travel pattern and increases in overall study area volume. Based on the analysis of trip patterns from the SNHPC travel demand model, Alternative A would provide a more parallel route to bypass downtown Derry by creating a new connection between I-93 and eastern Derry. Alternative A would result in more east-west regional trips using the new I-93 Exit 4A interchange, which would then disperse between Exits 4 and 5 to reach destinations to the west along NH 102 and NH 28. Under Alternative A, freeway conditions would improve at Exit 4, 11 study area intersection operations would improve, and 4 study area intersections would worsen. Therefore, this alternative would result in beneficial impacts on the freeway operations and beneficial impacts (11 improved versus 4 worsened) to the study area intersections. At least one of the intersections performing worse than the No Build Alternative would be addressed by the Woodmont Commons traffic mitigation requirements imposed by Londonderry.

Based on the Woodmont Commons Memorandum of Understanding, to "unlock" parcels within the PUD Master Plan for the developer to continue construction, the developer must submit a traffic study to the Londonderry Planning Board to ascertain the level of roadway mitigation necessary to handle the new vehicle trips generated (Pillsbury Realty Development, LLC, 2018). The assessment in this study does not include the future mitigation because the future mitigation is not known until completion of the next set of Woodmont Commons traffic studies. Because it is assumed that Alternatives A and B would induce a fully built-out Woodmont Commons PUD, two traffic issues were identified:

- The number of vehicle trips generated through the study area was based on a fully built-out Woodmont Commons PUD.
- The appropriate level of traffic mitigation was not in place to address the forecasted vehicle trips generated by the Woodmont Commons PUD.

Alternative B

Under Alternative B, there would be a reduction in trips on north-south roadways such as NH 28 and NH 28 Bypass (Appendix A, Table 7). The creation of a new route to northeast Derry would create a shift in traffic patterns from NH 28 Bypass to I-93 for destinations south of Derry. Comparing the No Build Alternative to Alternative B shows the following volume changes:

- Mainline volumes on I-93 between Exits 4 and 4A would decrease an average of 1 percent and between Exits 4A and 5 would increase an average of 10 percent.
- Volumes along NH 102 east of Exit 4 would decrease by 28 percent.
- Volumes along NH 28 east of Exit 5 would decrease by 35 percent.
- Volumes would increase along NH 102 west of Exit 4.

Based on the analysis under Alternative B compared to the No Build Alternative, all freeway facilities would operate at LOS D or better. Nine intersections would improve from LOS E or F to LOS B through D. Three intersections would degrade from LOS B through D to LOS F. All new intersections and freeway facilities created under Alternative B would operate at LOS D or better, except Connector Road/Tsienneto Road (Intersection #24) and NH 102/English Range Road (Intersection #27), which would operate at LOS E. Figure 4.2-5 shows the Alternative B LOS results. Table 4.2-10 provides a comparison between the No Build and Alternative B freeway analysis. Table 4.2-11 provides a comparison between the No Build and Alternative B intersection analysis. Appendix A contains the detailed freeway and intersection analysis.

Table 4.2-10. Comparison between No Build and Alternative B Freeway Analysis

Location		Facility Type	Time Period	No Build LOS	Alternative B LOS
A	I-93 Northbound to NH 102	Diverge	AM	A	A
			PM	B	B
	NH 102 to I-93 Northbound	Merge	AM	C	C
			PM	C	C
	I-93 Southbound to NH 102	Diverge	AM	C	C
			PM	F	C
	NH 102 Westbound to I-93 Southbound	Merge	AM	B	B
			PM	B	A
	NH 102 Eastbound to I-93 Southbound	Merge	AM	C	C
			PM	B	B
B	I-93 Northbound to NH 28	Diverge	AM	C	C
			PM	C	D
	NH 28 to I-93 Northbound	Merge	AM	C	C
			PM	C	C
	I-93 Southbound to NH 28	Diverge	AM	D	C
			PM	D	C
	NH 28 to I-93 Southbound	Merge	AM	C	B
			PM	C	B
C	I-93 South of Exit 4—Northbound	Mainline	AM	B	B
			PM	C	C
	I-93 South of Exit 4—Southbound		AM	C	C
			PM	B	B
D	I-93 between Exits 4 and 5—Northbound	Mainline	AM	B	C[a]
			PM	C	C[a]
	I-93 between Exits 4 and 5—Southbound		AM	C	D[a]
			PM	C	D[a]
E	I-93 North of Exit 5—Northbound	Mainline	AM	C	C
			PM	C	C
	I-93 North of Exit 5—Southbound		AM	C	C
			PM	C	C

Note: Green shading represents improving from operating at a failing LOS to operating at an acceptable LOS.

[a] Represents the worst-case LOS between Exits 4 and 4A or Exits 4A and 5.

Table 4.2-11. Comparison between No Build and Alternative B Intersections Analysis

Location		No Build		Alternative B	
		AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
1	Exit 4 SB Off-Ramp/NH 102	D	F	C	**D**
2	Exit 4 NB Off-Ramp/NH 102	E	F	**D**	F
3	Exit 5 SB Off-Ramp/NH 28	E	C	**C**	B
4	Exit 5 NB Off-Ramp/NH 28	D	D	D	C
5	NH 102/Londonderry Road	B	E	A	**B**
6	NH 102/Fordway	C	D	C	C
7	NH Routes 102/28	D	D	D	D
8	North High Street/Ash Street Extension[a]	F	F	**B**	F
10	North High/Folsom/Franklin Streets[a]	B	D	B	**F**
11	Ross' Corner (Folsom/NH 28)	F	E	**C**	**D**
12	Tsienneto Road/Pinkerton Street[a]	C	F	**F**	F
13	NH 28/Linlew Drive	B	B	A	B
15	NH 28/Scobie Pond Road[a]	F	D	**B**	C
16	NH 102/NH 28 Bypass/East Derry Road[b]	D	F	C	**C**
17	NH 28 Bypass/Pinkerton/Nesmith[a]	A	A	**F**	**F**
18	NH 28 Bypass/Tsienneto Road	E	F	**C**	**C**
19	NH 102/Tsienneto Road[c]	C	F	A	
20	Exit 4A SB off ramp/Connector Road	N/A	N/A	D	
21	Exit 4A NB off ramp/Connector Road	N/A	N/A	C	
22	Connector Road/NH 28	N/A	N/A	C	
23	Connector Road/NH Bypass 28	N/A	N/A	C	
24	Connector Road/Tsienneto Road[a]	N/A	N/A	E	
27	NH 102/English Range Road[a]	N/A	N/A	C	

Note: Green shading represents improving from operating at a failing LOS to operating at an acceptable LOS; red shading indicates moving from an acceptable LOS to a failing LOS.
[a] Unsignalized intersections do not have an overall LOS; worst-case approach LOS reported.
[b] Roundabout analysis based on HCM 6 procedure.
[c] Unsignalized intersection under No Build and signalized intersection under Alternative B.

The creation of a new parallel route to NH 102 in conjunction to the induced effect of a fully built-out Woodmont Commons would substantially contribute to these volume changes. Alternative B would create a new direct connection to areas northeast of downtown Derry. Based on the travel patterns reported from the model, this new connection would attract more north-south regional trips by shifting vehicles from the NH 28 Bypass to I-93 because the travel time to access I-93 would drop with the Alternative B alignment. The trips destined to locations south of Derry and Londonderry would use I-93 rather than the NH 28 Bypass starting from the new I-93 Exit 4A interchange. The model also indicates that Alternative B would have more downtown Derry pass-through trips than Alternative A. A majority of the affected intersections would be a result in a shift of trip patterns to access the Alternative B alignment. Under Alternative B, freeway conditions would improve at Exit 4, the I-93 NB on-ramp from NH 102 would continue to queue into NH 102, eleven study area intersection operations would improve, and three study area intersections would worsen. Therefore, this alternative would result in beneficial impacts to the freeway operations and beneficial impacts (11 improved versus 3 worsened) to the study area intersections.

Alternative C

Under Alternative C, there would be a reduction in trips on several roadways such as NH 28 and NH 102 (Appendix A, Table 7). The creation of a new route to NH 28 would create a shift in traffic patterns from NH 28 to Exit 4A along I-93 to access destinations along NH 28 in Derry. Comparing the No Build Alternative to Alternative C shows the following volume changes:

- Mainline volumes on I-93 between Exits 4 and 4A would decrease an average of 7 percent and between Exits 4A and 5 would increase an average of 13 percent.
- Volumes along NH 102 east of Exit 4 would decrease by 24 percent.
- Volumes along NH 28 east of Exit 5 would decrease by 45 percent.

Based on the analysis under Alternative C compared to the No Build Alternative, all freeway facilities would operate at LOS D or better. Seven intersections would improve from LOS E or F to LOS B through D. Four intersections would degrade from LOS B through D to LOS E or LOS F. All new intersections and freeway facilities created under Alternative C would operate at LOS D or better, except NH 102/English Range Road (Intersection #27), which would operate at LOS E. Figure 4.2-6 shows the Alternative C LOS results. Table 4.2-12 provides a comparison between the No Build and Alternative C freeway analysis. Table 4.2-13 provides a comparison between the No Build and Alternative C intersection analysis. Appendix A contains the detailed freeway and intersection analysis.

Table 4.2-12. Comparison between No Build and Alternative C Freeway Analysis

Location		Facility Type	Time Period	No Build LOS	Alternative C LOS
A	I-93 Northbound to NH 102	Diverge	AM	A	A
			PM	B	B
	NH 102 to I-93 Northbound	Merge	AM	C	B
			PM	C	B
	I-93 Southbound to NH 102	Diverge	AM	C	C
			PM	F	C
	NH 102 Westbound to I-93 Southbound	Merge	AM	B	B
			PM	B	B
	NH 102 Eastbound to I-93 Southbound	Merge	AM	C	C
			PM	B	B
B	I-93 Northbound to NH 28	Diverge	AM	C	C
			PM	C	C
	NH 28 to I-93 Northbound	Merge	AM	C	C
			PM	C	C
	I-93 Southbound to NH 28	Diverge	AM	D	C
			PM	D	C
	NH 28 to I-93 Southbound	Merge	AM	C	C
			PM	C	C
C	I-93 South of Exit 4 – Northbound	Mainline	AM	B	B
			PM	C	C
	I-93 South of Exit 4—Southbound		AM	C	C
			PM	B	B
D	I-93 between Exits 4 and 5—Northbound	Mainline	AM	B	C[a]
			PM	C	C[a]
	I-93 between Exits 4 and 5—Southbound		AM	C	C[a]
			PM	C	C[a]
E	I-93 North of Exit 5—Northbound	Mainline	AM	C	C
			PM	C	C
	I-93 North of Exit 5—Southbound		AM	C	C
			PM	C	C

Note: Green shading represents improving from operating at a failing LOS to operating at an acceptable LOS.

[a] Represents the worst-case LOS between Exits 4 and 4A or Exits 4A and 5.

Table 4.2-13. Comparison between No Build and Alternative C Intersections Analysis

	Location	No Build		Alternative C	
		AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
1	Exit 4 SB Off-Ramp/NH 102	D	F	D	E
2	Exit 4 NB Off-Ramp/NH 102	E	F	E	F
3	Exit 5 SB Off-Ramp/NH 28	E	C	C	B
4	Exit 5 NB Off-Ramp/NH 28	D	D	D	C
5	NH 102/Londonderry Road	B	E	A	B
6	NH 102/Fordway	C	D	C	C
7	NH 102/28	D	D	C	D
8	North High Street/Ash Street Extension[a]	F	F	D	F
10	North High/Folsom/Franklin Streets[a]	B	D	B	F
11	Ross' Corner (Folsom/NH 28)	F	E	C	D
12	Tsienneto Road/Pinkerton Street[a]	C	F	F	F
13	NH 28/Linlew Drive	B	B	A	B
15	NH 28/Scobie Pond Road[a]	F	D	F	F
16	NH 102/NH 28 Bypass/East Derry Road[b]	D	F	C	C
17	NH 28 Bypass/Pinkerton/Nesmith[a]	A	A	F	E
18	NH 28 Bypass/ Tsienneto Road	E	F	C	C
19	NH 102/Tsienneto Road[c]	C	F	B	B
20	Exit 4A SB off ramp/Connector Road	N/A	N/A	C	B
21	Exit 4A NB off ramp/Connector Road	N/A	N/A	A	A
22	Connector/NH 28	N/A	N/A	C	C
23	Connector Road/NH Bypass 28	N/A	N/A	C	C
24	Connector Road/Tsienneto Road[a]	N/A	N/A	A	A
25	Connector Road/NH 28	N/A	N/A	B	B
27	NH 102/English Range Road[a]	N/A	N/A	C	E

Note: Green shading represents improving from operating at a failing LOS to operating at an acceptable LOS; red shading indicates moving from an acceptable LOS to a failing LOS.

[a] Unsignalized intersections do not have an overall LOS; worst-case approach LOS reported.

[b] Roundabout analysis based on HCM 6 procedure.

[c] Unsignalized intersection under No Build and signalized intersection under Alternative C.

Alternative C provides variations to Alternatives A and B in terms of the connection route between I-93 and eastern Derry. This alternative would include a new proposed interchange in a more northern location; therefore, it would not create the best parallel route to downtown Derry. This alternative would create more of a bypass to NH 28 between I-93 Exit 5 and where NH 28 intersects the alignment, and it would attract more vehicle trips from NH 28 than NH 102 and far fewer trips to Exit 4A than Alternatives A and B. A majority of the affected intersections would be affected by a shift of trip patterns to access the Alternative C alignment. Under Alternative C, freeway conditions would improve at Exit 4, nine study area intersection operations would improve, and four study area intersections would worsen. Therefore, this alternative would result in beneficial impacts on the freeway operations and beneficial impacts (nine improved versus four worsened) on the study area intersections.

Alternative D

Under Alternative D, there would be a reduction in trips on several roadways such as NH 28 and NH 102 (Appendix A, Table 7). Similar to Alternative C, a new route to NH 28 would shift traffic patterns from NH 28 Exit 4A along I-93 to access destinations along NH 28 in Derry. Comparing the No Build Alternative to Alternative D shows the following volume changes:

- Mainline volumes on I-93 between Exits 4 and 4A would decrease an average of 9 percent and between Exits 4A and 5 would increase an average of 13 percent.
- Volumes along NH 102 east of Exit 4 would decrease by 16 percent.
- Volumes along NH 28 east of Exit 5 would decrease by 47 percent.

Based on the analysis under Alternative D compared to the No Build Alternative, all freeway facilities would operate at LOS D or better. Nine intersections would improve from LOS E or F to LOS B through D or improve from LOS F to LOS E. Two intersections would degrade from LOS B through D to LOS F. All new intersections and freeway facilities created under Alternative D would operate at LOS D or better. Figure 4.2-7 shows the Alternative D LOS results. Table 4.2-14 provides a comparison between the No Build and Alternative D freeway analysis. Table 4.2-15 provides a comparison between the No Build and Alternative D intersection analysis. Appendix A contains the detailed freeway and intersection analysis.

Table 4.2-14. Comparison between No Build and Alternative D Freeway Analysis

Location		Facility Type	Time Period	No Build LOS	Alternative D LOS
A	I-93 Northbound to NH 102	Diverge	AM	A	A
			PM	B	B
	NH 102 to I-93 Northbound	Merge	AM	C	B
			PM	C	B
	I-93 Southbound to NH 102	Diverge	AM	C	C
			PM	F	C
	NH 102 Westbound to I-93 Southbound	Merge	AM	B	B
			PM	B	B
	NH 102 Eastbound to I-93 Southbound	Merge	AM	C	C
			PM	B	B
B	I-93 Northbound to NH 28	Diverge	AM	C	C
			PM	C	D
	NH 28 to I-93 Northbound	Merge	AM	C	C
			PM	C	C
	I-93 Southbound to NH 28	Diverge	AM	D	C
			PM	D	C
	NH 28 to I-93 Southbound	Merge	AM	C	C
			PM	C	C
C	I-93 South of Exit 4—Northbound	Mainline	AM	B	B
			PM	C	C
	I-93 South of Exit 4—Southbound		AM	C	C
			PM	B	B
D	I-93 between Exits 4 and 5—Northbound	Mainline	AM	B	C[a]
			PM	C	C[a]
	I-93 between Exits 4 and 5—Southbound		AM	C	C[a]
			PM	C	C[a]
E	I-93 North of Exit 5—Northbound	Mainline	AM	C	C
			PM	C	C
	I-93 North of Exit 5—Southbound		AM	C	C
			PM	C	C

Note: Green shading represents improving from operating at a failing LOS to operating at an acceptable LOS.

[a] Represents the worst-case LOS between Exits 4 and 4A or Exits 4A and 5.

Table 4.2-15. Comparison between No Build and Alternative D Intersections Analysis

Location		No Build		Alternative D	
		AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
1	Exit 4 SB Off-Ramp/NH 102	D	F	D	E
2	Exit 4 NB Off-Ramp/NH 102	E	F	E	F
3	Exit 5 SB Off-Ramp/NH 28	E	C	C	B
4	Exit 5 NB Off-Ramp/NH 28	D	D	D	C
5	NH 102/Londonderry Road	B	E	A	B
6	NH 102/Fordway	C	D	C	C
7	NH 102/28	D	D	D	D
8	North High Street/Ash Street Extension[a]	F	F	D	F
10	North High/Folsom/Franklin Streets[a]	B	D	B	F
11	Ross' Corner (Folsom/NH 28)	F	E	C	D
12	Tsienneto Road/Pinkerton Street[b]	C	F	C	C
13	NH 28/Linlew Drive	B	B	B	C
14	NH 28/Ashleigh Drive	B	C	C	C
15	NH 28/Scobie Pond Road[a]	F	D	F	F
16	NH 102/NH 28 Bypass/East Derry Road[c]	D	F	D	D
17	NH 28 Bypass/Pinkerton/Nesmith[a]	A	A	F	F
18	NH 28 Bypass/Tsienneto Road	E	F	C	C
19	NH 102/Tsienneto Road[b]	C	F	A	C
20	Exit 4A SB off ramp/Connector Road	N/A	N/A	B	B
21	Exit 4A NB off ramp/Connector Road	N/A	N/A	A	A
25	Connector Road/NH 28	N/A	N/A	B	B
27	NH 102/English Range Road[a]	N/A	N/A	C	D

Note: Green shading represents improving from operating at a failing LOS to operating at an acceptable LOS; red shading indicates moving from an acceptable LOS to a failing LOS.

a Unsignalized intersections do not have an overall LOS; worst-case approach LOS reported.

b Unsignalized intersection under No Build and signalized intersection under Alternative D.

c Roundabout analysis based on HCM 6 procedure.

Alternative D provides a variation to Alternatives A, B, and C in terms of the connection route between I-93 and eastern Derry. This alternative would include a new proposed interchange in a more northern location; therefore, it would not create the best parallel route to downtown Derry. This alternative would create more of a bypass to NH 28 between I-93 Exit 5 and where NH 28 intersects the two alignments, and it would attract more vehicle trips from NH 28 than NH 102 and far fewer trips to Exit 4A than Alternatives A and B. Under Alternative D, freeway conditions would improve at Exit 4, 10 study area intersection operations would improve, and 2 study area intersections would worsen. Therefore, this alternative would result in beneficial impacts on the freeway operations and beneficial impacts (10 improved versus 2 worsened) on the study area intersections.

Alternative F

Under Alternative F, there would be a minor change in trips on NH 28 and NH 102 (Appendix A, Table 7). Improvements to NH 102 would create a minor shift in traffic patterns throughout the study area. Comparing the No Build Alternative to Alternative F shows the following volume changes:

- Mainline volumes on I-93 between Exits 4 and 4A and between Exits 4A and 5 would not change.
- Volumes along NH 102 east of Exit 4 would increase by 10 percent.
- Volumes along NH 28 east of Exit 5 would decrease by 3 percent.

Based on the analysis under Alternative F compared to the No Build Alternative, the SB I-93 off-ramp to NH 102 would remain LOS F. Six intersections would improve from LOS E or F to LOS C through D or improve from LOS F to LOS E. Four intersections would degrade from LOS B through D to LOS E or LOS F. One intersection would improve during the AM peak hour and degrade during the PM peak hour. Figure 4.2-8 shows the Alternative F LOS results. Table 4.2-16 provides a comparison between the No Build and Alternative F freeway analysis. Table 4.2-17 provides a comparison between the No Build and Alternative F intersection analysis. Appendix A contains the detailed freeway and intersection analysis.

Table 4.2-16. Comparison between No Build and Alternative F Freeway Analysis

Location		Facility Type	Time Period	No Build LOS	Alternative F LOS
A	I-93 Northbound to NH 102	Diverge	AM	A	A
			PM	B	B
	NH 102 to I-93 Northbound	Merge	AM	C	C
			PM	C	C
	I-93 Southbound to NH 102	Diverge	AM	C	C
			PM	F	F
	NH 102 Westbound to I-93 Southbound	Merge	AM	B	B
			PM	B	B
	NH 102 Eastbound to I-93 Southbound	Merge	AM	C	C
			PM	B	B
B	I-93 Northbound to NH 28	Diverge	AM	C	C
			PM	C	C
	NH 28 to I-93 Northbound	Merge	AM	C	C
			PM	C	C
	I-93 Southbound to NH 28	Diverge	AM	D	C
			PM	D	C
	NH 28 to I-93 Southbound	Merge	AM	C	B
			PM	C	C
C	I-93 South of Exit 4—Northbound	Mainline	AM	B	B
			PM	C	C
	I-93 South of Exit 4—Southbound		AM	C	C
			PM	B	B
D	I-93 between Exits 4 and 5—Northbound	Mainline	AM	B	C
			PM	C	C
	I-93 between Exits 4 and 5—Southbound		AM	C	C
			PM	C	D
F	I-93 North of Exit 5—Northbound	Mainline	AM	C	C
			PM	C	C
	I-93 North of Exit 5—Southbound		AM	C	C
			PM	C	C

Table 4.2-17. Comparison between No Build and Alternative F Intersections Analysis

Location		No Build		Alternative F	
		AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
1	Exit 4 SB Off-Ramp/NH 102	D	F	D	E
2	Exit 4 NB Off-Ramp/NH 102	E	F	E	F
3	Exit 5 SB Off-Ramp/NH 28	E	C	E	C
4	Exit 5 NB Off-Ramp/NH 28	D	D	D	D
5	NH 102/Londonderry Road	B	E	B	C
6	NH 102/Fordway	C	D	C	C
7	NH Routes 102/28	D	D	C	C
8	North High Street/Ash Street Extension[a]	F	F	D	F
9	North High Street/Madden Road[a]	D	F	D	E
10	North High/Folsom/Franklin Streets[a]	B	D	B	F
11	Ross' Corner (Folsom/NH 28)	F	E	C	D
12	Tsienneto Road/Pinkerton Street[a]	C	F	F	F
13	NH 28/Linlew Drive	B	B	B	B
14	NH 28/Ashleigh Drive	B	C	B	C
15	NH 28/Scobie Pond Road[a]	F	D	D	F
16	NH 102/NH 28 Bypass/East Derry Road[b]	D	F	E	F
17	NH 28 Bypass/Pinkerton/Nesmith[a]	A	A	D	E
18	NH 28 Bypass/Tsienneto Road	E	F	C	C
19	NH 102/Tsienneto Road[a]	C	F	C	F
27	NH 102/English Range Road[a]	N/A	N/A	C	D

Note: Green shading represents improving from operating at a failing LOS to operating at an acceptable LOS; red shading indicates moving from an acceptable LOS to a failing LOS.

[a] Unsignalized intersections do not have an overall LOS; therefore, worst-case approach LOS is reported.

[b] Roundabout analysis based on HCM 6 procedure.

Alternative F would minimally change vehicle trip patterns. Under Alternative F, freeway impacts would continue to occur at Exit 4 as the I-93 NB on-ramp from NH 102 would continue to queue into NH 102, seven study area intersection operations would improve, and two study area intersections would worsen. Therefore, this alternative would not result in significant impacts on the freeway and would result in beneficial impacts (seven improved versus three worsened) to the study area intersections.

4.3 Land Use, Zoning, and Public Policy

This section addresses land use, zoning, and public policy. Parks, recreational resources, and conservation lands are discussed in Section 4.19.

Transportation projects may affect land use both directly and indirectly. Direct land use impacts may include changes in land use from ROW acquisition and residential and/or business displacements to accommodate new or expanded transportation facilities. Changes in land use because of a transportation project, or the transportation project itself, may be inconsistent with future land use plans and goals put forth in municipal and regional plans and regulations. Finally, transportation projects may influence the location and form of future development by making some areas relatively more accessible and therefore more attractive for development. This type of induced growth effect, along with related potential impacts on land use patterns and environmental resources, is evaluated in Chapter 5.

4.3.1 Affected Environment

In NH, land use is regulated at the local level by municipalities through zoning and subdivision regulations. Zoning ordinances regulate land uses by area and the type and form of built improvements allowed within each land use. Subdivision ordinances seek to control the density of development on new parcels of land. Land use can also be influenced by other public policy goals expressed as part of land use, transportation, and infrastructure planning processes.

Current land use and zoning conditions were identified using geographic information systems (GIS) datasets of land use by tax parcel and zoning district boundaries provided by the Towns of Derry and Londonderry. In addition, the data were supplemented with reference to the towns' zoning ordinances (Town of Derry, 2016a; Town of Londonderry, 2016). The study area for the analysis of direct effects to land use was defined as the land area within 500 feet of the proposed alternative alignments, which corresponds to the study area for direct effects to noise levels (Figure 4.3-1). Field visits and windshield surveys were used to verify land use conditions.

Land use policies and plans for the Project area were identified through a review of the following comprehensive and master plans:

- Master Plan of Derry (Town of Derry, 2010)
- Comprehensive Master Plan of Londonderry (Town of Londonderry, 2013)
- Southern New Hampshire Planning Commission's Moving Southern New Hampshire Forward: 2015-2035 Regional Comprehensive Plan (SNHPC, 2014)

This section summarizes land use and zoning along the Build Alternative corridors (A, B, C, D, and F), as well as municipal land use plans in Derry and Londonderry. Regional land use patterns and land use policies are discussed in Chapter 5, *Indirect Effects and Cumulative Impacts*.

Land Use

Land uses along Alternatives A, B, C, and D include commercial, industrial, single-family and multi-family residential, institutional, civic, and open space. Alternative F runs along NH 102 through downtown Derry, and the land uses are primarily commercial and residential with other uses including institutional, civic, recreational (golf course), and industrial. Land uses along the alignments are described in more detail in the following sections and shown in Figure 4.3-1.

Alternative A

Between I-93 and the Londonderry-Derry town boundary, land use is open space/undeveloped; however, the land is slated for future development as part of the Woodmont Commons PUD. From the town boundary along Madden Road, land use is a combination of single-family residential and industrial. The alignment crosses a planned future segment of the Rail Trail adjacent to the Madden Road intersection (see Section 4.19). After the intersection of Madden Road and North High Street, land use on the north side of North High Street is in commercial use, and land use on the south side of North High Street is residential (single-family and multi-family) with a small area of open space adjacent to the curve of North High Street. East of the Franklin Street intersection, North High Street becomes Folsom Road. Land use along Folsom Road between Franklin Street and Claremont Avenue is single- and multi-family residential with one undeveloped parcel of land. Between Claremont Avenue and Crystal Avenue (NH 28), land uses are commercial and civic north of Folsom Road and single-family residential and commercial south of Folsom Road. The civic use is associated with the Greater Derry Salvation Army (18 Folsom Road), which serves the towns of Derry, Londonderry, and Windham. At Crystal Avenue, Folsom Road becomes Tsienneto Road. Between Crystal Avenue and North Main Street (NH 28 Bypass), land uses on the north side of Tsienneto Road are industrial and undeveloped, while land uses on the south side are commercial, multi-family residential, and undeveloped. East of North Main Street to the eastern project terminus at Chester Road (NH 102), land uses along the north side of Tsienneto Road are institutional, commercial, civic, and single- and multi-family residential, with a few small parcels of undeveloped land. Land uses on the south side of Tsienneto Road are primarily single- and multi-family residential, with one parcel in institutional use adjacent to North Main Street and two parcels in commercial use near NH 102. The Greater Derry Salvation Army is the only community facility along the alignment for Alternative A.

Alternative B

Between I-93 and the Londonderry-Derry town boundary, land use is open space/undeveloped; however, the land is slated for future development as part of the Woodmont Commons PUD. From the town boundary, Alternative B continues to traverse undeveloped land and the planned future segment of the Rail Trail (see Section 4.19) until it reaches the Franklin Street Extension. Along B Street between the Franklin Street Extension and Manchester Road (NH 28), land uses north of B Street are primarily commercial and industrial with a small area of undeveloped land near the Franklin Street Extension. Land uses south of B Street are primarily commercial and industrial with a small area of residential use along the Franklin Street Extension. Between NH 28 and North Main Street (NH 28 Bypass), land uses near NH 28 are commercial and industrial, and then they transition to open space/undeveloped land and single-family residential as the alignment for Alternative B approaches North Main Street. Between North Main Street and Scenic Drive, land uses on the north side of the alignment are single-family residential, undeveloped land, and commercial. Land uses on the south side of the alignment are single-family residential, civic, undeveloped, and commercial. East of Scenic Drive, land uses along the alignment are primarily undeveloped land and single-family residential with small areas of commercial use at the project terminus (Chester Road/NH 102). Along the alignment for Alternative B, there are no community facilities.

Alternative C

Between I-93 and Rockingham Road (NH 28), land uses along the north side of the alignment for Alternative C are a combination of open space/undeveloped, commercial, industrial, and single-family residential. Land use on the south side of the alignment is primarily open space/undeveloped, with a small area of single-family residential, commercial, and industrial uses near Rockingham Road. As the alignment travels along Rockingham Road to the intersection with Seasons Lane, land uses are undeveloped land and single-family residential. At the Rockingham Road/Seasons Lane intersection, NH 28 becomes Manchester Road, and the roadway (and alignment) crosses the Londonderry Rail Trail (see Section 4.19). Along NH 28 south of Seasons Lane, land use is primarily commercial, with areas of single-family residential, institutional, and civic (municipal) uses west of Scobie Pond Road. South of Ashleigh Drive, the alignment for Alternative C joins the alignment for Alternative B. Between Manchester Road (NH 28) and Chester Road (NH 102), land uses along Alternative C are the same as those described for Alternative B. Along the alignment for Alternative C, there are no community facilities.

Alternative D

From I-93 to Rockingham Road (NH 28) south of Ashleigh Drive, the alignment for Alternative D follows the alignment for Alternative C. South of Ashleigh Road, Alternative D continues along NH 28 to Tsienneto Road. Land uses along this portion of the alignment are commercial and industrial, with a small area of undeveloped land near Ashleigh Drive and civic land use on the northwest corner of the intersection of Crystal Avenue and Folsom Road. At the intersection between Crystal Avenue (NH 28) and Folsom Road/Tsienneto Road, Alternative D joins the alignment for Alternative A. Along Tsienneto Road, from Crystal Avenue to Chester Road (NH 102), land uses along the alignment for Alternative D are the same as those described for Alternative A. Along the alignment for Alternative D, there are no community facilities.

Alternative F

Alternative F includes improvements to Broadway (NH 102) in Derry between Londonderry Road/St. Charles Street and North/South Main Street (NH 28 Bypass). Along NH 102, between the western project terminus and the intersections of Broadway with Elm Street and West Everett Streets, land uses are single- and multi-family residential and commercial, with one parcel in institutional use at the NH 102/West Everett Street intersection. Between West Everett Street and Central Street, land uses are a combination of commercial, residential (single- and multi-family), and civic uses. NH 102 crosses the Rail Trail (see Section 4.19). Between Central Street and the intersection of NH 102 with Boyd Road and Fenway Street, land uses include a combination of commercial, institutional, and multi-family residential. Between Boyd Road and Hood Kroft Drive, land use is residential (single- and multi-family) and recreational. The recreational parcel is a golf course (Hoodkroft Country Club) and is discussed in more detail in Section 4.19. Between Hood Kroft Drive and the eastern project terminus, land uses are a combination of commercial, residential (single- and multi-family), recreational, civic, open space, and industrial. Table 4.3-1 lists community facilities along the alignment for Alternative F.

Table 4.3-1. Community Facilities within 500 feet of Alternative F

Name	Address
Marion Gerrish Community Center	39 W Broadway, Derry, NH 03038
Adams Memorial Opera House	29 W Broadway, Derry, NH 03038
Derry History Museum	29 W Broadway # 6, Derry, NH 03038
Community Park/Farmer's Market	Intersection of Broadway and Manning
Derry Friendship Center	6 Rail Road Avenue, Derry, NH 03038
The Vineyard Community Church	Near 11½ E Broadway
Banister Family Dentistry	1 Birch Street, Derry, NH 03038
First Baptist Church	44 E Broadway, Derry, NH 03038
Masonic Temple	58 E Broadway, Derry, NH 03038
St. Luke's United Methodist Church	63 E Broadway, Derry, NH 03038
Derry Public Library	64 E Broadway, Derry, NH 03038
MacGregor Park	64 E Broadway, Derry, NH 03038
First Church–Christ Scientist	1 Boyd Road, Derry, NH 03038
Hoodkroft Golf Course	121 E Broadway, Derry, NH 03038
Scott Copeland DDS	132 E Broadway, Derry, NH 03038
Pinkerton Academy Athletic Field	10 North Main Street, Derry, NH 03038

Source: Town of Derry (2017a); Derry Rail Trail Alliance (2017); Londonderry Conservation Commission (2014)

Zoning

Zoning along the Build Alternatives is shown in Figure 4.3-2. Table 4.3-2 provides a list of the zoning districts within 500 feet of the alignments for the Build Alternatives (study area). In the following section, the permitted uses in each zoning district are summarized by alternative (Town of Derry, 2016a; Town of Londonderry, 2016).

Table 4.3-2. Zoning Districts

Name	Town
Agricultural-Residential	Londonderry
Commercial II	Londonderry
General Commercial	Derry
General Commercial 2	Derry
Industrial I	Londonderry
Industrial II	Londonderry
Industrial 4	Derry
Medium High Density Residential	Derry

Name	Town
Medium High Density Residential 2	Derry
Multi-Family Residential	Derry
Medium Density Residential	Derry
Low Density Residential	Derry

Source: Town of Derry (2016a), Town of Londonderry (2016)

Alternative A

Between I-93 and North Main Street (NH 28 Bypass), zoning districts along Alternative A include industrial, commercial, medium high density residential, and multi-family residential. Between North Main Street and Chester Road, a small commercial district is located adjacent to North Main Street on both sides of Tsienneto Road, and the remainder of the Project area is zoned as medium density and low density residential.

The industrial I (Londonderry) and industrial 4 (Derry) allow a variety of permitted uses. Industrial I allows the manufacture of various products; large scale uses such as warehousing, storage, freight, and sand and gravel pits; agricultural and forestry uses; and wireless communication facilities. Industrial 4 permits all of the uses outlined for industrial I as well as retail sales establishments, restaurants, commercial service establishments, indoor commercial recreational facilities, office buildings, hotels, and automobile repair and service facilities.

The general commercial district allows for a wide range of commercial uses as well as single-family housing. The purpose of the general commercial 2 district is to encourage uses that fit existing infrastructure and land within the district and provides the potential to increase the commercial tax base as well as employment opportunities for local residents.

The multi-family residential zoning districts allow the following residential uses: single-family detached dwellings, two-family dwellings, multi-family dwellings, and accessory apartments. The medium high density residential district permits the uses outlined in the multi-family residential district as well as commercial performing and fine arts schools and studios and private schools. The medium high density residential 2 district limits dwellings to single-family detached dwellings and accessory apartments.

The medium density residential zoning district permits single-family detached dwellings (conventional subdivisions), manufactured housing subdivisions, accessory apartments, campgrounds, production or sale of farm produce by residents, and community-oriented recreational facilities (e.g., YMCA).

The low density residential district permits single-family detached dwellings (conventional subdivisions) and wireless communication facilities in the telecommunications overlay zone. No overlay zones are mapped for the Project area.

Alternative B

Between I-93 and North Main Street (NH 28 Bypass), zoning districts along Alternative B include industrial and medium density residential. Between North Main Street and Chester Road, a small commercial district is located adjacent to North Main Street north of Tsienneto Road, and the remainder of the Project area is zoned as medium density and low density residential.

Alternative C

Between I-93 and Rockingham Road (NH 28) and along NH 28 until a point near Scobie Pond Road, zoning districts along Alternative C include agricultural-residential and commercial. The Agricultural-Residential District is designed to permit uses that are compatible with and protective of certain areas that have been and are being developed for agricultural and forestry uses, water quality preservation, residential use, and public use. Londonderry designates five commercial subdistricts, for example, Subdistrict C-II is intended to encourage development of business areas to serve the motoring public.

Near Scobie Pond Road, the area is zoned as industrial until the alignment for Alternative C approaches North Main Street. The industrial II district is primarily a district that allows a more intensive industrial use than industrial I; however, the Londonderry Zoning Ordinance (2016) does not separate the districts using business type. Near North Main Street on the north side of the alignment, there is a medium density residential zoning district. Between North Main Street and Chester Road, a small commercial district is located adjacent to North Main Street north of Tsienneto Road, and the remainder of the Project area is zoned as medium density and low density residential.

Alternative D

Between I-93 and Rockingham Road (NH 28) and along NH 28 until a point near Scobie Pond Road, zoning districts along Alternative D include agricultural-residential and commercial. Near Scobie Pond Road, the area is zoned as industrial until the alignment for Alternative D approaches Tsienneto Road. The intersection of NH 28 and Tsienneto Road includes a commercial zoning district. Between Crystal Avenue (NH 28) and North Main Street (NH 28 Bypass), zoning districts include commercial, multi-family residential, and medium high density residential. Between North Main Street and Chester Road, a small commercial district is located adjacent to North Main Street on both sides of Tsienneto Road, and the remainder of the Project area is zoned as medium density and low density residential.

Alternative F

Alternative F travels through downtown Derry. Zoning districts along the portion of NH 102 to be improved include commercial, office business district, central business district, and medium high density residential.

The purpose of the office business district is to limit the land use activities that do not “greatly aggravate” the already serious traffic issues on West Broadway and would not result in a “severe detrimental impact” on existing residential uses in the district. The central business district is established to encourage appropriate uses within an area of the community where the predominant character has been and will continue to be historical, municipal, cultural, residential, and commercial. The permitted uses in this district are allowed based on avoiding detrimental impact on existing uses.

Public Policy

This section summarizes the comprehensive plans for Derry and Londonderry as related to land use and transportation goals.

As stated in the Town of Derry’s Master Plan (2010), the town’s vision is to be:

> *"…an attractive, thriving community that has a strong sense of cohesiveness in all aspects of community and government; a balance between open space preservation and development while maintaining the Town's rural character; improving and maintaining a healthy economy; improving sustainable growth and development practices that contribute to good health, attractiveness and economic development in town; continued preservation of important historical sites and buildings; an increased effort to reduce the residential tax burden; the creation of Derry as a destination and improving upon drawing visitors and increasing economic development at a sustainable rate."*

To that end, the town identified goals related to land use to achieve the vision described in the Master Plan (Town of Derry, 2010). The goals are primarily related to promoting economic development in Derry while controlling and directing sustainable future growth. The Master Plan goals related to economic development include:

- creating a new commercial/industrial zone in the area north of Tsienneto Road and along Manchester Road in the area currently zoned as industrial;
- rezoning and expanding the area along the NH Route 28 corridor in the southern portion of the town to commercial;
- strengthening the economic character and development in the downtown area; and
- developing a town-wide economic development plan.

Master Plan goals related to directing and controlling growth consider:

- use of a historic overlay district to protect sites and properties from adjacent residential and commercial uses;
- continued use of the town's growth management ordinance; and
- a cost of community services study to determine how land uses should be balanced in the future in the Town of Derry.

The Master Plan also outlines goals for the transportation system, including addressing traffic and safety concerns, specifically at Danforth Circle and on Tsienneto Road at Crystal Avenue and NH 102; developing pedestrian-friendly streets, and continuing participation in the regional transportation funding programs for local and state transportation projects. Additional transportation-related goals focus on continued development of the bike trail and improvement of public transportation to link key areas within Derry. Derry's Master Plan identifies the proposed Exit 4A Project as a potential long-term solution to relieve traffic on NH 102 and promote the safe and efficient movement of people, goods, and services.

As stated in the Town of Londonderry's Comprehensive Master Plan (2013), the town's vision is to:

> *"…remain a close-knit, vibrant community in the heart of protected forests and farms. Residents, businesses, and visitors should expect a government that works diligently to link development with quality of life, while strengthening community and economic vitality. Efficient Town services, inviting public spaces, and a top-tier school system make the Town a great place to live and raise a family. A highly-educated work force, proximity to a regional airport, and an efficient transportation system make the Town an ideal place to work and invest in new business."*

The guiding principles for this vision include stay “forever green”, promote unique activity centers, emphasize housing choice and diversity, increase transportation choice and walkability, enhance the municipal advantage, and excel in education and town services. With regard to transportation, the goals outlined in the Master Plan include improving mobility, reducing congestion, and providing greater travel mode choice for Londonderry’s residents. The primary focus for improving the transportation system includes expansion and improvement of existing infrastructure, reduction of the overreliance on motorized vehicles for daily travel needs, and implementation of a town-wide complete streets policy. The Master Plan does not mention the proposed Exit 4A Project; however, it has been considered in the Woodmont Commons PUD Master Plan (Pillsbury Realty Development, LLC, 2013). The Woodmont Commons PUD is planned on the east and west sides of I-93 near the Proposed Project. Based on discussions with the Town of Londonderry and the developer, the remainder of the Woodmont Commons PUD area (east and west of I-93) is anticipated to be built out by 2040. Additional discussion regarding Woodmont Commons is provided in Chapter 5.

4.3.2 Environmental Consequences

The following sections include a discussion of compatibility of the No Build Alternative and the Build Alternative with land use, zoning, and public policy. Residential acquisitions and business displacements are discussed in more detail in Section 4.7.2, *Socioeconomics*.

Land Use

No Build Alternative

Under the No Build Alternative, the Proposed Project would not be implemented, and no changes to land use attributable to the Proposed Project would occur. No impact on community facilities would occur.

Alternative A

Under Alternative A, approximately 41.45 acres of new ROW would be required, and these takes would include 14 residential acquisitions and 25 business displacements. Implementation of Alternative A would provide direct Interstate access to commercial and industrial lands and be compatible with existing and future commercial and industrial uses. It could be incompatible with existing and future residential land uses, but it would be more compatible than Alternatives B and C, which have more low density residential use along their alignments. The Salvation Army of Derry (18 Folsom Road) would be displaced by Alternative A. No other community facilities would be affected.

Alternative B

Under Alternative B, approximately 52.81 acres of new ROW would be required, and these takes would include 16 residential acquisitions and 11 business displacements. Residential acquisitions and business displacements are discussed in more detail in Section 4.7.2. Implementation of Alternative B would provide direct Interstate access to commercial and industrial lands and be compatible with existing and future commercial and industrial uses. It would be incompatible with existing and future residential land uses. No impacts on community facilities would occur.

Alternative C

Under Alternative C, approximately 53.35 acres of new ROW would be required, and these takes would include 13 residential acquisitions and 2 business displacements. Residential acquisitions and business displacements are discussed in more detail in Section 4.7.2. Implementation of Alternative C would provide improved access to commercial and industrial lands and generally be compatible with existing and future commercial and industrial uses. It would be incompatible with existing and future residential uses. No impacts on community facilities would occur.

Alternative D

Under Alternative D, approximately 43.20 acres of new ROW would be required, and these takes would include 2 business displacements (see Section 4.7.2). No residential acquisitions or impacts on community facilities would occur under Alternative D. Implementation of Alternative D would provide improved access to commercial and industrial lands and generally be compatible with existing and future commercial and industrial uses. It could be incompatible with existing and future residential use, but it would be more compatible with residential use than Alternatives B and C, which have more low density residential use along their alignments. No impacts on community facilities would occur.

Alternative F

Under Alternative F, approximately 1.17 acres of new ROW would be required. Although no residential acquisitions would be required, Alternative F would result in 16 business displacements. These displacements are discussed in more detail in Section 4.7.2. Implementation of Alternative F would be incompatible with existing residential and commercial land uses and incompatible with future local planning goals for downtown Derry businesses. No acquisitions of community facilities would occur.

Zoning

No Build Alternative

Under the No Build Alternative, the Proposed Project would not be implemented, and no changes to zoning attributable to the Proposed Project would occur.

Build Alternatives

As described in Chapter 5, *Indirect Effects and Cumulative Impacts,* presently, the Town of Derry is undertaking a study to determine whether to rezone several residential properties along North High Street currently zoned as medium-high density residential to an industrial zoning category. Under Alternative A, these properties would have direct access to I-93. Under Alternative B, Franklin Street and Folsom Road could provide access for these properties to connect to I-93. These properties would not have access to I-93 under Alternatives C, D, or F. No other changes to zoning would be attributable to or affected by the Build Alternatives.

Public Policy

No Build Alternative

Under the No Build Alternative, the downtown Derry area would continue to experience high traffic volumes, and opportunities for enhanced economic vitality would not occur. Therefore, the No Build Alternative is incompatible with public policy related to the Derry and Londonderry master plans.

Build Alternatives

Alternatives A and B would be compatible with public policy in that they would reduce traffic in downtown Derry and provide opportunities for economic development. Although Alternatives C and D would reduce traffic in downtown Derry, they would not provide additional opportunities for economic development beyond supporting the revitalization of the downtown area. Alternative F would be incompatible with public policy in that it would not reduce through traffic in downtown Derry, would impact street parking in the downtown area, and would not provide opportunities for economic development.

Mitigation Measures

Mitigation measures for potential impacts related to land use, zoning, and public policy have not been proposed. Section 4.7, *Socioeconomics*, discusses mitigation measures related to residential relocations and business displacements.

4.4 Air Quality

4.4.1 Introduction

Transportation projects may affect air quality in the vicinity of a project both temporarily and over the long term. During construction, suppliers and site workers would travel to the Project site by automobile and truck; once the new exit is complete, there is likely to be an increase in normal daily traffic in the immediate area. This increase in vehicular traffic may result in emissions of pollutants such as carbon monoxide (CO), particulate matter (PM), and the precursor pollutants that contribute to the formation of ground-level ozone (O_3).

This section describes the standards used to assess air quality, the attainment status of the Project area, existing air quality monitoring data, potential air quality impacts associated with Project operation and construction, and mitigation measures for air quality impacts. The existing air quality was assessed by compiling measured data for existing and historical air quality conditions in the study area. The measured data compiled for ambient pollutant concentrations were compared to applicable air quality standards.

National and State Air Quality Standards

The Clean Air Act (CAA) and its amendments led to the creation of National Ambient Air Quality Standards (NAAQS) by EPA for six criteria air pollutants: CO, sulfur dioxide (SO_2), O_3, PM, nitrogen dioxide (NO_2), and lead (Pb). The NAAQS are set at levels designed to protect public health.

CO is a colorless, odorless gas that results from the incomplete combustion of gasoline and other fossil fuels. Approximately 80 percent of CO emissions are from motor vehicles. Because CO disperses quickly, concentrations can vary greatly over relatively short distances. Elevated concentrations are usually limited to locations near crowded intersections and along congested roadways and can cause adverse health impacts by reducing oxygen delivery to vital organs.

O_3 is also a colorless gas and a major constituent of photochemical smog at the earth's surface. Precursors in the formation of ozone are volatile organic carbon (VOCs) and nitrogen oxide (NO_x). In the presence of sunlight, ozone is formed through a series of chemical reactions that take place in the atmosphere. Because the reactions occur as the pollutants are diffusing downwind, elevated ozone levels are often found many miles from precursor pollutant sources. Health effects of O_3 exposure include respiratory irritation, reduced lung function, and worsening of diseases such as asthma. People with lung disease, children, older adults, and people who are active outdoors may be particularly sensitive to O_3. Elevated O_3 can also impact sensitive vegetation. For the Project, ground-level O_3 is a consideration within the entire Project area.

NO_2 is a major component of NO_x. In addition to being a precursor to ozone, NO_2 is also a criteria pollutant under NAAQS. Nitrogen dioxides form when fuel is burned at high temperatures. The primary manmade sources are motor vehicles, electric utilities, and other industrial, commercial, and residential sources that burn fuels. It is one of the main ingredients involved in the formation of ground-level ozone, which can trigger serious respiratory problems. NO_2 forms small particles that penetrate deep in the lungs, and can cause or worsen existing respiratory system problems such as asthma, emphysema, or bronchitis. It also contributes to: formation of acid rain; nutrient loading to waterbodies; atmospheric particles; and visibility impairment in parks. NO_x are also a precursor to the formation of ozone. NO_2 emission sources associated with the Project include cars, trucks, and construction equipment.

PM is a broad class of air pollutants that exist as liquid droplets or solids, with a wide range of size and chemical composition. PM is emitted by a variety of sources, both natural and human-made. Major human-made sources of PM include the combustion of fossil fuels in vehicles, power plants, and homes; construction activities; agricultural activities; and wood-burning fireplaces. Smaller particulates that are smaller than or equal to 10 and 2.5 microns in size (PM_{10} and $PM_{2.5}$) are of particular health concern because they can get deep into the lungs and affect respiratory and heart function. Particulates can also impact visibility; damage soil, plants, and water quality; and stain stone materials. PM emissions at the Project are primarily a concern from heavy-duty trucks and other equipment with diesel engines.

SO_2 is part of a group of reactive gases called oxides of sulfur. Health effects of SO_2 exposure include adverse respiratory effects, such as increased asthma symptoms. The largest sources of SO_2 emissions nationally are from fossil fuel combustion at power plants/industrial facilities, electrical utilities, and residential/commercial boilers. Because mobile sources are not a significant source of SO_2 emissions, SO_2 is not a primary concern at the Project.

Pb is a toxic heavy metal that can have numerous adverse health impacts, including neurological damage to children and cardiovascular effects in adults. Pb emissions can contribute to exposure through the air directly or indirectly by causing soil/water contamination. Prior to the phase out of leaded gasoline in 1980, automobiles were a source of Pb emissions. According to EPA, the major sources of Pb emissions to the air today are ore and metals processing and piston-engine aircraft operating on leaded aviation gasoline. The Project does not involve Pb emissions; therefore, Pb is not discussed further in the air quality analysis.

Table 4.4-1 presents the current NAAQS and NH state standards for criteria pollutants. There are two types of standards, primary standards and secondary standards. Primary standards are designed to protect public health, and represent levels at which there are no known significant effects on human health. The secondary standards are designed to protect the environment from any known or anticipated adverse effects of a pollutant, including the effects on the natural environment (soil, water, vegetation) and the human-made environment (physical structures).

Table 4.4-1. National and New Hampshire Ambient Air Quality Standards

Pollutant	Primary/ Secondary		Averaging Time	Level	Form
Carbon Monoxide (CO)	primary		8-hour	9 ppm	not to be exceeded more than once per year
			1-hour	35 ppm	
Ozone (O_3)	primary and secondary		8-hour	0.070 ppm	annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Nitrogen Dioxide (NO_2)	primary		1-hour	100 ppb	98th percentile, averaged over 3 years
	primary and secondary		Annual	53 ppb	annual mean
	secondary		**Annual**	**100 μg/m^3**	**annual mean**
Particulate matter ($PM_{2.5}$ and PM_{10})	$PM_{2.5}$	primary	Annual	12 μg/m^3 **15 μg/m^3**	annual mean, averaged over 3 years
		secondary	Annual	15 μg/m^3	annual mean, averaged over 3 years
		primary and secondary	24-hour	35 μg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24-hour	150 μg/m^3	not to be exceeded more than once per year on average over 3 years
Sulfur dioxide (SO_2)	primary		1-hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	secondary		3-hour	0.5 ppm	not to be exceeded more than once per year
Lead (Pb)	primary and secondary		Rolling 3-month average	0.15 μg/m^3	not to be exceeded

Note: **Bold** text denotes New Hampshire's deviations from the national standard.
ppm = parts per million; ppb = parts per billion; μg/m3 = micrograms per cubic meter
Source: EPA (2015a); NHDES (n.d.a)

Attainment Status

Areas that do not meet the NAAQS are classified as nonattainment areas for that pollutant. Areas that have never been designated nonattainment for a pollutant and NAAQS are considered attainment areas. Former nonattainment areas currently meeting the NAAQS are designated maintenance areas and must have maintenance plans for 20 years.

The Project location within Rockingham County is in attainment for all six criteria pollutants. Therefore, transportation conformity does not apply.

Mobile Source Air Toxics

In addition to the criteria air pollutants for which there are NAAQS, EPA 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). Mobile Source Air Toxics (MSATs) are compounds emitted from highway vehicles and non-road equipment (e.g., volatile organic compounds, nonvolatile organics, diesel particulate matter/diesel exhaust gases, or metals). 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 revised list of current air toxics identified by the CAA Amendments of 1990 includes 187 air toxics (EPA, 1990). In 2007, EPA assessed all 187 air toxics in its Control of Hazardous Air Pollutants from Mobile Sources and identified a group of 93 compounds emitted from mobile sources (Federal Register, 2007). Also, EPA evaluated 180 of the 187 CAA air toxics, plus diesel PM, in its 2015 National Air Toxics Assessment (NATA),[7] identifying nine compounds from mobile sources that are national and regional cancer risk contributors (EPA, 2015b). These compounds include formaldehyde, benzene, polycyclic organic matter, 1, 3-butadiene, acetaldehyde, acrolein, diesel particulate matter (diesel PM), ethylbenzene, and naphthalene and are considered priority MSATs by FHWA (FHWA, 2016a).

Greenhouse Gas Emissions

Greenhouse gases are trace gases that trap heat in the earth's atmosphere. Some greenhouse gases occur naturally and are emitted into the atmosphere through natural processes and human activities. Naturally occurring greenhouse gases include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and O_3. Other greenhouse gases such as chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs) are created and emitted solely through human activities. Certain human activities can also add to the levels of most of the naturally occurring gases. The principal greenhouse gases that enter the atmosphere because of human activities are CO_2, CH_4, N_2O, and fluorinated gases.

Transportation contributes to global warming through the burning of gasoline and diesel fuel. Any process that burns fossil fuels, such as gasoline and diesel fuel, releases CO_2 into the air. CO_2 from fossil fuel combustion is responsible for almost all greenhouse gas emissions from mobile sources, which include both transportation sources and non-transportation equipment,

[7] The December 17, 2015, National Air Toxics Assessment report contains 2011 emissions data.

such as agricultural and construction equipment. CH_4 and N_2O emissions also result from fuel combustion, while HFC emissions are associated with motor vehicle air conditioners.

In contrast with trends in other air emissions, greenhouse gas emissions from transportation continue to rise, in large part because the demand for travel has outpaced improvements in fuel efficiency. In 2014, the transportation sector contributed 26 percent to the total greenhouse gas emissions, a 17 percent increase from 1990, making transportation the second largest contributor to greenhouse gas emissions and one of the fastest growing economic sectors that produces CO_2 emissions (EPA, 2017a).

To date, no national standards have been established regarding greenhouse gases, nor has EPA established criteria or thresholds for greenhouse gas emissions applicable to transportation projects.

In December 2007, NH established a Climate Change Policy Task Force and charged the task force with developing a Climate Change Action Plan that establishes climate change goals and recommends meaningful steps to meet those goals, based on Executive Order Number 2007-3. NHDES is designated as the lead agency for the task force. The *2009 New Hampshire Climate Action Plan: A Plan for New Hampshire's Energy, Environmental and Economic Development Future* was published in March 2009. The plan recommends a long-term goal of reducing greenhouse gas emissions by 80 percent below 1990 levels by 2050 and a mid-term goal of reducing greenhouse gas emissions 20 percent below 1990 by 2025 (NHDES, 2009). The plan contains 67 recommended actions for individuals, businesses, and government organized around the following 10 overarching strategies:

1. Maximize energy efficiency in buildings.
2. Increase renewable and low-CO_2-emitting sources of energy in a long-term sustainable manner.
3. Support regional and national actions to reduce greenhouse gas emissions.
4. Reduce vehicle emissions through state actions.
5. Encourage appropriate land use patterns that enable fewer vehicle-miles traveled.
6. Reduce vehicle-miles traveled through an integrated multimodal transportation system.
7. Protect natural resources (land, water, wildlife) to maintain the amount of carbon fixed or sequestered.
8. Lead by example in government operations.
9. Plan for how to address existing and potential climate change impacts.
10. Develop an integrated education, outreach, and workforce training program.

4.4.2 Affected Environment

Ambient air quality is monitored by the New Hampshire Ambient Air Monitoring Program maintained by NHDES, and the study area for air quality is Rockingham County. No existing air quality monitoring sites are located on or adjacent to the Project site. The closest air monitoring station to the Project is located at the Moose Hill School in Londonderry (Weinstock, 2012). The

Londonderry station was activated in 2011 and monitors five of the criteria pollutants. Monitoring for Pb was discontinued on June 30, 2016 (NHDES, 2016a).

Existing monitored criteria air pollutant concentrations in the statistical form comparable to the NAAQS were obtained from EPA's design value reports, which incorporates the monitoring data reported by states (including NHDES). Table 4.4-2 summarizes the available air quality monitoring data for a 3-year period from 2014 through 2016 from the Londonderry station at Moose Hill School (except where stated otherwise).

Table 4.4-2. Londonderry Air Quality Monitoring Data, 2014–2016

Pollutant	Averaging Time	NAAQS/ NHAAQS[a] and units	2014	2015	2016
Carbon monoxide (CO)	8-hr	9 ppm	0.5	0.4	0.4
	1-hr	35 ppm	0.6	0.6	0.5
Ozone (O_3)	8-hour	0.070 ppm	0.067	0.065	0.065
Nitrogen dioxide (NO_2)	1-hour	100 ppb	NA	22.7	24.3
	annual	53 ppb	NA	3	3
Particulates ($PM_{2.5}$)[b]	annual	12 µg/m^3 **15 µg/m^3**	8.2 (2012-2014)	8.0 (2013-2015)	6.6 (2014-2016)
	24-hour	35 µg/m^3	18 (2012-2014)	18 (2013-2015)	16 (2014-2016)
Sulfur dioxide (SO_2)	1-hour	75 ppb	5.4	6.0	2.9

Notes: **Bold** text denotes New Hampshire's deviations from the national standard.
ppm – parts per million; ppb – parts per billion; µg/m3 – micrograms per cubic meter
a Sources: EPA (2018a, 2015a)
b Particulates (PM_{10}) data for a 3-year averaging period for the years 2014-2016 were not available at Londonderry nor any nearby station.

All pollutants monitored measured concentrations well below both the NAAQS and NH standards. The measured concentrations of 8-hour O_3 have come close to the standards for this pollutant, but not exceeded them, based on the averaging timeframe and methods used to determine compliance. $PM_{2.5}$ concentrations at the Londonderry station exhibit a downward trend in concentrations over time.

4.4.3 Environmental Consequences

Air Quality

Transportation Conformity

As noted in Section 4.4.1, the project area is in attainment for all the criteria pollutants. Therefore, the regional and project-level transportation conformity regulations (40 CFR 93 Subpart A) are not applicable to this project.

The Project area is located in a former nonattainment area for the revoked 1997 ozone NAAQS. The 1997 NAAQS were subsequently replaced by the stricter 2008 NAAQS, and the Project area was designated attainment for the 2008 NAAQS. On February 16, 2018, the U.S. Court of Appeals for the District of Columbia issued a decision in *South Coast Air Quality Management District v. EPA et al.* (Case No. 15-1115) that invalidated certain provisions of EPA's rulemaking governing the revoked 1997 NAAQS, including the removal of transportation conformity requirements in former 1997 ozone nonattainment areas. Although the implementation of changes to transportation conformity as a result of this court case was not fully resolved at the time this SDEIS was prepared, if transportation conformity to the 1997 ozone standard is found to be applicable, the proposed Project would need to be included in the SNHPC transportation conformity determination on the long-range transportation plan and transportation improvement program prior to the FHWA approval of the FEIS/ROD. Because ozone is a regional pollutant, there are no potential implications of the court case to the Project in terms of Project-level or hot-spot analysis requirements.

Carbon Monoxide Hot-Spots

Potential impacts on CO concentrations near congested intersections were evaluated based on a worst-case intersection. The worst-case intersection was identified based on ranking the LOS, delay, and traffic volumes for all the intersections in the traffic study area (plus additional intersections considered for the Interchange Justification Report [see Appendix C]).

The NH 102 and Hampton Drive/Garden Lane intersection represents a location with increased volumes and congestion with the Build Alternatives. For this intersection, the No Build is analyzed in comparison to Alternative A (the alternative with the highest volumes and delay) to quantify the maximum potential incremental increase in CO concentrations for all alternatives.

Table 4.4-3. 2040 PM Peak Hour Volumes, Delay, and LOS for NH 102 and Hampton Drive/Garden Lane

Alternative	LOS	Delay (sec)	Volume
No Build	D	49.9	5,264
Alternative A	F	83.9	5,821
Alternative B	E	78.1	5,782
Alternative C	D	53.0	5,688
Alternative D	E	55.8	5,781
Alternative F	D	50.9	5,463

A microscale CO analysis was conducted for the NH 102 and Hampton Drive/Garden Lane intersection using MOVES2014a and CAL3QHC. The key MOVES inputs were as follows:

- Analysis year: 2025 (analyzed as a potential opening year, conservatively using the traffic volumes estimated for 2040. Using an analysis year closer to the present is conservative given that the fleet becomes cleaner over time as older and higher-emitting vehicles are retired).
- Links: links were delineated to represent each of the intersection approach, queue, and departure traffic movements for the PM peak hour. Approach links were assumed to have an average speed of 5 mph (which simulates stop/start conditions, with idling), while departure links were assumed to have an average speed of 15 mph. Approach link lengths all exceeded the 95th percentile queue lengths from the traffic analysis. The average grade for each link was calculated based on LIDAR data. All links were defined as the "urban unrestricted access" type, which is the appropriate roadway type for arterials with intersections.
- Vehicle classification: for screening analysis purposes, 100 percent of the vehicles were assumed to be gasoline passenger cars. Diesel heavy-duty vehicles have lower CO emissions than passenger vehicles; therefore, it was not necessary to model heavy-duty vehicles separately.
- Age distribution: for screening purposes, the EPA national default vehicle age distribution for 2025 was used.
- Fuels: for screening purposes, the MOVES default fuel distribution was used.
- Inspection/maintenance purposes: for screening purposes, no credit for inspection/maintenance programs was taken in the emissions modeling.
- Meteorology: based on the analysis hour of 5 p.m. in January, the default temperature of 32.3 degrees F and a relative humidity of 56 percent was used.

CAL3QHC modeling was performed with a dense network of receptors and atmospheric stability class D. Table 4.4-4 provides the CO microscale analysis results for the receptor with the highest concentration. The modeled result for Alternative A and the No Build are the same because CAL3QHC rounds the concentrations to the nearest 10th, meaning that minor differences due to higher volumes under Alternative A do not change the rounded concentration. The 8-hour concentration was estimated from the modeled 1-hour concentration using the default 0.7 persistence factor. The results show predicted maximum CO concentrations would be well under the 1-hour and 8-hour NAAQS at the worst-case intersections. This means that CO impacts at other intersections in the study area with lower volumes and/or less congestion would similarly not have adverse impacts on CO concentrations under Alternative A or any of the other Build Alternatives.

Table 4.4-4. Microscale CO Analysis Results for NH 102 and Hampton Drive/Garden Lane (2040 PM Peak Hour Traffic)

	NAAQS	No Build and Alternative A modeled concentration	Background concentration	Total Concentration
1-hour concentration (ppm)	35	0.4	0.6	1.0
8-hour concentration (ppm)	9	0.28	0.5	0.78

Fine Particulate Matter Hot-Spots

Although not subject to transportation conformity requirements, the transportation conformity regulations were used for NEPA purposes to determine if a PM2.5 hot-spot analysis was necessary. The transportation conformity regulations are relevant to use for this purpose because they are intended to prevent violations of the NAAQS or worsening of existing violations. A transportation project that is located in a “nonattainment” or “maintenance” area for PM10 or PM2.5, and meets one of the following conditions, is referred to as a “project of local air quality concern”, and requires a quantitative PM hotspot analysis under transportation conformity.

1. New highway projects that have a significant number of diesel vehicles, and expanded highway projects that have a significant increase in the number of diesel vehicles; (40 CFR 93.123(b)(1)(i))
2. Projects affecting intersections that are at LOS D, E, or F with a significant number of diesel vehicles, or those that will change to LOS D, E, or F because of increased traffic volumes from a significant number of diesel vehicles related to the project; (40 CFR 93.123(b)(1)(ii))
3. New bus and rail terminals and transfer points that have a significant number of diesel vehicles congregating at a single location; (40 CFR 93.123(b)(1)(iii)).
4. Expanded bus and rail terminals and transfer points that significantly increase the number of diesel vehicles congregating at a single location; (40 CFR 93.123(b)(1)(iv)) and

Projects in or affecting locations, areas, or categories of sites which are identified in the PM10 or PM2.5 applicable state implementation plan, as sites of violation or possible violation. (40 CFR 93.123(b)(1)(v)) The types of projects that would require PM hot-spot analysis were further clarified through a series of examples provided in the preamble of the March 2006 Final Rule. Some examples of projects of local air quality concern that **would** be covered by 40 CFR 93.123(b)(1)(i) and (ii) are:

- a project on a new highway or expressway that serves a significant volume of diesel truck traffic, such as facilities with greater than 125,000 AADT and 8 percent or more of such AADT is diesel truck traffic;
- new exit ramps and other highway facility improvements to connect a highway or expressway to a major freight, bus, or intermodal terminal;
- expansion of an existing highway or other facility that affects a congested intersection (operated at LOS D, E, or F) that has a significant increase in the number of diesel trucks; and,

- similar highway projects that involve a significant increase in the number of diesel transit busses and/or diesel trucks.

The following are examples of projects that **are not** a local air quality concern under 40 CFR 93.123(b)(1)(i) and (ii):

- any new or expanded highway project that primarily services gasoline vehicle traffic (i.e., does not involve a significant number or increase in the number of diesel vehicles), including such projects involving congested intersections operating at LOS D, E, or F;
- an intersection channelization project or interchange configuration project that involves either turn lanes or slots, or lanes or movements that are physically separated. These kinds of projects improve freeway operations by smoothing traffic flow and vehicle speeds by improving weave and merge operations, which would not be expected to create or worsen PM NAAQS violations; and,
- intersection channelization projects, traffic circles or roundabouts, intersection signalization projects at individual intersections, and interchange reconfiguration projects that are designed to improve traffic flow and vehicle speeds, and do not involve any increases in idling. Thus, they would be expected to have a neutral or positive influence on PM emissions.

The proposed new alignment connector roads under Alternatives A, B, C and D would have AAWDT (Average Annual Weekday Traffic) volumes in the range of 36,728 (Alternative D) to 54,523 (Alternative B) immediately east of I-93. The heavy-duty vehicle percent for the connector roads is 2.3 percent to 2.6 percent during the AM peak hour and to 1.0 percent to 2.5 percent during the PM peak hour based on the traffic analysis. These volumes are well under the EPA suggested AADT threshold of 10,000 heavy duty vehicles for a project of local air quality concern (8 percent of 125,000 AADT). In addition, the proposed connector roads would not connect to major freight, bus, or intermodal terminals. The traffic data shows that the proposed connector roads would not have the potential for significant adverse impacts on $PM_{2.5}$ concentrations and further detailed analysis is not warranted.

The potential for $PM_{2.5}$ impacts at intersections was also reviewed based on the traffic study. There are less than 350 heavy duty vehicle approaching any of the intersections in the project area during the AM and PM peak hours. Therefore, the alternatives would not affect intersections with a substantial volume of heavy-duty vehicle traffic.

Mobile Source Air Toxics

A qualitative analysis provides 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 FHWA entitled *A Methodology for Evaluating Mobile Source Air Toxic Emissions among Transportation Project Alternatives* (FHWA, 2017b).

For each Alternative, the amount of mobile source air toxics (MSAT) emitted would be proportional to the vehicle miles traveled (VMT), assuming that other variables such as fleet mix are the same for each Alternative. The VMT estimated for Alternatives A and B is slightly higher than that for the No Build Alternative, because the interchange facilitates new development that attracts trips that would not otherwise occur in the area (see Table 4.4-3). This increase in VMT means MSAT under the Alternatives A and B would probably be higher than the No Build Alternative in the study area. There could also be localized differences in MSAT from indirect effects of the project such as associated access traffic, emissions of evaporative MSAT (e.g., benzene) from parked cars, and emissions of diesel particulate matter from delivery trucks associated with land development. Alternative D would result in a slight increase in VMT, although to a lesser extent than Alternatives A and B. Alternatives C and F would result in a decrease in total VMT compared to the No Build and thus would be expected to decrease overall MSAT emissions.

Because the estimated VMT under each of the Build Alternatives are nearly the same, varying by less than 1.64 percent compared to the No Build, it is expected there would be no appreciable difference in overall MSAT emissions among the various Build Alternatives. For all Alternatives, emissions are virtually certain to be lower than present levels in the design year as a result of the Environmental Protection Agency's (EPA) national control programs that are projected to reduce annual MSAT emissions by over 90 percent from 2010 to 2050 (Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents, Federal Highway Administration, October 12, 2016). 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 than they are today.

In locations along existing roads, the improvements 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 mobile source air toxics (MSAT) would be higher under certain Alternatives than others. However, the magnitude and the duration of these potential increases cannot be reliably quantified due to incomplete or unavailable information in forecasting project-specific MSAT health impacts. Further, under all Alternatives, overall future MSAT are expected to be substantially lower than today due to implementation of the Environmental Protection Agency's (EPA) vehicle and fuel regulations.

In sum, under all Build Alternatives in the design year it is expected there would be either slightly higher or lower MSAT emissions in the study area relative to the No Build Alternative. There also could be increases in MSAT levels in a few localized areas where VMT increases. However, EPA's vehicle and fuel regulations will bring about significantly lower MSAT levels for the area in the future than today.

Table 4.4-5. 2040 SNHPC Model Wide Vehicle Miles Traveled

Functional Class	No Build	Alternative A	Alternative B	Alternative C	Alternative D	Alternative F
1 (Interstate)	3,673,155	3,751,514	3,752,621	3,705,076	3,699,371	3,678,589
2 (Other Freeways and Expressways)	1,158,441	1,155,931	1,160,018	1,151,498	1,154,379	1,153,307
3 (Other Principal Arterial)	1,343,582	1,377,420	1,389,936	1,340,840	1,339,339	1,342,044
4 (Minor Arterial)	1,293,208	1,284,638	1,291,845	1,292,279	1,305,777	1,290,478
5 (Major Collector)	1,085,570	1,120,288	1,095,701	1,070,866	1,071,633	1,082,510
6 (Minor Collector)	131,656	134,291	134,591	131,610	134,748	130,126
7 (Local)	543,985	556,786	544,999	536,275	537,041	543,637
Total	**9,229,597**	**9,380,868**	**9,369,711**	**9,228,444**	**9,242,288**	**9,220,691**

Source: SNHPC (2018)
Note: The SNHPC travel demand model encompasses 15 communities: Auburn, Bedford, Candia, Chester, Deerfield, Derry, Francestown, Goffstown, Hooksett, Londonderry, Manchester, New Boston, Raymond, Weare, and Windham.

Construction Impacts and Mitigation

Construction activities would result in emissions from equipment exhaust and fugitive dust from earthwork/ground disturbance. To minimize the potential impacts of construction on air quality at sensitive receptors, the following mitigation commitments will be incorporated in construction contracts.

- Mitigation measures for controlling fugitive dust emissions during construction will include wetting and stabilization of all work areas, cleaning paved roadways, and scheduling construction to minimize the amount and duration of exposed earth.
- The Towns of Derry and Londonderry will require that contractors involved with the construction of this project 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 during the final design process and in consultation with the contracting community at large.

Greenhouse Gas Emissions

A quantitative greenhouse gas analysis was conducted to provide a relative comparison of the Alternatives in terms of carbon dioxide-equivalent (CO2e) emissions from the motor vehicle travel in the region. The scale of the analysis is the SNHPC travel demand model region, which encompasses 15 communities: Auburn, Bedford, Candia, Chester, Deerfield, Derry, Francestown, Goffstown, Hooksett, Londonderry, Manchester, New Boston, Raymond, Weare, and Windham. The SNHPC model was used as part of the traffic analyses conducted for the Project (see Section 4.2), and the model was used to estimate the total VMT under each Alternative. The SNHPC VMT data were broken down by roadway functional class. For the greenhouse gas emissions analysis, the VMT data were further stratified by vehicle classification using NH-specific data reported to FHWA's Highway Performance Monitoring System (HPMS) (FHWA, 2016b).

The key assumptions used in the development of the greenhouse gas emissions analysis emission factors are as follows:

- Emissions Model: MOVES2014a (latest EPA-approved model at time of analysis)
- Scale: National scale, using EPA-default data for Rockingham County, New Hampshire. This level of detail is appropriate given the scale and objectives of the analysis.
- Analysis Year: 2040
- Month: January (January-based emission factors were applied to annual VMT because sensitivity testing of multiple months showed negligible seasonal variation in emission rates)
- Hour: AM Peak, 7am-8am
- Road types: Urban restricted (e.g., highways with access control/interchanges) and Urban unrestricted (e.g., arterials with intersections)
- Vehicle types: motorcycles, passenger cars, light trucks, buses, single-unit trucks and combination trucks (e.g., tractor trailers)
- Fuels: All fuel types per default percentage of vehicles using each fuel type (e.g., percent of diesel vs. gasoline light duty trucks)
- Speed: Simplified average speed assumptions were used given the regional scale and comparative nature of the analysis. Interstate and other freeways/expressways (Functional classes 1 and 2) = 65 mph, other principal arterials, and minor arterials (Function classes 3 and 4) = 55 mph, collectors and other local roads (functional classes 5, 6, and 7) = 30 mph

Table 4.4-6 summarizes the emission factors generated for each roadway type and vehicle type.

Table 4.4-6. MOVES CO2e Emission Factors (grams/veh-mile) by Roadway Type and Functional Class

MOVES Road Type	Road Functional Class	Ave. Speed (mph)	Motorcycle	Passenger Car	Light truck	Buses	Single-unit trucks	Combination Trucks
Urban Restricted Access	1 and 2	65	404.11	476.11	837.70	3,711.05	1,352.54	1,479.53
Urban Unrestricted Access	3 and 4	55	381.09	495.31	846.67	3,877.78	1,757.63	1,420.15
	5, 6, and 7	30	335.26	552.25	935.00	5,114.91	2,318.47	1,919.08

Table 4.4-7 summarizes the greenhouse gas emissions analysis results in terms of tons of CO2e per day within the SNHPC model region. Alternatives A and B result in an increase of approximately 1.5 percent relative to the No Build Alternative, and this result is likely due in part to the substantial increase in employment and economic activity added to the SNHPC model for these alternatives based on the analysis presented in the Land Use Scenarios Technical Report. The remaining alternatives result in differences in emissions from the No Build of 1/10th of one percent or less. It is important to note that the analysis does not take into account the impacts of potential changes in speeds as a result of the alternatives and associated emission reductions associated with congestion relief. The emissions shown are based on the change in VMT only and provide an order-of-magnitude disclosure of potential impacts for comparative purposes.

Table 4.4-7 summarizes the greenhouse gas emissions analysis results.

Table 4.4-7. Summary of Greenhouse Gas Analysis Results, 2040

	CO2e Emissions (Tons/year)	Change from No Build	Percent Change from No Build
No Build	6,447.74	-	-
Alternative A	6,556.40	108.66	1.69%
Alternative B	6,543.99	96.24	1.49%
Alternative C	6,443.63	-4.12	-0.06%
Alternative D	6,453.75	6.01	0.09%
Alternative F	6,441.04	-6.70	-0.10%

4.5 Noise

Transportation projects may affect ambient noise levels both directly and indirectly. Direct noise effects may include introducing a new roadway segment, and indirect effects may include the increase or decrease of traffic on an existing roadway due to the modification of a nearby roadway. The study area for noise is a 500-foot buffer of the Build Alternative alignments (Figure 4.5-1).

To provide a baseline for assessing potential noise impacts, locations within noise sensitive areas (NSAs) were selected where monitored noise would be representative of conditions along the proposed alignment. Generally, NSAs should correspond to existing or future planned noise sensitive developments (or groups of noise sensitive receptors as defined in 23 CFR Part 772), which are likely to be affected by changes in traffic volumes and where roadway, ramp, and interchange improvements are proposed. Figure 4.5-1 shows the five monitoring locations: Sites A, B, C, D, and E.

To establish existing noise conditions in the Project corridor, existing A-weighted noise levels were measured in 2016 during mid-week AM and PM peak hours in general accordance with FHWA requirements (FHWA, 1996). Measurements were taken at 20-minute intervals at each noise measurement location site to establish the baseline noise environment of the Project area. Detailed information regarding the noise monitoring methods and results is provided in the Noise Technical Report.

The receptors most sensitive to noise along the corridor are categorized as FHWA Noise Abatement Criteria (NAC) Activity B,[8] and the FHWA NAC are presented in Table 4.5-1. For Activity B receptors, outdoor noise levels that approach or exceed 67 a-weighted decibel (dBA) Leq (h) would require consideration of some form of noise abatement or mitigation measure. Leq (h) is the equivalent of a continuous sound level which, in a stated time period (1 hour) and at a stated location, has the same A-weighted sound energy as the time-varying sound.

A traffic noise impact is identified, and consideration of noise abatement is required, when:

> Leq (h) noise levels approach or exceed the FHWA NAC given in Table 4.5-1, where "approach" means within 1 dBA of the NAC (i.e., at an absolute noise level of 67 dBA for Activity B land uses).

A substantial increase in the predicted noise levels occurs over the existing noise levels, regardless of whether or not the NAC level is exceeded. Because the FHWA NAC does not specifically define the increased noise level of an affected receptor, the increase of 15 dBA from existing conditions, as defined in NHDOT's policy, was used in the analysis for this study.

Therefore, based on the above criteria, any receptor(s) experiencing at least a 15 dBA increase over the existing outdoor noise level, regardless of absolute noise level, is eligible for noise abatement. In addition, any Activity B land uses experiencing a post-project outdoor noise level of 67 dBA or greater are also eligible for noise abatement (NHDOT, 2016d).

Table 4.5-1. FHWA Noise Abatement Criteria: Hourly A-weighted Sound Level in Decibels

Activity Category	NAC Leq (h)	Activity Description
A (Exterior)	57	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 purpose.
B (Exterior)	67	Residential.

[8] These noise abatement criteria are identical to those presented in NHDOT's *Policy and Procedural Guidelines for the Assessment and Abatement of Highway Traffic Noise for Type I and Type II Highway Projects*.

Activity Category	NAC Leq (h)	Activity Description
C (Exterior)	72	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day-care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D (Interior)	52	Auditoriums, day-care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E (Exterior)	52	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A, D, or F.
F	-	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	-	Undeveloped lands that are not permitted.

Source: Title 23 CFR, Part 772.

Noise abatement measures must meet the criteria for *feasibility* and *reasonableness*, as presented in NHDOT's Policy.

The *feasibility* of noise abatement primarily relates to engineering and safety considerations for providing mitigation. A minimum of a 5-dBA noise reduction for at least one impacted receiver is required for a proposed noise barrier to be feasible, the design goal is to obtain a 10-dBA or greater insertion loss at the first row receptors. Safety considerations in designing noise barriers could include such factors as maintaining a clear recovery zone, redirection of errant vehicles, adequate sight distance, and fire/emergency vehicle access.

The factors considered when evaluating the *reasonableness* of a noise barrier are as follows:

- **Effectiveness**. The NHDOT’s base effectiveness criterion is 1,500 square feet per benefited receptor (defined as all receptors receiving 5 dBA or greater insertion loss from the proposed barrier). For Type I projects, the effectiveness criterion is reduced depending on the percentage of benefited properties permitted for development after November 30, 2017. The effectiveness criterion is increased by 200 square feet (e.g., to a total of 1,700 square feet) for municipalities that have enacted noise compatible planning requirements to mitigate noise impacts associated with new development near state highways.
- **Noise Reduction Design Goal.** The design goal is to provide 10-dBA insertion loss to the first row of benefited receptors. At a minimum, it must provide 7-dBA noise reduction for one benefited receptor.

- **Views of the Benefited Receptors.** Viewpoints of the affected community are considered through the NEPA public outreach process. If there are objections to a proposed barrier, a voting process is used to make the final reasonableness determination.

4.5.1 Affected Environment

2007 DEIS Noise Monitoring

Noise monitoring was conducted for the 2007 DEIS at 10 receptor locations in May and July 2006. The 10 monitoring sites are shown on Figure 4.5-1 as Sites 1 through 10. Table 4.5-2 presents noise levels from the 2007 DEIS monitoring effort.

Table 4.5-2. 2007 Monitoring Locations and Noise Levels

Site Number	Address	Leq (dBA)
1	1 Tsienneto Road	61
2	75 Tsienneto Road	69
3	4 Seasons Lane	63
4	12 Trolley Car Lane	64
5	5 Coteville Road	63
6	1 London Road	61
7	29 Scenic Drive	51
8	112 Franklin Ext	57
9	120 East Broadway[a]	65
10	70 West Broadway[a]	66

[a] In the 2007 DEIS, 120 East Broadway was incorrectly identified as 70 East Broadway, and 70 West Broadway was incorrectly identified as 120 West Broadway.

2016 Noise Monitoring Update

Given the passage of time since the 2007 DEIS, updated noise monitoring was conducted in five locations along the Alternative A corridor in September 2016. The monitoring sites are:

- Site A: 25 Trolley Car Lane
- Site B: 52 Trolley Car Lane
- Site C: 60 Seasons Lane
- Site D: 4 Folsom Road
- Site E: 71 Tsienneto Road

Two of these sites, A and D, were chosen because they were monitored in the 2007 DEIS and determined to be impacted receptors. The other three sites, B, C, and E, were selected because they were shown as impacted receptors under Alternative A and were not monitored in the 2007 DEIS. Sites A, B, and C are located in an area where barriers are proposed as part of the I-93 widening, but would need to be modified as a result of the Exit 4A Project.

Figure 4.5-1 shows the monitoring locations, and monitoring results are summarized in Table 4.5-3. Short-term noise levels were measured during the AM peak hours (7:00–8:00 AM) and PM peak hours (5:00–6:00 PM) at each location. Traffic counts with vehicle classification were conducted simultaneously with the noise monitoring locations. Additional information regarding the methodology for noise monitoring is provided in Appendix E, *Noise Technical Report*.

Table 4.5-3. 2016 Existing Conditions Noise Monitoring Results

Site	Address	Date	Time	L_{eq} (dBA)
A	25 Trolley Car Lane	9/20/2016	7:00 AM	**63.8**
			5:30 PM	**63.0**
		9/21/2016	7:00 AM	**66.0**
			5:08 PM	**64.2**
B	52 Trolley Car Lane	9/20/2016	7:03 AM	**70.5**
			5:35 PM	**69.1**
		9/21/2016	7:00 AM	**70.9**
			5:08 PM	**70.3**
C	60 Seasons Lane	9/20/2016	7:45 AM	**60.5**
			5:00 PM	**60.8**
		9/22/2016	7:15 AM	**62.2**
			4:30 PM	**60.7**
D	4 Folsom Road	9/20/2016	7:43 AM	**74.2**
			5:03 PM	**74.4**
		9/21/2016	7:36 AM	**73.5**
			4:30 PM	**75.2**
E	71 Tsienneto Road	9/21/2016	7:33 AM	**65.1**
			4:30 PM	**63.5**
		9/22/2016	7:16 AM	**63.9**
			4:30 PM	**64.1**

Alternative A

The area of the new interchange under Alternative A is wooded, and noise receptors consist of scattered residences (NAC Activity B) along the east of I-93, and along the west side of I-93 near the proposed interchange. As Table 4.5-2 shows, noise levels in the residential areas near the proposed interchange ranged from 60.5 dBA Leq to 70.9 dBA Leq in the AM peak traffic period, and from 60.7 dBA Leq to 70.3 dBA Leq in the PM peak traffic period.

The western portion of the connector road is through wooded and unoccupied land. Approaching the eastern end of the connector, land use includes commercial and industrial (NAC Activity F), giving over to residential near N. High Street.

Land use along both sides of Folsom Road and Tsienneto Road includes residential interspersed with commercial uses. As Table 4.5-3 shows, noise levels in the residential areas along Folsom Road ranged from 73.5 dBA Leq to 74.2 dBA Leq in the AM peak traffic period, and from 74.4 dBA Leq to 75.2 dBA Leq in the PM peak traffic period. Noise levels along Tsienneto Road ranged from 63.9 dBA Leq to 65.1 dBA Leq in the AM peak traffic period, and from 63.5 dBA Leq to 64.1 dBA Leq in the PM peak.

Alternative B

The interchange area land use and noise levels for Alternative B are the same as described above for Alternative A. The western portion of the connector road is through wooded and unoccupied land. Approaching the central portion of the connector, land use includes commercial and industrial (NAC Activity F) in the areas of Franklin Street Extension and NH 28. Approaching N. Main Street, and east of N. Main Street to the intersection of Tsienneto Road and NH 102, land is characterized by residential uses (NAC Activity B). Noise monitoring was conducted at two locations in the residential areas along Alternative B in 2007 (Figure 4.5-1, sites 6 and 7). The results show noise levels in the range of 51 to 61 dBA Leq.

Alternative C

The area of the new interchange under Alternative C is wooded, and noise receptors consist of scattered residences south and east of the proposed interchange, and commercial uses occupy land northeast of the proposed interchange. Noise monitoring near the interchange area in 2007 (site 3, Seasons Lane) determined the existing noise level was 63 dBA Leq. Similar monitoring of the Seasons Lane neighborhood near I-93 to the south confirms a similar noise level in 2016 (site C, 61-62 dBA).

Commercial and residential uses are located on either side of the Alternative C alignment along NH 28. From the NH 28 Bypass to NH 102, the corridor extends through commercial land use, then changes to residential land use toward the eastern end. Noise monitoring was conducted in this area in 2007, refer to Alternative B for a summary of the results for sites 6 and 7.

Alternative D

The interchange area land uses and existing noise levels for Alternative D are the same as Alternative C. Along Tsienneto Road, land uses and noise levels are the same as described for Alternative A.

Alternative F

Noise receptors along the Alternative F corridor through downtown Derry include residential, recreational, and commercial. Existing conditions noise monitoring conducted in 2007 (Figure 4.5-1, sites 9 and 10) showed noise levels in the range of 65-66 dBA, and current noise levels would be expected to be of a similar magnitude.

In accordance with FHWA requirements and NHDOT traffic noise policy, the Traffic Noise Model (TNM) 2.5 noise model for the Project was validated by modeling traffic volumes recorded during noise monitoring fieldwork. Table 4.5-2 summarizes noise model validation results, showing that the modeled noise levels differ from the measured values by less than the required 3 dBA threshold.

Table 4.5-4. Traffic Noise Model Validation Summary

Monitoring Location	Date/Time Period	Measured Leq, dBA	Modeled Leq, dBA	Difference
A	Sept. 20 AM	63.8	66.2	2.4
	Sept. 20 PM	63.0	64.9	1.9
	Sept. 21 AM	66.0	66.0	0.0
	Sept. 21 PM	64.2	65.6	1.4
B	Sept. 20 AM	70.5	68.8	-1.7
	Sept. 20 PM	69.1	67.5	-1.6
	Sept. 21 AM	70.9	68.5	-2.4
	Sept. 21 PM	70.3	68.2	-2.1
C	Sept. 20 AM	60.5	62.3	1.8
	Sept. 20 PM	60.8	61.8	1.0
	Sept. 22 AM	62.2	63.1	0.9
	Sept. 22 PM	60.7	62.0	1.3
D	Sept. 20 AM	74.2	71.8	-2.4
	Sept. 20 PM	74.4	73.8	-0.6
	Sept. 21 PM[a]	75.2	73.3	-1.9
E	Sept. 21 PM[a]	63.5	62.9	-0.6
	Sept. 22 AM	63.9	61.5	-2.4
	Sept. 22 PM	64.1	63.7	-0.4

[a] AM Time period not validated due to lack of traffic count data during the noise monitoring for that particular location/time period. Additional monitoring was not necessary since AM peak bi-directional traffic counts with classification were available from the second day of monitoring at each site.

4.5.2 Environmental Consequences

Design year 2040 predicted noise levels were determined using Version 2.5 of the FHWA TNM. The alternatives were divided into 11 NSAs for traffic noise modeling purposes as shown in Figure 4.5-2. Within each NSA, sensitive receptors were delineated within approximately 500 feet of the alternative corridors based on detailed land use and building data provided by Derry and Londonderry, with actual building use and location confirmed by aerial imagery. The *Noise Technical Report* (Appendix E) includes detailed modeling methodology and FHWA TNM files.

Table 4.5-5 summarizes the initial noise modeling results for existing conditions, the No Build Alternative, and Build Alternatives A, B, C, D, and F in terms of impacted receptor points. The approximate boundaries of the NSAs shown in the table are mapped in Figure 4.5-2. Noise impacts were identified considering both the absolute predicted hourly Leq in comparison to the NAC. The incremental increase in noise relative to existing conditions was also evaluated to identify receptors potentially experiencing a substantial increase (defined by NHDOT policy as an increase of 15 dBA or greater over existing conditions). AM and PM peak hour traffic was modeled separately for each Alternative, and the worst result for each receptor was used for purposes of the impact summary shown in Table 4.5-5. Detailed tables and figures for the modeling results are provided in Appendix E.

It is important to note that the results in Table 4.5-5 include construction of noise barriers as part of the I-93 widening project under the No Build Alternative (and the Build Alternatives, where the barrier is not in conflict with the particular alternative). As a result, the number of impacted receptors in each NSA is different from the detailed noise barrier evaluations presented in Section 4.3 of the *Noise Technical Report* (Appendix E) where a true "no barrier" condition is evaluated for purposes of determining cost reasonableness of modified barrier configurations.

The single-family residential and multi-family residential receptors in Table 4.5-5 correspond to FHWA Noise Abatement Criteria Activity Category B. The community facility and parkland receptors identified in the study area are all considered Activity Category C for purposes of the corridor-wide comparison of alternatives (further detailed investigation of receptors impacted by Alternative A was conducted as part of the mitigation analysis). The commercial with outdoor use land use type corresponds to Activity Category E. Category G (undeveloped lands that are not permitted) is addressed in Section 4.5.2.1.

Table 4.5-5. Traffic Noise Impacts Summary

Noise Sensitive Area	Land Use	Existing	No Build Alt. (2040)	Alt. A	Alt. B	Alt. C	Alt. D	Alt. F
1 (NH 28 Corridor, I-93 to Scobie Pond Road)	Single-Family	3	5	4	3	7	7	6
	Multi-Family/Apartment	1	1	1	0	1	1	1
	Community Facility/Park	0	0	0	0	1	0	0
	NSA Subtotal	*4*	*6*	*5*	*3*	*9*	*8*	*7*
2 (Alts. B and C connector near Olde Coach Road and Bypass 28)	Single-Family	9	5	5	2 exceed NAC + 1 substantial increase	2	5	4
	NSA Subtotal	*9*	*5*	*5*	*3*	*2*	*5*	*4*
3 (Alts. B and C connector near Barkland Drive, and Scenic Drive)	Single-Family	0	0	0	2 exceed NAC + 8 substantial increase	2 exceed NAC + 7 substantial increase	0	0
	NSA Subtotal	*0*	*0*	*0*	*10*	*9*	*0*	*0*
4 (I-93 at Alts. A and B interchange, Trolley Car Lane)	Single-Family	14	1	10	11	1	1	2
	NSA Subtotal	*14*	*1*	*10*	*11*	*1*	*1*	*2*
5 I-93 at Alts. A and B interchange, Seasons Lane	Single-Family	*8*	*1*	*3*	*3*	*1*	*1*	*1*
	NSA Subtotal	*8*	*1*	*3*	*3*	*1*	*1*	*1*
6 (Alts. A and B Connector from Derry Town Line to NH 28, Folsom Road)	Single-Family	11	11	13 (includes one receptor impacted due to both NAC and substantial increase)	6	12	11	11
	Multi-Family/Apartment	0	2	2	0	0	0	2
	NSA Subtotal	*12*	*13*	*15*	*6*	*12*	*11*	*13*
7 (Tsienneto Road from NH 28 to Bypass 28)	Single-Family	0	0	0	0	0	0	0
	Multi-Family/ Apartment	3	4	4	0	1	2	4

Noise Sensitive Area	Land Use	Existing	No Build Alt. (2040)	Alt. A	Alt. B	Alt. C	Alt. D	Alt. F
	Community Facility/Park	0	0	1	0	0	0	0
	NSA Subtotal	*3*	*4*	*5*	*0*	*1*	*2*	*4*
8 (Tsienneto Road from Bypass 28 to NH 102)	Single-Family	5	9	13	4	4	13	9
	Multi-Family/Apartment	0	2	1	1	0	0	0
	NSA Subtotal	*5*	*11*	*14*	*5*	*4*	*13*	*9*
9 (NH 102, Exit 4 to Griffin Street)	Single-Family	20	20	19	15	13	15	17
	Multi-Family/Apartment	12	12	12	11	11	11	12
	Community Facility/Park	1	1	1	1	1	1	1
	Commercial w/outdoor use	0	0	0	0	0	0	1
	NSA Subtotal	*33*	*33*	*32*	*27*	*25*	*27*	*31*
10 (NH 102, Griffin Street to NH 28)	Single-Family	1	1	1	1	1	1	1
	Multi-Family/Apartment	11	9	11	11	11	11	11
	Community Facility/Park	5	5	5	5	5	5	6
	NSA Subtotal	*17*	*15*	*17*	*17*	*17*	*17*	*18*
11 (NH 102, NH 28 to Bypass 28)	Single-Family	12	13	15	4	6	13	15
	Multi-Family/Apartment	13	11	13	10	10	13	12
	Community Facility/Park	4	4	4	2	2	4	4
	NSA Subtotal	*29*	*28*	*32*	*16*	*18*	*30*	*31*
Total Impacts	Single-Family	83	66	83	60	56	67	66
	Multi-Family/Apartment	40	41	44	33	34	38	42
	Community Facility/Park	10	10	11	8	9	10	11
	Commercial w/outdoor use	0	0	0	0	0	0	1
	Grand Total	*133*	*117*	*138*	*101*	*99*	*115*	*120*

Note: Results account for I-93 widening barriers, except sections of barriers in conflict with the alternatives (see Figure 4.5-2).

No Build

In the majority of NSAs, noise impacts under the No Build Alternative would be similar to those predicted under existing conditions. In some cases, the number of No Build impacts would increase relative to existing conditions as a result of future growth in traffic volumes, such as along Tsienneto Road where the No Build Alternative would result in five additional impacted single-family homes and three additional multi-family/apartment receptor impacts (NSAs 7 and 8). The No Build Alternative noise levels at these Tsienneto Road receptors would be in the 66–68 dBA range.

In the vicinity of the proposed Exit 4A under Alternative A and B interchange (Trolley Car Lane and Seasons Lane, NSA 4 and 5), the number of impacted receptors would decrease substantially relative to existing conditions because the No Build Alternative model includes the noise barriers proposed as part of the I-93 widening project. Overall, the total study area noise impacts under the No Build Alternative would decrease to 117, compared to 133 under existing conditions.

Alternative A

Alternative A would conflict with portions of the I-93 widening noise walls in the new interchange area, resulting in 10 single family receptors impacted at NSA 4 and three impacted in NSA 5. The conflicting noise walls were assumed to be not constructed for the initial impact analysis. I-93 improvements proposed noise walls not in conflict with the new ramps were assumed to be in place. The majority of the impacted receptors at the interchange area would be in the 66 to 69 Leq, dBA range. Alternative A would also increase noise impacts on portions of Folsom Road (NSA 6) and Tsienneto Road (NSA 8) due to increased traffic volumes on these roadways. Overall, the number of impacted receptors would increase from 117 under the No Build Alternative to 138 under Alternative A (before considering mitigation).

Alternative B

Similar to Alternative A, Alternative B would conflict with portions of noise walls planned for the I-93 widening project, increasing the number of impacted receptors at NSA 4 and 5 (Trolley Car Lane and Seasons Lane). Alternative B would cause traffic diversions that would reduce the number of noise impacts on portions of Tsienneto Road relative to the No Build Alternative (see for example NSA 8). Alternative B related traffic reductions on NH 102 in Derry would reduce the number of impacted receptors in NSA 11 (NH 28 to NH Bypass 28) relative to the No Build Alternative. However, Alternative B would impact residential areas along the new connector road alignment through Derry, including neighborhoods at Old Coach Road and Bypass 28 (NSA 2) and Barkland Drive and Scenic Drive (NSA 3). Overall, the total number of impacted receptors in the study area (101) would be less than the No Build Alternative. This result is consistent with Alternative B being located more on new alignment (in areas with fewer sensitive receptors) relative to the existing roadway corridor used by much of Alternative A (e.g., Folsom Road and Tsienneto Road).

Alternative C

Alternative C would result in nine impacted receptors in the vicinity of the new interchange location and along NH 28 (NSA 1). Impacts along the new alignment portion of the connector road through Derry would be similar to Alternative B (NSA 2 and 3). Also similar to Alternative

B, noise impacts would be reduced on portions of Tsienneto Road (NSA 8 and 11 most notably). Overall, the total number of impacted receptors in the study area would decrease relative to the No Build Alternative to 99.

Alternative D

Alternative D would result in eight impacted receptors in the vicinity the new interchange location and along NH 28 (NSA 1). Impacts along Tsienneto Road from increased traffic volumes would similar to Alternative A (NSA 8 and 9). Overall, the total number of impacted receptors in the study area (115) would be similar to the No Build Alternative.

Alternative F

Noise impacts under Alternative F (120) would be similar to the No Build Alternative. Although traffic in downtown Derry would increase, it would not increase to an extent that would result in a substantial increase in newly impacted receptors. Noise levels would increase at receptors already considered affected in the No Build Alternative.

Undeveloped Lands Analysis for Future Land Use Planning

In addition to identifying impacts to existing land uses, FHWA's traffic noise regulations require consideration of "undeveloped lands for which development is planned, designed and programmed, which may be affected by noise from the highway." For this Project, the primary undeveloped lands are the site of Woodmont Commons on the east and west side of I-93. Woodmont Commons is a PUD approved by the Town of Londonderry in 2013. Additional site plan review and local approvals are required for each portion of the plan to advance to construction—as of July 2018 no specific development proposal has been submitted for the portions of Woodmont Commons East and West closest to the interchange area (the areas of Woodmont East under construction are closer to Exit 4 and outside the study area). Although no building permit has been issued that would require detailed analysis of impacts and mitigation, noise contours were developed to aid the Town of Londonderry in future land use planning decisions in this area, as shown in Figure 4.5-3. For additional information on the methodology used to generate the future noise contours, see Appendix E.

Mitigation

Mitigation was considered for areas along the Alternative A alignment where noise impacts were predicted for the 2040 analysis year. Detailed noise barrier evaluations were completed for Trolley Car Lane (NSA 4), and Seasons Lane (NSA 5), two neighborhoods where barriers planned as part of the I-93 widening project would be affected by the new interchange ramps under Alternative A. Noise barrier evaluations were also conducted along Folsom Road/Tsienneto Road (NSA 6, 7, and 8). For detailed technical information on the mitigation analyses, see Appendix E. A summary of the noise mitigation analysis conclusions is provided in the following section.

NSA 4 Trolley Car Lane

A noise barrier was recommended for Trolley Car Lane in the 2004 I-93 widening FEIS (FHWA, 2005). During the I-93 final design process, the recommended barrier was revised to be 12–18 feet in height (with 10 feet of the height on berm) and 4,450 feet long. With Exit 4A, this barrier cannot be constructed as originally designed because of conflicts with the interchange ramps. Therefore, a new barrier analysis was conducted accounting for Exit 4A.

Trolley Car Lane was divided into two separate areas for purposes of the Exit 4A noise barrier evaluation (Trolley Car Lane North and Trolley Car Lane South), separated by three single-family homes that would be total acquisitions under Alternative A (receptors Trolley Car 12, 13, and 14). As a result of these acquisitions and the placement of fill for the Exit 4A ramps shielding certain receivers in the center of the neighborhood from I-93 mainline traffic noise, a continuous noise barrier would not be logical for this location.

Multiple barrier configurations were evaluated for Trolley Car Lane North and Trolley Car Lane South, as documented in Appendix E. The selection of a preferred option by NHDOT and FHWA was based on consideration of which option would provide a benefit to impacted receptors comparable to the benefit that would be provided if the I-93 widening barriers were built without Exit 4A. NHDOT and FHWA are committed to providing noise barriers in these locations by the I-93 widening 2005 ROD and 2010 Supplemental ROD, regardless of whether the options meet the current noise policy effectiveness criterion. For both Trolley Car Lane North and South, the recommended barrier option for further evaluation during final design is Option 1.

- Trolley Car Lane North Option 1 (Figure 4.5-4). This barrier would be approximately 1,161 feet in length, between 4 and 16 feet in height (average height of 10.8 feet), and benefit three residential receptor units.
- Trolley Car Lane South Option 1 (Figure 4.5-5). This barrier would be approximately 1,535 feet in length, between 12 and 20 feet in height (average height of 15.6 feet) and benefit 10 residential receptor units.

Based on the studies so far completed, NHDOT is committed to the construction of feasible and reasonable noise abatement measures at Trolley Car Lane (North and South). These preliminary indications of likely abatement measures are based upon preliminary design for two discontinuous barriers with a combined length of approximately 2,700 feet and an average height of approximately 13.5 feet, that would reduce the noise level by at least 5dB(A) for 13 residents. If it is subsequently found during final design that these conditions have substantially changed, the abatement measure(s) might not be provided. A final decision on the installation of the abatement measure(s) would be made during the final design process following the completion of public involvement.

NSA 5 Seasons Lane

A noise barrier was recommended for Seasons Lane in the 2004 I-93 widening FEIS (FHWA, 2005). During the I-93 final design process, the recommended barrier was revised to be 14–18 feet in height (with 10 feet of the height on berm) and 3,050 feet long.

Multiple barrier configurations were evaluated for Seasons Lane, as documented in Appendix E. The horizontal barrier alignment for the Seasons Lane area was kept the same as the I-93 widening final design barrier alignment, from station 1717+50 at the northern end to station 1694. From station 1694 to 1687+25, the barrier alignment was shifted east to follow the ROW line to avoid conflict with the Alternative A northbound on-ramp and to take advantage of the terrain.

The selection of a preferred option by NHDOT and FHWA was based on consideration of which option would provide a benefit to impacted receptors comparable to the benefit that would be provided if the I-93 widening barriers were built without Exit 4A. NHDOT and FHWA are committed to providing noise barriers in these locations by the I-93 widening 2005 ROD and 2010 Supplemental ROD, regardless of whether the options meet the current noise policy effectiveness criterion. The recommended barrier option for further evaluation during final design is Option 1:

- Seasons Lane Option 1 (Figure 4.5-6). This barrier would be 2,983 feet in length, between 10 and 22 feet in height (average height of 18.1 feet), and benefit 16 residential receptor units.

Based on the studies so far completed, NHDOT is committed to the construction of feasible and reasonable noise abatement measures at Seasons Lane. These preliminary indications of likely abatement measures are based upon preliminary design for a barrier with a length of about 3,000 feet and an average height of approximately 18.1 feet, that will reduce the noise level by at least 5dB(A) for 16 residents. If it is subsequently found during final design that these conditions have substantially changed, the abatement measure(s) might not be provided. A final decision on the installation of the abatement measure(s) will be made during the final design process following the completion of public involvement.

Folsom/Tsienneto Road

Noise barriers were evaluated in 13 locations along Folsom/Tsienneto Road where noise impacts were predicted to occur under Alternative A. Each potential barrier was developed to include breaks as necessary to not directly conflict with driveways. Multiple heights were modeled (10, 12, 14, and 16 feet) and compared to NHDOT's minimum acoustic criteria (7 dBA insertion loss for at least one benefited receptor, and 5 dBA insertion loss for at least one impacted receptor). Barriers that met these acoustic criteria were then evaluated in comparison to the NHDOT effectiveness criterion of 1,500 square feet per benefited receptor. Three potential barriers met the effectiveness criterion:

- Barrier 3, located on the south side of the connector road between Ferland Drive and Franklin Street
- Barrier 5, located on the south side of Tsienneto Road east of Pinkerton Street
- Barrier 10, located on the north side of Tsienneto Road between Jeff Lane and Scenic Drive

Mapping of the evaluated barrier options is provided in Appendix E. The three barriers that were potentially reasonable and feasible based on acoustic performance and the effectiveness criterion were advanced for further evaluation of engineering, environmental, and safety issues. The engineering/environmental feasibility evaluations are as follows:

- Barrier 3: To provide adequate clear zones, the barrier would need to be located 6 feet offset from the sidewalk (or 4 feet behind a guardrail), which would result in an unacceptable slope limit encroachment into the entrance of the apartment building at 99 North High Street. In addition, this barrier could require extending the Shields Brook Bridge and additional costs of constructing the barrier on the structure.

- Barrier 5: There is insufficient space for construction of a sidewalk and barrier in several sections of this area without resulting in additional property acquisitions or construction of retaining walls that would make the barrier not feasible in terms of cost effectiveness. Existing retaining walls would also be impacted, as well as existing driveways. The eastern end of this proposed barrier would increase wetland impacts.
- Barrier 10: Construction of the noise barrier would necessitate the removal of mature trees in the front yard of two historic properties, which would likely constitute an adverse effect to the setting of these historic resources. There is also a sight distance issue at the intersection of Tsienneto Road and Scenic Drive that would necessitate locating the barrier almost to the front of the historic home at 72 Tsienneto Road to provide clear sight lines for the 35 mph design speed.

In conclusion, barriers 3, 5, and 10 would not be feasible from an engineering/environmental perspective and are not recommended for further consideration. The other 10 barriers evaluated for Tsienneto Road/Folsom Road are either not feasible based on acoustic considerations or not reasonable because they would not meet the NHDOT effectiveness criterion.

4.6 Visual Resources

Roadway projects may change the character and or/quality of the visual environment, as experienced by viewer groups such as local residents, through travelers, commuters, and tourists.

4.6.1 Affected Environment

The study area for assessing visual resources includes a 1,000-foot buffer of the alignments for the Build Alternatives. The study area is situated in the eastern-central portion of the coastal lowlands region of NH. Low-lying ponds, lakes, and streams that are bounded by gently rolling hills or nearly level sandy terraces characterize much of the study area. The viewshed of the study area includes a variety of natural amenities such as farm fields, forests, wetlands, and several water bodies. Vegetation communities range from open lands (e.g., maintained croplands and freshwater marshes) to diverse upland and wetland forest types.

The viewshed of the study area also includes human-made development, which in some instances enhances the quality of the view because of the presence of important cultural resources. These resources include the Derry Village Historic District; Hoodkroft Country Club golf course; Adams Memorial Building; and the Matthew Thornton House, designated a National Historic Landmark and listed on the National Register of Historic Places (NRHP) in 1971. The Rockingham Recreational Trail and the Derry Bike Path, two converted railroad beds, provide scenic vistas for walking, jogging, biking, snowshoeing, cross country skiing, and equestrian traffic.

In Londonderry, Apple Way consists of approximately 10 miles of roads that have been designated by the New Hampshire Office of Energy and Planning as a NH Scenic and Cultural Byway and includes stretches of Pillsbury Road directly west of the Interstate, where extensive apple orchards contribute to the diversity of the viewshed.

A section of the Robert Frost Scenic Byway follows NH 28 through Derry, along East Broadway between Crystal Avenue and North Main Street. The Derry Rail Trail and the former train station, once a regular stop along the former M&L branch of the Boston & Maine Railroad, is located directly south of East Broadway.

In contrast, portions of the study area that diminish the quality of the viewshed because of the type of land use include the more commercially oriented developments along NH Routes 28 and 102, as well as the Derry Wastewater Treatment Plant and Derry Transfer Station and transmission line corridors.

Along Alternative A, the alignment includes sparse residential areas west of I-93, and east of I-93, the alignment begins in undeveloped, forested land with rolling hills. Near Madden Road, a combination of industrial and commercial properties along with some residential areas dominate the viewshed. The views along the alignment as it follows Tsienneto Road are primarily of commercial development, and east of North Main Street (NH 28), the views are dominated by residential areas. Near the eastern terminus of Alternative A at Chester Road (NH 102), the viewshed is dominated by residential areas and Beaver Lake.

Along Alternative B, the alignment includes sparse residential areas west of I-93, while east of I-93 the alignment begins in undeveloped, forested land with rolling hills. It diverges from Alternative A west of the industrial area along Madden Road. To the north and east of Franklin Street, the viewshed is dominated by commercial areas. East of NH 28, the view transitions from commercial development to undeveloped, forested land, interspersed with residential use. As the alignment continues to Chester Road (NH 102), the view is a combination of residential areas and undeveloped, forested land. At the eastern project terminus, Beaver Lake is also visible.

Along Alternatives C and D, the alignments begin in undeveloped land and sparse commercial development. When the alignments join Rockingham Road (NH 28), the views include sparse residential development and transitions to more dense commercial development. When Alternatives C and D diverge, Alternative C follows Alternative B. East of NH 28, the view transitions from commercial development to undeveloped, forested land. As the alignment continues to Chester Road (NH 102), the view is a combination of residential areas and undeveloped, forested land. At the eastern project terminus, Beaver Lake is also visible.

At the divergence of Alternatives C and D, Alternative D follows Alternative A. The views along the alignment as it follows Tsienneto Road are primarily of commercial development, and east of North Main Street (NH 28), the views are dominated by residential areas. Near the eastern terminus of Alternative A at Chester Road (NH 102), the viewshed is dominated by residential areas and Beaver Lake.

The viewshed along Alternative F is dominated by developed land, with commercial and industrial-oriented developments near I-93, dense development along the commercial downtown Derry extending east on Broadway (NH 102), and residential developments and the Golf Course as the alignment travels east of downtown Derry to the terminus at the NH 102/NH 28 Bypass /East Derry Rd traffic circle.

4.6.2 Environmental Consequences

Visual impacts may include changes to both the natural and man-made environments. Impacts can result from introducing new roadway elements into the existing environment, demolishing buildings in both commercial and residential areas, and widening existing roads.

In general, widening the Interstate for Alternatives A through D would increase the overall roadway footprint and create larger cut and fill slopes, which would increase the visual scale of the roadway. The addition of overpasses would increase the distance from which the highway would be visible. The larger footprint would necessitate removal of some existing roadside vegetation. Where this vegetation is part of forested buffer between the highway and adjacent development, this would have an adverse effect upon the quality of views from the highway.

Removal or reduction of the vegetative buffers between the highway and development would have a more substantial adverse effect on nearby residences and businesses than on highway users.

The following discussion highlights potential impacts on the visually sensitive resources for each alternative, including areas where vegetative buffers provide screening of the highway from residential areas adjacent to the Project.

Alternative A

The majority of the Alternative A corridor includes existing roads located in highly developed residential and commercial/industrial areas. Therefore, in most areas of the Alternative A corridor, the existing traffic volumes, along with the type of development and its density, make for an environment that is not particularly sensitive from a visual perspective. Following the upgrade of Tsienneto Road, businesses and residences would front a road with improved points of access and egress. In some cases, improvements to the roadway and business entrances and exits would likely result in an enhanced visual environment when compared to existing conditions. One potential area of exception may be the residential neighborhood between NH 28 Bypass and NH 102. The neighborhood along this section of roadway is primarily residential, and it includes two historic properties (see Section 4.18) as well as areas of open fields and a large, emergent wetland near the intersection of Tsienneto Road and NH 102. Most of the homes in this area are set back from the road and located in subdivisions. Alternative A would not result in adverse effects to historic structures located along this segment of the corridor. Therefore, the upgrade of Tsienneto Road would have very little impact on the existing viewshed.

Between I-93 and Franklin Street Extension, the Alternative A corridor would be constructed in an undeveloped area of land. This area likely provides an opportunity for local residents to hike, bird watch, hunt, and participate in other forms of outdoor recreation. From a visual perspective, the area represents a visually pleasing landscape of woodlands and wetlands. However, there is also abundant evidence of past and ongoing illegal dumping activities, as well as all-terrain vehicle usage, which detracts from the overall visual experience. Moreover, a portion of the land that would be used for Alternative A is privately owned and has been posted. Thus, recreational opportunities, including enjoyment of the visual environment on these portions of the undeveloped land, would be limited to those individuals with landowner permission to access the property.

Alternative B

Between I-93 and Franklin Street Extension, the Alternative B corridor would cross the same undeveloped land as Alternative A. Here, the impacts on the visual experience associated with Alternative B would be essentially the same as Alternative A, with one notable difference. It is likely that the requirement to construct a new crossing over Shields Brook with Alternative B would influence the existing visual environment to a far greater degree than the widening required for the existing Folsom Road crossing associated with Alternative A. Farther to the east, Alternative B would cross the highly developed areas associated with the Derry Industrial Park and NH 28. This portion of the corridor is not visually sensitive, and construction of the Alternative B roadway and associated improvements to NH 28 would likely have little effect, if any, on the existing visual experience. To the east of NH 28, Alternative B would cross currently undeveloped areas all the way to the intersection of Tsienneto Road and NH 102. These areas are generally visually sensitive and include forested uplands and wetlands, a beaver impoundment, scrub-shrub and emergent wetlands, open fields, and streams. The combination of these natural resources offers a pleasing landscape setting. Opportunities likely exist for hiking, bird watching, and other forms of outdoor recreation. However, the presence of the cleared utility corridor in proximity to the Alternative B corridor in this area would also likely be seen as detracting from the visual experience. Similar to Alternative A, some of the land that would be used for Alternative B is posted as private land, limiting public access to portions along the corridor. The Alternative B alignment would also likely have a negative effect on the existing viewshed for those residents living on both sides of the corridor.

Alternative C

The western end of the Alternative C corridor would be constructed in an undeveloped area of and east of I-93 and south and west of NH 28. This undeveloped area includes forested uplands and wetlands located between NH 28 and the existing utility line corridor. Large portions of this area appear to once have been part of a gravel pit, and there is evidence of this past disturbance present throughout the forested areas. The portion of the Alternative C corridor that follows NH 28 would pass through a commercial area and any visual impacts associated with roadway improvements would be negligible. From NH 28 to the east of the corridor at the intersection of Tsienneto Road and NH 102, the visual impacts would be similar to those already described for Alternative B.

On the west side of I-93, in the vicinity of the proposed interchange location for Alternative C, is the Reed Paige Clark Homestead properties. It was determined that the work associated with the west side of the interchange for Alternative C would have a Section 106 adverse effect on this historic property. This impact would include the potential for visual impacts caused by having a major raised interchange approximately 2,000 feet south of the historic farmhouse, which is located on the north side of Stonehenge Road.

Alternative D

Between I-93 and NH 28, the Alternative D corridor would have similar impacts on the visual environment as Alternative C, including the Section 106 adverse effect on the historic Reed Paige Clark Homestead. To the east of NH 28, Alternative D would follow the same alignment as Alternative A. As a consequence, this portion of the corridor would have identical visual impacts as Alternative A.

Alternative F

Because of the existing historic buildings along NH 102, the viewshed of this corridor would likely experience substantial impacts. The proposed Alternative F would extend along NH 102 through the Broadway Historic District, adjacent to the Derry Village Historic District, and past one individual historic building. This would profoundly affect the character of downtown Derry.

Following the upgrade of NH 102, businesses and residences would front a wider road, diminishing the small town and historic characteristics of this portion of the corridor. The residential and commercial buildings would likely suffer from decreased distance from the edge of road to the existing buildings, loss of available parking, decreased access for pedestrians, and difficulty accessing properties.

Mitigation

In general, mitigation measures for visual impacts would include designing roadway elements, culverts, bridges, and other structures to be less intrusive. In visually sensitive areas, landscape screening and/or privacy fencing could buffer residences from impacts caused by adjacent development of, and improvements to, roadways. In particular, landscaping and plantings in the area of bridge abutments, retaining walls, and the interchange could be used to lessen visual impacts. Following selection of an Alternative, mitigation measures for visual impacts would be further evaluated, and where practicable, incorporated into the design.

4.7 Socioeconomics

This section addresses demographic and economic conditions and housing. For each topic, an introduction (including an overview of applicable regulations), data collection and analysis methodology, existing conditions (affected environment), and impacts are presented for the No Build and Build Alternatives. The potential impacts on minority and low-income populations are addressed in Section 4.8, *Environmental Justice.* Additional information related to population and employment projections is provided in Chapter 5, *Indirect Effects and Cumulative Impacts*.

4.7.1 Affected Environment

U.S. Census data (U.S. Census Bureau, 2015) are the primary source for information on socioeconomic conditions in the Project area municipalities (Derry and Londonderry). The Census block groups that intersect a 500-foot buffer of the alternative alignments were selected as the socioeconomics study area (Figure 4.7-1).

Demographic and economic trends for the larger five-town study area are described in Chapter 5, I*ndirect Effects* and *Cumulative Impacts*. The following section summarizes key demographic and economic indicators in the Census block groups along the Build Alternative alignments in comparison to the Project-area municipalities (Derry and Londonderry) and to Rockingham County.

Demographics

Table 4.7-1 shows the total population with a breakdown of race and ethnicity for the Build Alternative alignment block groups, Project-area municipalities, and Rockingham County. The total minority population in the study area is 4.1 percent, with the percentage of minorities in the block groups ranging from 0.0 to 7.4 percent. The population of Derry is 3.8 percent minority, and the population of Londonderry is 3.5 percent minority. Hispanic persons comprise 3.1 percent of the population in the study area, with the percentage of Hispanic persons in the block groups ranging from 0.0 to 12.1 percent. Hispanic persons comprise 2.2 and 3.8 percent of the populations in Derry and Londonderry, respectively.

The median age within the study area is 41.3 years, which is similar to the median ages of Derry and Londonderry (39.7 and 41 years, respectively). The median age of Rockingham County is 43.5 years.

Table 4.7-2 shows the medium household income and percentage of residents living in poverty for the Build Alternative alignment block groups, Project-area municipalities, and Rockingham County.

Table 4.7-1. Race and Ethnicity

Census Tract	Block Group	Total Population	White Alone		Black or African American Alone		American Indian and Alaskan Native Alone		Asian Alone		Native Hawaiian and Other Pacific Islander		Some Other Race		Two or More Races		Minority Population Total		Hispanic		Non-Hispanic	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
3301	1	2,156	2,106	97.7	0	0.0	13	0.6	14	0.6	0	0.0	0	0.0	23	1.1	50	2.3	42	1.9	2,114	98.1
3302	1	2,750	2,620	95.3	12	0.4	0	0.0	65	2.4	0	0.0	45	1.6	8	0.3	130	4.7	113	4.1	2,637	95.9
3400	1	2,401	2,244	93.5	93	3.9	0	0.0	45	1.9	0	0.0	19	0.8	0	0.0	157	6.5	72	3.0	2,329	97.0
3400	2	837	799	95.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	38	4.5	38	4.5	30	3.6	807	96.4
3400	3	1,814	1,779	98.1	35	1.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	35	1.9	0	0.0	1,814	100.0
3400	4	677	669	98.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	8	1.2	8	1.2	27	4.0	650	96.0
3500	1	626	626	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	626	100.0
3500	2	2,619	2,547	97.3	35	1.3	0	0.0	12	0.5	0	0.0	0	0.0	25	1.0	72	2.7	0	0.0	2,619	100.0
3500	3	2,186	2,118	96.9	0	0.0	10	0.5	0	0.0	0	0.0	12	0.5	46	2.1	68	3.1	192	8.8	1,994	91.2
3701	1	1,455	1,348	92.6	52	3.6	0	0.0	0	0.0	0	0.0	47	3.2	8	0.5	107	7.4	176	12.1	1,279	87.9
3701	2	1,852	1,777	96.0	17	0.9	0	0.0	22	1.2	0	0.0	0	0.0	36	1.9	75	4.0	17	0.9	1,835	99.1
3703	2	2,310	2,206	95.5	104	4.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	104	4.5	28	1.2	2,282	98.8
3703	3	1,564	1,484	94.9	18	1.2	0	0.0	11	0.7	0	0.0	15	1.0	36	2.3	80	5.1	9	0.6	1,555	99.4
3901	1	2,637	2,495	94.6	0	0.0	56	2.1	13	0.5	0	0.0	26	1.0	47	1.8	142	5.4	97	3.7	2,540	96.3
Study Area Total		25,884	24,818	95.9	366	1.4	79	0.3	182	0.7	0	0.0	164	0.6	275	1.1	1,066	4.1	803	3.1	25,081	96.9
Town of Derry		33,202	31,925	96.2	332	1.0	23	0.1	447	1.3	0	0.0	237	0.7	238	0.7	1,277	3.8	740	2.2	32,462	97.8
Town of Londonderry		24,563	23,704	96.5	271	1.1	56	0.2	148	0.6	0	0.0	188	0.8	196	0.8	859	3.5	931	3.8	23,632	96.2
Rockingham County		299,006	284,738	95.2	2,237	0.7	363	0.1	5,551	1.9	0	0.0	1,466	0.5	4,651	1.6	14,268	4.8	7,369	2.5	291,637	97.5

Source: U.S. Census Bureau (2015)

Table 4.7-2. Income and Poverty Status

Census Tract	Block Group	Median Household Income	Population Living Below Poverty (%)
3301	1	$73,750	1.6
3302	1	$59,643	5.3
3400	1	$51,835	0.0
3400	2	$35,205	3.7
3400	3	$50,080	4.7
3400	4	$53,097	7.4
3500	1	ND	0.0
3500	2	$40,060	3.9
3500	3	$55,625	7.5
3701	1	$78,618	0.8
3701	2	$100,086	1.1
3703	2	$72,344	1.9
3703	3	$82,981	7.5
3901	1	$62,951	0.3
Study Area		**$61,551**	**3.4**
Town of Derry		$65,723	7.9
Town of Londonderry		$92,264	2.6
Rockingham County		$81,198	5.5

Source: U.S. Census Bureau (2015)
Notes: ND – No data provided

Housing

Table 4.7-3 shows the total number of households, occupied households, and of the occupied households, the number that are owner and renter occupied households for the study area, project area municipalities and Rockingham County. Within the study area, 94.8 percent of the available housing is occupied, which is similar to the occupancy rates for Derry (95.7 percent) and Londonderry (96.7 percent). Rockingham County has a slightly lower occupancy rate of 92.3 percent. The study area contains a higher percentage of renter-occupied housing than the Towns or Rockingham County. About 44.2 percent of the occupied housing is renter-occupied in the study area compared to 37.0 percent in Derry, 14.4 percent in Londonderry, and 23.5 percent in Rockingham County.

Table 4.7-3. Housing

Census Tract	Block Group	Housing Units					Occupied Housing Units				
		Total	Occupied		Vacant		Total	Owner Occupied		Renter Occupied	
		No.	No.	%	No.	%	No.	No.	%	No.	%
3301	1	853	821	96.2	32	3.8	821	627	76.4	194	23.6
3302	1	1,099	1,074	97.7	25	2.3	1,074	491	45.7	583	54.3
3400	1	1,020	929	91.1	91	8.9	929	599	64.5	330	35.5
3400	2	421	421	100.0	0	0.0	421	129	30.6	292	69.4
3400	3	815	777	95.3	38	4.7	777	364	46.8	413	53.2
3400	4	390	363	93.1	27	6.9	363	185	51.0	178	49.0
3500	1	266	266	100.0	0	0.0	266	174	65.4	92	34.6
3500	2	1,416	1,371	96.8	45	3.2	1,371	514	37.5	857	62.5
3500	3	1,185	1,054	88.9	131	11.1	1,054	113	10.7	941	89.3
3701	1	689	659	95.6	30	4.4	659	587	89.1	72	10.9
3701	2	705	638	90.5	67	9.5	638	629	98.6	9	1.4
3703	2	857	830	96.8	27	3.2	830	647	78.0	183	22.0
3703	3	634	634	100.0	0	0.0	634	446	70.3	188	29.7
3901	1	1,136	1,046	92.1	90	7.9	1,046	569	54.4	477	45.6
Study Area Total		**11,486**	**10,883**	**94.8**	**603**	**5.2**	**10,883**	**6,074**	**55.8**	**4,809**	**44.2**
Town of Derry		13,609	13,020	95.7	589	4.3	13,020	8,207	63.0	4,813	37.0
Town of Londonderry		8,870	8,576	96.7	294	3.3	8,576	7,340	85.6	1,236	14.4
Rockingham County		127,944	118,095	92.3	9,899	7.7	118,095	90,387	76.5	27,708	23.5

Source: U.S. Census Bureau (2015)

4.7.2 Environmental Consequences

No Build Alternative

The No Build Alternative would not involve new construction; no impacts associated with residential relocations or business displacements, property taxes, or community character and cohesion would occur.

Build Alternatives

Relocations and Displacements

Table 4.7-4 provides a summary of partial and full parcel acquisitions for each Build Alternative, and Table 4.7-5 shows residential relocations and business displacements. For Alternatives A and B, the additional residential relocations are due to multiple residences on one parcel. The business displacements for all alternatives vary from the parcels acquired. In most cases where there is a full parcel acquisition, there are multiple businesses on one parcel. Additional discussions are provided in subsequent sections by alternative.

Table 4.7-4. Parcel Acquisitions by Build Alternative

Alternative	Residential Parcels				Commercial/Industrial Parcels			
	Full Acquisition	Partial Acquisition or Easement			Full Acquisition	Partial Acquisition or Easement		
		<0.1 acre	0.1-0.5 acre	>0.5 acre		<0.1 acre	0.1-0.5 acre	>0.5 acre
A	13	99	26	3	4	23	9	10
B	16	48	17	6	2	6	11	14
C	13	45	11	6	4	23	21	11
D	0	79	17	3	4	43	30	11
F	0	78	1	0	2	84	2	1

Table 4.7-5. Residential Relocations and Business Displacements by Build Alternative

Alternative	Residential Relocations	Business Displacements
A	14	25
B	19	11
C	13	2
D	0	2
F	0	16

Property Tax Impacts

Taxable assessed valuation is calculated in this analysis, as well as an equalized valuation based upon 2017 property tax equalization ratios prepared by the NH Department of Revenue Administration. This is consistent with the methodology used in the 2007 DEIS analysis. This analysis reflects changes in the real estate economy that have occurred since the prior analyses.

Since the prior analyses, the economy has experienced a recovery from the so-called "Great Recession," which began in late 2007 and continued into 2010. The assessed value of property increased by an annual average of 10.7 percent in Derry during the pre-recession years (2003 through 2007) and by 8.3 percent in Londonderry. The total value in Derry increased from $1.79 billion in 2003 to nearly $2.98 billion in 2007, for a cumulative increase of more than 66 percent. For Londonderry, the 2003 value was $2.22 billion, increasing to $3.31 billion in 2007, for a cumulative increase of a little over 49 percent.

During the Great Recession and immediately after (2008 through 2011), the assessed value of property in Derry declined by an annual average of 1.4 percent, from $2.66 billion in 2008 to $2.52 billion in 2011. In Londonderry, the average annual increase in valuation was nominal at 0.05 percent, increasing from $3.39 billion in 2008 to nearly $3.40 billion in 2011.

In the post-recession years (2012 through 2017), there has been recovery in the assessed values for both Derry and Londonderry. The average annual change for Derry has been 3.4 percent, less than half the pre-recession average annual change. For Londonderry the average annual change has been slightly less at 2 percent, also less than in the pre-recession years.

Over the 2003 through 2017 time-period, the average annual change in assessed value was approximately 3.2 percent for Derry and 3.8 percent for Londonderry. These metrics were used to update the 2017 assessed values and property data. This broader time span includes a full economic cycle of pre- and post-recessionary times.

The 2007 DEIS presented Alternative routes for the proposed Exit 4A access. In the 2007 DEIS, these included Alternative A (51.96), Alternative B (65.90 acres), Alternative C (64.44 acres), Alternative D (31.39 acres), and Alternative F (0.21 acre). Table 4.7-6 presents the estimated acquisition costs associated with these Build Alternatives. The properties and acreage presented in the DEIS are assumed constant in this SDEIS analysis. The 2004 taxable assessed value for the acquisitions, both in Derry and in Londonderry, as presented in the DEIS, are expressed in terms of the estimated 2017 taxable assessed values in Table 4.7-6. The 2004 values were updated to 2017 by compounding the annual rate of change in assessed value, per Town, over the 2004 to 2017 time, which is 1.76 percent annually for Derry and 3.25 percent for Londonderry. Property taxes derived from the 2017 assessed values were then calculated for each Town, using the FY 2017 tax rates. Equalized values were also determined for 2017 using each Town's equalization ratio for FY 2017. The estimated costs of acquisitions for each Alternative are shown in Table 4.7-7 and range from $281,826 (Alternative F) to $9,690,710 (Alternative B).

Table 4.7-6. Property Tax Impacts by Build Alternative

Alternative and Town	Acres (2004)[a]	Taxable Assessed Value (2004)[a]	Taxable Assessed Value (2017)[b]	Estimated Property Taxes (2017)[c]	Equalized Value (2017)[d]
Alternative A	51.96	$4,719,160	$6,302,129	$165,730	$7,028,556

Alternative and Town	Acres (2004)[a]	Taxable Assessed Value (2004)[a]	Taxable Assessed Value (2017)[b]	Estimated Property Taxes (2017)[c]	Equalized Value (2017)[d]
Derry	*28.69*	*$3,249,360*	*$4,074,564*	*$117,592*	*$4,542,434*
Londonderry	*23.27*	*$1,469,800*	*$2,227,565*	*$48,138*	*$2,486,122*
Alternative B	65.90	$6,622,052	$8,690,069	$234,570	$9,690,710
Derry	*41.59*	*$5,145,401*	*$6,452,121*	*$186,208*	*$7,193,000*
Londonderry	*24.32*	*$1,476,651*	*$2,237,948*	*$48,362*	*$2,497,710*
Alternative C	64.44	$4,318,464	$5,579,601	$154,121	$6,221,476
Derry	*37.18*	*$3,689,922*	*$4,627,010*	*$133,536*	*$5,158,317*
Londonderry	*27.26*	*$628,542*	*$952,591*	*$20,585*	*$1,063,159*
Alternative D	31.39	$1,706,898	$2,304,467	$59,615	$2,570,265
Derry	*4.13*	*$1,079,649*	*$1,353,835*	*$39,072*	*$1,509,293*
Londonderry	*27.26*	*$627,249*	*$950,631*	*$20,543*	*$1,060,972*
Alternative F	0.21	$201,600	$252,798	$7,296	$281,826
Derry	*0.21*	*$201,600*	*$252,798*	*$7,296*	*$281,826*
Londonderry	*0*	*$ -*	*$ -*	*$ -*	*$ -*

Source: Town of Derry (2018), New Hampshire Department of Revenue Administration (2017)
[a] As indicated in 2007 DEIS.
[b] Assessed value in 2017 $ - inflated by town wide annual change in assessed value 2004-2017.
[c] Derry at $28.86 and Londonderry at $21.61.
[d] Derry at 89.7% and Londonderry at 89.6%.

Depending on the alternative selected, impacted properties would be revisited at the time of taking, and the cost of the takings would reflect that current year's assessed value (as equalized) plus any premiums, hardships, or relocation expenses as may be required and appropriate. The loss of assessed value would reduce property taxes collected by the Towns from the acquired properties. Taxable building valuation losses are either partial or total, depending upon the ROW acquisitions.

Community Character and Cohesion

The Project alternatives may impact community or neighborhood character and cohesion in several instances. This type of impact can result when a new corridor is introduced (or expanded) through a residential neighborhood area in such a way as to disrupt the normal social or physical interaction of that neighborhood and thus, potentially affect its cohesion. Alternatives A, B, C, and D could have such impacts on residential areas that exist along the eastern portions of these alignments in the Town of Derry. In particular, a segment of Alternatives B and C would create a new road corridor from NH 28 to NH 102. This roadway would lie between the Barkland, Birchwood, and Brookview Drives neighborhood and Barka Elementary School. Although an existing electrical powerline ROW currently runs along this same corridor, construction of a new roadway would create a further impediment within the neighborhood, particularly for pedestrian movement, as well as for school bus routes.

The westerly segment of Alternative A could also have a neighborhood impact in the residential areas of Derry that include Madden and Folsom Road corridors that would be upgraded as part of the A and B interchange alternative. Although much of the land use along this roadway segment is commercial or industrial, it also traverses along the northerly edge of a densely developed residential area. The widening of this road to accommodate higher traffic volumes generated by a new interchange could create safety issues for vehicles and pedestrians originating from the homes in this neighborhood.

Community character can also be affected when special or significant locations are affected, such as a downtown area. Alternative F would involve removal of all on-street parking in downtown Derry. Such an action, even if mitigated with the creation of additional off-street parking, is likely to result in negative economic impacts on many of the small businesses located there. The downtown represents a unique commercial environment within the community, as well as a place that offers potential for social gathering and interaction. Loss of businesses and a degraded pedestrian environment would have an overall adverse impact on the functionality of this downtown area within the community.

Mitigation

Relocations, Displacements, and Property Tax Impacts

In addition to compensation for property acquisition, relocation assistance would be provided to residential, non-profit, and business owners displaced by the Project in conformance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended. Advisory assistance would be supplied along with financial assistance to eligible displaced persons.

Real estate assessments would be reviewed by an independent appraiser to ensure that any property owner whose land is acquired to accommodate this project would be fairly treated and offered fair market value for the property. Any property owner or resident of property to be directly acquired with this project would be offered (as pertinent):

- Fair market value for the acquired property;
- Payments for moving and relocation costs;
- Replacement housing payments for home owners and/or tenants;
- Relocation advisory assistance services; and/or
- Residential mortgage interest differential payments and closing costs.

Any directly displaced businesses would be eligible for relocation benefits, including:

- Fair market value for the acquired property;
- Business re-establishment costs;
- Payments for actual reasonable moving expenses; and
- Relocation advisory assistance services.

Mitigation for property tax impacts is not proposed because impacts to the Towns would be negligible.

Community Character and Cohesion

Neighborhood cohesion impacts, such as those noted above near the Barka Elementary School area, for Alternatives C and D, or in downtown Derry, for Alternative F, could be mitigated through various transportation improvements and pedestrian safety measures. These could include, but are not limited to, installation of sidewalks, crosswalks, and warning signals at appropriate locations, as well as sidewalk bump-outs or traffic islands where practical. The loss of on-street parking in the downtown could be offset through creation of new off-street lots that are strategically located to compensate those businesses that would lose spaces in front of their shops. Adequate signage could also be installed to direct motorists to these lots. Maintaining a safe and attractive pedestrian environment in the downtown would be challenging under Alternative F, but similar methods to those described above should also be considered in this area.

4.8 Environmental Justice

NEPA requires the evaluation of impacts of a proposed project "on the human environment," particularly minority and low-income populations. Title VI of the 1964 Civil Rights Act requires federal agencies to ensure non-discrimination while implementing their programs and activities. Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, stipulates that each federal agency shall, to the greatest extent allowed by law, administer and implement its programs, policies, and activities that affect human health or the environment to identify and avoid "disproportionately high and adverse" effects on minority and low-income populations.

The U.S. Department of Transportation (USDOT) Order 5610.2(a), *Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, sets forth the USDOT policy to consider environmental justice principles in its programs, policies, and activities. FHWA Order 6640.23A, *Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, establishes policies and procedures for FHWA to use in complying with Executive Order 12898.

4.8.1 Affected Environment

Council on Environmental Quality guidance provides that 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." FHWA encourages the use of the meaningfully greater threshold to identify potential minority populations and. defines a minority as a person who is:

(1) Black: a person having origins in any of the black racial groups of Africa;

(2) Hispanic or Latino: a person of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race;

(3) Asian American: a person having origins in any of the original peoples of the Far East, Southeast Asia or the Indian subcontinent;

(4) American Indian and Alaskan Native: a person having origins in any of the original people of North America, South America (including Central America), and who maintains cultural identification through tribal affiliation or community recognition; or

(5) Native Hawaiian and Other Pacific Islander: a person having origins in any of the original peoples of Hawaii, Guam, Samoa or other Pacific Islands (FHWA Order 6640.23A).

The Order defines a low-income person as a person whose median household income is at or below the Department of Health and Human Services poverty guidelines.

The study area block groups (see Figure 4.7-1) and the Towns of Derry and Londonderry have few ethnic or racial minority groups. The study area includes a total minority population of 4.1 percent, and 3.1 percent of the population within the study area is of Hispanic descent. As previously stated, these percentages are in line with the percentages of minority and Hispanic persons in Derry and Londonderry as well as Rockingham County. Within the study area, the minority population within the block groups ranges from 0.0 to 7.4 percent, and the Hispanic population within the block groups ranges from 0.0 to 12.1 percent (see Table 4.7-1).

The average household size in the study area is 2.4, and the household size in the individual block groups ranges from 1.9 to 2.9. As such, the 2017 poverty guideline for a family of three was used (HHS, 2017). None of the block groups within the study area has a median household income below $20,420. Within the study area, median household incomes in the block groups range from $35,205 to $100,086. About 3.4 percent of the population within the study area lives below the poverty threshold, and the percentage of the population living below the poverty threshold in the block groups ranges from 0.0 to 7.5 percent (see Table 4.7-2).

4.8.2 Environmental Consequences

No Build Alternative

The No Build Alternative would not result in residential relocations or displacements. Minority or low-income populations would not receive any disproportionately high and adverse effects.

Build Alternatives

Table 4.8-1 provides a summary of census block groups within which residential relocations and business displacements would occur.

Table 4.8-1. Residential Relocations and Business Displacements by Block Group

Alternative Requiring Relocations or Displacements	Census Tract	Block Group	Total Population	Total Minority	% Minority	% Hispanic	Median Household Income	% Below Poverty
A, B	3400	4	677	8	1.18	3.99	$53,097	7.4
A, B	3701	2	1852	75	4.05	0.92	$100,086	1.1
B, C	3302	1	2750	130	4.73	4.11	$59,643	5.3
C, D	3703	2	2310	104	4.50	1.21	$72,344	1.9
F	3500	2	2619	72	2.75	0.00	$40,060	3.9
F	3500	3	2186	68	3.11	8.78	$55,625	7.5

The minority population percentage of these block groups ranges from 1.18 percent to 4.73 percent, and the Hispanic population percentage of these block groups ranges from 0.0 to 8.78 percent. The block groups comprising the study area contain 4.1 percent minority and 3.1 percent Hispanic populations. None of the block groups that would experience relocations or displacements under the Build Alternatives has a median household income that would be classified as “low-income”; however, the percentage of the population living below poverty ranges from 1.1 to 7.5 percent, compared to an average of 3.4 percent living below poverty in the block groups comprising the study area. While some of the relocations and displacements could include minority or Hispanic persons or persons living below poverty, the relocations and displacement associated with the Build Alternatives would not be disproportionately borne by minority or low-income populations.

NHDOT conducted an additional environmental justice population analysis based on a larger study area, which included a 1-mile radius for the impacted area and a 3-mile radius for the surrounding area. Appendix F contains the results of this analysis. The NHDOT analysis considered additional populations that are not directly covered by federal environmental justice policies (which focus on low-income and minority populations), such as elderly. The NHDOT analysis resulted in recommendations about Americans with Disabilities Act access that will be considered as the design is advanced and the identification of organizations related to low-income and elderly populations that should be contacted during Project outreach activities. These organizations have been added to the Project mailing list to be notified of the availability of the SDEIS and the public hearing.

4.9 Geology, Minerals, and Soils

4.9.1 Affected Environment

Geology

The 2007 DEIS provides an overview of bedrock and surficial geology in the study area (see Section 3.4.1 of the DEIS). Currently, erosion, sedimentation, and landscape alteration is an ongoing process, and soils continue to form in post-glacial material.

Minerals

Economic mineral resources in the study area include sand and gravel. The stratified drift deposits represent an important source of sand and gravel. The 2007 DEIS noted two gravel pits located on U.S. Geological Survey (USGS) topographic maps that are no longer active.

- The gravel pit to the north of Hoods Pond in Derry is now closed and zoned for residential use.
- A 16.5-acre sand and gravel pit was also once located in Londonderry, just south of Pillsbury Road and north of Wheeler Pond. This gravel pit is no longer in use, and a commercial building has since been constructed at this site.

Soils

Within 500 feet of the Alternatives, there are two general soil associations (Kelsea and Gove, 1994), each named for the dominant soils that are found together within a particular landscape setting (Brady and Weil, 2001). The soil associations near the Build Alternatives are Hinckley-Windsor-Canton and Canton-Hollis-Chatfield.

The Hinckley-Windsor-Canton soil association is found within the southern and southwestern portions of the study area. Its soils are derived from glacial outwash and are excessively drained to well-drained, sandy and loamy soils formed in areas that are nearly level to steep. They are typically found on wide plains and broad, low, knobby hills. In most places, the plains are adjacent to streams and rivers. Many areas containing these soils are used for commercial, industrial, and residential development, or remain as woodland. This association contains approximately 18 percent Windsor, 16 percent Hinckley, 10 percent Canton, and 56 percent similar[9] and dissimilar[10] soils of minor extent (Brady and Weil, 2001). The soils of minor extent include the moderately well-drained Deerfield series, the somewhat poorly drained Pipestone, and the very poorly drained Greenwood and Chocorua soils.

The Canton-Hollis-Chatfield association is found throughout the study area and is typically well-drained to somewhat excessively well-drained. It is located on mountains, hills, and ridges that have many basins and narrow drainage ways. This association was formed in glacial till and consists of very deep to shallow, loamy soils that are gently sloping to steep. Approximately 20 percent of this association consists of the Canton soil series, 15 percent Chatfield, 10 percent Hollis, and 55 percent similar and dissimilar soils of minor extent. The minor extent soils include the Ossipee, Montauk, Scituate, and Newfields soils.

Table 4.9-1 and Figure 4.9-1 show the soils mapped within 500 feet of the Build Alternative alignments (study area). A discussion of hydric soils is provided in Section 4.12.

Table 4.9-1. Soils within 500 feet of the Alternatives

Map Unit	Soil Name	Alternatives
12B	Hinckley loamy sand, 3 to 8 percent slopes	ABCD
12C	Hinckley loamy sand, 8 to 15 percent slopes	F
12E	Hinckley loamy sand, 15 to 60 percent slopes	CD
26B	Windsor loamy sand, 3 to 8 percent slopes	CD
42B	Canton fine sandy loam, 3 to 8 percent slopes	ABCDF
42C	Canton fine sandy loam, 8 to 15 percent slopes	ABCD
43B	Canton fine sandy loam, 0 to 8 percent slopes, very stony	BC
43C	Canton fine sandy loam, 8 to 15 percent slopes, very stony	BC
43D	Canton fine sandy loam, 15 to 25 percent slopes, very stony	ABCD

[9] Similar Soils—These are soils that differ so little from the named soil in the map unit that there are no important differences in interpretations. These soils are not named components in the map unit. Recognition is limited to a brief description of the feature or features by which the soil in question differs from the soils in the map unit named.

[10] Dissimilar Soils—Map units are permitted to have certain proportions of included soils that differ sufficiently from the named soil to affect major interpretations. Usually the dissimilarities are such that the soils behave differently. Dissimilar soils are named in the map unit description if they are part of the name of another map unit in the soil survey area.

Map Unit	Soil Name	Alternatives
97	Freetown and Natchaug mucky peats, ponded, 0 to 2 percent slopes	ABCDF
140B	Chatfield-Hollis-Canton complex, 0 to 8 percent slopes, rocky	ABCDF
140C	Chatfield-Hollis-Canton complex, 8 to 15 percent slopes, rocky	ABCDF
140D	Chatfield-Hollis-Canton complex, 15 to 35 percent slopes, rocky	ABCD
295	Freetown mucky peat, 0 to 2 percent slopes	ACD
298	Pits, sand and gravel	ABCD
299	Udorthents, smoothed	ABCDF
305	Lim-Pootatuck complex	BCDF
313B	Deerfield fine sandy loam, 3 to 8 percent slopes	CD
395	Swansea mucky peat, 0 to 2 percent slopes	ABCDF
446B	Scituate-Newfields complex, 3 to 8 percent slopes	AD
447B	Scituate-Newfields complex, 3 to 8 percent slopes, very stony	ABCD
495	Natchaug mucky peat, 0 to 2 percent slopes	BCD
546A	Walpole very fine sandy loam, 0 to 5 percent slopes	ABCD
547A	Walpole very fine sandy loam, 0 to 3 percent slopes, very stony	ABCD
599	Urban land-Hoosic complex, 3 to 15 percent slopes	F
657A	Ridgebury very fine sandy loam, 0 to 3 percent slopes, very stony	AD
699	Urban land	ABCDF
799	Urban land-Canton complex, 3 to 15 percent slopes	ABCDF
W	Water	ABCD

Source: NRCS (1993)

4.9.2 Environmental Consequences

No Build Alternative

The No Build Alternative would not involve new construction; no impacts on geology, minerals, or soils would occur.

Build Alternatives

Geology

None of the Build Alternatives would result in substantive changes to bedrock or surficial geology. Impacts related to soil disturbance are discussed below.

Minerals

Sand and gravel are the only geologic and mineral resources that have been identified within the study area.

American Excavating Corporation is located at 5 Madden Road, adjacent to Alternative A. The driveway to access the property will be moved to square it with the North High Street intersection. While part of the property will be acquired for the connector road and to provide access for Madden Road, the property appears to be in use for stock piling, rather than mining operations. The driveway to American Excavating Corporation will be moved to create a signalized intersection with North High Street. Additionally, a partial acquisition of this property will be used to provide access to provide a connection to Madden Road. Operation of this stockpiling facility is not anticipated to be impacted by Alternative A.

No active sand or gravel operations are located along Build Alternatives B, C, D, and F. Therefore, substantive economic or resource impacts on existing sand or gravel extraction operations are not expected to result from any of these proposed Build Alternative alignments.

Soils

As described in the 2007 DEIS, several soil series in the study area may pose substantial engineering challenges and/or have high potential for soil erosion. For example, within the Hinckley-Windsor-Canton soil association, the very poorly drained Greenwood and Chocorua soils have a high water table, or ponded water table, and the potential for severe frost action. In the Canton-Hollis-Chatfield association, the moderately well-drained Ossipee, Scituate, and Newfields soils possess a high water table and the potential for moderate frost action. In the Canton-Montauk-Paxton soil association, the Ridgebury and Walpole soils are known for having a high water table, and the Lim-Pootatuck complex can have a high water table along with a potential for severe frost action and frequent flooding.

Several other soil series that could be crossed by some of the Build Alternatives include areas that are shallow to bedrock with water seepage issues (e.g., the Hollis soil series), or that have difficulty establishing vegetation (e.g., the Hinckley soil series). Table 4.9-2 presents potential impacts on soils, including several of the more problematic types, by alternative.

Table 4.9-2. Soils Disturbed by the Build Alternatives

Alternative	Soils Disturbed (acres)	Potentially Problematic Soils
A	75.16	A large area of potential shallow to bedrock soils between I-93 and Shields Brook and an area of Walpole, Greenwood, and Ridgebury soils located along Tsienneto Road between Jeff Lane and NH 102.
B	78.69	A large area of potential shallow to bedrock soils between I-93 and Shields Brook; an area of Scituate-Newfields complex soils located just north and east of NH 28; an area of Ossipee mucky peat just east of where Alternative B would cross Scenic Drive; and areas mapped as Greenwood and Walpole soils to the north of Tsienneto Road between Jeff Lane and NH 102.
C	89.91	Areas of shallow to bedrock soils between I-93 and Ashleigh Drive. Because Alternative C would follow the same alignment as Alternative B from NH 28 east to Tsienneto Road, the soil-related impacts along this portion of the proposed roadway would be the same as those for Alternative B.

Alternative	Soils Disturbed (acres)	Potentially Problematic Soils
D	93.18	Similar to Alternative C, Alternative D would cross areas of shallow to bedrock soils between I-93 and Ashleigh Drive. Further to the south along NH 28, the alignment would cross an area of Lim-Pootatuck complex before following the same alignment as Alternative A along Tsienneto Road.
F	21.51	An area of Lim-Pootatuck complex, located along Shields Brook in downtown Derry.

Mitigation

Impacts associated with the problematic soils described are expected to be relatively minor, regardless of the alternative selected. Design and construction of new roadways frequently require addressing engineering challenges resulting from encountering soils with high water tables, surface seepage, severe frost activity, and ledge outcrops or soils that are shallow-to-bedrock. Typically, these issues can be resolved through the removal of unstable soils, placement of appropriate clean fill and granular base, installation of appropriate drainage structures, and installation of landscape plantings.

During construction, potential impacts associated with soil erosion can also be minimized through implementation of BMPs for erosion control (Rockingham County Conservation District, 1992). These practices could involve such measures as the installation of silt fencing, straw or hay bale barriers, or temporary sediment traps; mulching of disturbed areas, followed by seeding for long-term cover; and use of vegetated swales. Additionally, in areas with poor soil fertility, topsoil or an appropriate soil amendment would be used, as needed, prior to seeding or planting. A combination of these measures would mitigate any potential impacts associated with any of the Build Alternatives.

4.10 Contaminated Properties and Hazardous Materials

An environmental review was conducted in an attempt to identify the presence of potential and/or known contaminated properties and hazardous material sites near the Alternatives. The liability that may be encountered through acquisition of properties impacted by hazardous materials, as well as worker health and safety issues related to exposure to a potentially hazardous environment, can substantially increase construction costs.

The presence or absence of potential petroleum and hazardous material sites within 500 feet and known petroleum and hazardous material sites within 1,000 feet of the Alternatives was assessed based on present or former property use and best professional judgment. This study area is shown on Figure 4.10-1. Hazardous waste sites are regulated by both the Resource Conservation and Recovery Act (RCRA) of 1980 (40 CFR part 261, Subtitle C) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 (Pub. Law 96-510) as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986. Known petroleum and hazardous materials sites include but are not limited to listed National Priorities List (NPL) “Superfund” sites, CERCLA hazardous waste sites, and NHDES State hazardous waste sites (SHWS), leaking underground storage tank (LUST) sites, and existing solid waste facilities. Sites with potential petroleum and hazardous materials include, but are not limited to, sites with registered underground storage tanks (USTs), aboveground storage tanks (ASTs), registered RCRA generators, Facility Index System (FINDS) sites, and Underground Injection Control (UIC) sites. In addition to hazardous material and contaminated sites, the potential to encounter per- and polyfluoroalkyl substances (PFAS) (groundwater contaminants that are by-products of industrial processes) must also be considered. PFAS are groundwater contaminants with effects to human health.

Statewide analytical data collected by NHDOT, as well as nationwide information, indicates that roadside soils commonly contain metals and polycyclic aromatic hydrocarbons (PAHs) at concentrations above background conditions. Soil along existing roadways that will be excavated may contain elevated levels of a number of contaminants due to deposition of airborne particles from vehicles, from asphalt and asphalt sealants, tire treads, or motor oil. These “Limited Reuse Soils” (LRS) excavated from within the operational ROW shall be addressed in accordance with applicable NHDES rules and/or waivers. Soils that are anticipated to meet the definition of LRS may be subject to management through a Soils Management Plan. Roadside soils currently managed as LRS by the Department include all topsoil within the limits of the existing ROW, regardless of its depth and any ground or pulverized asphaltic materials. In those instances where there is no measureable topsoil, LRS will be measured from the top of ground to a depth of six inches.

4.10.1 Affected Environment

Potential and known hazardous material, contaminated, and solid waste sites were reviewed by performing a search of State and Federal database records. The search was conducted in October 2016 by Environmental Data Resources, an environmental database subcontractor, and included a search of databases using search radii listed in the American Society for Testing and Materials (ASTM) Phase I Environmental Site Assessment standard (E1527-13) (Environmental Data Resources, Inc., 2016). The results of the 2016 database were compared with the results from an environmental database search conducted in 2010 (Environmental Data Resources, Inc., 2010). The 2016 records search was conducted based on a refined study area based on 500-foot and 1,000-foot search radii (Figure 4.10-1) and revealed a total of 260 sites within the search radii; 220 of those sites remained from the 2010 review and 40 were new sites added in 2016. The sites are summarized in Appendix G, which includes a site number, site activity, general site address, the site category or environmental database(s) the site is listed on, and whether the site was an existing database listing from 2010 or a new database listing in 2016. New database listings were also added to each site if applicable, while database listings that were no longer listed were removed. Windshield surveys had been conducted previously for the study areas and had identified a group of potential sites of concern based on field observations. These sites were listed on the summary table as “Field.” A windshield survey was not conducted in 2016.

This review meets the government requirements for records search per ASTM E 1527-13. Initial Site Assessments (ISA), which were conducted previously for some sites, followed American Association of State Highway and Transportation Officials guidance for performing such investigations at the corridor level. Of the sites for which ISAs were undertaken, Preliminary Site Investigations (PSIs), which involve subsurface investigations, were recommended for seven sites. The analysis included a review of federal and state environmental databases, review of state and local records, and site reconnaissance. ISAs were not conducted as part of the 2016 study, but new and existing sites were reviewed to determine their relative risk, and ISAs were recommended for five sites. Appendix G lists databases researched as part of this report.

Potential and Known Petroleum, Hazardous Material, and Solid Waste Sites

The potential and known petroleum, hazardous materials, and solid waste sites map (Figure 4.10-1) illustrates the approximate location of each site identified through the database searches but does not include actual detailed site information. An arbitrary number has been assigned to each site that corresponds with the numbers on the known and potential petroleum and hazardous materials lists presented in Appendix G. The lists include the site activity, site address, database source for each site and if the site is an existing site from the 2010 review or whether it was added in 2016. Sites listed as CLOSED by NHDES are included in the list.

Several “orphan sites” were identified during the database search. Orphan sites are those sites that have an incomplete address, and therefore their exact locations are not discernible. A limited windshield survey was conducted in 2010 to locate these sites, and it was determined that several of these orphan sites were outside the study area. These sites could not be located and thus remain as “estimated locations.” The 2016 database search also identified several orphan sites. These were attempted to be identified, and any that were located within the search radii are included in the summary table in Appendix G.

Summary of Findings

The most common types of contaminated or hazardous material sites within the Project area consist of sites listed on the RCRA/RCRIS and UST databases. RCRA/RCRIS sites include several categories of hazardous material generators: those that produce small, large, and very large quantities of hazardous materials. RCRA/RCRIS sites also include those facilities that transport, store, treat, and/or dispose of hazardous materials. Most listings are of the RCRA NonGen type.

4.10.2 Environmental Consequences

Known and potential hazardous material and petroleum-contaminated sites within 1,000 feet and 500 feet of the Alternative footprints, respectively, are tallied in Table 4.10-1. Hazardous material or contaminated sites within 1,000 feet of any Alternative where PSIs were previously recommended, and where ISAs are currently recommended, are identified in Table 4.10-2. The analysis included a review of site locations as depicted on project mapping and as provided by the EDR report. In some cases, site locations were adjusted to reflect locations depicted by NHDES rather than the locations depicted by the EDR report, because the EDR locations are based upon a street address rather than a site location. A comparison of the proximity of the Alternatives to known and potential hazardous material or petroleum-contaminated sites reveals that Alternative F is close to the highest number of potential and known remediation sites (119 sites total); Alternative D ranks second in proximity to sites (81 sites total); and Alternatives A, B, and C are all in a similar range of proximity to sites (A = 49 sites, B = 42 sites, and C = 49 sites).

Table 4.10-1. Hazardous Material and Petroleum-contaminated Sites

Hazardous Site Type	A	B	C	D	F
Known hazardous material or petroleum-contaminated sites (number) within 1,000 feet	23	18	17	27	42
Potential hazardous material or petroleum-contaminated sites (number) within 500 feet	27	24	32	55	77

Table 4.10-2. Hazardous Material and Petroleum-contaminated Sites Where PSIs Were Previously Recommended or ISAs are Currently Recommended

Site no.	Site Activity	Site Address	Alternative Footprint within 1,000 feet					2011 PSI rec.	2018 ISA rec.
45	PRINTING BUSINESS	TINKHAM AVENUE	A	B	C	D		PSI	
118	SERVICE STATION	DANFORTH CIRCLE					F	PSI	
52	OIL COMPANY	CRYSTAL AVENUE	A			D		PSI	
53	SCHOOL	GRINNEL ROAD					F		ISA
129	MANUFACTURING FACILITY	MANCHESTER ROAD	A	B	C	D		PSI	
157	MARKET	MANCHESTER ROAD	A	B	C	D		PSI	
209	DRY CLEANERS	LINLEW DRIVE	A	B	C	D			ISA
231	SERVICE STATION	NASHUA ROAD					F	PSI	
71	METAL FINISHING BUSINESS	HILLSIDE AVENUE					F		ISA
245	GENERAL CONTRACTOR	ROUTE 28 / ROCKINGHAM ROAD			C	D			ISA

No Build Alternative

Because the No Build Alternative would not require any new construction, no impacts on existing potential petroleum-contaminated and hazardous material sites would be expected.

Build Alternatives

Alternative A

The Alternative A footprint falls within 1,000 feet of 23 known hazardous material or contaminated sites. Seven ISAs were previously undertaken within 1,000 feet of the Alternative

A alignment as currently proposed, and PSIs were previously recommended at four of them: two circuit board manufacturing facilities and two sites, a market and a gas station, with ongoing monitoring for remediation of LUSTs. An ISA is recommended at one new site, a dry cleaner, within 1,000 feet of the Alternative A footprint. In addition, there are 27 sites within 500 feet of the Alternative A footprint recognized as potential hazardous material or petroleum-contaminated sites.

Alternative B

The Alternative B footprint falls within 1,000 feet of 18 known hazardous material or contaminated sites. Four ISAs were previously undertaken within 1,000 feet of the Alternative B alignment as currently proposed, and PSIs were previously recommended at three of them: a circuit board manufacturing facility, a printing business, and a store with a LUST remediation file with ongoing monitoring. ISAs are currently recommended at one dry cleaner. Also, there are 24 sites within 500 feet of the Alternative B footprint recognized as potential hazardous material or petroleum-contaminated sites.

Alternative C

The Alternative C footprint falls within 1,000 feet of 17 known hazardous material or contaminated sites. Seven ISAs were previously undertaken within 1,000 feet of the Alternative C alignment as currently proposed, and PSIs were previously recommended at the same three sites recommended for PSIs for Alternative C. ISAs are currently recommended at two sites: a dry cleaner and a general contractor. In addition, there are 32 sites within 500 feet of the Alternative C footprint recognized as potential hazardous material or petroleum-contaminated sites.

Alternative D

The Alternative D footprint falls within 1,000 feet of 27 known hazardous material or contaminated sites. Seven ISAs were previously undertaken within 1,000 feet of the Alternative D alignment as currently proposed, and PSIs were previously recommended at the same three sites recommended for PSIs for Alternatives B and C. ISAs are currently recommended at the same two sites as Alternative C: a dry cleaner and a general contractor. In addition, there are 55 sites within 500 feet of the Alternative D footprint recognized as potential hazardous material or petroleum-contaminated sites.

Alternative F

The Alternative F footprint falls within 1,000 feet of 42 known hazardous material or contaminated sites, more than any of the other Alternatives because of its highly developed setting. Seventeen ISAs were undertaken along this corridor, and PSIs were recommended at two service stations. ISAs are currently recommended at a school and a metal finishing business within 1,000 feet of this alternative. In addition, there are 77 sites within 500 feet of the Alternative F footprint recognized as potential hazardous material or petroleum-contaminated sites.

Mitigation

Mitigation for hazardous material or petroleum-contaminated involvement would follow standard NHDOT procedures. If the selected Alternative involves potential contamination from hazardous material, all stages of design and construction would address contaminant and project-specific avoidance and remediation measures that may be required. Standard procedures for building demolition, LRS, and PFAS are outlined below.

Building Demolition

Before building structures are removed, a professional hazardous material specialist would complete a building audit to identify and quantify all pertinent building materials and waste materials. Materials that may be identified in the audit include:

- Asbestos;
- Lead-based paint;
- Polychlorinated biphenyls (PCBs);
- Electrical transformers that may contain PCB dielectric oil;
- Mercury-containing fluorescent light bulbs;
- Mercury thermostats;
- Miscellaneous containers of oil or hazardous materials;
- Refrigerants (commonly found in such items as air conditioners, refrigerators, etc.);
- Hydraulic lifts;
- ASTs; and
- USTs.

The level of audit for each location would vary based on building type, age, and current use. Residential buildings would typically be limited to asbestos and lead paint reviews. Commercial buildings would include a more intensive review for all pertinent materials.

Any miscellaneous containers of oil and hazardous materials would be removed before each relevant building is demolished. In addition, tank closure assessments would be completed after each UST is removed. If contaminants are found with the tank closure assessments, remediation may be required.

Limited Re-use Soils (LRS)

Limited Reuse Soils (LRS) excavated from within the operational ROW shall be addressed in accordance with applicable NHDES rules, waivers, and/or Soils Management Plans.

Per- and Polyfluoroalkyl Substances (PFAS)

NHDES has identified PFAS as emerging contaminants and has developed Ambient Groundwater Quality Standards (AGQSs) for two PFAS compounds: perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). Groundwater that could have PFAS-impacted groundwater above AGQSs may be subject to management through a Groundwater Management Plan.

4.11 Surface Waters and Water Quality

4.11.1 Affected Environment

The proposed Project lies within the Upper Beaver Brook watershed (Level 12 Hydrologic Unit 010700061025) as mapped in USGS' Watershed Boundary Dataset (NHDES, 2017a). Beaver Brook, south of the proposed Project, flows west under I-93 and then south into Massachusetts where it joins the Merrimack River in Lowell. Upper Beaver Brook has been subject to water quality investigations since 2003 in response to proposed development in the watershed, including widening and improvements to I-93 (NHDES, 2008a).

Surface waters of the state are classified as Class A or Class B, pursuant to NH RSA 485-A:8, I-III, Water Pollution and Waste Disposal. Class A waters have the highest quality designation and are required to stay below certain threshold values with regard to bacteria (*Escherichia coli*), and discharges of sewage or wastes are not allowed. Class A waters are considered potentially acceptable for use as water supply after adequate treatment. Class B waters are the second highest quality designation and are required to meet less stringent bacteriological criteria, as well as several other biological, physical, and chemical criteria. By default, all surface waters in New Hampshire are designated as Class B. New Hampshire's Administrative Rules Env-Wq 1700 provide thresholds for pollutants, dissolved oxygen (DO), color, temperature, and other criteria that must be met for Class A and Class B waters.

Regulatory Framework

Project developers are subject to a variety of state and federal regulations and associated programs that ensure surface water quality is preserved or restored in all waters of the U.S. Impacts on waterbodies near the Project alignment would necessitate involvement with these regulations as the Project proceeds through final design to construction.

Clean Water Act Sections 303(d) and 305(b)

Sections 303(d) and 305(b) of the Clean Water Act[11] (CWA) require each state to submit two reports (CWA 303(d) report and CWA 305(b) report) to EPA every two years, documenting the water quality status of surface waters within the state. New Hampshire's "305(b) Report" describes the quality of New Hampshire's surface waters and analyzes the extent to which all such waters provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife and allow recreational activities in and on the water.

The second report, required by Section 303(d) of the CWA, requires submittal of a list of waters that are:

- impaired or threatened by a pollutant or pollutant(s);

[11] The Federal Water Pollution Control Act (PL 92-500) as last reauthorized by the Water Quality Act of 1987.

- not expected to meet water quality standards within a reasonable time even after application of best available technology standards for point sources or best management practices (BMPs) for nonpoint sources; and
- require development and implementation of a comprehensive water quality study (i.e., a TMDL study) designed to meet water quality standards.

New Hampshire Surface Water Assessment

New Hampshire's process for assessing surface water quality is detailed in the "Consolidated Assessment and Listing Methodology" that interprets New Hampshire's Surface Water Quality Regulations (Env-Wq 1702.17) and identifies "designated uses" for New Hampshire surface waters, defined as "the uses that a waterbody should support" (NHDES, 2017b). Table 4.11-1 lists designated uses.

Table 4.11-1. Designated Uses for New Hampshire Non-Tidal Surface Waters

Designated Use	NHDES Definition	Applicable Surface Waters
Aquatic Life	Waters that provide suitable chemical and physical conditions for supporting a balanced, integrated and adaptive community of aquatic organisms.	All surface waters
Fish Consumption	Waters that support fish free from contamination at levels that pose a human health risk to consumers.	All surface waters
Shellfish Consumption	Waters that support a population of shellfish free from toxicants and pathogens that could pose a human health risk to consumers	All tidal surface waters
Drinking Water Supply After Adequate Treatment	Waters that with adequate treatment will be suitable for human intake and meet state/federal drinking water regulations.	All surface waters
Primary Contact Recreation (i.e., swimming)	Waters that support recreational uses that involve minor contact with the water.	All surface waters
Secondary Contact Recreation	Waters that support recreational uses that involve minor contact with the water.	All surface waters
Wildlife	Waters that provide suitable physical and chemical conditions in the water and the riparian corridor to support wildlife as well as aquatic life.	All surface waters

Source: NHDES (2017b)

Designated uses are assessed in the Consolidated Assessment and Listing Methodology using a 1–5 TMDL Priority scale, with 1 indicating that all designated uses are attained, and 5 indicating that one or more uses is impaired and a TMDL is required. A score of 4 or 5 indicates that the Assessment Unit (AU, the waterbody or stream segment used for recording assessments) is impaired for one or more designated uses, as defined in the Consolidated Assessment and Listing Methodology:

- **AU Category 4A**: Impaired or threatened for one or more designated uses but does not require the development of a TMDL because a TMDL has been completed.
- **AU Category 4B**: Impaired or threatened for one or more designated uses but does not require the development of a TMDL because other pollution control requirements are reasonably expected to result in attainment of the water quality standard in the near future.
- **AU Category 4C**: Impaired or threatened for one or more designated uses but does not require the development of a TMDL because the impairment is not caused by a pollutant.
- **AU Category 5**: Impaired or threatened for one or more designated uses by a pollutant(s), and requires a TMDL (this is the 303(d) List) (NHDES, 2017b).

Parameters for assessing wildlife are under development, so no assessments for this designated use have been conducted to date.

Total Maximum Daily Load Program

Waterbodies designated in New Hampshire as AU Category 5 (updated every two years in the NHDES 303(d) list) are impaired or threatened waters for one or more designated uses by a pollutant or pollutants and require development of a TMDL for the pollutant(s) causing the threat(s) or impairment(s). The TMDL establishes the maximum amount of a pollutant that can be allowed in a waterbody to achieve water quality standards for all designated uses (NHDES, 2008a). A TMDL report also identifies the sources of the pollutant(s) of concern and the load allocations for each source that are allowed while achieving water quality standards. All TMDLs are subject to public review and comment, review, and approval by EPA (NHDES, 2008a). A TMDL is determined as:

$$\text{TMDL} = \text{WLA} + \text{LA} + \text{MOS}$$

Where “WLA” is the waste load allocation for point sources of a pollutant; “LA” is the load allocation for nonpoint sources of a pollutant; and “MOS” is the margin of safety to account for uncertainty and unknowns (NHDES, 2008a).

TMDL Implementation Plans

A TMDL establishes a target for reducing a pollutant(s) to achieve water quality standards in an impaired waterbody, and often a TMDL report is partnered with (although not required) an implementation plan for achieving the necessary load reductions to meet the TMDL. A TMDL implementation plan may identify a framework for achieving load reductions through existing or necessary controls that address the identified source(s) of pollutant(s). One example of pollution controls is BMPs that are structural (e.g., stormwater infiltration) and non-structural methods of achieving pollution reduction (e.g., public outreach and education). Developing and executing an implementation plan may be a permit condition for certain types of projects in TMDL watersheds (e.g., the 401 Water Quality Certification (WQC) for the I-93 widening project [NHDES, 2006]).

Clean Water Act Section 319 Nonpoint Source Pollution Management Program

Section 319 of the CWA was established to address nonpoint sources of polluted runoff. Under this program, the NHDES Watershed Assistance Bureau distributes grants to non-profit organizations, government entities, and watershed organizations to develop watershed management plans, implement BMPs, and assist with organization and outreach. The program also distributes grants annually to these organizations for restoration of impaired waterbodies. The program awarded $705,159 in 2017 for 18 projects throughout the state (http://www4.des.state.nh.us/OneStopOrig/Watershed_NPSGrants_Results).

National Pollutant Discharge Elimination System

The National Pollutant Discharge Elimination System (NPDES) permit program addresses water pollution by regulating point sources that discharge pollutants to waters of the United States. The NPDES program was created in 1972 by the CWA and allows EPA to transfer authority to state governments to perform many permitting, administrative, and enforcement aspects of the program. Two permitting programs under NPDES are relevant to highway construction projects in the Exit 4A study area: the Construction General Permit (CGP) and the MS4 general permit.

Construction General Permit

EPA's CGP program is designed to ensure that proper stormwater controls are used to protect water resources and the surrounding environment while allowing construction activities to proceed as planned. EPA issued a new CGP on January 11, 2017 (EPA, 2017b) that covers:

- Large construction sites larger than 5 acres,
- Construction sites 1 to 5 acres, and
- Construction sites smaller than 1 acre if they are part of a larger common plan of development.

The 2017 CGP requires the owner and operator of the construction site to develop and implement a Stormwater Pollution Prevention Plan (SWPPP), and includes requirements for oversight and inspection of construction sites. A Notice of Intent (NOI) is submitted electronically to EPA.

Municipal Separate Storm Sewer System (MS4) General Permit

In addition to notification requirements for construction, the NPDES program requires that municipalities that operate MS4s obtain a permit for stormwater discharge from these systems. Owners and operators in 61 New Hampshire municipalities, including Derry and Londonderry, are required to apply for coverage under the MS4 permit program. In January 2017, EPA released the General Permits for New Hampshire MS4s, which became effective July 1, 2018 (EPA, 2017c). The MS4 general permit has special requirements for discharges to impaired waterbodies and water bodies with an approved TMDL as discussed further in *Chloride Mitigation* in Section 4.11.2.

Clean Water Act Section 401

Section 401 of the CWA requires that owners or operators of projects that seek a federal license or permit for a project that may result in a discharge obtain a certification that state water quality standards will be met. NHDES administers this federal requirement. Projects that require a WQC include those that require:

- CWA Section 404 permits from USACE
- Federal Energy Regulatory Commission licenses
- NPDES permits

USACE, which administers the Section 404 permits, has issued Programmatic General Permits for certain activities (USACE, 2017). Under these permits, the WQC is also programmatic and requires no separate filing. For larger projects, when an individual Section 404 permit is required, a separate 401 WQC application must be filed. The application must demonstrate that the project as proposed will not cause exceedances of NH Water Quality Standards (Env-Wq 1700).

Alteration of Terrain Program

The NH Alteration of Terrain (AoT) Bureau is also charged with oversight of the NH Water Quality Standards (NHDES, n.d.). The AoT Bureau issues permits for projects that disturb:

- 100,000 square feet or more,
- 50,000 square feet or more for projects within 250 feet of surface waters under the jurisdiction of RSA 483, the New Hampshire Water Quality Protection Act, or
- Projects of any size that disturb areas with a grade of 25 percent or greater within 50 feet of any surface water.

NHDOT has been granted an exemption from the AoT Permit and fee by NHDES as detailed in an agreement signed by NHDOT and NHDES titled “Department of Transportation Terrain Alteration Permit Exemption” (NHDES, 2011b). The agreement recognizes that NHDOT projects are designed, constructed and maintained to comply with all provisions of state water quality standards under a number of state and federal regulations, standards, guidance documents, and contract provisions. These standards are listed in the agreement and are updated by NHDOT as needed:

- DOT Standard Specifications for Road and Bridge Construction, specifically Sections 107 and 645 (approved August 17, 2010)
- AASHTO Highway Drainage Guidelines, 4th Edition, 2007
- EPA's Developing Your Stormwater Pollution Prevention Plan-A Guide for Construction Sites, May 2007
- DOT, Best Management Practices for Erosion and Sediment Control, June 1995
- NHDES New Hampshire Stormwater Management Manual, Volumes 1, 2 & 3, December 2008
- NHDOT Guidelines for Temporary Erosion Control and Stormwater Management, 2002
- NHDOT Best Management Practices for Routine Roadway Maintenance Activities in New Hampshire, August 2001

- NHDOT *Construction Manual*; June 1, 2006
- FHWA's Guidance Manual for Monitoring Highway Runoff Water Quality, March 2001
- FHWA's Urban Drainage Design Manual, August 2001
- FHWA's Hydraulic Design of Highway Culverts, September 2001
- All applicable Federal Aviation Administration Advisory Circulars and Orders
- AREMA's Manual for American Railway Engineering and Maintenance-of Way Association, April 2009

Surface Waters in the Exit 4A Project Area

Several lakes, ponds, and streams in the Project area may be affected by the construction and maintenance of any of the Alternatives. The surface waters described below are depicted in Figure 4.11-1.

Lakes in the Exit 4A Project Area

- Beaver Lake, the largest waterbody in the study area, which has a surface area of 134 acres and a maximum depth of 46 feet. Beaver Lake is an important recreational resource for the Town of Derry.

Ponds in the Exit 4A Project Area

- Hoods Pond, an impoundment of Shields Brook located in Derry near the center of the study area. Hoods Pond is approximately 5 acres, with a maximum depth of 6 feet and an average reported depth of approximately 2 feet (NHDES, 1998; 2017a). The estimated watershed area is 6.13 square miles. NHDES classifies the pond as mesotrophic, although noted that it was highly biologically productive and close to being classified as eutrophic (NHDES, 1998).
- Horns Pond, also an impoundment of Shields Brook located in Derry near the center of the study area. Horns Pond is not listed as a Public Water, and no further data were found regarding Horns Pond.
- Scobie Pond, a natural pond located in Londonderry along the town line with Derry, near the northern limits of the study area. This pond covers a surface area of just under 27 acres and has a maximum depth of nearly 26 feet (NHDES, 2017c). The pond has an average depth of approximately 12 feet and is classified as mesotrophic by NHDES (NHDES, 2017c). Scobie Pond is listed on the NHDES *Official List of Public Waters* (NHDES, 2016b).
- Wheeler Pond is located in Londonderry just east of I-93 Exit 4, and it is less than 10 acres (NHDOT, 2004). The surrounding watershed is highly developed. Sampling of basic biological and water quality parameters was attempted by NHDES in August 1997 but at that time it was determined that this waterbody was a wetland rather than a pond (NHDES, 1997). Consequently, data collection was not completed. Wheeler Pond is less than 10 acres in area and is thus not listed on the NHDES *Official List of Public Waters*.

- Lower Shields Pond is located in Derry near the northern limits of the study area. This waterbody forms part of the headwaters of Shields Brook. Because it is less than 10 acres in size, it is not listed on the NHDES *Official List of Public Waters*. Therefore, physical and biological data were not available for Lower Shields Pond.

Streams and Brooks in the Exit 4A Project Area

- Beaver Brook is a perennial stream, the largest stream in the study area. It flows from Beaver Lake in the northeastern corner of the study area in Derry to the south and west through adjacent portions of Derry and Londonderry. It is listed as a public water, and its watershed upstream of I-93 is slightly less than 24 square miles (NHDES, 2007). Much of the watershed area for Beaver Brook is highly developed with commercial, industrial, and residential properties, as well as supporting transportation and utility infrastructure.
- Shields Brook[12] is a perennial stream that starts at the northern limits of the study area where it flows out of Lower Shields Pond, and flows in a generally southerly direction through Hoods Pond and Horns Pond to Beaver Brook. Scobie Pond also flows into Shields Brook just north of NH 28. Between NH 28 and its confluence with Beaver Brook, Shields Brook flows through very highly developed areas associated with the commercial and industrial development along NH Routes 28 and 102, as well as mixed use and residential areas. The stream has a watershed area upstream of NH 102 in Derry of just over 7.3 square miles. Shields Brook discharges into Beaver Brook just upstream of Fordway Street in Derry.
- West Running Brook a perennial stream located within the eastern portion of the study area and flows in a southerly direction. It drains residential and commercial areas to the east of NH 102 and NH 28.

Other Streams in the Exit 4A Project Area

Numerous additional unnamed streams and tributaries are within the study area, including a perennial stream that originates along I-93 near Trolley Car Lane (Unnamed Stream 1). This tributary flows along I-93 and drains into Wheeler Pond near Exit 4. Below Wheeler Pond, the stream flows under NH 102 before draining into a large wetland system associated with Beaver Brook near Transfer Lane in Derry. Upstream of NH 102 (immediately downstream of Wheeler Pond), the contributing watershed of this Beaver Brook tributary is about 1.2 square miles.

Another small perennial stream originates in a large wetland complex located on the west side of I-93 to the south of Stonehenge Road (Unnamed Stream 2). This stream flows to the north and east under I-93, then under NH 28 into a large wetland system (Peat Bog) before flowing to the east and south into Shields Brook. The watershed area for this tributary upstream of NH 28 near its confluence with Shields Brook is approximately 2.4 square miles.

[12] Shields Brook is identified in some sources as Beaver Brook. To minimize confusion, for the purpose of the SDEIS, Shields Brook is as described above.

Also, there are several unnamed tributaries located in the northeastern corner of the study area that flow under Tsienneto Road in Derry. This includes a small intermittent stream that originates just east of the NH 28 Bypass and drains through residential areas to the south before crossing under NH 102 and discharging into Beaver Brook near Hoodkroft Country Club. Three other tributary streams associated with Beaver Lake cross under Tsienneto Road near its extreme east end. Two of these streams have relatively small watershed areas (i.e., less than 0.25 square mile). However, the most substantial stream in this portion of the study area drains through a large wetland complex, identified as Prime Wetland B-12, before flowing under Tsienneto Road near NH 102 (see Figure 4.12-2 in Section 4.12). This perennial stream drains a watershed area of just over 1.3 square miles.

Impaired Waters in the Exit 4A Project Area

As described in Section 4.11.1, New Hampshire is required by Sections 303(d) and 305(b) of the CWA to identify impaired surface waters (i.e., waters that have designated uses that score a 4 or 5) and report them every two years (referred to as the CWA 303(d) list). Impaired waters are also identified in published TMDL reports which designate pollutant reduction goals in impaired waters where a TMDL has been completed. The most recent 303(d) list was produced in 2016 and a summary of impaired waterbodies is presented in Table 4.11-2. These impaired reaches are shown on Figure 4.11-2. Fish consumption in all surface waters in New Hampshire is impaired by elevated mercury caused by atmospheric deposition. EPA approved a regional TMDL for all surface waters for mercury in 2007 (NEIWPCC, 2007). This regional impairment is not listed in Table 4.11-2.

Table 4.11-2. NHDES Listed Impaired Waters in the Study Area

Assessment Unit ID	Town	Surface Water	Year of Listing	Impaired Use	TMDL PC[a]	Reason for Impairment Listing
Lakes and Ponds						
NHLAK700061203-02-01/02/03/04	Derry	Beaver Lake	Statewide Bacteria TMDL approved in 2010. (NHDES, 2010)			
			2016	Aquatic Life	5	Chlorophyll a[b], DO saturation, pH, phosphorus (total)[b]
NHLAK700061203-03-01/02	Derry	Hoods Pond	Hoods Pond Phosphorous TMDL approved in 2012 (AECOM, 2012)			
Rivers and Streams						
NHRIV700061203-09	Derry	Beaver Brook, West Running Brook	Statewide Bacteria TMDL approved in 2010. (NHDES, 2010)			
			2016	Aquatic Life	5	Benthic-macroinvertebrate bioassessments,[b] chloride,[b] pH

<table>
<tr><th>Assessment Unit ID</th><th>Town</th><th>Surface Water</th><th>Year of Listing</th><th>Impaired Use</th><th>TMDL PC[a]</th><th>Reason for Impairment Listing</th></tr>
<tr><td>NHRIV700061203-11</td><td>London-derry/ Derry</td><td>Beaver Brook</td><td>2016</td><td>Aquatic Life</td><td>5</td><td>Chloride[b]</td></tr>
<tr><td rowspan="2">NHRIV700061203-16</td><td rowspan="2">London-derry</td><td rowspan="2">Beaver Brook</td><td colspan="4">Beaver Brook Chloride TMDL approved by EPA in 2008 (for AU NHRIV700061203-16)</td></tr>
<tr><td>2016</td><td>Aquatic Life</td><td>5</td><td>pH</td></tr>
</table>

Source: NHDES (2017d)
[a] TMDL Priority Scale.
[b] Identified by NHDES as development impairments (NHDOT, 2017c).

TMDLs in the Exit 4A Project Area

The Exit 4A Project area encompasses waterbodies with approved TMDLs including the Beaver Brook Chloride TMDL, the Statewide Bacteria TMDL and the Regional Mercury TMDL. This section describes the current TMDLs in the Project area and any subsequent actions related to the TMDL process including implementation plans and compliance actions.

Beaver Brook Chloride TMDL

Elevated chloride levels in Beaver Brook were documented close to I-93 as part of the EIS for the Salem to Manchester I-93 widening project. As a nontidal Class B waterbody, Beaver Brook is subject to water quality criteria defined in Env-Ws 1703.21 which states that chloride concentrations should not exceed 860 milligrams/liter (mg/L) for acute exposures or 230 mg/L for chronic exposures. Data collected in 2002 and 2003 from locations in Beaver Brook upstream and downstream of I-93 documented average chloride levels between 98 and 99 mg/L[13] (NHDOT, 2003; 2004). Numerically higher chloride concentrations were observed downstream of the I-93 crossing. However, the relatively high chloride levels observed upstream of the I-93 crossing of Beaver Brook suggested substantial sources upstream of the highway (NHDOT, 2004). Water quality violations of the chronic standard for chloride were detected at two monitoring stations, 10-BVR (below I-93) and 10A-BVR (upstream of I-93 and just downstream of the confluence of Beaver and Shields Brooks) in February 2004 and again in January 2005 at station 10A-BVR (NHDES, 2008a). The documented water quality violations prompted NHDES and NHDOT to conduct a comprehensive water quality monitoring program in the Upper Beaver Brook watershed in 2006 and 2007 and the subsequent data, which documented further violations of the acute chloride standard, resulted in listing Beaver Brook (AU NHRIV700061203-16) as impaired for chloride on the 2006 CWA 303(d) list and ultimately led to the development of a TMDL study and implementation plan for Beaver Brook to meet water quality standards (NHDES, 2008a; NHDES, 2011a).

[13] Most chloride values are determined indirectly by correlation of chloride concentration to measurements of specific conductance. In this document, we do not provide specific conductance values in addition to the calculated chloride values, and we note that most of the reported chloride levels were derived from specific conductance measurements.

Because of the chloride threshold exceedances observed in portions of Beaver Brook and some of the contributing tributaries, and as a result of the I-93 widening project, NHDOT and NHDES entered into a Memorandum of Agreement (NHDES, 2016d) to develop and implement a TMDL study for chloride in Beaver Brook. The TMDL study was a permit condition of the CWA Section 401 Water Quality Certificate issued for the Salem-Manchester I-93 widening project (NHDES, 2006).

The Beaver Brook chloride TMDL, completed in April 2008, documented chloride levels in selected areas of the Upper Beaver Brook watershed and identified and quantified the contributing sources of chloride. According to the TMDL, the majority (approximately 95 percent) of chloride loading in the watershed is associated with de-icing activities for public and private roadways and parking lots. The TMDL was set as a load duration curve based on the chronic water quality standard (230 mg/L Cl) reduced by 10 percent to include a 10 percent margin of safety (=207 mg/L Cl) multiplied by each streamflow value in a 4-day average flow duration curve developed by NHDES (NHDES, 2008a). The load duration curve expresses the TMDL in tons of chloride per day that can be imported to the watershed at a given flow and meet the chronic water quality standard (NHDES, 2008a). Of the daily chloride load expressed by the TMDL, 66 percent is reserved for the WLA (MS4 permittees) and 34 percent is reserved for the LA (nonpoint sources) (NHDES, 2008a).

NHDES has also expressed the TMDL for Beaver Brook as an alternative form, the Percent Reduction Goal, which establishes an annual quantity of salt to be applied (known as the “salt load allocation”) in tons of salt per year (NHDES, 2008a). The annual salt load allocation is not the TMDL (the TMDL is the load duration curve), but it is used for implementing the TMDL by establishing a longer term goal (i.e. versus daily criteria) for watershed salt imports that can be expected to meet water quality standards. Based on empirical water quality data and annual salt imports from all salt sources in the watershed and including a 10 percent margin of safety, NHDES set the salt load allocation at 9,069 tons of salt per year (NHDES, 2008a). The TMDL report also sets forth the process by which each sector would be allocated a percentage of the total salt load allocation. The recommended sector salt load allocations were negotiated via a Salt Reduction Workgroup, with representatives from each sector of salt applicators (NHDES, 2008a). Recommended salt load allocations per sector were established in the *Chloride Reduction Implementation Plan for Beaver Brook–Derry, Londonderry, Auburn, Chester, NH* (NHDES, 2011a). Although sector salt load allocations can be changed and redistributed by the Salt Reduction Workgroup, the total watershed salt load allocation of 9,069 tons will remain unchanged as the maximum level of salt imports that can be assimilated by the Upper Beaver Brook watershed in support of water quality standards (NHDES, 2008a).

The TMDL specifies the chloride load (point source waste load + nonpoint source load) that can be imported to the watershed while achieving water quality standards and describes the activities that should be used to meet the chloride load (NHDES, 2008a). The *Chloride Reduction Implementation Plan for Beaver Brook* (NHDES, 2011a) specifies a number of BMPs to optimize salt use efficiency and identifies activities and target dates for achieving compliance with the TMDL (see Table 4.11-3). The BMPs were identified consistent with the implementation plan goals to reduce salt loads and attain chloride water quality standards in the Upper Beaver Brook watershed while preserving winter road maintenance standards and traffic safety (NHDES, 2011a).

Table 4.11-3. Chloride Reduction Implementation Plan Matrix

	Action	Target Completion Date of Responsible Agencies							
		NH DES	UNH	NH DOT	Towns[a]	LER[b]	RPC[c]	PS[d]	NH DOS[e]
	Objective: Creation of Educational Manuals, Training Programs and Procedural/Operational Strategies								
1	State Snow and Ice BMP Manual for Roadways	2012		2012					
2	State Snow and Ice BMP Manual for Parking Lots	2012		2012				2012	
3	Develop DOT Winter Maintenance Training Program for Salt Reduction			2012					
4	Certification Training Program for Private Sector		2011						
5	Training and Certification Program for Municipal Staff		2011		2011				
6	Legislative approval of salt applicators license program	DLA[f]							
7	Legislative approval of mandatory use of snow tires								DLA
8	Develop Join Incident Protocols			2011					2011
9	Complete Driver Behavior Study	2012							
10	Adopt traffic violation procedure to address reckless driving during inclement road conditions								DLA
11	Develop winter driving training and require attendance for repeat traffic violation offenders								DLA
12	Develop training for inexperienced drivers, such as high school students				2012				2012
13	Reduce driving speed limits during inclement weather conditions			2010	2010				
14	Hold prewinter meetings to review LOS				2011	2011			
15	Develop call-back ranking system				2012	2012			
16	Develop and adopt a formal snow and ice removal policy				2011				
17	Revise site plan review process to include designs and/or management strategies that may decrease chloride use				2012		2012		
18	Revise permit review process to include designs and/or management strategies that may decrease chloride use	2012							
19	Creation of a salt reduction ordinance				2015				
20	Require mandatory training for employees and contracted staff that deal with winter maintenance			2012	2012			2012	
21	Review and update Salt Management Plans every 5 years				2015				
22	Development of company operational procedure manual for snow and ice removal							2015	
23	Develop record keeping strategy for salt application			2012	2012			2012	

Action		Target Completion Date of Responsible Agencies							
		NH DES	UNH	NH DOT	Towns[a]	LER[b]	RPC[c]	PS[d]	NH DOS[e]
24	Properly store salt under cover and on an impervious surface and away from surface water			2011	2011			2011	
	Objective: Snow and Ice Removal BMP Applications								
1	Modify existing equipment for pre-wetting				2012			2012	
2	Implement pre-wetting watershed wide			2014	2014			2014	
3	Implement anti-icing watershed wide			2016	2016			2016	
4	Use handheld or truck mounted spreaders			2011	2011			2011	
5	Install ground speed oriented spreaders to trucks			2014	2014			2014	
6	Use alternative snow fighting methods such as snow fences where applicable			2011	2011			2011	
7	Manage overflow parking areas based on level of use			2013				2013	
8	Properly maintain and calibrate equipment			2011	2011			2011	
9	Complete periodic inspections of parking lots and walk ways for over application of deicer. Follow up with staff/contractor on findings.							2012	
10	Adopt BMP's at all salt storage and handling facilities			2012	2012			2012	
11	Track salt use utilizing salt accounting system developed by UNH T2[g]							2012	
12	Install automatic vehicle location (AVL) systems to collect real time data			2015	2015				

Source: NHDES (2011)
[a] Derry and Londonderry
[b] LER - Local Emergency Responders
[c] RPC - Rockingham Planning Commission
[d] PS - Private Sector
[e] NH DOS - NH Department of Safety
[f] DLA - Dependent on Legislative Approval
[g] UNH T2 - University of New Hampshire Technology Transfer Center

Since development of the NHDOT TMDL implementation plan in 2009 (NHDOT, 2009), incorporated into the NHDES Chloride Reduction Implementation Plan in 2011 (NHDES, 2011a), NHDOT has implemented many BMPs for reducing chloride imports to the Upper Beaver Brook watershed as documented in a letter from NHDOT (NHDOT, 2018), which demonstrates compliance with NHDOT permits related to the I-93 roadway. A summary of the BMP activities implemented in the I-93 roadway, including in the Upper Beaver Brook watershed, follows (NHDOT, 2018).

- Salt accounting—NHDOT meticulously monitors its salt stock in each patrol shed and reports that information annually to NHDES.
- Pre-wetting—NHDOT applies liquid deicer to dry salt at time of application.

- Anti-icing—NHDOT applies brine directly to the pavement in advance of an oncoming storm when conditions allow.
- Underbelly plows—NHDOT uses these plows that enhance snow scraping/removal capabilities.
- Ground-speed spreader controllers—All NHDOT trucks utilized out of Shed 528 have ground-speed, closed loop controllers.
- Mobile pavement temperature sensors—All NHDOT trucks located in Shed 528 have mobile pavement temperature sensors. Several road weather stations have also been established along the I-93 corridor.
- Equipment calibration—NHDOT annually calibrates their spreader equipment prior to each season.
- Enhanced training—NHDOT provides enhanced training tracks participation via an online accounting system. Hired equipment operators are encouraged to attend.
- Improved storage practices—NHDOT has just completed upgrading a depot shed in Salem which has increased indoor storage capacity.
- Snow and ice forecasting—NHDOT utilizes computer software that provides forecast for plowing and salting with information feed from it Roadside Weather Information System.
- Enhanced plow blade technology—NHDOT uses flexible plow blades that provide better road contact and enhance snow scraping/removal capabilities.
- GPS/automatic vehicle location (AVL) technology—All NHDOT spreader trucks located in Shed 528 are equipped with GPS/AVL, which helps track salt usage by specific trucks and areas or interest.
- Variable messaging signs—Variable messaging signs have been installed to warn drivers of impending or current weather and traffic conditions and set lower speed limits.
- Enhanced material reporting relative to winter severity—NHDOT has been reporting post-implementation salt usage relative to pre-implementation usage while adjusting for winter weather severity.

To address the Beaver Brook chloride TMDL, the Town of Derry developed a salt reduction plan in 2011 (Town of Derry, 2011) with subsequent updates in 2016 (Town of Derry, 2016b); the plan was also incorporated into the *2011 Chloride Reduction Implementation Plan for Beaver Brook* (NHDES, 2011a). The 2016 salt reduction plan details several measures that have been implemented to reduce salt loading in Beaver Brook (Town of Derry, 2016b):

- Five salt-reducing plow trucks were purchased.
- New trucks include salt pre-wetting sprayers, groundspeed controls, and pavement temperature sensors.
- A salt spreader calibration program was developed and implemented to ensure accurate application rates.

- All Derry municipal operators have been trained in the Green Snow Pro Program offered by the University of New Hampshire (UNH) Technology Transfer Center.
- Derry regularly hosts the Green Snow Pro Program training in its municipal center on Manning Street.
- Derry officials supported the passage of the voluntary certified salt applicator law each time it was presented to the state legislature.
- Derry has filmed and broadcast plow truck ride-alongs on its public access television station.
- Derry has provided ride-alongs for the NHDES Salt Reduction Coordinator.
- Derry public television interviewed NHDES and UNH salt reduction experts during a segment about the chloride contamination issues in Beaver Brook.

Derry committed in 2016 to equipping nine plow trucks with AVL technology which will allow the town to track the amount of salt applied on each salt route and will log salt applied in a central database. This system also helps avoid duplicating salting efforts by displaying a trail showing where other salt applicators have been.

The Town of Londonderry also developed a salt reduction plan (Town of Londonderry, 2011) in response to the TMDL that was incorporated into the *2011 Chloride Reduction Implementation Plan for Beaver Brook* (NHDES, 2011a). The Londonderry salt reduction plan identified a number of BMPs and implementation goals for reducing salt loads, including equipment upgrades, improved equipment calibration procedures, private sector outreach, and improved weather monitoring. Londonderry reports in the document *Town of Londonderry, NH Salt Reduction Best Management Practices for the Beaver Brook Watershed within the Boundaries of the Town of Londonderry* (Town of Londonderry, 2018) that, as of March 2018, it has completed the following steps:

- Purchase of five dump trucks with underbody discharge spreaders
- New trucks include salt pre-wetting, groundspeed controls, and pavement temperature sensors
- Spreader control units on new trucks allow adaptive road treatment
- Spreader calibration policies were developed and implemented
- Salt use tracking policies were developed and implemented
- A salt reduction training program is required for town staff and road maintenance contractors
- The local weather forecast service was upgraded to aid the road maintenance decision-making process

NHDES's 2011 chloride reduction plan for Beaver Brook provides recommendations for salt reduction by the private sector including reporting of salt usage to the UNH Technical Transfer Center (NHDES, 2011a). Specific elements of the implementation plan applicable to the private sector are itemized in Table 4.11-3. NHDES has also published *Best Management Practices and Salt-Use Minimization Efforts in Chloride-Impaired Watersheds of New Hampshire–A Guidance Document for Private Developers and Contractors* (NHDES, 2016e), which reiterates elements of the 2011 chloride reduction plan and provides specific guidance on how to develop an individual salt minimization plan. Individual salt minimization plans identify and describe the development being maintained and provide the following:

- Operational Guidelines
- Winter Operator Certification Requirements—such as Green SnowPro[14] Training, which is administered by NHDES
- Weather Monitoring—how weather information is gathered and communicated
- Equipment Calibration Requirements
- Mechanical Removal—information such as snow storage and plowing frequency
- Salt Usage Evaluation and Monitoring—description of salt usage monitoring and reporting
- Analysis of Alternative De-icing Materials, Site Design Considerations, and Watershed Offsets

Statewide Bacteria TMDL

In 2010, NHDES completed and EPA approved a New Hampshire Statewide TMDL for Bacteria Impaired Waters (NHDES, 2010) to document impairments to state waters, establish allowable loadings, and identify reductions needed to meet water quality standards. Currently, there is no implementation plan for the statewide bacteria TMDL. Conformance with the TMDL is stated as percentage reduction and threshold values for mean and single sample bacteria concentrations for each waterbody specific TMDL. Table 4.11-4 lists the waterbodies in the Exit 4A Project Area identified in the 2010 Bacteria TMDL, with the TMDL threshold and achievement criteria for each AU.

Table 4.11-4. Statewide Bacteria TMDL—Affected AUs in Exit 4A Project Area

Waterbody	TMDL Threshold	TMDL Achievement Criteria
Beaver Brook (AU NHRIV700061203-09)	126 CTS/100ml for a geometric mean and 406 CTS/100ml for a single sample	29% reduction in the geometric mean for E. coli sample concentration
Beaver Brook (AU NHRIV700061203-22)	126 CTS/100ml for a geometric mean and 406 CTS/100ml for a single sample	21% reduction in the geometric mean value for E. coli sample concentration and a 63% reduction in the single sample value of E. coli concentration
Beaver Lake (AU NHLAK700061203-02-02)	47 CTS/100ml for a geometric mean and 88 CTS/100ml for a single sample (NHDES, 2010)	55% reduction in the geometric mean value for E. coli sample concentration and a 78% reduction in the single sample value of E. coli concentration
Hoods Pond	47 CTS/100ml for a geometric mean and 88 CTS/100ml for a single sample	69% reduction in the geometric mean value for E. coli sample concentration and a 94% reduction in the single sample value

[14] Voluntary Certified Salt Applicator Program, authorized in Env-Wq 2200.

Waterbody	TMDL Threshold	TMDL Achievement Criteria
(AU NHLAK700061203-03-02)		

Hoods Pond Phosphorous TMDL

Hoods Pond, an impoundment of Shields Brook located in the center of the Exit 4A Project area, has experienced periodic summer cyanobacteria blooms and was listed on the 2006, 2008, and 2010 303(d) lists as having a primary contact recreation use impairment due to the presence of hepatotoxic cyanobacteria (NHDES, 2006; NHDES, 2008a; NHDES, 2010, AECOM, 2012). Subsequently, a phosphorous TMDL study was completed for Hoods Pond in 2012 (AECOM, 2012) because nutrient enrichment, specifically total phosphorous, was identified as the most likely contributing factor to the documented cyanobacteria impairment. The TMDL study identified contributions from the Shields Brook watershed to Hoods Pond as the primary source (96.8 percent of total) of the annual total phosphorous load in Hoods Pond (AECOM, 2012). A lake loading response model was used to determine the annual and daily phosphorous loads that would support a numeric water quality target in Hoods Pond of 12 ug/L total phosphorous. Previously, NHDES identified an in-lake total phosphorous water quality target value of 12 ug/L as a threshold criterion for mesotrophic status (Hoods Pond is classified as mesotrophic) as discussed further in the Hoods Pond phosphorous TMDL study (AECOM, 2012). The TMDL study recommends a maximum annual load of 273 pounds (lbs)/year total phosphorous, about a 75 percent reduction from existing conditions as of 2012, to meet the water quality target in Hoods Pond. The maximum daily load in Hoods Pond was set at 2.18 lbs/day of total phosphorous and allocated to a single waste load allocation because the report authors found it infeasible to separate point and nonpoint source loads in the watershed.

The Hood Pond phosphorous TMDL study outlines an implementation plan to achieve total phosphorous reductions in Hoods Pond. The implementation plan advocates a watershed approach to achieving the phosphorous reduction goals due to the majority of the total phosphorous load originating from a number of sources in the Shields Brook watershed. The implementation plan outlines a number of BMPs for stormwater management that can be used to reduce nutrient loads to the watershed and help achieve the total phosphorous target reductions. BMPs considered in the implementation plan were selected for mitigation effectiveness for a variety of factors and are categorized in Table 4.11-5 based on nutrient removal rankings (from AECOM, 2012).

Table 4.11-5. Nutrient Mitigation BMPs from Hoods Pond Phosphorous TMDL Implementation Plan

Good Mitigation	Moderate Mitigation	Minimal Mitigation
Infiltration swale Infiltration trench/galley Retention infiltration basin Bioretention Green roof Minimize disturbance area Minimize site imperviousness Porous pavement Rain garden	Disconnecting impervious area Flow path practices Preserve infiltratable soils Preserve natural depression areas Rain barrels/cisterns Soil amendment Vegetated filter strip Vegetation preservation Created wetland/biofilter detention Extended detention pond Wet detention, sand/organic filter Swale	Deep sump catch basins Water quality inlet

Source: AECOM (2012)

Regional Mercury TMDL

Fish consumption in all surface waters in New Hampshire is impaired by elevated mercury caused by atmospheric deposition. EPA approved a regional TMDL for all surface waters for mercury in 2007 (NEIWPCC, 2007), including all waterbodies in the Project area. Major point sources of air pollution are restricted to a concentration of 0.3 parts per million (ppm) mercury in emissions to meet the mercury reduction goals in the TMDL.

CWA Section 319 Nonpoint Source Pollution Plans

The Project area includes one waterbody (Beaver Lake) with a completed watershed management plan funded in part by CWA Section 319 nonpoint source pollution grants (EPA, 2018b.

Beaver Lake Watershed Management Plan

In recognition of increasing development pressure and population growth since 1960 and reduced water quality in Beaver Lake and its tributaries, the Beaver Lake Watershed Partnership (BLWP) developed the Beaver Lake Watershed Management Plan in 2007 (BLWP, 2007) to address the threats and impairments to water quality in the Beaver Lake Watershed using a Section 319 grant from NHDES (EPA, 2018b). The Beaver Lake Watershed Management Plan identifies a number of specific goals and targets for protecting the Beaver Lake Watershed from polluted nonpoint source runoff including local land use regulations implemented by the partnering towns and affects development in the Project area.

- Goal 1: All watershed towns share the same vision for protecting the watershed and coordinate their approach to regulations and protections.

- Goal 2: The watershed is protected through land use policies that minimize adverse impacts to the Beaver Lake watershed.
- Goal 3: Land use in the Beaver Lake watershed is consistent with watershed protection.
- Goal 4: All non-prime wetlands within the Beaver Lake watershed have greater buffer protection.
- Goal 5: Auburn, Chester, and Derry have Open Space Ordinances.

BLWP provides a means for measuring success with achieving the goals by conducting annual reviews of the Beaver Lake Watershed Management Plan to make revisions and develop annual work plans.

Exit 4A Regulatory Environment

The Exit 4A Project would be subject to several regulatory and existing permit requirements as outlined in the *Regulatory Framework* section of 4.11.1. Specifically, the Project would be subject to the following requirements.

NH Small MS4 General Permit

In January 2017, EPA released the General Permits for New Hampshire MS4s, which became effective July 1, 2018 (EPA, 2017c). Both Derry and Londonderry, and therefore the Exit 4A Project area are included in this program. Because both towns have discharges that impact an impaired AU for which a TMDL has been prepared (i.e., Beaver Brook), both are required to meet additional requirements of the MS4 permitting program. One requirement will be to develop BMP-based chloride reduction plans that include specific actions designed to achieve chloride reduction on both municipal and private facilities that discharge to applicable MS4s. Chloride reduction plans, already developed as part of the TMDL process, have addressed chloride loading from all sectors. The new MS4 permit requires each town to explicitly address the private sector in their chloride reduction plan, with plan enforcement prescribed through town ordinances.

The 2017 NH MS4 defines in section 6.0 of the permit (EPA, 2017c) requirements for transportation agencies and requires transportation agencies to comply with all conditions of the permit. Under *Appendix F–Requirements of Approved Total Maximum Daily Loads* of the MS4 permit (Appendix F of the MS4) Part I.1, municipalities (which includes NHDOT under this permit) must develop a chloride reduction plan by July 1, 2019, which must be fully implemented by July 1, 2023. Elements of the municipal chloride reduction plan, briefly, are:

- Tracking of salt applied (starting July 1, 2020)
- Planned activities for salt reduction such as:
- Operational changes (pre-wetting, pre-treating salt stockpile, increased plowing prior to de-icing, monitoring of road surface temperature) – implemented by July 1, 2019
- New or modified equipment
- Staff training—implemented by July 1, 2019

- Adoption of guidelines for application rates
- Equipment calibration
- Designation of no-salt and low salt zones
- Estimate of total tonnage of salt reduction expected
- Implementation schedule—full implementation by July 1, 2023

Alteration of Terrain Permit

As a NHDOT-sponsored project, Exit 4A would be exempt from obtaining an individual permit from the AoT Bureau as outlined above. The Project would be subject to all of the design standards, state and federal regulations, contract provisions, and BMPs listed in the 2011 agreement between NHDOT and NHDES as discussed previously in the Regulatory Framework section of 4.11.1.

401 WQC

As discussed in section 4.11.1, proponents of federal actions that propose discharges to waters of the U.S. that require a federal permit or license, such as a permit under Section 404 or Section 402 (e.g. MS4 GP) of the CWA are required to obtain a Water Quality Certification (WQC) through Section 401 of the CWA. In New Hampshire, the NHDES Watershed Management Bureau administers this program. For projects that require a Section 404 permit from USACE and that fall under the NH Programmatic General Permit (USACE, 2017) the 401 WQC is programmatic under state WQC #2017-404P-001, and no separate application is needed. Projects that require an individual Section 404 permit from USACE must apply for a WQC from the NHDES Watershed Management Bureau. The proposed Exit 4A Project would likely require an individual WQC.

The NHDES Watershed Management Bureau commonly requires applicants for individual WQCs to develop and adopt a BMP-based Chloride Management Plan, as discussed in "*Best Management Practices and Salt-Use Minimization Efforts in Chloride-Impaired Watersheds of New Hampshire–A Guidance Document for Private Developers and Contractors*" (NHDES, 2016c). Accordingly, the WQC issued for Exit 4A would likely require a condition that NHDOT and the Towns prepare and adopt BMP-based Chloride Management Plans similar to the chloride reduction plan required in Appendix F of the MS4.

4.11.2 Environmental Consequences

Total Suspended Solids and Nutrients

Conventional stormwater systems have been traditionally designed to efficiently convey runoff from roadways and other impervious surfaces while modifying flow rates and timing at discharge points to surface waters. Without treatment, however, highway runoff can be a significant contributor to nonpoint source pollution in surface waters (NHDES, 2008b).

Current stormwater regulations (e.g., 2017 NH MS4 permit–EPA, 2017c) require treatment of pollutants, including total suspended solids (TSS) and nutrients, primarily nitrogen and phosphorous, prior to discharge into any surface water. Pollutant loads from roadways and other impervious surfaces, as used in stormwater treatment planning and design, are typically estimated based on published loading rates. Various sources cite a range of values for estimating average annual loading rates resulting from stormwater runoff from roadways. The 2017 NH MS4 permit (EPA, 2017c) cites estimated annual loading rates from connected highway impervious surfaces as 1.34 lbs/acre/year for phosphorous and 10.5 lbs/acre/year for nitrogen. The NHDES SIMPLE method (NHDES, 2015b) indicates 1,098 lbs/acre/year for TSS, 2.5 lbs/acre/year for phosphorous, and 23.2 lbs/acre/year for nitrogen as the annual load from urban highways (assuming 40 in. of rainfall and a runoff producing event fraction of 0.9). The *Fundamentals of Urban Runoff Management* (Shaver et al., 2007) lists the annual loading rates from highway runoff as 1,700 lbs/acre/year for TSS, 0.9 lbs/acre/year for phosphorous, and 12.8 lbs/acre/year for nitrogen (as Total Kjedahl nitrogen + nitrate-N + nitrite-N). The Exit 4A Project Build Alternatives plan for creation of new impervious surface in the Upper Beaver Brook watershed that, left untreated, could result in additional stormwater contributions to suspended solids and nutrients in the watershed. Regulatory requirements for stormwater treatment at new development and redevelopment construction projects are discussed in Section 4.11.2.

No Build Alternative

The No Build Alternative assumes that no major new construction would occur for the Exit 4A Project except for projects that are already planned and programmed. Under the No Build Alternative, no development or redevelopment is planned as a direct result of the Project that would result in any new additions of roadway or impervious surface, and no development- or redevelopment-related changes in land use are planned. Therefore, no increases in the Upper Beaver Brook watershed pollutant load would occur as a direct result of added impervious surface, roadway, or other changes in land use resulting from the Project.

Build Alternatives

Each of the Project Build Alternatives includes development of new roadway in undeveloped areas or areas with non-roadway current land use as well as redevelopment of existing roadway that would result in new impervious surface within Upper Beaver Brook watershed. The addition of new impervious roadway surfaces that contribute stormwater runoff to surface waters has the potential to add new TSS and nutrient loads to the watershed. As discussed previously, typical load rates for nutrients are on the order of pounds to tens of pounds/acre/year, and, for TSS, typical load rates are on the order of 1,000+ pounds/acre/year for roadways. The Build Alternatives would result in a minimum new roadway area of 3.0 acres for Alternative F and a maximum new roadway area of 27.4 acres for Alternative C. These roadway impervious areas were transformed to estimated annual pollutant loads using the loading rates cited previously. TN loading rates were estimated to range from 10.5 lbs/acre/year–23.2 lbs/acre/year. Total phosphorous loading rates were estimated to range from 10.5 lbs/acre/year (EPA, 2017c)–23.2 lbs/acre/year. TSS loading rates were estimated to range from 1,098 lbs/acre/year–1,700 lbs/acre/year (Shaver et al., 2007). The Build Alternatives would potentially contribute a minimum post-construction annual pollutant load ranging from 143–316 pounds of nitrogen, 18–34 pounds of phosphorous, and 14,933–23,120 pounds of TSS at Alternative F to 501–1107 pounds of nitrogen, 64–119 pounds of phosphorous, and 52,375–81,090 pounds of TSS at Alternative D. The post-construction total impervious surface areas and associated annual pollutant load estimates are presented in Tables 4.11-6 through 4.11-9. The 2017 NH MS4 permit has requirements for stormwater treatment based on the total post-construction impervious area that are presented in Section 4.11.2.

Table 4.11-6. Post-Construction Impervious Surface Area by Alternative

Source	A	B	C	D	F
Redevelopment Impervious Surface Area (acres)	13.7	11.5	15.3	25.4	10.6
New Development Impervious Surface Area (acres)	21.4	25.8	27.4	22.3	3.0
Total Post-Construction Impervious Surface (acres)	35.1	37.4	42.7	47.7	13.6

Table 4.11-7. Post-Construction Annual Total Phosphorous Load by Alternative

Source	A	B	C	D	F
Post-Construction Total Phosphorous Load from Redevelopment Impervious Surfaces (lbs)	18 - 34	15 - 29	21 - 38	34 - 64	14 - 27
Post-Construction Total Phosphorous Load from New Development Impervious Surfaces (lbs)	29 - 54	35 - 65	37 - 69	30 - 56	4 - 8
Post-Construction Total Phosphorous Load from New Development and Redevelopment Impervious Surfaces (lbs)	47 - 88	50 - 94	57 - 107	64 - 119	18 - 34

Table 4.11-8. Post-Construction Total Nitrogen Load by Alternative

Source	A	B	C	D	F
Post-Construction Total Phosphorous Load from Redevelopment Impervious Surfaces (lbs)	144 - 318	121 - 267	161 - 355	267 - 589	111 - 246

Source	A	B	C	D	F
Post-Construction Total Phosphorous Load from New Development Impervious Surfaces (lbs)	225 - 496	271 - 599	288 - 636	234 - 517	32 - 70
Post-Construction Total Phosphorous Load from New Development and Redevelopment Impervious Surfaces (lbs)	369 - 814	393 - 868	448 - 991	501 - 1107	143 - 316

Table 4.11-9. Post-Construction Total Suspended Solids Load by Alternative

Source	A	B	C	D	F
Post-Construction Total Phosphorous Load from Redevelopment Impervious Surfaces (lbs)	15,043 – 23,290	12,627 – 19,550	16,799 – 26,010	27,889 – 43,180	11,639 – 18,020
Post-Construction Total Phosphorous Load from New Development Impervious Surfaces (lbs)	23,497 – 36,380	28,328 – 43,860	30,085 – 46,580	24,485 – 37,910	3,294 – 5,100
Post-Construction Total Phosphorous Load from New Development and Redevelopment Impervious Surfaces (lbs)	38,540 – 59,670	41,065 – 63,580	46,885 – 72,590	52,375 – 81,090	14,933 – 23,120

Chlorides

Chloride originating from road salt applied for winter road maintenance creates a potential impact to water quality and aquatic life. NHDES and EPA have an established chronic toxicity criterion for chloride of 230 mg/L and acute toxicity criterion of 860 mg/L to protect aquatic life in surface waters. As noted in Section 4.11.1, portions of Beaver Brook and its tributary, Shields Brook, are listed by NHDES as impaired due to chloride, with historic exceedances of the chronic water quality standard. A chloride TMDL study was completed in 2008 for the Upper

Beaver Brook Watershed that documented chloride levels in surface waters of the Upper Beaver Brook watershed and identified and quantified the contributing sources of chloride (NHDES, 2008a). The TMDL study concluded that the majority (approximately 95 percent) of chloride loading in the watershed is associated with de-icing activities for public and private roadways and parking lots. The TMDL study established a chloride load duration curve for the Upper Beaver Brook watershed (tons per day of salt imports for a given 4-day average stream flow) that could be expected to achieve water quality standards in the impaired reaches and identifies implementation goals and strategies for reducing salt imports in the watershed. The impaired segments of Beaver Brook and Shields Brook are downstream of the Build Alternatives for Exit 4A and could therefore be negatively affected by increased salting activities should one of Exit 4A's Build Alternatives be constructed. All Build Alternatives would necessarily be expected to implement salt reduction strategies consistent with the TMDL and as will be required for Project permits (MS4, 401 WQC, and AoT rules), as discussed further in Section 4.11.2, *Mitigation*.

No Build Alternative

Under the No Build Alternative, no additional Project related increases in salt loading would occur. It is expected that the Towns of Derry and Londonderry and NHDOT would reduce salt loading, per their respective Salt Reduction Plans (Derry, 2016; Londonderry, 2018; NHDOT, 2009) and consistent with the recommended salt allocations that were determined by the Salt Reduction Workgroup and finalized in the Chloride Reduction Implementation Plan (NHDES, 2011a).

Build Alternatives

While many factors determine annual salt loading rates from winter road and parking lot maintenance, including the timing, frequency, duration, and type of winter precipitation events, and other winter weather elements including temperature and cloudiness (these elements are often evaluated cumulatively as the weather severity index, see NHDES, 2016d), the total winter salt application to roadways (i.e., the salt load) typically varies with the treated roadway area (i.e., treated lane miles). All Build Alternatives would result in increased road salt treated roadway within the Project area as demonstrated in Table 4.11-10 and would therefore result in increased annual salt use if mitigation measures are not employed.

Table 4.11-10. Exit 4A Additional Lane Miles for Chloride Loading, by Build Alternative

Source	A	B	C	D	F
NHDOT Patrol Shed 528	1.51	1.69	1.81	1.81	0.00
Town of Londonderry	2.50	2.75	3.90	3.78	0.53
Town of Derry	3.59	6.66	4.84	2.73	0.81
Total	7.60	11.10	10.56	8.32	1.34

Notes: Calculation methodology is as follows:

For Town-maintained roads:

1. 1 salt pass for each direction on collector & minor arterial roadways with one or two lanes in each direction
2. 1 salt pass per through lane for principal arterial roadways
3. 1 salt pass total for local roads
4. 1 additional salt pass for turn lanes 300 feet or greater in length (single and double turn lanes only get one additional pass)

For State-maintained roads:
1. 1 salt pass for each ramp
2. 1 salt pass per through lane
3. 1 salt pass per turn lane

Chloride impacts for all Build Alternatives were quantified in a Chloride Technical Report prepared with this SDEIS (see Appendix H) and are summarized in Table 4.11-12. As demonstrated in Table 4.11-11, all Build Alternatives would result in new salt treated roadway and are therefore considered potential salt sources. Anticipated additional salt loading for each alternative is presented in Table 4.11-12. The methods used to estimate chloride loading from the Build Alternatives are presented in Section 3.1 of this SDEIS. All data were updated to include the FY16 salt loading data for the Upper Beaver Brook watershed (NHDES, 2017e). The presented estimated salt loading by alternative is based on historical salt application rates; actual salt application rates will be affected by the requirements of Project permits (including salt reduction BMPs) discussed further in Section 4.11.2, *Mitigation*.

Indirect impacts from the planned Woodmont Commons East development and additional commercial/industrial development in Derry, and cumulative impacts from the planned Woodmont Commons West development, including Market Basket redevelopment, were also evaluated and are presented in Section 3.1 of this SDEIS.

Table 4.11-11. Anticipated Salt Loading from Each Build Alternative

Generator	Average annual salt usage FY08-FY16 (tons/lane-mile/year)	Estimated salt loading by build alternative (tons/year)				
		A	**B**	**C**	**D**	**F**
NHDOT Patrol Shed 528	21.90	33.10	36.99	39.69	39.69	0.00
Town of Londonderry	10.60	26.50	29.12	41.39	40.02	5.62
Town of Derry	11.10	39.85	73.96	53.71	30.34	8.98
	Total	**99.45**	**140.07**	**134.79**	**110.05**	**14.60**

Note: This quantity assumes that all chloride generators responsible for maintenance of Exit 4A would continue to employ the BMPs currently being used to minimize salt loading in the watershed.

Mitigation

Total Suspended Solids and Total Phosphorous

The Project would be subject to the regulatory requirements discussed previously in Section 4.11.1 including coverage under the 2017 NH MS4 permit, compliance with the Memorandum of Understanding exempting NHDES from AoT rules, and WQC under CWA Section 401.

The 2017 NH Small MS4 General Permit (EPA, 2017c), under which the Project would obtain coverage, requires permitted entities to reduce pollutants to the "Maximum Extent Practicable" as detailed in Part 2.3 of the MS4 permit. Part 2.3.6 of the MS4 permit details the requirements for stormwater management in new development and redevelopment areas. New development and redevelopment projects addressed in Part 2.3.6 include any project that disturbs one or more acres and discharges into the MS4. The proposed Project Build Alternatives each include disturbances of more than 1 acre and would be required to develop a stormwater management program consistent with Part 2.3.6 of the MS4 permit. Further, Part 2.3.6.a.i of the MS4 permit states "*The permittee's new development/ redevelopment program shall include projects less than 1 acre if the project is part of a larger common plan of development or redevelopment which disturbs one or more acre*." Therefore, within each of the Exit 4A Build Alternatives, each roadway segment, whether new development or redevelopment of existing roadway, that creates any land disturbance, regardless of size, must be included in the stormwater program. Project road segments that are exclusively roadway maintenance and improvement and do not increase impervious area (i.e., no increase to pavement, parking lot, or sidewalk areas) are not required to manage stormwater in accordance with Part 2.3.6(a)ii.(e) (see Part 2.3.6(a)ii.(f)).

Alternatives A through F each contain areas of new development (e.g., creation of new roadway in areas of other current land use) and/or redevelopment (e.g., improvements such as redesign and reconstruction or resurfacing of existing roadway). The MS4 permit has stormwater treatment requirements designed to reduce or minimize the effects of land-disturbing projects on water quality as detailed in Part 2.3.6(a)ii.(d) for new development and Part 2.3.6(a)ii.(e) for redevelopment. These permit requirements include the use of stormwater BMPs with specific stormwater retention volumes, treatment volumes, or specific pollutant removal criteria to reduce pollutant loads from runoff (EPA, 2017c). New development sites are required to provide retention of stormwater runoff equivalent to the Water Quality Volume[15] (defined in Env-Wq 1504.10) for the new development site or are required to have BMPs designed to remove at least 90 percent of TSS and 60 percent of total phosphorous from the average annual pollutant load generated by the total post-construction impervious surface and are required to have long-term maintenance practices for stormwater BMPs (EPA, 2017c). Redevelopment sites have similar requirements but are also permitted to use BMP treatment of stormwater runoff equivalent to the Water Quality Volume or use BMPs designed to remove at least 80 percent of TSS and 50 percent of total phosphorous from the average annual pollutant load generated by the total post-construction impervious surface to satisfy condition 1 of Part 2.3.6(a)ii.(e) (EPA, 2017c). Redevelopment sites are also permitted to use offsite stormwater mitigation within the same USGS HUC10 or smaller watershed to satisfy condition 1 of Part 2.3.6(a)ii.(e) (EPA, 2017c).

Roadway pavement areas shown in Table 4.11-11 indicate the total new development and redevelopment post-construction impervious surface that would result from each of the Build Alternatives. Because each of the Build Alternatives would increase the post-construction impervious surface, stormwater retention or treatment would be required for each Build Alternative in accordance with Part 2.3.6 of the MS4 permit (EPA, 2017c). Final stormwater management plans are not available at the time of this report, but are expected to fully meet the required stormwater retention or treatment provisions of the MS4 permit by using BMPs to the maximum extent practicable. New development roadway segments are expected to be fully treated and meet either the Water Quality Volume retention criteria or the specified TSS and total phosphorous removal

[15] Water Quality Volume = 1 inch of rainfall * total area draining to a stormwater structure * [0.05 + (0.9 * % imperviousness of drainage area)]. From NH Administrative Rule Env-Wq 1504.10.

efficiencies detailed in the MS4 permit. Redevelopment areas are also expected to be fully treated and meet either the Water Quality Volume retention or BMP treatment criteria or the specified TSS and total phosphorous removal efficiencies detailed the MS4 permit. If redevelopment areas cannot be treated onsite (e.g. due to the space constraints of the developed urban areas), then stormwater would be treated within the same HUC10 watershed (0107000612 Stony Brook-Merrimack River) as is required in the MS4 permit.

The MS4 permit has additional requirements that, for new or increased discharges to impaired waters, no net increase of pollutant(s) for which the waterbody is impaired will occur. The permittee may demonstrate compliance with this permit condition by documenting that the pollutant(s) for which the waterbody is impaired are not present in the MS4's discharge or by documenting that the total load of the pollutant(s) of concern from the MS4 to the impaired water body would not increase as a result of the activity (EPA, 2017c).

The Project Build Alternatives A, B, C, and D would result in development and/or redevelopment in the Beaver Lake watershed, which is shown on the latest 303(d) list (NHDES, 2017b) as impaired for aquatic life due to total phosphorous, chlorophyll ***a*****,** DO saturation, and pH. When stormwater plans are finalized, they must be consistent with the requirement that either no new or increased stormwater discharges would be introduced to Beaver Lake (i.e., the stormwater management area within the watershed would not increase as a result of the Project) or the stormwater management would need to be designed such that the pollutant load from the new or increased discharge would not increase for any of the Beaver Lake impairments. The latter condition can be easily met for the redevelopment roadway segments of the Build Alternatives where the planned use of stormwater BMPs would result in treatment of currently untreated stormwater areas (e.g., Tsienneto Road and NH 102) and should easily offset the effects of minor road widening pavement increases.

The 2017 NH MS4 permit includes further requirements for discharges to waterbodies with an approved TMDL for which there is a specified Waste Load Allocation. The Hoods Pond phosphorous TMDL identifies a Waste Load Allocation for total phosphorous within the Hoods Pond watershed and has an MS4 nexus with the proposed Project as detailed in the requirements of Appendix F of the MS4. The MS4 permit requires that permittees develop a lake phosphorous control plan designed to reduce the amount of phosphorous in stormwater discharges and specifies the percent reduction in stormwater phosphorous load for each municipality consistent with the Waste Load Allocation in the applicable phosphorous TMDL. Permittees may develop an alternative phosphorous control plan in coordination with and approval from NHDES.

Build Alternatives A, B, C, and D would have development and/or redevelopment road segments with potential stormwater impacts to tributaries of Hoods Pond. The Project would be required to develop and/or adopt a lake phosphorous control plan or other approved management plan consistent with the requirements of the MS4 permit to demonstrate conformance with the water quality goals of the Hoods Pond phosphorous TMDL. It is expected that the Project stormwater management plan can be consistent with the waste load allocation goals of the Hoods Pond TMDL, which amounts to a 76 percent reduction of total phosphorous load in Shields Brook watershed. Currently, stormwater treatment BMPs are not used in the proposed Project area within the Hoods Pond watershed. The provisions for BMP treatment of stormwater in new development and redevelopment projects specified in Part 2.3.6 of the MS4 permit and the Project plans that include treating currently untreated stormwater areas should result in a net decrease in pollutants in the Hoods Pond watershed. Final stormwater plans would have to ensure that the Project stormwater treatment plans are consistent with Hoods Pond phosphorous TMDL goals.

Chloride

Chloride mitigation in the Upper Beaver Brook watershed is addressed in the 2017 NH MS4 permit (EPA, 2017c), which became effective on July 1, 2018, and is discussed in Section 4.11.1. The towns of Derry and Londonderry, as well as the NHDOT, would be required to obtain coverage under the MS4 permit and, consequently, the Exit 4A Project would be subject to all permit conditions, including specific conditions for permittees that discharge to a watershed subject to an approved TMDL for chlorides. A requirement of the 2017 MS4 permit is for permittees that discharge to a watershed subject to an approved chloride TMDL to develop a chloride reduction plan by July 2019, as detailed in Appendix F of the MS4 permit. One of the key components to developing a successful chloride reduction plan will be identifying mitigating actions (BMPs) to reduce chlorides and achieve the waste load allocation specified in the applicable chloride TMDL (EPA, 2017c).

The TMDL chloride reduction implementation plan (NHDES, 2011a), developed in support of the Beaver Brook chloride TMDL, outlines a number of BMPs that can be used to achieve significant reductions in salt use by the various salt users in the watershed as discussed in Section 4.11.1. Many of the same salt reduction activities identified in the TMDL implementation plan are also identified in Appendix F of the MS4 permit as recommended components of a chloride reduction plan as required for dischargers to watersheds subject to an approved chloride TMDL. The salt reduction BMPs identified in the TMDL chloride reduction implementation plan (NHDES, 2011a) are summarized in Table 4.11-13 including the associated percent chloride reduction potential for each BMP and the implementation status to date by the NHDOT and the Towns. As demonstrated in Table 4.11-13, many salt applicator BMPs that are planned or already implemented in the watershed have the potential to reduce salt use, during the specified operation, by as much as 30–50 percent. These actions also satisfy the salt reduction activities listed in Appendix F of the MS4 permit and therefore would likely be included as core components of the required chloride reduction plans for NHDOT and the Towns and likely be extended to any future actions requiring chloride mitigation, including the proposed Exit 4A Project.

Table 4.11-12. Chloride BMPs

Chloride Reduction BMPs	Definition	Potential % Chloride Reduction[a]	Implementation Status
Pre-Wetting	Application of salt brine or proprietary chemical to dry salt as it is being applied to the roadway	20% - 30%	NHDOT–Implemented Derry–Implemented Londonderry - Implemented
Pre-Treating	Application of salt brine or proprietary chemical to dry salt either before, during, or after it has been loaded into the truck.	10% - 30%	NHDOT–Planned Derry–Planned Londonderry–Planned
Anti-Icing	Application of salt brine or proprietary chemical up to 48 hours in advance of onset of storm.	10% - 30%	NHDOT–Implemented Derry–Planned Londonderry -Planned

Chloride Reduction BMPs	Definition	Potential % Chloride Reduction[a]	Implementation Status
Zero-Velocity Spreaders	Spreader ejects salt particles at the same velocity of the forward motion of the truck's traveling speed; allowing salt to drop as if the spreading vehicle was standing still.	10% - 50%	NHDOT–Not planned Derry–Not planned Londonderry–Not planned
Groundspeed Oriented Spreader Controls	Allows accurate dispensation of prescribed salt application rates irrespective of vehicle speed. Controls can be integrated to automatically vary application rate with ground temperature. Controller units can integrate GIS and wirelessly download application rate data for review	10% - 30%[b]	NHDOT–Implemented Derry–Implemented Londonderry–Planned
Equipment Calibration	Ensures equipment application of chlorides is accurate	5 - 20%	NHDOT–Implemented Derry–Implemented Londonderry–Implemented
In-Cab Air/Ground Temp. Sensor	Installation of pavement and air temperature sensors with in-cab readout.	1% - 10%[b]	NHDOT–Implemented Derry–Implemented Londonderry–Implemented
Training, improved storage and handling practices	Training staff about various best management practices, improving storage and handling practices for loading and unloading salt	10%-25%[b]	NHDOT–Implemented Derry–Implemented Londonderry–Implemented

Source: NHDES (2011a, Table 9)

[a] Reductions assumed do not take into account existing practices.

[b] Highly dependent on existing procedures and level of adoption.

The Beaver Brook chloride TMDL specifies a daily maximum Waste Load Allocation for chloride as discussed in Section 4.11.1. The alternative expression of the TMDL sets an annual salt load allocation for the Upper Beaver Brook watershed at 9,069 tons salt/year and is a not-to-exceed quantity for all salt imports in the watershed (NHDES, 2008a). The Exit 4A Project would be subject to the requirements of Appendix F of the MS4 permit including the requirement to "*reduce chloride discharges to support achievement of the WLA included in the applicable approved TMDL*." Because the Beaver Brook chloride TMDL has a fixed annual salt load allocation distributed among current sectors, and because the MS4 permit requires permittees to support achievement of the applicable TMDL Waste Load Allocation, any new development in the watershed would require load reductions elsewhere in the watershed to be consistent with the TMDL and MS4 permit conditions. Development projects such as Exit 4A can occur in the Upper Beaver Brook watershed as long as the 9,069 tons/year salt load allocation is not exceeded as a result of the development.

Salt-reducing BMPs have been implemented in the Upper Beaver Brook watershed by NHDOT and the Towns consistent with the TMDL Chloride Reduction Implementation Plan (NHDES, 2011a) and summarized in Table 4.11-13. The annual salt load from private roads and parking lots, one of the largest combined salt use sectors in the watershed (NHDES, 2008a), will likely decrease with adoption of the 2017 NH MS4 permit that became effective on July 1, 2018, due to the salt-reduction measures included in the permit. Given the current level of adoption of salt-reducing BMPs in the watershed by NHDOT and the Towns, and the anticipated further reductions that will be made in the private sector, it is likely that the watershed salt load, required to be reported in 2020 per the MS4 permit, will meet the TMDL goal. The Exit 4A Project would contribute an additional salt load to the watershed estimated to be about 14 to 140 tons/year as presented in Section 4.11.2. This load represents 0.1 to 1.5 percent of the 9,069 tons/year Upper Beaver Brook watershed salt load allocation, which is a minor increase. This additional salt load is expected to be offset by NHDOT and the Towns through development and execution of chloride reduction plans, as required in the 2017 NH MS4 permit, and through watershed-wide salt reductions already planned or implemented.

4.12 Wetlands and Vernal Pools

4.12.1 Affected Environment

Regulatory Overview

Federal Regulations

Wetlands are defined under Section 404 of the CWA as "…areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." Wetlands include swamps, bogs, and marshes and do not necessarily feature standing water. Wetlands and surface waters (streams, rivers, ponds, and lakes) are regulated under federal and state law and local zoning and regulations. Under federal law, discharges of dredged or fill material into "waters of the United States," including wetlands, requires a permit under Section 404 of the CWA. In addition, work in "navigable" waters also requires a permit under Section 10 of the Rivers and Harbors Act. In both cases, the issuing authority is USACE. In addition to permitting requirements, federal actions must adhere to Executive Order 11990 (dated May 24, 1977), which requires, among other things, that, in complying with NEPA, federal agencies shall avoid undertaking or providing assistance for new construction in wetlands unless the agency finds that there is no practicable alternative and the proposed action includes all practicable means to reduce harm to wetlands.

State Regulations

New Hampshire's wetland definition is substantively the same as the federal definition. State law (RSA 482-A) and Administrative Rules (Wt 100-900) require a permit to be issued by the NHDES Wetlands Bureau prior to conducting regulated activities in wetlands. Derry and Londonderry each have a municipal Conservation Commission that reviews permit applications and makes recommendations to the NHDES Wetlands Bureau.

Municipal Regulations

Each community also has a locally regulated wetland protection district in their zoning ordinance.

Londonderry Wetland Regulation

Londonderry's zoning ordinance (Town of Londonderry, 2016) has a conservation overlay district that includes the following within the study area:

- specifically named wetlands and land area within 100 feet of the edge of these wetlands;
- specific perennial streams and adjoining land within 100 feet of the centerline of these streams; and
- all other wetlands and land within 50 feet of the edge of these wetlands with an exemption of wetlands less than 0.5-acre in size.

Figure 4.12-1 depicts wetlands within the study area. Named wetlands are listed in Londonderry's zoning ordinance and shown on Figure 4.12-2. Named wetlands within the study area are described briefly as follows:

- **Duck Pond** is a 40-acre mostly open-water wetland that lies within an orchard west of I-93. There is commercial development on NH 102 directly adjacent to Duck Pond to the south. Soils are mapped as Greenwood and Ossipee soils, ponded.
- **Mammoth 1** is a 35-acre wetland complex on the west side of the study area. This wetland is predominantly beaver impounded with standing dead trees. Soils are mapped as Chocorua mucky peat.
- **Mammoth 2** is a 50-acre wetland complex that is partially within a powerline ROW where vegetation is maintained. Other portions of the wetland are forested and scrub-shrub. Mammoth 2 drains north into Mammoth 1. Soils are mapped as Chocorua mucky peat.
- **Peat Bog** is a 128-acre scrub-shrub and forested wetland east of I-93. Hydrology in portions of the wetland has been altered by a railroad bed that bisects it, with the eastern portion dominated by shrub vegetation and the western portion by deciduous and evergreen trees. Soils are mapped as Greenwood mucky peat, a very poorly drained soil. Parts of this wetland are a true low-nutrient bog, and other parts dominated by cattails and other emergent vegetation. Beaver Brook passes through the southern portion of the wetland, but the northern portion of the wetland has no apparent inlet.
- **Scobie Pond** is a 50-acre wetland complex with an open water portion in the south and an acidic scrub-shrub/forested portion in the north that likely features a floating peat mat. Soils are mapped as Ossipee mucky peat in the vegetated portion of the wetland, a very poorly drained soil, and as water in the open water portion. Scobie Pond has no apparent inlet and drains southward into Beaver Brook.
- **Stonehenge** is a 40-acre historically ditched emergent, scrub-shrub and forested wetland complex that lies west of I-93. Ditching in the emergent portion of the wetland was likely performed for mosquito control. The ditches feed into a stream that in turn drains into Beaver Brook. Soils in this wetland are mapped as Scarboro muck and Greenwood and Ossipee, ponded.

- **Wheeler Pond** is a 9-acre mostly open water pond fringed by emergent wetland vegetation. Commercial development abuts the pond on the south and east sides. Wheeler Pond is fed by an unnamed tributary stream from the north and drains eastward under NH 102 eventually into Beaver Brook. Soils are mapped as water.

Derry Wetland Regulation

Derry's zoning ordinance (Town of Derry, 2016a) has a wetlands conservation overlay district that regulates the use of land subject to extended periods with a high water table, standing water, or flooding. This overlay district is defined by:

- all areas of very poorly drained soils;
- areas of poorly drained soil that are 2,000 square feet or more in size and that exhibit a predominance of 50 percent or more of wetland vegetation;
- areas of wetlands of any size if contiguous to surface waters such as lakes, ponds, and streams; and
- areas designated as bogs regardless of size.

Proposed projects that are reviewed by the Derry Planning Board may be required to undergo an environmental assessment to evaluate impacts to wetland resources. In addition to the wetland overlay district, Derry's zoning provides for extra protection designated prime wetlands. NH Administrative Rules Wt-700 et seq. provide a means for municipalities to grant an additional level of protection under state permitting to those wetlands determined to be exceptional by the municipality. Prime wetlands are designated by the municipality according to the requirements of RSA 482-A:15 and Chapter Wt-700, and include those wetland areas that are of "significant value and worthy of extra protection because of their uniqueness, fragility, and/or unspoiled character" (Wt-701.01). NHDES Administrative Rules Wt-700 includes procedures that must be followed before a permit may be issued for impacts to designated prime wetlands. Derry's designated prime wetlands are depicted on Figure 4.12-2. Derry's zoning has additional restrictions including a 150-foot regulated buffer around designated prime wetlands.

The designated prime wetlands located within the study area in Derry are briefly described below and depicted on Figure 4.12-2.

- **Prime Wetland A-01**: This 5-acre wetland is located north of Hoods Pond and west of Franklin Street and includes areas characterized as emergent wetland and other areas of forested/scrub-shrub wetland. Shields Brook flows south through this wetland and then into Hoods Pond. Dominant vegetation includes cattail (*Typha* spp.), sedges (*Carex* spp.), sensitive fern (*Onoclea sensibilis*), cinnamon fern (*Osmunda cinnamomea*), jack-in-the-pulpit (*Arisaema triphyllum*), alder (*Alnus* spp.), willow (*Salix* spp.), and pond lilies (*Nuphar* spp.). Wildlife observations made within this wetland include songbirds and dragonflies (*Odonata*). The soil within this wetland is mapped as Greenwood mucky peat, which is a very poorly drained soil.
- **Prime Wetland A-06**: This 36-acre wetland is located west of NH 28 Bypass and east of Scobie Pond Road. The wetland is bounded by NH 28 Bypass to the east, Scobie Pond Road to the west, and Old Manchester Road to the north, and an Eversource power line bisects the southern portion of the wetland. It includes

areas characterized as forested, scrub-shrub, and emergent wetland. Shields Brook flows from Lower Shields Pond to the southwest through this wetland. Common vegetation within the wetland includes peat moss (*Sphagnum* spp.), willow, sensitive fern, monkey flower (*Mimulus* spp.), and blueberry (*Vaccinium* spp.). Wildlife species observed in this wetland include red-winged blackbirds (*Agelaius phoeniceus)* and sandpipers (*Actitis macularia)*. The soil within this wetland is mapped as Chocorua mucky peat, which is a very poorly drained soil.

- **Prime Wetland A-09**: This 61-acre wetland is located east of NH 28 Bypass and south of English Range Road near the northern limits of the study area. This wetland surrounds Lower Shields Pond and a portion of Shields Brook. It includes areas characterized as forested wetland and areas of scrub-shrub wetland. Vegetation present within this wetland includes jack-in-the-pulpit, jewelweed (*Impatiens capensis*), pond lily, wood lily (*Lilium philadelphicum*), and partridgeberry (*Mitchella repens*). Common wildlife species observed within this wetland include muskrats (*Ondatra zibethicus*), various songbirds, and northern harrier (*Circus cyaneus*). The soil within this wetland is mapped as Greenwood mucky peat, which is a very poorly drained soil.
- **Prime Wetland B-12**: North of Tsienneto Road and west of NH 102 and English Range Road is a 10-acre prime wetland. It includes areas characterized as forested wetland and areas of emergent/scrub-shrub wetland. An unnamed tributary stream flows south through this wetland and into Beaver Lake via a culvert under NH 102. Dominant vegetation includes red maple (*Acer rubrum*), green ash (*Fraxinus pennsylvanica*), silky dogwood (*Cornus amomum*), speckled alder (*Alnus incana*), arrowwood (*Viburnum dentatum*), meadowsweet (*Spiraea alba* var. *latifolia*), purple loosestrife (*Lythrum salicaria*), Canada goldenrod (*Solidago canadensis*), jewelweed, meadow rue (*Thalictrum* spp.), poison ivy (*Toxicodendron radicans*), sedges, sensitive fern, cinnamon fern, interrupted fern (*Osmunda claytoniana*), common arrowhead (*Sagittaria* spp.), and peat moss. Wildlife species observed within this wetland include painted turtle (*Chrysemys picta picta*) and green frog (*Rana clamitans*). The soils within this wetland are mapped as Greenwood and Ossipee soils, which are very poorly drained soils.
- **Prime Wetland F-13**: This 122-acre wetland is located north of Pierce Avenue, adjacent to Hoodkroft Country Club, and is associated with portions of West Running Brook and Beaver Brook. It includes areas characterized as scrub-shrub wetland and scrub-shrub/emergent wetland. Dominant vegetation includes cattail, red maple, buttonbush, alder, willow, arrowhead, bulrush, duckweed, and northern swamp dogwood (*Cornus racemosa*). Wildlife species observed in this wetland include mallard, great blue heron, songbirds, white-tailed deer, and muskrat. Soils within this wetland are mapped primarily as Greenwood and Ossipee soils. This soil unit consists of very poorly drained soils.

Wetland Mapping

Wetlands for the Proposed Project have been mapped in different ways between 2005 and 2016. The approximate boundaries of wetlands within the study area were initially photo-interpreted by comparing hydric soil map units (Table 4.12-1) from the USDA *Soil Survey of Rockingham*

County, New Hampshire Part 1 (Kelsea and Gove, 1994), with the National Wetland Inventory (NWI) maps produced by USFWS. Aerial photographs were reviewed to further refine wetland boundaries, and limited field reconnaissance was used to resolve discrepancies between these various sources. In 2005 and 2006, wetlands interpreted from the aerial review were verified in the field during the vernal pool surveys conducted in the same years. The wetland verification was done along 200 foot wide corridors associated with Alternatives A through D. Wetlands in the undeveloped parcels to the east of I-93 (Woodmont Commons East, also previously known as the "Hyrax Parcels") were delineated and GPS surveyed in 2011 (Normandeau, 2011). In 2016 additional field review was undertaken to verify aerial interpretations for Alternatives B, C, D, and F, and to modify wetland boundaries as needed. Wetlands within 200 feet of Alternative A were field delineated in September–December 2016 and wetland boundaries were located with a Trimble hand-held GPS unit with sub-meter accuracy under ideal conditions. In addition, boundaries of wetlands outside the Build Alternative footprints within the study area were re-examined using 2017 aerial photography and, in some cases, the boundaries were redefined.

Existing wetlands in the study area, which corresponds to the study area for surface waters and water quality, are depicted on Figure 4.12-1.

Prime wetland locations were provided by the Town of Derry through its GIS Coordinator, and the Derry Conservation Commission provided supporting documentation.

Hydric Soils

NRCS maps soils according to characteristics of drainage, particle size, soil horizons, organic content, and other features. Soils are named by towns where the soil series was first recognized. NRCS soil mapping rates the soil's ability to drain water into seven values from excessively drained to very poorly drained. Wetlands most commonly occur in poorly drained and very poorly drained soils, described by NRCS as:

- "**Poorly drained**: Water is removed so slowly that the soil is wet at shallow depths periodically during the growing season or remains wet for long periods. The occurrence of internal free water is shallow or very shallow and common or persistent. Free water is commonly at or near the surface long enough during the growing season so that most mesophytic crops cannot be grown, unless the soil is artificially drained. The soil, however, is not continuously wet directly below plow-depth. Free water at shallow depth is usually present. This water table is commonly the result of low or very low saturated hydraulic conductivity of nearly continuous rainfall, or of a combination of these.
- **Very poorly drained**: Water is removed from the soil so slowly that free water remains at or very near the ground surface during much of the growing season. The occurrence of internal free water is very shallow and persistent or permanent. Unless the soil is artificially drained, most mesophytic crops cannot be grown. The soils are commonly level or depressed and frequently ponded. If rainfall is high or nearly continuous, slope gradients may be greater" (NRCS, 2013).

Table 4.12-1. Poorly Drained and Very Poorly Drained Soils within the Study Area

Symbol	Soil Name	Drainage Class
97	Greenwood and Ossipee soils, ponded	Very poorly drained
115	Scarboro muck	Very poorly drained
125	Scarboro muck, very stony	Very poorly drained
295	Greenwood mucky peat	Very poorly drained
305	Lim-Pootatuck complex	Lim—poorly drained; Pootatuck—moderately well drained
314A	Pipestone sand, 0 to 5 percent slopes	Poorly drained
395	Chocorua mucky peat	Very poorly drained
495	Ossipee mucky peat	Very poorly drained
546A	Walpole very fine sandy loam, 0 to 5 percent slopes	Poorly drained
547A	Walpole very fine sandy loam, 0 to 3 percent slopes, very stony	Poorly drained
547B	Walpole very fine sandy loam, 3 to 8 percent slopes, very stony	Poorly drained
656A	Ridgebury very fine sandy loam, 0 to 5 percent slopes	Poorly drained
657A	Ridgebury very fine sandy loam, 0 to 3 percent slopes, very stony	Poorly drained
657B	Ridgebury very fine sandy loam, 3 to 8 percent slopes, very stony	Poorly drained

Source: NRCS (2017)

Wetland Cowardin Classification

Wetlands within the study area were classified according to the system developed by Cowardin et al. (1979), and implemented by USFWS for the NWI. This system recognizes groups of wetland types based upon the presence of shared hydrologic, geomorphic, chemical, and/or biological factors. A hierarchical approach is used that recognizes the following five basic levels of classifying wetlands: system, subsystem, class, subclass, and dominance type. At the system level, there are five different wetland types, including marine (e.g., open ocean areas overlying the continental shelf and high energy coast line), estuarine (e.g., deep water tidal habitats and adjacent tidal wetlands), riverine (e.g., flowing freshwater within a channel), lacustrine (e.g., deep water areas and wetlands associated with a freshwater lake), and palustrine (e.g., non-tidal wetlands dominated by trees, shrubs and emergent vegetation). At the class level, the classification system recognizes similarities in substrate (e.g., rocky shore, rocky bottom, unconsolidated bottom) and dominant vegetation type (e.g., emergent, shrub, forested).

Approximately 14 percent of the study area is composed of wetlands (Figure 4.12-1). These include a variety of different wetland types, as classified by Cowardin et al. (1979), and most are associated with the major lakes, ponds, brooks, and streams in the study area. Surface waters, including rivers, lakes, and ponds, are not discussed in this document. Palustrine wetland types within the study area are generalized into forested, scrub-shrub, and emergent and are described as follows.

Forested wetlands (Cowardin Code PFO) within the study area are typically dominated by species such as red maple, green ash, American elm (*Ulmus americana*), yellow birch (*Betula alleghaniensis*), eastern hemlock (*Tsuga canadensis*), and eastern white pine (*Pinus strobus*). These wetlands typically have an understory composed of common shrub species such as silky dogwood, red osier dogwood (*Cornus sericea*), highbush blueberry, speckled alder, meadowsweet, and tree seedlings, as well as herbaceous ground cover. Common herbaceous species present included sensitive fern, cinnamon fern, royal fern (*Osmunda regalis*), purple loosestrife, jewelweed, rough-stemmed goldenrod (*Solidago rugosa*), bluejoint, and wool-grass (*Scirpus cyperinus*).

Scrub-shrub wetlands (Cowardin Code PSS) are dominated by species such as speckled alder; long-beaked willow (*Salix bebbiana*); winterberry (*Ilex verticillata*); silky dogwood; common elder (*Sambucus canadensis*); witch hazel (*Hamamelis virginiana*); and saplings of red maple, gray birch (*Betula populifolia*), and other tree species.

Emergent wetlands (Cowardin Code PEM) are shallow and deep marshes associated with streams and seasonally flooded areas that are too wet for scrub-shrub or forested vegetation. In some cases, emergent wetlands may result from management of vegetation in powerline ROW or hay fields (known as “wet meadows”). Dominant species in these types of wetlands include common cattail, purple loosestrife, bluejoint, sedges, and wool-grass. Vegetation in wet meadows includes red osier dogwood, long-beaked willow, meadowsweet, jewelweed, goldenrods, bluejoint, and reed canarygrass (*Phalaris arundinacea*).

Palustrine Open Water Wetlands (Cowardin Code PUB) are ponds and other open water wetlands. Palustrine open water wetlands are distinguished from lacustrine wetlands in that they are smaller than 20 acres, less than 2 meters deep, and lack wave-formed or bedrock shorelines.

Wetlands occur in a variety of landscape settings within the study area. One wetland-landscape association that is present throughout the study area consists of wetlands associated with small streams. These stream-associated wetlands include forested, scrub-shrub, and emergent communities that typically occur over very poorly drained Greenwood mucky peat, Ossipee mucky peat, Chocorua mucky peat, and Greenwood and Ossipee soils. The wetland system associated with Beaver and West Running Brook along the east central portion of the study area is a good example of this wetland-landscape association.

Wetland Functions and Values

Wetlands in the study area provide a variety of functions and values that benefit the natural environment and society. *The Highway Methodology Workbook Supplement* (USACE, 1999) recognizes up to 13 different functions and values, including:

- groundwater recharge/discharge;
- floodflow alteration;
- fish and shellfish habitat;
- sediment/toxicant retention;

- nutrient removal /retention/transformation;
- production export;
- sediment/shoreline stabilization;
- wildlife habitat;
- recreation;
- education/scientific value;
- uniqueness/heritage;
- visual quality/aesthetics; and
- endangered species.

Many of the larger tracts of undeveloped land within the study area are composed at least in part of wetland communities. In the direct vicinity of the alternatives, a large wetland complex (Stonehenge) is bisected by I-93 at the interchange point for Alternatives C and D. A generalized discussion of wetland functions provided by wetlands in the study area follows. Anticipated effects to specific wetland functions from the Proposed Project are discussed in Section 4.12.2.

The undeveloped land along streams in the study area is mostly wetlands, including several prime wetlands in Derry and named wetlands in Londonderry. These streams, and the undeveloped lands associated with them, likely serve as important travel corridors for wildlife. In addition, wetlands are important habitats for waterfowl and wading birds, and are also at least periodically important to other wildlife populations. For example, vernal pools are critical breeding habitats for species such as wood frogs (*Rana sylvatica*), spotted salamanders (*Ambystoma maculatum*), and blue-spotted salamanders (*Ambystoma laterale*). Vernal pools can also be important habitat for rare species of wildlife such as Blanding's turtles (*Emydoidea blandingii*), spotted turtles (*Clemmys guttata*), and marbled salamanders (*Ambystoma opacum)*. Previous studies documented the presence of three vernal pools adjacent to I-93, and there are numerous other potential vernal pools scattered throughout the study area (Figure 4.12-1, 4.12-3, 4.12-4, 4.12-7, 4.12-8, 4.12-9, 4.12-10, and 4.12-11). Other wetlands are seasonally important to migratory species such as the American woodcock (*Scolopax minor*).

Wetlands can provide recreational opportunities such as hunting, fishing, canoeing, and hiking (see also section 4.19). Large open water bodies such as Beaver Lake and Scobie Pond provide a variety of recreational opportunities. Beaver Lake has a public boat launch and a public beach (Galiens Beach) along its western shoreline near the eastern end of all the Build Alternatives.

Wetlands can provide valuable water treatment functions by removing excess nutrients and retaining sediments and toxicants. Those wetlands with high stem densities, dense emergent vegetation, and slow moving and sinuous watercourses are generally the most effective at performing these functions, which are particularly valuable in a landscape that includes residential and commercial development where there is opportunity for wetlands to receive urban runoff. These functions can also be important in less developed landscapes where specific activities, such as recreational all-terrain vehicle use, can result in soil erosion.

Wetlands that overlie aquifers are important for the protection of groundwater from potential contaminations during recharge. Portions of all of the Alternatives, which include numerous streams and stream-associated wetlands, are underlain by a low-yielding aquifer (0 to 1,000 square feet/day). Just south of Alternative F, a high yielding aquifer (1,001 to 4,000 square feet/day) extends south from a point near the confluence of Beaver Brook and Shields Brook. Other wetlands that occur near public wells, but that are not directly associated with an aquifer, are also important in protecting water quality.

Floodflow alteration (i.e., storage and desynchronization) is another valuable function of wetlands. Typically, wetlands that occur within broad, flat floodplains are particularly good examples. Within the study area, floodplains are generally confined to narrow corridors along the various streams, but broader floodplains do occur along Beaver Brook just south of the intersection of the NH 28 Bypass (South Main Street) and NH 102 in Derry, and in association with a broad marsh located north of NH 28, and east of Exit 5 in Londonderry. The presence of these wetlands reduces potential flood damage to downstream residential and commercial areas and reduces erosion.

Wetlands are sometimes associated with rare or uncommon plants and are occasionally associated with other unique features such as archaeological sites. These embedded features can afford educational and scientific research opportunities or otherwise make the wetland unique. For example, peatlands such as bogs and fens are uncommon natural communities in this part of NH, and they can support a variety of rare plant species. Peat Bog in Londonderry is an example of a low nutrient bog.

Vernal Pools

Vernal pools are temporary or permanent shallow pools that provide essential breeding habitat for certain amphibian and invertebrate species. Vernal pools are defined in NH State Administrative Rules (Env-Wt 101.108) as follows:

"**Vernal pool**" means a surface water or wetland, including an area intentionally created for purposes of compensatory mitigation, which provides breeding habitat for amphibians and invertebrates that have adapted to the unique environments provided by such pools and which:

(a) Is not the result of ongoing anthropogenic activities that are not intended to provide compensatory mitigation, including but not limited to:

(1) Gravel pit operations in a pit that has been mined at least every other year; and

(2) Logging and agricultural operations conducted in accordance with all applicable New Hampshire statutes and rules; and

(b) Typically has the following characteristics:

(1) Cycles annually from flooded to dry conditions, although the hydroperiod, size, and shape of the pool might vary from year to year;

(2) Forms in a shallow depression or basin;

(3) Has no permanently flowing outlet;

(4) Holds water for at least 2 continuous months following spring ice-out;

(5) Lacks a viable fish population; and

(6) Supports one or more primary vernal pool indicators, or 3 or more secondary vernal pool indicators.

“**Primary vernal pool indicators**” means the presence or physical evidence of breeding by marbled salamander, wood frog, spotted salamander, jefferson-blue spotted salamander complex, or fairy shrimp.

“Secondary vernal pool indicators” means physical evidence used by wildlife biologists or certified wetlands scientists who are familiar with vernal pool habitats as evidence of the presence of a vernal pool, if primary vernal pool indicators are absent and other vernal pool characteristics suggest vernal pool habitat. Secondary vernal pool indicators include, but are not limited to, caddisfly larvae and cases (*Limnephilidae*, *Phryganeidae, or Polycentropodidae*), clam shrimp and their shells (*Laevicaudata*, *Spinicaudata*), fingernail clams and their shells (*Sphaeriidae*), aquatic beetle larvae (*Dytiscidae, Gyrinidae, Haliplidae, and Hydrophilidae*), dragonfly larvae and exuviae (*Aeshnidae*, *Libellulidae*), spire shaped snails and their shells (*Physidae, Lymnaeidae*), flat-spire snails and their shells (*Planorbidae*), damselfly larvae and exuviae (*Coenagrionidae*, *Lestidae*), and true fly larvae and pupae (*Culicidae, Chaoboridae, and Chironomidae*).

Potential vernal pools located within 100 feet of the Alternatives and within the Woodmont Commons East parcels (collectively identified herein as the “vernal pool study area”) were first identified and mapped using aerial photo interpretation. Potential pools were then surveyed in the field in the spring of 2006 to determine presence/absence and extent of breeding activity by vernal pool amphibian species. An additional vernal pool survey was undertaken in the spring of 2009 using the primary and secondary indicators established in the NHDES Wetland Rules and Special Wetland definition in the PGP. Vernal pool habitats were also identified in the I-93 corridor as part of the I-93 widening project. In 2011, vernal pools were delineated within the Woodmont Commons East parcels as part of a larger wetland delineation effort. A third vernal pool study was undertaken within the Woodmont Commons East parcels in the spring of 2014 and 2015. Altogether, the I-93 widening data, 2006 and 2009 vernal pool surveys, and the 2014–2015 vernal pool surveys resulted in the identification of 46 vernal pools in the vernal pool study area (Appendix I). Two vernal pools that had been previously identified in earlier surveys were determined not to be vernal pools in the 2014–2015 vernal pool survey because they lacked the required indicators.

Vernal pools were evaluated for productivity by documenting the presence of vernal pool species, as follows:

- high productivity = 20 or more wood frog (WF), spotted salamander (SS) or blue spotted/Jefferson salamander (BS) egg masses; or fairy shrimp present)
- medium productivity = 10 to 19 WF, SS, or BS egg masses
- low productivity = fewer than 10 WF, BS, or SS egg masses

USACE, New England District, published wetland mitigation guidance in 2016 (USACE, 2016) that incorporates recommendations for vernal pool mitigation. The guidance recommends that vernal pools be evaluated using the USACE-New England District draft vernal pool characterization form (USACE, 2016, page 129), which uses several metrics including the quality of the surrounding landscape, cover type in the vernal pool, and hydroperiod of the vernal pool to rate each as low, medium, or high quality. Vernal pools were evaluated using the USACE vernal pool characterization form to guide recommendations for mitigation for impacts to vernal pools. Productivity and USACE quality are noted in the vernal pool summary in Appendix I.

4.12.2 Environmental Consequences

Wetland functions are affected by both direct impacts (dredging and filling) and by indirect impacts, such as alterations in hydrology, introduction of pollutants from road runoff, loss of vegetative cover caused by adjacent tree cutting, impacts on wildlife habitat for species that utilize both wetland and upland, or by creating barriers between wetlands that make up a habitat mosaic. Construction of any of the Alternatives may incur temporary impacts to adjacent wetlands. In addition, design details such as stormwater treatment and sound barriers may involve additional wetland impacts at the periphery of the treatment areas (stormwater treatment would not be designed in known wetland areas). The direct wetland impacts described below for each Alternative were calculated as the area where the Project footprint directly overlays adjacent wetlands. Indirect impacts on wetlands are discussed in Chapter 5, *Indirect Effects and Cumulative Impacts*.

Wetland Impact Types

The majority of wetland impacts for all alternatives would occur in forested wetlands (Table 4.12-2). Scrub-shrub and scrub-shrub/emergent wetland impacts would generally occur within previously disturbed wetlands and wetlands in powerlines where vegetation is maintained on a regular basis. Likewise, emergent wetland impacts would generally occur to wetlands situated within maintained powerlines and in areas adjacent to existing roads.

Table 4.12-2. Summary of Direct Wetland Impacts (Acres) by Wetland Type

Wetland Type[a]	Impact by Alternative[b] (Acres)			
	A	B	C	D
Forested	2.17	6.74	6.78	3.09
Scrub-Shrub	0.02	1.02	0.51	0.35
Scrub-Shrub/ Emergent	0.03	0.91	0.90	0.05
Emergent	0.12	0.23	0.26	0.13
Vernal Pools[c]	1.12	1.09	0.27	0.29
TOTAL	3.46	10.00	8.73	3.89

[a] Wetland cover types determined using NWI mapping, aerial photograph interpretation (high resolution September 2017), and ground-truthing. Wetland cover types are based on classification system of Cowardin et al., 1979. See Section 4.12.1 for descriptions of wetland cover types.
[b] No direct impacts to wetlands are proposed for Alternative F. Four stream crossings would be expanded as discussed in Section 4.11.
[c] Cowardin types are not provided here for vernal pools, but vernal pools within the study area are generally characterized as pockets of open water within forested wetland.

No Build Alternative

Because the No Build Alternative would not involve new construction, there would be no new impacts on wetlands caused by this Alternative.

Build Alternatives

The wetland and vernal pool impacts associated with each Build Alternative are discussed below and depicted on Figures 4.12-1 and Figures 4.12-3 through 4.12-13. In addition, Tables 4.12-1 through 4.12-4 provide summaries of impact information for wetlands and vernal pools. Appendix J provides detailed information by Alternative for functions and values affected in each wetland.

As might be expected, Alternatives with more new roadway alignment would incur greater direct wetland impacts, with Alternative B and C each resulting in approximately 5 acres of impacts located east of NH 28 along the powerline corridor and within adjacent forested wetlands. Alternative F would involve no direct wetland impacts. Construction of the access ramps would involve equivalent impacts for each Alternative, with each involving between 2.18 acres to 2.42 acres of impact to predominantly forested wetland. Impacts resulting from and permitted under the ongoing I-93 widening project are not included in this calculation. Road widening would result in a relatively small portion of the total wetland impact for each Alternative.

Table 4.12-3. Impact Totals by Purpose and Wetland Classification

Impact Location and Wetland Classification[a]	Impact by Alternative[b] (Acres)			
	A	B	C	D
Access Ramp Total	**2.20**	**2.18**	**2.42**	**2.42**
Forested	1.71	1.71	2.22	2.22
Emergent	0.02			
Vernal Pools[c]	0.47	0.47	0.20	0.20
New Alignment East of NH 28 Total		**5.03**	**5.01**	
Forested		3.81	3.79	
Scrub-Shrub		0.17	0.17	
Scrub-Shrub/Emergent		0.84	0.84	
Emergent		0.21	0.21	
New Alignment West of NH 28 Total	**0.47**	**2.71**	**1.21**	**1.21**
Forested	0.36	1.22	0.77	0.77
Scrub-Shrub	0.02	0.86	0.35	0.35
Emergent	0.10	0.02	0.02	0.02
Vernal Pools	0.64	0.62	0.08	0.08
Road Widening Total	**0.15**	**0.07**	**0.09**	**0.29**
Forested	0.10	0.01	0.00	0.10
Scrub-Shrub/Emergent	0.03	0.07	0.06	0.15
Emergent	0.01	0.00	0.03	0.03
Vernal Pools	0.01			0.01

Impact Location and Wetland Classification[a]	Impact by Alternative[b] (Acres)			
	A	B	C	D
Overall Total	**3.46**	**10.00**	**8.73**	**3.92**

a Wetland cover types determined using NWI mapping, aerial photograph interpretation (high resolution September 2017), and ground-truthing. Wetland cover types are based on classification system of Cowardin et al., 1979. See Section 4.12.1 for descriptions of wetland cover types.

b No direct impacts to wetlands are proposed for Alternative F. Four stream crossings would be expanded as discussed in Section 4.11.

c Cowardin types are not provided for vernal pools, but vernal pools are generally characterized as pockets of open water within forested wetland.

Vernal Pool Impacts

Alternatives A, B, C, and D all involve impacts to vernal pools as Table 4.12-4 shows. Most of the impacts would be to the entire pool, but remnant vernal pools are unlikely to provide productive habitat for vernal pool species because of impacts to the surrounding uplands that vernal pool species rely on. Indirect impacts are discussed in Chapter 5, *Indirect Effects and Cumulative Impacts*. Direct impacts to vernal pool buffers are discussed in this section.

Table 4.12-4. Vernal Pool Direct Impacts (square feet)

VP ID	Productivity[a]	USACE Rating[b]	A	B	C	D
VP 2	m	m	6,604	6,604		
VP 3	m	m	5,754	5,754		
VP 4	h	h	8,069	8,069		
VP 6	m	m	14,069	13,834		
VP 8	l	m	9,058			
VP 11	l	l	490			
VP 12	l	m		2,340		490
VP 13	h	h		5,445		
VP 15	l	l			1,611	1,611
VP 17	h	m			7,053	7,053
VP 19	l	m			3,292	3,292
VP 42	m	m	4,774	4,479		
VP 46	m	m		940		
TOTAL (sf)			48,818	47,466	11,956	12,446

a Qualitative Values: h = high productivity (20 or more WF, SS or BS egg masses; or fairy shrimp present); m=medium productivity (10 to 19 WF, SS, or BS egg masses); and l = low productivity (<10 WF, BS, or SS egg masses).

b USACE New England District DRAFT Vernal Pool Characterization Form (USACE, 2016)

Vernal Pool Buffer Impacts

Because vernal pool species are dependent on upland habitat for portions of their life cycle, impacts to the surrounding upland habitat were evaluated for each Alternative. USACE recognizes a 100-foot vernal pool envelope (VPE) and critical terrestrial habitat (CTH) from 100 feet to 750 feet from the edge of the vernal pool (USACE, 2015). USACE recommends avoiding any disturbance within the VPE and limiting disturbance within the CTH to 25 percent. To evaluate impacts to vernal pool upland habitat for each Alternative, the percentages of each cover type within the VPE and CTH for each vernal pool within the study area were calculated using GIS data provided by the Towns of Derry and Londonderry that identified forested edge and pavement. The forested areas within each zone for each vernal pool were modified to account for shrub habitat within power lines and to remove inaccessible habitat to create existing conditions of the vernal pool life zones. It was assumed that new roadway alignment and I-93 access ramps would create a barrier that would render upland habitat inaccessible. I-93, NH Route 28, and Tsienneto Road were assumed to be existing barriers to amphibian access. Roads within residential subdivisions were not assumed to pose a barrier to available forested upland habitat. Individual amphibians may successfully cross the busier roadways, and there is amphibian mortality within residential subdivisions on roads, but these assumptions were made to provide a consistent evaluation method for all alternatives.

Table 4.12-5 presents the percentage of VPE and CTH for each vernal pool that is available under existing and proposed conditions.

Table 4.12-5. Percentage of Vernal Pool Surrounding Upland Habitat Available under Each Alternative

Vernal Pool ID	Existing Conditions		Alt A		Alt B		Alt C		Alt D	
	VPE	CTH	VPE	CTH	VPE	CTH	VPE	CTH	VPE	CTH
VP 02	69%	***50%***	*55%*	***47%***	55%	***47%***	*69%*	***50%***	69%	***50%***
VP 03	62%	***52%***	*45%*	***48%***	45%	***48%***	*62%*	***52%***	62%	***52%***
VP 04	59%	***49%***	*30%*	***31%***	30%	***32%***	*59%*	***49%***	59%	***49%***
VP 05	98%	***66%***	98%	***38%***	98%	***40%***	98%	***66%***	98%	***66%***
VP 06	99%	97%	*65%*	87%	45%	***46%***	99%	97%	99%	97%
VP 07	97%	96%	89%	***55%***	97%	***61%***	97%	96%	97%	96%
VP 08	81%	***68%***	*62%*	***60%***	81%	***51%***	81%	***68%***	81%	***68%***
VP 09	84%	***61%***	*66%*	***39%***	84%	***60%***	84%	***61%***	84%	***61%***
VP 11	47%	***39%***	*39%*	***38%***	47%	***39%***	*47%*	***39%***	39%	***38%***
VP 12	64%	***73%***	*64%*	***62%***	6%	***33%***	*64%*	***73%***	64%	***73%***
VP 13	98%	92%	98%	***55%***	23%	***43%***	98%	92%	98%	92%
VP 15	59%	***48%***	*59%*	***48%***	59%	***48%***	*16%*	***1%***	16%	***1%***

Vernal Pool ID	Existing Conditions		Alt A		Alt B		Alt C		Alt D	
	VPE	CTH	VPE	CTH	VPE	CTH	VPE	CTH	VPE	CTH
VP 16	88%	***35%***	88%	***35%***	88%	***35%***	*72%*	***30%***	72%	***30%***
VP 17	99%	***57%***	99%	***57%***	99%	***57%***	*48%*	***26%***	48%	***26%***
VP 18	100%	***71%***	100%	***71%***	100%	***71%***	98%	***46%***	98%	***46%***
VP 19	91%	80%	91%	80%	91%	80%	*40%*	***27%***	40%	***27%***
VP 20	100%	84%	100%	84%	100%	84%	*74%*	***50%***	74%	***50%***
VP 21	94%	***66%***	94%	***64%***	94%	***66%***	86%	***28%***	86%	***28%***
VP 22	96%	86%	96%	86%	96%	86%	96%	86%	96%	86%
VP 23	86%	87%	86%	86%	86%	87%	86%	87%	86%	87%
VP 24	100%	78%	100%	76%	100%	76%	100%	76%	100%	76%
VP 25	88%	89%	88%	89%	88%	89%	88%	89%	88%	89%
VP 26	96%	88%	96%	88%	96%	88%	96%	88%	96%	88%
VP 26b	90%	86%	90%	86%	90%	86%	90%	86%	90%	86%
VP 27	82%	***52%***	82%	***48%***	82%	***48%***	82%	***49%***	82%	***49%***
VP 28	63%	***43%***	*63%*	***38%***	63%	***38%***	*63%*	***39%***	63%	***39%***
VP 29	59%	***43%***	*59%*	***36%***	59%	***36%***	*59%*	***37%***	59%	***37%***
VP 30	71%	81%	*71%*	81%	71%	***62%***	*71%*	81%	71%	81%
VP 31	90%	84%	90%	84%	90%	83%	90%	84%	90%	84%
VP 32	83%	81%	83%	81%	83%	80%	83%	81%	83%	81%
VP 33	68%	82%	*68%*	82%	68%	75%	*68%*	82%	68%	82%
VP 34	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
VP 35	91%	78%	91%	78%	91%	78%	91%	78%	91%	78%
VP 36	88%	***74%***	88%	***74%***	88%	***74%***	88%	***74%***	88%	***74%***
VP 37	91%	82%	91%	82%	91%	82%	91%	82%	91%	82%
VP 38	90%	84%	90%	84%	90%	84%	90%	84%	90%	84%
VP 39	80%	76%	80%	76%	80%	76%	80%	76%	80%	76%
VP 40	98%	84%	98%	84%	98%	84%	98%	84%	98%	84%
VP 41A	95%	92%	95%	92%	95%	92%	95%	92%	95%	92%
VP 42	100%	***67%***	*41%*	***22%***	46%	***24%***	100%	***67%***	100%	***67%***
VP 44	100%	***73%***	100%	***47%***	100%	***45%***	100%	***73%***	100%	***73%***

Vernal Pool ID	Existing Conditions		Alt A		Alt B		Alt C		Alt D	
	VPE	CTH	VPE	CTH	VPE	CTH	VPE	CTH	VPE	CTH
VP 45	98%	96%	79%	***54%***	60%	***51%***	98%	96%	98%	96%
VP 46	100%	97%	78%	***54%***	59%	***51%***	100%	97%	100%	97%
VP 47	85%	97%	85%	***65%***	85%	***61%***	85%	97%	85%	97%
VP 48	90%	97%	90%	***71%***	90%	***67%***	90%	97%	90%	97%
VP 49	98%	88%	98%	78%	98%	75%	98%	88%	98%	88%
VP 50	100%	86%	100%	86%	100%	86%	100%	86%	100%	86%
VP 51	58%	77%	*58%*	77%	58%	***63%***	*58%*	77%	58%	77%
VP 54	92%	80%	92%	***71%***	92%	80%	92%	80%	92%	80%
VP 56	96%	***75%***	96%	***72%***	96%	***72%***	96%	***75%***	96%	***75%***
VP 57	99%	81%	99%	78%	99%	78%	99%	81%	99%	81%
VP 58	98%	76%	98%	***74%***	98%	***74%***	98%	76%	98%	76%
VP 59	97%	93%	97%	92%	97%	92%	97%	93%	97%	93%
VP 60	96%	82%	96%	79%	96%	79%	96%	82%	96%	82%
VP 61	95%	77%	95%	***73%***	95%	***73%***	95%	77%	95%	77%
VP 63	96%	95%	96%	***67%***	96%	***72%***	96%	95%	96%	95%
VP 64	92%	***67%***	92%	***47%***	92%	***67%***	92%	***67%***	92%	***67%***

Note: Vernal pools proposed to be directly impacted are shaded gray.

Table 4.12-6 presents a tally of impacts to VPEs, by Alternative. No vernal pool envelopes are intact under the existing condition, as presented in Table 4.12-5. Because the USACE guidance uses 75 percent as a threshold for providing sustainable CTH, tallies of impacted CTHs and tallies of CTHs for which the usable habitat would be decreased to below 75 percent are provided.

Table 4.12-6. Vernal Pool Surrounding Upland Habitat Impact Summary

Impact Type	Alt A	Alt B	Alt C	Alt D
Count of Impacts to VPEs	5	7	4	7
Count of Impacts to CTHs	25	26	8	11
Count of Impacts to CTH that decrease available habitat to below 75%	4	5	0	0

Note: Vernal pools directly impacted are not included in these tallies.

Alternative A

Alternative A would result in an estimated 3.46 acres of wetland impact, including direct impacts to seven documented vernal pools. Wetland impact areas for Alternative A are depicted in Appendix J, *Wetland Photographs*. Photo locations are depicted in Figures 4.12-7 through 4.12-11. Wetland 14 is west of I-93 and falls within the footprint of the interchange for Alternative A. This primarily forested wetland includes an intermittent stream with a 269-acre watershed that parallels the highway and flows east under the highway near the Ash Street overpass. Portions of the stream and wetland would be impacted by the I-93 widening project. The wetland is approximately 17 acres and has the capacity to provide the following functions and values: groundwater interchange, floodflow alteration, fish/shellfish habitat, sediment/toxicant retention, nutrient removal, production export, sediment/shoreline stabilization, wildlife habitat, and visual quality/aesthetics. Of these functions and values, floodflow alteration, sediment/toxicant retention, and wildlife habitat are considered principal. Approximately 1.17 acres of impact would occur to this forested wetland and associated stream network as a result of the new interchange construction. This is the largest single wetland impact that would occur under Alternative A.

East of I-93, where the access ramps would be constructed and in the footprint of the western portion of the alignment, are several vernal pools and associated forested wetlands that would be impacted by Alternative A. A total of six vernal pools would be directly impacted by new alignment in this section, and the CTEs of 25 vernal pools would be affected (many of which overlap).

Wetland impacts along the existing alignment would result from roadway widening. A vernal pool (VP11) is located north of Tsienneto Road that would be impacted (490 square feet of direct impact), and a prime wetland north of Tsienneto Road that would be impacted in conjunction with the widening of the road and replacement of the existing stream crossing.

Alternative B

Alternative B would have the most wetland impacts of all the Alternatives, because it involves the most new alignment in undeveloped land. Alternative B has comparable impacts to Alternative A from the interchange construction at 2.18 acres, and a small amount of impact from road widening and improvements. East of the I-93 interchange, eight vernal pools at the western end of the new alignment would be impacted, along with associated forested wetlands. The CTEs of 26 vernal pools would be impacted by this alternative.

West of Ashleigh Drive, a total of 5.03 acres of forested, scrub-shrub, and emergent wetland would be impacted on undeveloped land and powerline alignment. A total of 1.28 acres of a forested and scrub-shrub wetland complex (Wetland 42) that lies between and behind commercial buildings on NH 28 would be impacted.

Other large impacts under Alternative B would include 2.08 acres of forested wetland south of the power lines (Wetland 48), 1.14 acres of scrub-shrub wetland under the powerline intersection and adjacent forested wetland (Wetlands 54 and 60), and impacts on several other large wetland areas from new alignment (Wetland 52, 0.46 acre, and Wetland 47, 0.42 acre).

Alternative C

Alternative C would use the northern interchange, where construction of the access ramps would create 2.42 acres of wetland impact, including impacts to two vernal pools in the access ramp footprint. A third vernal pool at the western end of the alignment would also be impacted. The CTEs of eight other vernal pools would also be affected. Because Alternative C would also involve new alignment east of NH 28, the impacts in this area on undeveloped land and power lines would be comparable to Alternative B at 5.01 acres.

Alternative D

Alternative D would use the northern interchange where impacts would be comparable to Alternative C with 2.42 acres for interchange construction, and 1.21 acres of impact for new alignment west of NH 28. Because the rest of the Alternative follows existing roadway, the remaining impacts from widening and improvements would be relatively minor, with 0.29 acre of impact. There would be direct impacts to four vernal pools and impacts to the CTEs of eleven vernal pools.

Mitigation

Mitigation for wetland impacts has not yet been finalized, but it would likely involve a payment to the Aquatic Resource Mitigation fund at NHDES and potentially preservation of conservation land. The in-lieu fee amount and conserved land, if any, would be in accordance with NH RSA 482-A:28 and NHDES Wetland Rules and with federal Section 404 guidelines in 40 CFR (b)(1)J, and with the USACE's 2016 *New England District Compensatory Mitigation Guidance.* The 2016 Mitigation Guidance states that mitigation is not required for impacts to uplands, including vernal pool buffers. Mitigation for direct impacts to vernal pools will follow the recommended ratios for mitigation based on the value of the vernal pool as determined by assessment methods provided in the 2016 USACE Mitigation Guidance.

Other potential avenues for wetland mitigation include the Stream Passage Improvement Program, a partnership with NHDOT and NHDES that would use mitigation funds to address culverts within the Project watershed that have inadequate aquatic organism passage, structural condition, and/or aquatic organism passage.

4.13 Groundwater

4.13.1 Affected Environment

The study area for aquifers is shown in Figure 4.13-1 and is the same as the study area for surface waters and water quality. The study area for groundwater wells is based on a 1,300-foot buffer, which corresponds to a minimum radius for wellhead protection areas (WHPA). A WHPA is the surface and subsurface area surrounding a public water supply well from which water and contaminants are likely to reach the well. The WHPA for individual wells vary in radius from 1,300 feet to 4,000 feet, depending on the maximum daily amount of water withdrawn from the well. The groundwater resources identified in the study area include both fine-grained and coarse-grained stratified-drift aquifers and public wells (Stekl and Flanagan, 1992). Stratified-drift aquifers are characterized as sand and gravel deposits and were formed as a result of glacial activity during the late Pleistocene epoch (between approximately 18,000 and

10,000 years ago) (Kelsea and Gove, 1994). These types of geologic deposits typically are highly permeable and make up the most productive aquifers in the region (Stekl and Flanagan, 1992). Figure 4.13-1 presents mapped stratified drift aquifers in the study area.

Information pertaining to potential groundwater sources within the study area was obtained from the NH Geographically Referenced Analysis and Information Transfer System (GRANIT) and based on data obtained from USGS. NH GRANIT is a statewide geographic database maintained by the UNH and the New Hampshire Office of Energy and Planning, and it is developed and maintained by the UNH Institute for the Study of Earth, Oceans, and Space in Durham. Data from this source identifying areas of high, medium, and low transmissivity within the stratified drift areas were delineated on Project mapping to depict areas of sensitivity for groundwater resources (Figure 4.13-1). Transmissivity is an indirect measure of the potential yield of available water within the aquifer and is based on the permeability and thickness of the saturated deposits. The higher the transmissivity value, the greater the potential yield, and therefore the greater the resource value, for the specific aquifer area.

As Figure 4.13-1 shows, much of the Project study area includes aquifer areas with potential transmissivity values characterized as low (less than 1,000 square feet per day [square feet/day]). An area of medium (1,001–2,000 square feet/day) to high (2,001–4,000 square feet/day) transmissivity is present south of Alternative F. This area is located in proximity to the Beaver Brook stream corridor and extends south outside the study area. This medium to high transmissivity area is part of a large stratified drift aquifer.

Public and Private Water Supply

Water is supplied to public and private entities in the study area by a combination of municipal surface water supply and public and private wells. Much of the population living within the study area receives drinking water from Manchester Water Works via a network of pipelines. The source of this water is Lake Massabesic located to the north of the study area in Manchester, NH. In addition to Manchester Water Works, Pennichuck East Utility, Inc. (PEU) provides water to portions of Londonderry and Derry from a variety of sources. The rest of the water supply in the study area is provided by public and private wells, as discussed below.

Public Wells

The New Hampshire Safe Drinking Water Act (Revised Statute [RSA] 485:1-a) defines a public water system as any piped water system used for human consumption, if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily for at least 60 days out of the year. These public water systems can be further divided as described below.

- **Community water systems** serve at least 15 service connections used by year-round residents or regularly serve at least 25 residents (i.e., municipal systems, condominiums complexes, mobile home parks).
- **Non-community water systems** include public water systems that are not community water systems (i.e., they do not service residences), but service 15 or more connections and 25 or more people in a non-transient or transient facility.
- **Non-transient facilities** are defined as those facilities that serve 15 or more connections or 25 or more of the same people at least 180 days per year. Examples of non-transient facilities include schools, offices, and day-care

facilities. Transient facilities are those facilities that provide 15 or more service connections or service 25 or more different people at least 60 days per year. Examples of transient facilities include restaurants, hotels/motels, campgrounds, and convenience stores.

Public well information was obtained from NHDES' Groundwater Protection Bureau and Drinking Water Supply Protection Bureau. The locations and associated data for individual public wells and their WHPA, if applicable, were uploaded into the project GIS system to confirm the number of wells and associated WHPAs located within the Project study area. Fourteen public wells have WHPAs intersecting an Alternative corridor or are within 1,300 feet of an Alternative if no WHPA applies. Figure 4.13-1 shows this information and the previously discussed aquifer areas.

A total of 17 public water systems, and their associated WHPAs, if applicable, were identified within the study area (Table 4.13-1; Figure 4.13-1). Of these, NHDES lists 9 as active wells,[16] and 8 as inactive wells. The active wells include 9 community wells: 7 in Derry and 2 in Londonderry.

Among the 8 inactive wells identified by NHDES within the study area, 2 are community wells, 2 are non-community, transient wells, and 4 are non-community, non-transient wells. A total of 7 of the inactive wells are in Derry (2 community; 3 non-community, non-transient; and 2 non-community, transient), and 1 non-community, non-transient inactive well in Londonderry).

Several of the larger active community well systems (in terms of the number of service connections) include condominium complexes and subdivision homeowners associations in the study area, including: Barkland Acres Association in Derry (Well Nos. 1 and 2), Morningside Drive in Derry (Well Nos. 7 and 8) and PEU Springwood Hills in Londonderry (Well Nos. 16 and 17). These community water systems are all located within the study area. Three wells with 3,600-foot radius WHPAs (Wells no. 12, 13, and 14) serve a subdivision off NH 102 in the northeast corner of the study area, identified as Rand Shephard Hill.

Table 4.13-1. Summary of Public Water Supply Wells near the Project Alternatives

Well No.	Facility Name	Status	System Type	Well Head Protection Radius (feet)
		Derry		
1	Barkland Acres Assoc	A	C	1,500
2	Barkland Acres Assoc	A	C	1,500
3	Betley Chevrolet-Buick Inc	I	P	n/a
4	Cat-O-Nine Tails	I	N	n/a
5	Derry Day Care	I	P	n/a
6	Evco Water System	I	C	n/a
7	Morningside Drive Water Assoc	A	C	1,500

[16] For this SDEIS, the phrase "active well" refers to those wells that are being used for drinking water. This includes those systems whose system status and source status are both listed by NHDES as active.

Well No.	Facility Name	Status	System Type	Well Head Protection Radius (feet)
8	Morningside Drive Water Assoc	A	C	1,500
9	Old County Water Systems	I	C	n/a
10	Sonshine Day Care	I	P	n/a
11	Trinity Assembly Of God	I	N	n/a
12	Rand Shephard Hill	A	C	3,600
13	Rand Shephard Hill	A	C	3,600
14	Rand Shephard Hill	A	C	3,600
Londonderry				
15	Adventures In Learning Daycare	I	P	n/a
16	PEU/Springwood Hills	A	C	n/a
17	PEU/Springwood Hills	A	C	n/a

Notes: System Type Codes: C – community; N – non-community transient; P – non-community non-transient. Status: I – inactive; A – active. Active wells are those wells that are being used for drinking water, and are listed by NHDES as having both an active system status and an active source status.

The Town of Derry has several wells shown in Figure 4.13-1 that are located in the aquifer south of NH 102 in the Beaver Brook stream corridor. These wells are shallow and are no longer used as drinking water sources. According to the Derry Water Department, these wells were abandoned in the 1980s (Tom Carrier, Derry Water Department, pers. comm., August 2006).

Private Wells

Information on private wells was obtained from NHDES' Drinking Water and Groundwater Bureau. NHDES reports that approximately 65,000 of 130,000 reported wells have been georeferenced and are included in the GIS data. Since 2007, NHDES has required the locations of new wells be reported on a well completion form submitted to NHDES (NHDES, 2016f). Private wells do not have regulatory WHPAs, but wells within 1,300 feet of the Build Alternatives were counted in the following summary.

A total of 117 private wells (77 in Derry and 40 in Londonderry) were identified near the Alternative corridors with the majority listed as drilled bedrock wells. Of the 117 private wells, 102 are listed as domestic wells with 67 located in Derry and 35 located in Londonderry. One is listed as a commercial well in Londonderry; three are listed as agricultural wells (two in Derry and one in Londonderry); and 11 are listed as test/exploration wells (eight in Derry and three in Londonderry). Table 4.13-2 summarizes this information. To protect private rights, Figure 4.13-1 does not show the locations of private wells.

Table 4.13-2. Summary of Private Water Supply Wells Located in the Study Area

Well Use Type	Derry	Londonderry	TOTALS
Domestic	67	35	102

Well Use Type	Derry	Londonderry	TOTALS
Commercial	0	1	1
Agricultural	2	1	3
Test/Exploration	8	3	11
TOTALS	77	40	117

4.13.2 Environmental Consequences

Groundwater

No Build Alternative

Because the No Build Alternative would not involve any new construction, no impacts on groundwater above the existing conditions would be anticipated.

Build Alternatives

None of the Build Alternatives would cross an area that includes a high transmissivity aquifer, but all the Alternatives overlap with the lowest transmissivity recognized by NHDES in its aquifer mapping (0–1,000 square feet/day). Public water systems are located in proximity to Alternatives A, B, C, and D with WHPAs overlapping the Alternative footprints. As with any new development, there could be roadway-related environmental impacts, including the contamination of the groundwater source for these water supplies. Groundwater impacts can arise from infiltration of contaminated runoff from the road surface, spills of hazardous materials, and application of roadway de-icing salt. The potential for these types of impacts is typically estimated by comparing the proximity of newly paved surfaces and calculating the additional paved surface to be added within the WHPA associated with each well. Generally, as the distance between a water supply source and a proposed roadway system decreases, the potential for impacts increases. Similarly, as the amount of newly paved surface increases, the potential for contamination also increases.

A summary of potential impacts on groundwater associated with each Build Alternative is discussed below and included in Table 4.13-3.

Table 4.13-3. Summary of Impacts on Groundwater Resources by Alternative

Resource	A	B	C	D	F
Aquifers, 0–1,000 square feet/day[a]	23.17	13.56	32.67	37.66	19.15
Aquifers, 1,000–2,000 square feet/day	0.00	0.00	0.00	0.00	0.16
Direct impacts on public water supply wells	None	None	None	None	None
Public WHPAs[b]	6	5	5	7	0
WHPAs new impervious, acres[c]	0.22	1.16	1.16	0.22	0
Private wells (number)	0	2	2	0	0

Resource	A	B	C	D	F
Private wells (number within 150 feet)[d]	21	16	14	18	4

[a] Aquifer impacts are identified as acreage of the alignment footprint that overlaps statewide transmissivity rate aquifer mapping.
[b] The number of WHPA impacts does not identify that there are several overlapping WHPAs.
[c] The acreage of WHPA footprint overlap is not counted separately for each well.
[d] Private wells do not have regulated WHPAs. However, the metadata for the NH Water Well Inventory (NHDES 2016d) stipulates that their margin of error is ±150 feet for well locations. Given this margin of error, and to help in identifying the proximity of the alignments to private wells, wells within 150 feet of the Alternatives were also tabulated.

Alternative A

The Alternative A footprint overlaps seven WHPAs. However, as previously noted and depicted in Figure 4.13-1, several of these public wells are located near each other and therefore share largely overlapping WHPAs that occupy much of the same land area. Roadway and intersection improvements on existing alignment would result in 0.16 acre of new impervious area within four WHPAs (Barkland Acres, wells 1 and 2, and Morningside Drive, wells 7 and 8) that encompass Tsienneto Road and connections to five intersecting roads (Fieldstone Drive, Horseshoe Drive, Morningstar Drive, Scenic Drive and Beaver Drive). Tsienneto Road travels through the area where these four WHPAs overlap for a distance of 2,928 linear feet, all of which would involve wider pavement.

Approximately 120 linear feet of Alternative A also crosses three overlapping WHPAs associated with the Rand Shepard Hill development (wells 12, 13, and 14) at the northern end of the Alternative on NH 102, but there is no expansion of pavement proposed for this segment of Alternative A.

No private wells would be affected by Alternative A, but the alignment is within 150 feet of 21 private wells.

Alternative B

This Alternative would require construction of a new roadway alignment within the WHPAs of Well Nos. 1 and 2, with 1.16 acres of new pavement and approximately 1,560 linear feet of new roadway.

The footprint of Alternative B overlaps with two private wells as mapped by USGS and is within 150 feet of 16 private wells.

Alternative C

The portion of the Alternative C alignment that would be in proximity to active public water systems follows the same corridor as Alternative B. Consequently, 1.16 acres of new pavement within the WHPAs of Wells no. 4 and 5 would be constructed. Alternative C overlaps with two private wells as mapped by USGS and is within 150 feet of 14 private wells. Alternative C is also within 250 feet of community wells 16 and 17, which do not have WHPAs associated with them.

Alternative D

Alternative D would have virtually identical impacts on WHPAs as discussed for Alternative A. The Alternative D footprint overlaps no private wells and is within 150 feet of 18 private wells. Alternative D is also within 250 feet of community wells 16 and 17, which do not have WHPAs associated with them.

Alternative F

Alternative F would not result in any impacts on existing wells or WHPAs. It is within 150 feet of 4 private wells.

Mitigation

Mitigation measures for potential impacts related to groundwater resources will be consistent with NHDES's *Recommendations for Groundwater Protection Measures When Siting or Improving Roadways* (NHDES 1995).This document provides recommendations for structural and non-structural BMPS to protect groundwater based on the proximity of the roadway to a WHPAs for wells serving community and nontransient, non-community public wells, locally designated groundwater protection areas, and high value aquifers reserved for future water supply. Structural BMPs such as lined treatment swales and non-structural BMPs such as providing the water supplier, NHDES, and the Office of Emergency Management site specific information to aid in isolating a spill.

4.14 Aquatic Life and Essential Fish Habitat

4.14.1 Affected Environment

The study area for aquatic life and Essential Fish Habitat (EFH) corresponds to the previously defined study area for surface water and water quality.

Aquatic Life

Lakes and Ponds

Beaver Lake

Beaver Lake, located in Derry, has a history of management for both warm water and cold water fish species by the New Hampshire Fish and Game Department (NHFGD) (Connor and O'Loan, 1993). Beaver Lake is known to have populations of smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), horned pout/brown bullhead (*Ameiurus nebulosus*) white perch (*Morone americana*), yellow perch (*Perca flavescens*), eastern chain pickerel (*Esox niger*), American eel (*Anguilla rostrata*), bluegill (*Lepomis macrochirus*), black crappie (*Pomoxis nigromaculatus*), brook trout (*Salvelinus fontinalis*), and rainbow trout (*Oncorhynchus mykiss*) (NHFGD, 2016a; NHFGD, 2017). NHFGD manages Beaver Lake for both brook trout and rainbow trout and last completed stocking for these species in 2016 (NHFGD, 2016b). Brook trout is listed in the NH Wildlife Action Plan as a species of greatest conservation need (NHFGD, 2015a).

Lower Shields Pond and Scobie Pond

Lower Shields Pond and Scobie Pond are located in the northern portion of the study area. Aquatic life data were not available for Lower Shields Pond, whose waters join the outflow from Scobie Pond. Total phosphorus and chlorophyll levels for Scobie Pond indicate average (mesotrophic) conditions for phytoplankton (NHDES, 2017a). Scobie Pond supports fish species such as largemouth bass, black crappie, golden shiner (*Notemigonus crysoleucas*), bluegill (*Lepomis macrochirus*), smallmouth bass, creek chubsucker (*Erimyzon oblongus*), eastern chain pickerel, yellow bullhead (*Ameiurus natalis*), horned pout/brown bullhead, American eel, pumpkinseed sunfish (*Lepomis gibbosus*), and banded sunfish (*Enneacanthus obesus*) (NHFGD, 2016a; NHFGD, 2017).

Both the banded sunfish and American eel are listed as species of greatest conservation need in the NH Wildlife Action Plan and have also been identified as species of regional conservation concern (NHFGD, 2015a).[17] Additionally, recent surveys indicate that the banded sunfish is more common in southern NH than previously thought (NHFGD, 2015a).

Hoods Pond

Hoods Pond is located in the central portion of the study area. Hoods Pond exhibits a high amount of DO in its bottom waters (NHDES, 2017a), a condition that is considered supportive of fish populations, and has a satisfactory pH for aquatic organism survival. Chlorophyll and total phosphorus levels are reported to be excessive, although available data are limited to a single sampling event in August of 1997. Plant abundance is reported to be sparse, and the Hoods Pond waters are classified as having moderate algal production (NHDES, 2017a). Hoods Pond is listed as a warm water fishery (AECOM, 2012) and reportedly supports brook trout, eastern chain pickerel, horned pout/brown bullhead, and bluegill (NHFGD, 2016a). NHFGD stocks Hoods Pond with eastern brook trout (NHFGD, 2016b). Because Hoods Pond is impaired by cyanobacteria, a phosphorus TMDL study was recently conducted that concluded that an 80 percent reduction in phosphorus loading would be needed to meet water quality objectives (AECOM, 2012).

Wheeler Pond

Wheeler Pond is located immediately east of I-93 Exit 4. It receives waters from small tributary streams that flow along I-93 near Trolley Car Lane, as well as the Exit 4 interchange. Wheeler Pond outlets through a weir at a driveway entrance to a local commercial business, and the unnamed outlet stream flows under NH 102 before discharging into Beaver Brook. Aquatic life data were not available for Wheeler Pond.

Streams

The study area contains several streams and brooks, both named and unnamed, including Shields Brook, Beaver Brook, Little Cohas Brook, a small section of West Running Brook, and Flat Rock Brook. It also includes several unnamed drainages and tributaries.

[17] Species of regional concern are those species identified by the Northeast Wildlife Diversity Technical Committee as a regional concern, and did not include those species already listed as endangered or threatened.

Shields Brook

Shields Brook captures waters from Rainbow Lake (located north of the study area), Lower Shields Pond, Scobie Pond, and their accompanying tributaries. Hoods Pond and Horns Pond are impoundments located along Shields Brook. The stream meanders through some of the more highly developed portions of the study area, including the commercial and industrial areas along NH 28 near the Derry/Londonderry town line. Downstream of NH 28, Shields Brook flows into Hoods Pond before flowing through Horns Pond and downtown Derry, to its confluence with Beaver Brook. Shields Brook supports horned pout/brown bullhead, bluegill (*Lepomis macrochirus*), common white sucker, creek chubsucker (*Erimyzon oblongus*), brook trout, fallfish (*Semotilus lumbee*), smallmouth bass, banded sunfish, and redfin pickerel (NHFGD, 2017). Surveys conducted in 2000 and 2005 also documented the presence of pumpkinseed sunfish in Shields Brook (NHFGD, 2017). The banded sunfish and redfin pickerel are both listed as species of greatest conservation need in the NH Wildlife Action Plan (NHFGD, 2015a; 2017). Shields Brook supports 35 macroinvertebrate species. Habitat data show that, overall, Shields Brook exhibits low habitat quality (NHDES, 2000b).

Beaver Brook

Wheeler Pond; Shields Brook, including associated tributaries and ponds; Horns Pond; and Beaver Lake all drain into Beaver Brook, the major surface water feature in the study area. Sampling in Beaver Brook in Londonderry conducted in 2000 identified eight species of finfish, including common white sucker, pumpkinseed sunfish, fallfish, blacknose dace (*Rhinichthys atratulus*), golden shiner, common shiner, silvery minnow (*Hybognathus nuchalis*), and yellow bullhead (*Ameiurus natalis*) (NHFGD, 2017). Farther downstream, and outside the study area in Pelham, sampling conducted in Beaver Brook in 2006 documented the same species observed in Beaver Brook within Londonderry, as well as creek chubsucker (NHFGD, 2017). In both Derry and Windham species documented included American eel (*Anguilla rostrata*), horned pout/brown bullhead, eastern chain pickerel, largemouth bass, smallmouth bass, and redbreast sunfish (*Lepomis auritus*). The American eel is listed as species of greatest conservation need in the NH Wildlife Action Plan (NHFGD, 2015a). At a monitoring station located south of the study area, Beaver Brook was classified as having overall optimal fish and macroinvertebrate habitat; 31 insect species were also documented. However, Beaver Brook's Index of Biotic Integrity only narrowly exceeds the benchmark criterion for the southern NH bioregion (NHDES, 2000b). NHFGD stocks Beaver Brook in Derry and Londonderry with rainbow trout and eastern brook trout (NHFGD, 2016a).

Other Tributaries to Beaver Brook

Numerous tributaries exist within the study area, including West Running Brook and several small, unnamed streams that drain to Beaver Lake near the northeastern corner of the study area. No aquatic life data were available from either NHFGD or NHDES for these streams.

Essential Fish Habitat

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (Public Law 94-265; 16 U.S.C. 1801 et seq.) established requirements for identifying and protecting EFH.[18] In NH, the final determination of what areas constitute EFH is the responsibility of the New England Fisheries Management Council (NEFMC). Under the regulations, any federal agency that funds, permits, or initiates an activity potentially affecting designated EFH is required to consult with the National Marine Fisheries Service (NMFS).

Recent correspondence from NMFS to FHWA (letter dated November 18, 2016, Appendix K) stated that the Project area did not contain areas identified as EFH; therefore, no EFH conservation recommendations would be made for the proposed action.

4.14.2 Environmental Consequences

Aquatic Life

No Build Alternative

The No Build Alternative would not require any new disturbance or additional paved surfaces. Therefore, any new impacts on aquatic life, above and beyond those already occurring, would be as a result of continued development within the watersheds of the perennial streams, and from increasing traffic volumes.

Build Alternatives

Development projects, including roadways, may result in impacts on adjacent water bodies and the areas surrounding water bodies. These impacts can affect the physical, chemical, and biological features of a water body, including streams, and may include:

- Alteration of stream geomorphology (i.e., channelization of the stream, changes in patterns of erosion and deposition);
- Loss of structural complexity of existing stream banks;
- Changes to existing stream hydraulics;
- Loss or reduction in the complexity of stream flows (e.g., changes in the ratio of ripples to pools);
- Shading caused by bridges, culverts, and other engineered structures;
- Reduction in shading due to vegetation clearing;
- Changes in water temperature and DO levels; and
- Increases in pollutant loads from runoff (e.g., Na, Cl, metals) with acute and chronic effects.

Any combination of these potential impacts can result in the loss or degradation of existing habitat for aquatic life. The following analysis focuses on anticipated direct effects to aquatic life associated with each Build Alternative, as expressed by the number of proposed stream crossings and linear feet of physical disturbance to streams. No direct impacts to waterbodies (i.e. ponds or lakes) would occur under any of the Alternatives.

[18] The 1996 amendments to the Magnuson-Stevens Act were promulgated by the Sustainable Fisheries Act (Public Law 104-297). Under the regulations, EFH is defined to include those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity.

In addition to the direct impact information presented, indirect impacts to streams can also occur as a result of construction activities and normal operations of roadways. Indirect impacts may result from increased pollutant loading from stormwater runoff, sedimentation, and vegetation removal. Section 4.11-1 provides a pollutant loading analysis.

A total of 10 perennial and 8 intermittent or ephemeral stream segments would be affected by one or more of the Build Alternatives. Impacts to these streams would occur as a result of constructing a new bridge or culvert crossing, extending an existing culvert or bridge; or potentially relocating the alignment of an existing stream. For comparison, all impacts are identified as "Crossings."

Table 4.14-1 compares linear feet of stream impact for the five Build Alternatives. For this SDEIS, linear impacts are measured as impacts to the centerline of the stream. Stream crossings are identified in Figure 4.14-1. In addition to the stream crossings discussed below, there are wetland crossings, both existing and proposed, that involve culverts to carry flow that is not channelized. These impacts are identified in Section 4.12-1, *Wetlands and Vernal Pools*. Stream impact totals are summarized for each Alternative in Table 4.14-2. Alternative F would involve the least total impact on stream channels, because all of the improvements would be on existing alignment. Alternatives A and B are comparable in impacts proposed, but Alternative B would have more impacts from new crossings on new alignment. Alternatives C and D would not have any new stream crossings, but Alternatives C and D would involve wetland crossings as described in Section 4.12.

Table 4.14-1. Summary of Direct Stream Disturbance Associated with Build Alternatives

Crossing	Flow Regime[a]	Watershed Size (Acres)[b]	Location	Activity Description	Linear Feet of Stream Impact by Alternative[c]				
					A	B	C	D	F
1	Perennial	269	New access ramp W of I-93 at southern Exit 4A interchange -71°20'56" 42°53'4"	Relocate perennial stream channel. Portions of channel already impacted from I-93 construction.	511	511			
2	Perennial, Shields Brook	3,767	N. High St - between Ferland Drive and Franklins St -71°19'54 42°53'23"	Extend existing culvert crossing to the north to accommodate connector road.	185				
3	Intermittent	148	Tsienneto Road - Approx. 200 ft west of Scenic Drive -71°18'26" 42°54'27"	Extend culvert to accommodate road widening.	22			22	
4	Intermittent	30	Tsienneto Road - between Scenic Drive and Jeff Lane -71°18'21" 42°54'31"	Extend culvert to accommodate road widening.	13			13	
5	Perennial, Unnamed	850	Tsienneto Road - 250 ft west of NH 102 -71°18'10 42°54'37	Extend culvert to accommodate road widening.	0[e]	0	13		
6	Perennial, Unnamed	1,061	NH 102 - 700 ft south of Tsienneto Road -71°18'9 42°54'29	Extend culvert to accommodate road widening.			8		
7	Intermittent	35	New access ramp - E of I-93 at southern interchange -71°20'56 42°53'11	Extend culvert under new I-93 northbound off-ramp and southbound on-ramp.	109	109			

Crossing	Flow Regime[a]	Watershed Size (Acres)[b]	Location	Activity Description	Linear Feet of Stream Impact by Alternative[c]				
					A	B	C	D	F
8	Intermittent	19	New alignment - 500 ft E of I-93 71°20'51" 42°53'15"	Construct new stream crossing/relocate stream for connector road.	329	333			
9	Intermittent	25	New alignment 960 ft W of Franklin Street Ext. -71°20'18" 42°53'26"	Construct new stream crossing for connector road.		124			
10	Intermittent	Undeter-mined[d]	New alignment - 1,550 ft W of Franklin Street Ext. -71°20'24" 42°53'21"	Construct new stream crossing for connector road.		51			
11	Ephemeral[a]	Undeter-mined[d]	New alignment - 300 ft N of Madden Drive -71°20'9" 42°53'21"	Stream relocation/impact.	77				
12	Perennial, Shields Brook	3,118	New alignment - 540 ft W of Franklin Street Ext. -71°20'16" 42°53'30"	Construct new bridge crossing for connector road.		214			
13	Perennial, Shields Brook	1,155	NH 28 - (W branch) -71°20'40" 42°54'0"	Extend culvert for connector road.			476	476	
14	Perennial, Shields Brook	1,629	NH 28 - (E branch) -71°20'32" 42°53'57"	Extend culvert for connector road.			65	65	
15	Perennial, Unnamed	826	NH 102 - 500 feet east of I-93 Exit 4 -71°20'17" 42°52'21"	Extension of existing culvert carrying water from Wheeler Pond.					61

Crossing	Flow Regime[a]	Watershed Size (Acres)[b]	Location	Activity Description	Linear Feet of Stream Impact by Alternative[c]				
					A	B	C	D	F
16	Perennial, Shields Brook	4,157	NH 102 - between Griffin St and Storer Ct -71°19'49" 42°52'44"	Extend culvert for connector road.					52
17	Intermittent	Undeter-mined[d]	NH 102 - 100 ft E of Hood Road 71°19'4" 42°53'14"	Extend culvert for connector road.					17
18	Perennial	278	NH 102 -100 ft S of Hoodkroft Drive -71°18'53" 42°53'22"	Extend culvert for connector road.					23
19	Perennial	561	Franklin St Extension -71°19'54" 42°53'25"	Extend culvert for connector road	22				

[a] Flow regime based on observation and watershed size. In the absence of long term monitoring for streams in the project area, streams with watersheds smaller than 200 acres were assumed to be intermittent, and larger than 200 acres were assumed to be perennial. Ephemeral streams had no measurable watershed and had physical characteristics meeting the NHDES definition of ephemeral streams.

[b] Watershed sizes based on Streamstats basin delineation: https://streamstats.usgs.gov/ss/.

[c] Linear disturbance estimates based on preliminary design information.

[d] Unable to determine watershed size using Streamstats.

[e] The upstream portion of Crossing #5 is mapped as wetland, which would be affected by the improvements to Tsienneto Road. No impacts would occur to the downstream portion of the channel under the currently proposed Project.

Table 4.14-2. Stream Impacts by Alternative

Impact Metric	Alternative				
	A	B	C	D	F
Number of New Stream Crossings/Impacts	3	5	0	0	0
Number of Proposed Improvements of Existing Stream Crossings	6	3	4	4	4
Total Number of Stream Impacts	**9**	**8**	**4**	**5**	**4**
Linear Feet New Stream Crossings	840	1,217	0	0	0
Linear Feet Improvements of Existing Stream Crossings	428	124	562	577	153
Total Linear Feet of Stream Disturbance	**1,268**	**1,341**	**562**	**577**	**153**

Alternative A

Alternative A would result in direct impacts on streams at nine different locations (Table 4.14-2). This includes six streams where an extension of an existing culvert or bridge would be required, totaling 406 linear feet of disturbance. Of these six existing crossing extensions, the most substantial crossing would be an extension of the culvert where North High Street/Folsom Road crosses Shields Brook (Crossing 2), which would create 185 linear feet of stream channel impact. The other five existing stream crossings are an extension of a culvert crossing under I-93 (Crossing 7), three crossings under Tsienneto Road that would be improved (Crossings 3, 4, and 5), and an extension of an existing crossing under Franklin Street Extension. As currently proposed, Crossing 5 would not impact a stream channel. The upstream end of Crossing 5 is impounded and delineated as wetland, and the downstream end would not impact the delineated stream channel. It is likely that the replacement of this stream crossing would ultimately involve impacts on the stream channel.

Stream impacts from new alignment would occur in three locations: west of I-93 where 511 linear feet of intermittent stream would be relocated (Crossing 1), east of I-93 on new alignment, where 328 linear feet of intermittent stream channel would be impacted, and on new alignment north of Madden Road where 77 linear feet of an ephemeral stream channel would be impacted.

Alternative B

Alternative B would result in direct impacts to streams at eight locations. This includes five new stream crossings: three intermittent streams on new alignment west of Franklin Street Extension (Crossings 8, 9, and 10), and similar impacts to Crossing 1 as for Alternative A. The largest new crossing would be a 210-foot long bridge over Shields Brook just west of the Franklin Street Extension/B Street intersection (Crossing 12).

Three existing culvert crossings, one under I-93 in the proposed southern Exit 4A interchange area (Crossing 7), a second along the Tsienneto Road just west of its intersection with NH 102 (Crossing 5), and a third on NH 102 south of Tsienneto Road would be extended. The total linear disturbance of streams associated with Alternative B, including stream relocations, would be 1,341 feet.

Alternative C

Alternative C would require direct impacts to four stream segments, all of which are extensions of existing crossings. The largest stream impact would be to Beaver Brook, which has two tributaries that meet just south of Rockingham Road (NH 28) (Crossings 13 and 14). The western tributary flows parallel to the road for about 420 feet, which would have to be relocated to accommodate the roadway widening. Alternative C would also require an extension to the culvert carrying a perennial stream into Beaver Lake under NH 102 (Crossing 6). As with Alternatives A and B, there would be impacts on the crossing carrying a perennial stream from the prime wetland on the north side of Tsienneto Road into the stream channel on the south side (Crossing 5).

Alternative D

Alternative D would result in direct impacts to approximately 575 linear feet of stream bed at five existing crossing locations, including the Shields Brook crossings that would be impacted by Alternative C (Crossings 13 and 14). Three crossings on Tsienneto Road would also be expanded for this Alternative (Crossing 3, 4, and 5).

Alternative F

Alternative F would result in direct impacts at approximately 152 linear feet of stream bed at four separate crossing locations, all of which are on NH 102. The first crossing is about 100 linear feet north of the intersection between Nashua Road and Action Boulevard. This stream originates from Wheeler Pond and would require extension of the culvert and impacts on a drainage swale that leads from the adjacent parking lot. The existing crossing over Shields Brook would be extended, as would intermittent and perennial stream crossings that flow into the golf course south of NH 102.

Mitigation

Mitigation for stream impacts would be provided as part of the wetland mitigation package. Some of the stream crossings, such as Crossing 2 (Shields Brook) will be widened in accordance with requirements in NHDES Administrative Rules Env-Wt 900 et seq., Stream Crossings. The rules provide that mitigation is not required for any crossing that is “self-mitigating.” The improvements proposed will provide improved hydraulic capacity and aquatic organism passage and as such will be self-mitigating. Stream impacts that are not self-mitigating will be mitigated through a payment to the Aquatic Resource Mitigation fund at NHDES and potentially preservation of conservation land. The in-lieu fee amount and conserved land, if any, would be in accordance with NH RSA 482-A:28 and NHDES Wetland Rules and with federal Section 404 guidelines in 40CFR (b)(1)J.

4.15 Floodplains

A floodplain is defined as the land along waterbodies that is inundated with water during floods. The Federal Emergency Management Agency (FEMA) oversees Flood Insurance Rate Mapping (FIRM) maps, which depict floodplains, floodways, and base flow elevations in some areas. The 100-year floodplain is the area with a 1 percent chance of flooding each year. FEMA defines the floodway as the channel of the stream, plus any additional floodplain areas, that must be kept free from encroachment so that the 100-year flood can be carried without an increase in flood elevation greater than 1 foot.

Beneficial floodplain functions include flood attenuation, water quality maintenance, groundwater recharge, riparian plant and wildlife habitat, natural beauty, open space, and agriculture. Absent appropriate design of fill placement and the hydraulic capacity of structures (e.g., culverts and bridges), roadway construction in floodplains can potentially raise flood elevations.

Federal Executive Order 11988, *Floodplain Management*, directs federal agencies to "take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains…." FHWA has established regulations to implement the requirements of Executive Order 11988 (23 C.F.R. § 650.101-117). The purpose of the FHWA regulations is to prevent hazardous development on floodplains, avoid construction on floodplains when practicable, minimize the impacts of FHWA actions on floodplains, and protect and restore beneficial floodplain functions. FHWA requires an "Only Practicable Alternative Finding" when the preferred alternative identified in the Final EIS would result in a significant encroachment on a floodplain. 23 CFR 650.105(q) defines a "significant encroachment" as a highway encroachment and any direct support of floodplain development that would involve one or more of the following construction- or flood-related impacts:

- A significant potential for interruption or termination of a transportation facility that is needed for emergency vehicles or provides a community's only evacuation route.
- A significant risk attributable to the encroachment.
- A significant adverse impact on natural and beneficial floodplain values.

Floodplains crossed by or near the Build Alternatives are based on the FEMA FIRM data and shown in Figure 4.15-1.

4.15.1 Affected Environment

The study area for floodplains includes those floodplains within 500-feet of the Build Alternatives. Several 100-year floodplains are crossed by or near each Build Alternative. These floodplains are typically associated with the major watercourses and their tributaries. Topography is the major influence on the extent of floodplains bordering the various drainageways. Table 4.15-1 summarizes the floodplain areas near the alignments for the Build Alternatives.

Table 4.15-1. 100-Year Floodplains near the Build Alternatives

Alternative	Waterbody Name	Nearest Road
A	Shields Brook	North High Street
	Unnamed Tributary to Beaver Lake	Tsienneto Road Chester Road (NH 102)
B	Shields Brook	Franklin Street

Alternative	Waterbody Name	Nearest Road
	Unnamed Tributary to Beaver Lake	Tsienneto Road Chester Road (NH 102)
C	Shields Brook	Rockingham Road (NH 28)
	Unnamed Tributary to Beaver Lake	Tsienneto Road Chester Road (NH 102)
D	Shields Brook	Rockingham Road (NH 28)
	Unnamed Tributary to Beaver Lake	Tsienneto Road Chester Road (NH 102)
F	Horne's Brook	Broadway (NH 102)
	Beaver Brook	Broadway (NH 102)

Beaver Brook runs southwest from the outlet of Beaver Lake through an area known as “The Meadows” in Derry. The floodplain area is associated with many smaller watercourses and tributaries in the area, including West Running Brook, and a small tributary that originates from Crystal Spring to the south. It passes through narrow channels designed to accommodate former mill operations in the eastern portion of Derry near NH 28 Bypass and then continues over flat, expansive areas that include the Hoodkroft Golf Course. Much of the golf course area is within the 100-year floodplain. The brook meanders through residential and commercial areas in Derry, crosses under I-93, and continues through several residential developments in Londonderry before reaching Kendall Pond.

Shields Brook, which runs from Lower Shields Pond to Hoods Pond, bisects the study area and has a large floodplain area in many locations. The floodplain for this brook is at its widest at the outlet from Lower Shields Pond, and south of NH 28 near the industrialized areas off A and B Streets on the Derry/Londonderry town line. An expansive floodplain also exists to the north of NH 28 and to the southwest of Scobie Pond. This floodplain is associated with a tributary of Shields Brook and a large wetland complex that drains to Shields Brook via a culvert under NH 28.

Horne’s Brook originates at Horne’s Pond in Derry and flows in a southerly direction before emptying into Beaver Brook. The floodplain for this brook is relatively narrow and crosses under Broadway (NH 102) and South Avenue before joining Beaver Brook near Fordway Street.

The unnamed tributary to Beaver Lake flows south-southeast into Beaver Lake and is crossed by Tsienneto Road and Chester Road (NH 102). The floodplain for this tributary is about 35 feet near the intersection of Tsienneto and Chester Roads and expands to about 120 feet wide near the confluence with Beaver Lake.

4.15.2 Environmental Consequences

No Build Alternative

Because the No Build Alternative does not involve new construction, there would be no impacts on FEMA-mapped floodplains or floodways.

Build Alternatives

Table 4.15-2 summarizes the potential impacts on 100-year floodplains and floodways by Build Alternative. The primary area of impact for Build Alternatives A, B, C, and D would be on the floodplain for Shields Brook (Figure 4.15-1). Alternative A would cross the Shields Brook floodplain near the existing Folsom Road/Madden Road crossing and Alternative B would cross the floodplain near the Londonderry/Derry town line. Alternatives C and D would cross the Shields Brook floodplain and the floodplain for a small tributary to Shields Brook where these streams cross beneath NH 28. Build Alternatives A, B, C, and D would also result in floodplain impacts near the eastern end of the alignment, near the intersection of Tsienneto Road and NH Route 102, where a small tributary of Beaver Lake flows under Tsienneto Road (Figure 4.15-1). Alternative F would cross the floodplain for Horne's Brook at the existing NH Route 102 crossing. In addition, Alternative F would require a minor impact on the floodplain along Beaver Brook along the east side of NH Route 102 near Hoodkroft Golf Course (Figure 4.15-1).

Table 4.15-2. Floodplain and Floodway Impacts by Build Alternative

Alternative	Floodway (acres)	100-Year Floodplain (acres)
A	0.15	0.45
B	0.20	0.90
C	0.45	1.87
D	0.45	1.84
F	0.06	0.31

Mitigation

With any Build Alternative selected, detailed hydraulic analyses would be completed during final design to avoid and/or minimize impacts on the floodway, and in particular to avoid raising the base flood elevation.

4.16 Plant Communities and Wildlife

The Fish and Wildlife Coordination Act (16 USC 661-666, as amended by PL 89-72) requires applicants of federally funded or federally permitted projects to consult USFWS and NHFGD throughout the course of the project. USFWS and NHFGD can issue recommendations to avoid, mitigate, or compensate for impacts to fish and wildlife resources within the study area. The study area for assessing plant communities and wildlife resources encompasses approximately 26 square miles within western portions of Derry and eastern Londonderry in western Rockingham County, NH (Figures 4.16-1 and 4.16-2).

Wildlife habitats are in large part determined by land cover types and land use. These variables within the project footprint and the surrounding landscape were assessed using the land cover data provided by the 2015 NH Wildlife Action Plan (NHFGD, 2015a), a document and data sets developed by NHFGD to provide information for wildlife conservation prioritization and planning. The NH Wildlife Action Plan land cover data are available as a GIS data layer from GRANIT. It identifies mixed forest types (Appalachian Oak-Pine and Hemlock-Harwood-Pine) as the dominant cover types in the Project study area. The study area is shown in Figure 4.16-1 and includes the plant communities and wildlife habitat near the Alternatives that may be affected by the Proposed Project. The analysis of plant community types within these cover types and associated wildlife habitat was augmented using publically available aerial photography (Google Earth, 2016) along with limited field reconnaissance. The plant community types within the study area include hardwood, softwood, and mixed wood forests, shrubland, agricultural fields, wetlands, and developed areas. Wetland communities include forested and scrub-shrub wetlands (including vernal pools), emergent marsh, and wetland meadows communities. In addition to land cover data, the NH Wildlife Action Plan provides an assessment of habitat value, ranking all lands within NH as highest ranked in the state by ecological condition, highest ranked in the biological region by ecological condition, supporting landscapes, and not ranked (all the rest). The habitat value of the lands within the study area was also assessed using this analysis (Figure 4.16-2).

4.16.1 Affected Environment

The study area is dominated by development, with about 50 percent of the land area influenced by residential development and transportation and utility infrastructure. In addition, many of the major roadway corridors, including NH 102, NH 28, and NH 28 Bypass, contain substantial commercial, industrial, and mixed-use development. Much of the remaining undeveloped land in the study area is fragmented by this development. However, the natural land covers and the less intensively developed areas present within the study area provide suitable habitat for a wide variety of wildlife species. These habitats and the wildlife that uses them are described in the following section.

Plant Communities

Hardwood Forests

Mature hardwood stands within the study area are typically dominated by a dense canopy of northern red oak (*Quercus rubra*), white oak (*Quercus alba*), red maple (*Acer rubra*), sugar maple (*Acer saccharum*), and white birch (*Betula papyrifera*), often with a variable softwood component. Other less commonly occurring canopy species include white ash (*Fraxinus americana*), black cherry (*Prunus serotina*), American beech (*Fagus grandifolia*), and American elm (*Ulmus americana*). The understory of the hardwood forests commonly includes witch-hazel *(Hamamelis virginiana*) and beaked hazelnut (*Corylus cornuta*) trees and seedlings. Bracken fern (*Pteridium aquilinum*) and other fern species, wintergreen (*Gaultheria procumbens*), Canada mayflower (*Maianthemum canadense*), lowbush blueberry, and additional forbs, sedges, and grasses occur in the herbaceous layer of these forests.

Mature hardwood forests support wildlife species requiring habitat features such as closed canopies (e.g., red-eyed vireo [*Vireo olivaceus*]) or moderately sized tree cavities (e.g., northern [*Glaucomys sabrinus*] and southern flying squirrels [*Glaucomys volans*]) (DeGraff and Yamasaki, 2001). Mature hardwood forest also provides thicker leaf litter, downed deadwood, and sparse herbaceous cover, all of which are important habitat features for a variety of wildlife species. Mature stands with mast producing trees (e.g., oaks and beech) provide important forage for a wide variety of wildlife species including squirrels, white-tailed deer, black bear (*Ursus americanus*), and wild turkey (*Meleagris gallopavo*).

Young hardwood stands that occur in cut-over or otherwise disturbed portions of the study area are typically dominated by pioneer species such as quaking aspen (*Populus tremuloides*), gray birch, pin cherry (*Prunus pensylvanica*), and stump sprouts of red maple, northern red oak, and white oak. The generally sparse overstory of young forests typically supports dense shrub and herbaceous layers that include early successional plant species. The wildlife species that use these stands depend on those early successional species or the dense growth forms. For example, American woodcock and ruffed grouse will use hardwood stands dominated by young aspen. Young hardwood stands characterized by moderately high structural complexity, may support a greater diversity of bird species than mature stands that typically have only moderate structural complexity.

Softwood Forests

Softwood forests within the study area are dominated by eastern white pine mixed with lesser amounts of red pine and hardwood species. Eastern hemlock is also present, especially on shaded slopes and along the edge of wetlands. Structural complexity is generally low within softwood forests, as shading and other factors limit development of understory vegetation. White-tailed deer in New England often use mature softwood stands during the winter because their dense, persistent canopies reduce snow cover and provides protection from the wind. Other wildlife species that prefer softwood forests include red squirrels (*Tamiasciurus hudsonicus*), red-breasted nuthatch (*Sitta canadensis)*, and black-throated green warblers (*Dendroica virens*).

Mixed Forests

Other forested communities within the study area are characterized by a mix of hardwood and softwood species. These mixed wood forests are often similar in plant species composition and structural complexity to the hardwood forests and likely support many of the same wildlife species.

Shrublands

Shrublands within the study area include old field areas that are reverting to forests and regenerating forest cuts, both of which are uncommon, and powerline corridors that are managed to remain as early successional vegetation. The maintained ROW shrubland vegetation contains early successional shrubs and trees such as red raspberry (*Rubus idaeus*), common blackberry (*Rubus allegheniensis*), and beaked hazelnut, as well as young aspens and cherry (*Prunus*) species. A variety of wildlife such as the blue-winged warbler (*Vermivora pinus)*, northern mockingbird (*Mimus polyglottos)*, willow flycatcher (*Empidonax traillii)*, and New England cottontail depend on shrubland habitats. Other species such as white-tailed deer, black bear, and red fox (*Vulpes vulpes*) also use the resources offered by shrublands on a regular basis.

Wetlands

Descriptions of the various wetland types and dominant vegetation found within each wetland class in the study area are provided in Section 4.12.1. In general, these wetland classes include forested wetlands (i.e., deciduous, evergreen, and mixed), shrub swamps, and swales and marshes. Vernal pools, temporary water bodies that serve as breeding grounds for certain amphibians and invertebrates, may occur in several wetland classes. Each wetland type provides important wildlife habitat. Amphibians (i.e., frogs and salamanders) rely on wetlands throughout much, if not all, of their life cycle. Several reptile species that may occur within the study area are often found in association with wetlands. These include the northern water snake (*Nerodia sipedon*), ribbon snake (*Thamnophis sauritus*), painted turtle, Blanding's turtle, and spotted turtle. Mink (*Mustela vison*), muskrat, river otter (*Lutra canadensis*), and beaver are some mammals that rely on wetland and aquatic habitats. A number of other typically terrestrial species such as white-tailed deer will also use these habitats. In addition, wetlands frequently are used as travel corridors used by a variety of wildlife species. Wetlands also represent critical habitat for waterfowl and wading birds such as ducks, geese, herons, rails, and bitterns.

Landscape Characteristics

The study area is part of a landscape that has been altered by residential and commercial development, and by historic and current agricultural uses including orchards and agricultural fields. Undeveloped blocks (i.e., open areas without commercial or residential development) include orchards and other farmlands, forested uplands, shrublands, and wetlands communities. Although the study area does not contain any designated wildlife refuges, it does contain conserved areas and town parkland. Many of these conserved areas are made up of multiple parcels, and most are within or abut an undeveloped block of natural habitat (Figures 4.16-1 and 4.16-2). Undeveloped blocks that are relatively long and narrow typically have lower value wildlife habitat because of their high edge-to-interior ratio. The effects of surrounding development (e.g., disturbance, nest predation) penetrate deeper into these narrow bands of habitat than large blocks that are square or circular in shape (USGS, 2002).

Many of the undeveloped blocks in the study area are composed either entirely or in large part of wetlands. The undeveloped blocks range in size from approximately 10 acres to 760 acres. In general, habitat blocks less than about 20 acres typically support only generalist species (e.g., raccoons, skunks, squirrels, deer, blue jays, robins) that can readily adapt to the urban and suburban habitats within which these small, undeveloped areas are embedded (NHFGD, 2015b). Larger blocks (i.e., 50 acres of grassland or 250 acres of forest) that have a low edge-to-interior ratio can provide habitat for habitat specialists (e.g., grassland birds or interior forest-dwelling species). Larger wildlife species such as moose, black bears, and raptors require much larger habitat blocks (i.e., 500 to 2,500 acres).

Habitat Ranking within the Study Area

One analysis that NHFGD conducted for the NH Wildlife Action Plan was an assessment of habitat value of all lands within NH. This analysis rated the ecological condition of land as highest ranked in the state, highest ranked in the biological region, supporting landscape, and not ranked (all the rest). A data layer of the map delineating these ranked areas was created as part of the NH Wildlife Action Plan and is available through GRANIT.

Based on size, shape, and landscape position, the undeveloped forest block within the study area that provides the most valuable wildlife habitat is the block located north of NH 28 in Londonderry. This habitat block, encompassing 760 acres (including land extending beyond the study area depicted in Figure 4.16-1), includes a large wetland system and forested uplands, and parts of it are designated as "highest ranked habitat in biological region" as well as "supporting landscape." Disturbance within this block appears to be limited to a powerline corridor. The three other largest unfragmented blocks in the study area that are designated as "supporting landscape" also likely provide good quality wildlife habitat. They appear to primarily comprise forested uplands with some smaller areas of forested wetlands. Although a few small clearings are apparent within these blocks, disturbance appears to be limited. Alternatives A, B, C, and D intersect areas of supporting landscapes, and Alternatives C and D pass near an area recognized as highest ranked in the biological region. An area of habitat recognized as highest ranked in the state lies west of I-93 and does not intersect any of the alternatives (Figure 4.16-2).

Appendix L provides a list of wildlife species with ranges that are likely to overlap with the study area and that use some of the previously described plant communities found in the study area.

Wildlife

The NH Wildlife Action Plan indicates that the state is home to more than 500 vertebrate species, including mammals, birds, amphibians, reptiles, and fish, and thousands of invertebrates. Most of these are common nongame species that are distributed throughout the state's diverse landscape and the wildlife species are broadly discussed below. Additionally, a relatively small number of wildlife species are harvested and a summary of those species is also presented.

Nongame Species

Nongame wildlife species, including mammals, birds, amphibians, and reptiles, are widely distributed and abundant throughout the study area. Most of these species are small in size and include small mammals (mice, voles, and squirrels), foliage roosting bats, songbirds, snakes, frogs, and salamanders. Because of their small size, the resources provided by the habitats in the study area is sufficient to support relatively large populations of these species, and in turn support viable populations of small- and medium-sized predators such as red and grey fox, owls, and hawks. The Project area is also large enough to support breeding populations of other medium-sized wildlife species, such as porcupine, raccoon, and skunk.

Game and Furbearer Species

The Towns of Derry and Londonderry (and the study area) are located within NHFGD's Wildlife Management Unit (WMU)-M, which extends roughly from the Massachusetts border north to NH 101, west to NH 13, and east to the Maine border/Atlantic Ocean. The habitat within the study area is typical of habitat within the WMU, and species and their abundances in the study area are also expected to parallel those recorded in the WMU. The most recent harvest statistics available from NHFGD summarized below provide general information on game and furbearer populations within WMU-M, and by extension, the Project area (NHFGD, 2016b).

White-tailed deer are the most abundant game species throughout NH. Statewide, deer populations have been relatively steady for the last 10 years, and NHFGD estimates they are almost 40 percent greater than their target levels in WMU–M. As in other states, NHFGD estimates the deer population based in part on the annual antlered buck kill, which was 2.24/square mile in Derry, and 2.12/square mile in Londonderry. This is above the state average of 1.22/square mile, but is very similar to the average for the abutting towns (2.39/square mile). White-tailed deer coexist well with human development, especially moderate density suburban development, which is common in Derry and Londonderry, as well the abutting towns. Other large game species are uncommon in southeastern NH. In the southeastern management region, which includes WMU-M, NHFGD's target level for black bears is 0.05/square mile, reflecting a desire to minimize bear/human conflicts. The 2015 level was estimated to be 0.07/square mile.

The target population level for moose in southeastern NH is 0.10 /square mile, reflecting the general lack of suitable habitat conditions for this species in the southern part of the state. NHFGD estimated that the 2015 level in the region to be 0.11/square mile.

NHFGD also sets population targets for turkeys by WMU. The target population for WMU-M is 1.00/square mile, and the 2015 population level was estimated to be 0.89/square mile. NHFGD does not have specific population targets or population-level information on two other game bird species, ruffed grouse or American woodcock, but does conduct annual drumming and singing surveys, respectively, to track relative population levels. 2016 results indicate that ruffed grouse populations in the southeastern management region are very low, with no drumming males heard. American woodcock populations appear to be consistent with the long-term average in the region, based on the number of sing males heard in 2016.

All NH common furbearer species occur with in the southeastern management region and are likely to be present in the Towns of Derry and Londonderry. Many furbearer species, including red fox, skunk, raccoon, and opossum (*Didelphis virginiana)*, coexist well with human development. The 2015 harvest statistics indicate that muskrat, beaver, and raccoon are the species most often harvested in the region, and that they are harvested at comparable rates to other regions of the state. Harvest statistics reflect several different factors including population size, trapper access, pelt value, and nuisance complaints. Beaver are often targeted for trapping because they conflict with human development.

4.16.2 Environmental Consequences

Plant Communities

Direct impacts on plant communities for each Alternative would result from the removal of vegetation and the conversion of undeveloped land to developed land within the footprint of each Alternative. Adjacent areas would also be subject to indirect effects of vegetation clearing. Indirect effects can include increased sunlight penetrating forested areas, altered hydrology in wetlands, and a potential increase in sediment and toxicants from the new roadway. The most prevalent undeveloped cover types in the Project area are northern hardwood forests and conifer forests, and these are the most affected plant community types regardless of Alternative, with the exception of Alternative F.

Impacts associated with construction activities outside the footprint of the alignment would not result in a complete loss of the vegetation community. These temporary work areas and areas of side clearing would revert to an early successional state of grasslands; shrublands; and, where taller growing vegetation would not interfere with infrastructure, early successional forests. Standard and Project-specific erosion control BMPs would be implemented to limit unintended impacts on adjacent undeveloped land.

Impacts on wetland communities are discussed in detail in Section 4.12 of this SDEIS. Wetland impacts are under the regulatory jurisdiction of NHDES and USACE under Section 404 of the CWA.

Wildlife

Overview of Impacts

As discussed above, the Project area and surrounding landscape is home to a wide variety of vertebrate species, including mammals, birds, amphibians, reptiles, and fish, as well as many invertebrate species. Any of these species currently using habitats within or adjacent to the Project footprint would be exposed to direct, indirect, temporary, and/or permanent impacts as a result of Project construction and operations.

Impacts on terrestrial wildlife as a result of the proposed Project would be primarily indirect, as a result of habitat loss and habitat fragmentation, and due to disturbance. Roadways cause habitat fragmentation both by their physical presence and through road mortality. Habitat loss and habitat fragmentation impacts would be permanent and ongoing and result in a permanent reduction of habitat value in the Project area. Reductions in habitat value would occur because of the reduced amount of habitat; smaller habitat block sizes; and increased amount of edge relative to interior habitat, which can increase predation, parasitism, and lead to changes in plant structure and composition. Disturbance would occur as a result of the noise and activity associated with construction as well as the noise and activity associated with roadway operations. Construction-related disturbance is temporary and unpredictable, and wildlife would not acclimate to it. Operations-related disturbance would be permanent and, to some degree predictable, allowing wildlife to acclimate to it. However, operations-related noise may reduce wildlife’s ability to communicate and to perceive danger, and the activity associated with operations may disturb animals (FHWA, 2004). These effects functionally reduce habitat quality and can cause animals to avoid the area, contributing to habitat loss.

Direct impacts would occur on some small, less mobile species that cannot avoid construction activities, as well as on larger animals that would be exposed to road mortality as they travel through the Project area after the Project becomes operational. Direct impacts as a result of construction are limited to the construction period, and the small, less mobile species (e.g., mole salamanders, toads, small snakes, mice, voles) most likely to be affected as a result are generally abundant. Although some individuals would suffer mortality as a result of construction, a population-level impact is unlikely. Direct impacts from road mortality would continue as long as the road remains operational and may increase or decrease over time as a function of traffic volume and changes in the quality of the surrounding habitat due to additional development. Road mortality has the potential to have population-level effects, especially on smaller populations of animals that must cross the road regularly to access all the resources needed during their annual life cycle.

Comparison of Alternatives

The impacts of each of the five Alternatives vary based on the amount of the alternative that follows existing roadways versus requiring a brand-new footprint, the type of habitat each footprint would consume, and each Alternative’s position in the landscape relative to existing habitat resources. Additionally, wetlands impacts and the number of stream crossings vary among the Alternatives. The footprints of the five Alternatives vary in size from 21.2 acres (Alternative F) to 90.1 acres (Alternative D) (Table 4.16-1). Based on size alone, Alternative F clearly has the least impact. Additionally, this Alternative also wholly follows an existing roadway and is located within currently developed areas, creating essentially no new habitat impacts. The other four Alternatives are described in the following section.

Alternative A

Alternative A has the smallest footprint after Alternative F, and just over half of this Alternative (Table 4.16-1) follows an existing roadway through a developed area. However, at its western end, it bisects the largest mapped unfragmented habitat block in the Project area, and this block abuts another, even larger unfragmented habitat block to the north and is ranked as Supporting Landscape (Figure 4.16-2). Alternative A also impacts 2.3 acres of non-vernal pool wetland, seven vernal pools totaling 1.1 acres, and has a total of eight stream crossings, including three new ones (Table 4.16-1). In addition to the general impact of habitat lost to the construction footprint, both the forest fragmentation and vernal pool impacts created by this Alternative would have additional negative impacts on wildlife. Currently, the large unfragmented habitat block that would be bisected is sufficiently large to provide suitable habitat for a variety of forest-nesting birds species (e.g., wood thrush, scarlet tanager, red-eyed vireo, broad-winged hawk, barred owl) that are sensitive to the fragmentation and edge effects that the road would create. Habitat suitability for them in the remaining forest area would be reduced. Loss of vernal pool habitat and forest block fragmentation would also reduce the suitability of the remaining forest habitat for vernal pool breeding amphibians, which depend on both types of habitat for their annual life cycle. Medium-size mammals (skunk, fox, and raccoon) would primarily be affected by the barrier effect of the road and road mortality.

Table 4.16-1. Habitat Impacts and New vs. Existing Roadway by Alternative

Resource	Impact Calculation	A	B	C	D	F
Habitat	Undeveloped cover types (acres)	16	28	35	22	0
	Total footprint (acres)	70	76	90	90	21
Streams	New stream crossings (number)	3	5	0	0	0
	Existing stream crossings (number)	5	3	4	4	4
Wetlands and Vernal Pools	Non Vernal Pool Wetlands (acres)	2.3	8.9	7.7	3.6	0
	Vernal pools (acres)	1.1	1.1	0.3	0.3	0.0
	Vernal pools (number)	7	8	3	4	0
Plant Communities and Wildlife	Wildlife Action Plan supporting landscapes (acres)	15.3	22.5	8.7	1.8	0.0
	Wildlife Action Plan highest ranked habitat in biological region (acres)	0.0	0.0	0.2	0.2	0.0
	Wildlife Action Plan Unfragmented habitat Blocks (number)	1	4	4	3	0

Resource	Impact Calculation	A	B	C	D	F
Roadway Footprint	Existing roadway (linear feet)	14,477	7,716	14,250	20,231	12,870
	New roadway (linear feet)	13,497	21,820	18,760	9,525	0
	Total roadway (linear feet)	27,974	29,536	33,010	29,756	12,870

Alternative B

Although Alternative B has a larger footprint then Alternative A, it would be about 15 percent smaller than either Alternative C or D. Alternative B bisects the same large unfragmented habitat block as Alternative A, then east of NH 28 it passes through a mix of developed and undeveloped cover types, including three additional smaller areas mapped as Unfragmented Habitat Blocks, two of which are ranked as Supporting Landscape (Figure 4.16-2). Alternative B would impact 8.9 acres of non-vernal pool wetlands; impact eight vernal pools totaling 1.1 acres; and have a total of eight stream crossings, including five new ones (Table 4.16-1). West of NH 28, Alternative B would have the same impacts described above for Alternative A. East of NH 28, the Alternative B footprint follows an existing powerline ROW, which would reduce the amount of shrubby habitat associated with the ROW and reduce the value of the remaining habitat. In New Hampshire, powerline ROWs provide habitat for shrubland bird species (e.g., field sparrow, eastern towhee, prairie warbler), snakes, and insects that require open habitats (e.g., pollinators, butterflies).

Alternative C

Alternatives C and D have the same footprint size, but Alternative C would consume a larger amount of natural habitat (Table 4.16-1). Less than half (14,250 of 33,010 linear feet) of Alternative C follows existing roadway as it passes through a mix of developed and undeveloped areas, including four areas mapped as Unfragmented Habitat Blocks, of which two are ranked as Supporting Landscapes in the 2015 Wildlife Action Plan (Figure 4.16-2). Alternative C would consume about 7.7 acres of non-vernal pool wetland; impact three vernal pools totaling about 0.3 acres; and have four stream crossings, none of which are new (Table 4.16-1). West of NH 28, Alternative B and C follow the same footprint and would have the same impacts. Between Alternative C's I-93 interchange and its juncture with the Alternative B footprint, Alternative C follows an existing powerline ROW, then follows the existing NH 28 footprint where it abuts a small section of wetland habitat that is mapped in the 2015 Wildlife Action Plan as Highest Ranked Habitat in Biological Region (Figure 4.16-2). Within the powerline ROW, this portion of Alternative C also could impact shrubland-associated bird, reptile, and insect species, and the wetland likely provides habitat for a wide variety of wildlife, including reptiles and amphibians. Additional pavement or traffic associated with construction of Alternative C would potentially increase road-related impacts on wildlife associated with this wetland.

Alternative D

Alternative D primarily follows existing roadways (20,231 of 29,525 linear feet) (Table 4.16-1), but it does pass through one unfragmented habitat block (Figure 4.16-2) and would impact about 3.8 acres of non-vernal pool wetland; impact four vernal pools totaling about 0.3 acre; and have a total of six stream crossings, none of which are new (Table 4.16-1). Because Alternative D follows the same footprint as Alternative C as it departs from I-93, it would have the same impacts as Alternative C in this section. After joining with the existing NH 28 footprint, Alternative D follows existing roadways where impacts from road improvements would be minimal.

4.17 Threatened and Endangered Species

The federal Endangered Species Act of 1973 (16 USC 1531-1543) (ESA) designates certain species throughout the United States as threatened or endangered, and as such protects them and the habitats in which they occur. The ESA defines two categories of species warranting protection: endangered and threatened. An endangered species is "in danger of extinction throughout all or a significant portion of its range" (Sec. 3[4]). A threatened species is not immediately in danger of extinction but may become endangered due to overutilization or a habitat that will become vulnerable "within the foreseeable future" (Sec. 3[15]). The ESA protects only those species that are threatened or endangered on a federal level (i.e., throughout the United States) and does not include species of regional or statewide scarcity or those species at the limits of their range.

New Hampshire has also developed its own lists of plant and animal species that are considered to be threatened and endangered within the state. These species are protected by the NH Endangered Species Conservation Act of 1979 and the NH Native Plant Protection Act of 1987. Under the Endangered Species Conservation Act of 1979, NHFGD is authorized to designate and provide statutory protection for endangered and threatened wildlife (RSA 212A:1 et seq.). Endangered wildlife are defined as those native animal species whose prospects for survival in NH are in danger because of a loss of or change in habitat, overexploitation, predation, competition, disease, disturbance, or contamination. By definition, endangered species require assistance to ensure their continued existence as viable components of the state's wildlife community. Threatened wildlife are those species that may become endangered if conditions surrounding them begin, or continue, to decline. NH's Endangered Species Conservation Act makes it unlawful to export, take, possess, sell or offer for sale, deliver, carry, transport, or ship endangered and threatened wildlife species.

The NH Native Plant Protection Act of 1987 authorizes New Hampshire Division of Forests and Lands (NHDFL) to protect rare, threatened, and endangered plants, as well as rare or noteworthy natural communities (i.e., exemplary natural areas). Within NHDRED, the New Hampshire Natural Heritage Bureau (NHNHB) locates, tracks, and provides information regarding rare (i.e., threatened or endangered) plant species and ecosystems across NH. NHNHB defines threatened species as those species with a record of 10 or fewer natural occurrences in the last 20 years, or those that are otherwise threatened by extinction due to habitat loss or other factors. Endangered species are native plants with a record of three or fewer natural occurrences in the state in the last 50 years, or plants with more than three occurrences that are especially vulnerable to extirpation. The rules promulgated pursuant to the Native Plant Protection Act require that NHNHB be consulted regarding the actual or potential presence of listed plant species within a study area for any state project or any plant species on state-owned land. NHNHB reviews the information, assesses any potential impacts on the listed species, and recommends how to protect the survival of the species at the particular site.

Information on the potential presence of threatened or endangered species and exemplary natural communities within the study area was provided by NHNHB (Amy Lamb, letters dated April 4, 2016) and USFWS (New England Ecological Services Field Office, letter dated June 20, 2018).

A more inclusive study area, (encompassing 26 square miles, outlined in the NHNHB review) was used for these data requests to provide a broader context for rare plant, animal, and natural community occurrences. As NHNHB notes, the information provided is not based on a comprehensive field survey and is therefore not definitive. NHNHB provided supplemental data specific to the Project area in April, 2018 (NHNHB, 2018). Copies of the response letters from these agencies are included in Appendix K.

4.17.1 Affected Environment

Plants

Threatened and Endangered Plant Species (Federal)

No federally listed threatened or endangered plant species are known to occur within the study area.

Threatened and Endangered Plant Species (State)

NHNHB data provided for the Project in April 2018 identified occurrences for 11 plant species and one exemplary natural communities within the study area: a Medium Level Fen System identified in the vicinity of Scobie Pond. Low nutrient levels, high acidity, and accumulations of peat characterize this ecosystem. Threats to this natural community include changes in hydrology, increased nutrient input associated with stormwater runoff, and sedimentation from nearby disturbances. Rarity rankings are not applicable to natural community systems, which are typically assemblages of several community types. NHNHB has determined that, due to the quality of this system, it is to be considered exemplary and therefore of statewide significance. This system would not be encroached by any of the Build Alternatives considered for the Project, and, because it is upstream of all Alternatives, it is unlikely to be affected.

Table 4.17-1 lists threatened and endangered plant species that have been documented within the study area. These species could be present near the Alternatives if suitable habitat conditions exist. None of the recorded occurrences fall within the footprint of any Alternatives. Based upon the natural communities present and the relevant life histories of these particular species, the Alternative footprints could support bird-foot violet (*Viola pedata*), hairy star-grass (*Hypoxis hirsuta*), licorice goldenrod (*Solidago odora*), and red threeawn in the more open areas on site, including forest edges and transmission line ROW. Additionally, other open-site rare species such as late purple American-aster (*Symphyotrichum patens*) are known from the vicinity but currently unidentified within the Project area by NHNHB. Dragon’s-mouth orchid, dwarf huckleberry (*Gaylussacia bigeloviana*), and northern tubercled bog-orchid (*Platanthera flava* var. *herbiola*), are unlikely to be found near the Alternatives because of a lack of acidic peatland habitat that would be crossed.

Field surveys for all species and natural communities identified by NHNHB were performed within the proposed footprint of the Alternatives between August and October 2016 and May 2017. The field surveys failed to locate any extant populations of rare plant species in the Project area. Element occurrences were reported by NHNHB for two species in April 2018, after the field surveys were performed. These species, Nuttall's reed grass (*Calamagrostis cinnoides*) and licorice goldenrod, were not included in the 2016 information request that the field efforts were based upon. The surveyors were aware that the goldenrod in particular is present in the area and were actively searching for it during the field work. Nuttall's reed grass was not known from the area by the surveyors and may have gone undetected during the field surveys. Additional field work would be necessary to determine if this species is present within the Alternative footprints.

Table 4.17-1. Element Occurrences of Plants and Natural Communities in the Project Area

Scientific Name	Common Name	Preferred Habitat(s)	Survival Status[a]		Legal Status[b]	
			Global	State	Federal	State
Arethusa bulbosa[c]	Dragon's mouth	Acidic peatlands	G4	S1H	Unlisted	E
Aristida longespica var. *geniculata*	Red Threeawn	Moist, sandy pond shores	G5T5?	S1H	Not Listed	E
Asclepias tuberosa[c]	Butterfly weed	Dry fields, roadsides, sandy soils.	G5	S1H	Not Listed	E
Calamagrostis coarctata[d]	Nuttal's reedgrass	Wetlands—bogs, fens seeps and wet meadows	G5	S1	Not Listed	E
Gaylussacia bigeloviana	Dwarf huckleberry	Acidic peatlands	G5	S2	Not Listed	T
Gentianopsis crinita[c]	Fringed gentian	Low woods, wet meadows, stream banks	G5	S2	Not Listed	T
Hypoxis hirsuta[c]	Hairy star-grass	Dry, open, deciduous woods	G5	S2	Not Listed	T
Platanthera flava var. *herbiola*[c]	Pale green orchid	Boggy and swampy areas	G4T4	S1	Not Listed	E
Soldiago odora ssp. *odora*[d]	Licorice goldenrod	Dry forests, disturbed areas, sandplains	G5	S1	Not Listed	T
Viburnum rafinesquianum[c]	Downy arrowwood	Dry, calcareous woods	G5	S1H	Not Listed	E
Viola pedata[c]	Bird's foot violet	Dry fields, open woods	G5	S2	Not Listed	T
Exemplary Natural Community Description						
Medium Level Fen System: Stagnant wetland characterized by low-moderate nutrient levels and peat accumulation. More minerotrophic influence than Poor Level Fen Systems.						

Note: All data from NHNHB correspondence dated April 4, 2016, and data provided by NHNHB on April 27, 2018.

a Survival Status: Global level (G) and State level (S):

G1 S1 Critically imperiled (very rare and/or extremely prone to extinction)
G2 S2 Imperiled (rare and/or prone to extinction)
G3 S3 Rare and local, or of restricted range, or somewhat prone to extinction
G4 S4 Apparently secure
G5 S5 Demonstrably secure

T = subspecies or variety rank (e.g., G5T4 applies to a subspecies with a global species rank of G5, but with a subspecies rank of G4)

Survival Status Qualifiers: ? = Status ranking not final; H = Historical record, last documented occurrence at least 20 years prior to date of consultation (e.g., SH applies to a species that occurred historically in the state but has not been observed recently)

[b] Legal Status: E = Endangered, T = Threatened.

[c] Species known but not found in Study Area during 2016-2017 field surveys.

[d] Species added by NHNHB after field surveys were performed for the 2016–2017 field season.

Animals

Four classes of listed special status species are considered in this section, consisting of federally listed threatened and endangered species, state-listed threatened and endangered species, Species of Special Concern, and Species in Greatest Conservation Need. The four classes are defined in the following section. NHNHB provided information on the potential special status species within the study area (NHNHB, 2016; 2018) and USFWS (USFWS, 2018). As NHNHB notes, the information provided is not based on a comprehensive field survey and is therefore not definitive. Appendix K contains copies of the response letters from these agencies.

The ESA designates certain species throughout the United States as threatened or endangered and grants protections to them and to their habitat if it is designated as Critical Habitat. An endangered species is “in danger of extinction throughout all or a significant portion of its range” (Sec. 3[4]). A threatened species is not immediately in danger of extinction but may become endangered “within the foreseeable future” (Sec. 3[15]). This vulnerability may be due to one or multiple factors, including habitat loss, overutilization, or disease.

New Hampshire also designates species as threatened or endangered within the state, granting them protection under the NH Endangered Species Conservation Act of 1979. Endangered wildlife are defined as those native animal species whose prospects for survival in New Hampshire are in danger because of a loss of or change in habitat, over-exploitation, predation, competition, disease, disturbance, or contamination. Threatened wildlife are those species that may become endangered if conditions surrounding them begin, or continue, to decline.

In addition to threatened and endangered species, New Hampshire also designates Species of Special Concern, which are species that are either “Near-threatened” or are “Responsibility Species.” Near-threatened species include those that could become threatened in the foreseeable future if action is not taken as well as those which were recently down-listed (i.e., recovered) from the state endangered and threatened species list and where conservation action is prudent to ensure the species continues towards full recovery. Responsibility species are those species for which a large portion of their global or regional range (or population) occurs in New Hampshire and where actions to protect these species habitat will benefit the species' global population.

The 2015 New Hampshire Wildlife Action Plan also identifies 169 species as species of greatest conservation need (SGCN), which includes all Special Concern, Threatened, and Endangered species. Additional species are designated in the New Hampshire Wildlife Action Plan as SCGN for a variety of reasons, including a restricted distribution and/or abundance in New Hampshire and the Northeast, downward statewide, regional, or global population trends, known risks to the species, status and risk to species’ habitat in New Hampshire, the species’ vulnerability due to life-history traits, and the amount and quality of the information available to assess species status, trends, and threats.

Threatened and Endangered Animal Species (Federal)

As USFWS (2018) reports, the only federally listed species potentially present within the Project area is the federally listed as threatened northern long-eared bat (NLEB; *Myotis septentrionalis*). This species is also state-listed as threatened. This tree-roosting bat uses forested habitats during its active season from April 15 – October 31. The Project has the potential to affect this species via tree clearing, which could reduce roosting habitat or cause direct mortality if an occupied roost tree is felled when bats are present. Therefore, a survey compliant with USFWS' 2016 *Range-wide Indiana Bat Summer Survey Guidelines* (Guidelines) (USFWS, 2016), which are also applicable to summer survey for NLEB, was conducted, and this species was determined not to be present. Appendix M contains a full description of the survey and results.

Threatened and Endangered Animal Species (State)

Based on NHNHB records, six state-listed animal species have been recorded within the study area. Consultation with NHNHB in 2018 provided the year and location of observations within the study area for Blanding's turtle, box turtle, spotted turtle, northern black racer, spotted turtle, grasshopper sparrow, and New England cottontail. Table 4.17-2 summarizes these records. Additionally, the state-listed little brown bat has the potential to be present. Although not included in NHNHB's known records for the Project area, prior to the advent of White-nose Syndrome, this species was known to have state-wide distribution and was New Hampshire's most common bat species. However, manual review of the acoustic data collected during the survey for the NLEB indicate this species was not detected.

Species of Special Concern (State)

Based on records held by NHNHB, four Species of Special Concern have been recorded within the study area. Consultation with NHNHB in 2018 provided the year and location of observations within the study area of smooth green snake, wood turtle, redfin pickerel, and banded sunfish. Table 4.17-2 summarizes these records. The two fish species fall within the footprint of Alternatives C and D.

Species of Greatest Conservation Need

A total of 169 species are identified as SGCN in the 2015 Wildlife Action Plan, of which NH lists 27 species as endangered, 14 as threatened, and 61 as special concern. The remaining 77 species received the SGCN for a variety of reasons, including a restricted distribution and/or abundance in NH and the Northeast; downward statewide, regional, or global population trends; known risks to the species; status and risk to species' habitat in NH; the species' vulnerability due to life-history traits; and the amount and quality of the information available to assess species status, trends, and threats. NHNHB does not track SGCNs. Of the SGCN species not previously discussed as state-endangered, threatened, or special concern species, there are 23 additional species that could occur within the study area, based on their known habitat preferences and distribution within the state. Table 4.17-3 lists these species.

Table 4.17-2. Element Occurrences of Rare Wildlife Species

Species	Status	Town	Preferred Habitat	Observations within the last 25 Years
Blanding's Turtle (*Emydoidea blandingii*)	Endangered (State)	Derry	Wetlands with permanent shallow water and emergent vegetation, vernal pools, may use slow rivers and streams for travel and terrestrial habitats for nesting and travel among wetlands	Lower Shields Pond—1997, 2005, 2006, 2006, 2008, 2010 Scobie Pond—2005
		Londonderry	Described above	Nesenkeag Brook—2006, 2006, 2013, 2013 Little Cohas Brook—2004, 2009, 2012, 2014 Scobie Pond—2006, 2012, 2013
		Windham	Described above.	Mitchell Pond – 2007, 2013
Eastern Box Turtle *(Terrapene Carolina)*	Endangered (State)	Londonderry	Terrestrial areas such as dry and moist woodlands, old fields, pastures, power-line corridors, and edges of marshes, bogs, and shallow streams.	Cohas Brook Headwaters 2016
New England Cottontail (*Sylvilagus transitionalis*)	Endangered (State)	Derry	Dense shrubs and regenerating clear cuts	2012
		Londonderry	Described above.	Little Cohas Brook—2002, 2013 South of Moose Hill—2002
Northern Black Racer (*Coluber constrictor constrictor*)	Threatened (State)	Londonderry	Dry brushy pastures, powerline corridors, rocky ledges, and woodlands	Scobie Pond—2013 I-93—2014, 2014
Spotted Turtle (*Clemmys guttata*)	Threatened (State)	Derry	Wetlands with shallow, permanent water bodies and emergent vegetation	Rainbow Pond—1997, 2006 Scobie Pond—2015 Beaver Lake—2014 Robert Frost Farm—2012
		Londonderry	Described above.	Old Derry Rd—2006

Species	Status	Town	Preferred Habitat	Observations within the last 25 Years
Grasshopper Sparrow (*Ammodramus savannarum*)	Threatened (State)	Derry	Sites at least 30 acres. Dry upland sites, with short native bunch grasses, minimal litter cover, patches of bare ground, scattered forbs, and short shrubs.	2003—Old Derry Landfill
Smooth Green Snake (*Opheodrys vernalis*)	Special Concern	Derry	Found in upland grassy fields, pastures, meadows, and forest openings	Vista Ave.—2008
		Londonderry	Described above.	Little Cohas Marsh—2003
Wood Turtle (*Glyptemys insculpta*)	Special Concern	Derry	Slow-moving streams and channels with sandy bottoms	South of Beaver Lake – 2011
		Londonderry	Described above.	Old Nashua Rd—2006 Beaver Brook Tributary – 2014 2015 (Beaver Brook)
Banded Sunfish *(Enneacanthus obesus)*	Special Concern	Londonderry	Acidic, heavily vegetated waters small and large rivers	Shields Brook – 2005
Redfin Pickerel *(Esox americanus americanus)*	Special Concern	Londonderry	Streams with dense vegetation and/or decaying matter	Shields Brook – 2005

Note: All data from NHNHB, 2016, 2018.

Table 4.17-3. Species of Greatest Conservation Need that may be Present within the Project Area

Species	Habitat Associations
Butterflies & Moths	
Monarch	Open habitats with milkweed
Bumblebees	
American Bumble Bee	Open farmland, hay, old fields
Yellowbanded Bumble Bee	Meadows, wetlands, woodlands, urban areas
Dragonflies & Damselflies	
Coppery Emerald	Breeds in sluggish forest streams, feeds in open habitats
Amphibians	
Northern Leopard Frog	Wetlands, wet meadows
Blue-Spotted/Jefferson Salamander	Palustrine wetlands including (but not limited to) vernal pools, forested uplands
Reptiles	
Eastern Ribbonsnake	Wetlands, wet meadows
Birds	
American Woodcock	Field edges, shrublands
Black-billed Cuckoo	
Brown Thrasher	Shrublands
Chimney Swift	Various, nests in chimneys
Eastern Towhee	Shrublands
Field Sparrow	Shrublands
Prairie Warbler	Shrublands
Purple Finch	Mixed and coniferous forest
Scarlet Tanager	Mixed and deciduous forest
Veery	Forested wetland and stream edges
Wood Thrush	Mixed and deciduous forest
Mammals	
Big Brown Bat	Fields, forest edges
Eastern Red Bat	Fields, forest edges
Hoary Bat	Fields, forest edges
Silver-haired Bat	Fields, forest edges
Tricolored Bat	Fields, forest edges

Source: NHFGD (2015a)

4.17.2 Environmental Consequences

State Threatened and Endangered Plant Species

No Build Alternative

The No Build Alternative would not require any new roadway construction. The No Build Alternative would, therefore, not result in any new impacts on state-listed threatened or endangered plant species.

Build Alternatives

As discussed in Section 4.17.1, several state-listed threatened and endangered plant species have been documented within or adjacent to the study area. None have been specifically documented within the potential area of impact for any of the proposed Build Alternatives. In addition, preliminary searches for threatened and endangered plant species along each proposed Build Alternative corridor did not identify extant populations. The greatest opportunity for any undocumented populations of rare plants to be affected by the proposed Project is along portions of the Project that cross or are aligned with transmission line ROW. These areas pose the greatest potential to support populations of anise-scented goldenrod, bird-foot violet, and spiked needle-grass, although none of these were found during surveys. Table 4.17-4 provides a comparison of the likelihood of rare plants that are known to occur within the study area to be found within the existing habitat of the proposed Alternative footprints.

Table 4.17-4. Potential for Rare Plants to Occur Within Exit 4A Alternative Footprints

Scientific Name	Common Name	Preferred Habitat(s)	Likelihood of Occurrence, by Alternative[a]				
			A	B	C	D	F
Arethusa bulbosa[b]	Dragon's mouth	Acidic peatlands	U	U	U	U	U
Aristida longespica var. *geniculata*	Spiked needle grass	Moist, sandy pond shores	U	P	P	U	U
Asclepias tuberos [b]	Butterfly weed	Dry fields, roadsides, sandy soils.	U	P	P	U	U
Calamagrostis coarctata[c]	Nuttall's reedgrass	Wetlands—bogs, fens seeps and wet meadows	P	P	P	P	U
Gaylussacia bigeloviana	Dwarf huckleberry	Acidic peatlands	U	U	U	U	U
Gentianopsis crinita[b]	Fringed gentian	Low woods, wet meadows, stream banks	P	P	P	P	U
Hypoxis hirsuta[b]	Hairy star-grass	Dry, open, deciduous woods	P	P	P	P	P

Scientific Name	Common Name	Preferred Habitat(s)	Likelihood of Occurrence, by Alternative[a]				
			A	B	C	D	F
Platanthera flava var. *herbiola*[b]	Pale green orchid	Boggy and swampy areas	P	P	P	P	U
Soldiago odora ssp. *odora*[c]	Licorice goldenrod	Dry forests, disturbed areas, sandplains	P	P	P	P	P
Viburnum rafinesquianum[b]	Downy arrowwood	Dry, calcareous woods	P	P	P	P	U
Viola pedat[b]	Bird's foot violet	Dry fields, open woods	P	P	P	P	U

[a] U = Unlikely, P = possible.
[b] Species known from Derry or Londonderry, but not found specifically within the study area. From NHNHB 2016.
[c] Species added by NH NHB after field surveys were performed for the 2016-2017 field season.

Similarly, although one exemplary natural community was identified within the study area limits, it is more than 0.5- mile upstream of Alternatives C and D. Therefore, direct impacts on this natural community are not anticipated as a result of implementing any of the Build Alternatives.

Wildlife

Federal Threatened and Endangered Wildlife Species

As discussed in Section 4.17.1, no federally endangered species are known to be present in the Project area. Therefore, no impacts on federally endangered species are expected as a result of the Project.

State-Listed Wildlife

Banding's, Spotted, and Wood Turtles:

As discussed in Section 4.17-1 (Table 4.17-3), four state-listed turtle species have been documented in or near the Project area: Blanding's turtle (state endangered), box turtle (state endangered), spotted turtle (state threatened), and wood turtle (Species of Special Concern). Box turtles are terrestrial and inhabit woodlands; pastures and fields; transmission line ROW; and edges of marshes, bogs, and streams. The other three species are more dependent on, and associated with, wetlands. Blanding's turtle habitat typically includes relatively still, shallow waters with soft muddy bottoms and abundant emergent and submergent aquatic vegetation. Ponds, lake margins, and river backwaters all potentially provide suitable habitat. Spotted turtle habitat consists of scrub-shrub and emergent wetlands, including vernal pools and shallow coves of small ponds, and this species is also known to estivate in upland fields and woodland edges during the summer. Wood turtle habitat consists of deep, slow moving streams with sandy, gravelly substrates in forested communities, and this species uses adjacent upland forests as well as emergent and scrub-shrub wetlands for foraging during the summer months. All four of these turtle species prefer sandy or gravelly upland areas with abundant sunshine to nest and will travel through upland areas to access suitable nest habitat. Additionally, the three wetland-dependent species are known to travel across and/or forage in uplands during warmer months. Uplands within 300 meters of suitable wetlands should be considered as habitat for spotted, wood, and Blanding's turtles, and there is potential for these species to be present up to 1,000 meters from their preferred wetland habitats.

Wetlands, vernal pools, and ponds that provide preferred habitat for Blanding's and spotted turtles are present throughout the landscape surrounding the Project area, and within the footprint of the Alternatives. Recent observation records for Blanding's and spotted turtles are found within the vicinity of Alternatives B, C, and D, or at locations connected to the Alternatives by areas of suitable, undeveloped habitat. The upland habitats in and around the Project are suitable for box turtles, and there is a recent observation for this species in the approximately 1 mile west of the Alternative C and D access ramps. The Interstate likely forms an impermeable barrier for this species which would be unlikely to be able to successfully cross I-93 either at-grade or below grade. The likelihood of box turtles being present east of the highway, where the Alternative alignments are, is low. Deep, slow moving streams with sandy, gravelly substrates that provide preferred wood turtle habitat are not as widely distributed through the surrounding landscape, as compared to wetlands, and the recorded occurrences for this species are separated from the Alternative alignments by development, I-93, and other unsuitable habitats.

Snakes

As discussed in Section 4.17-1 (Table 4.17-3), based on available habitat and recent records in the Project area, two state-listed snake species have been documented in or near the Project area: the northern black racer (state threatened) and the smooth greensnake (Species of Special Concern). Black racers use a wide variety of forested and open habitat types, including uplands and wetlands. Smooth greensnakes prefer open, grassy habitats, but also use shrubby habitats. Recent records for northern black racer are located in the vicinity of Alternatives A, B, C, and D. Recent records for smooth greensnake are located in the vicinity of Alternatives B and C.

Grasshopper Sparrow

The grasshopper sparrow is a habitat specialist, requiring relatively large (>30 acres) grassland habitats, composed primarily of short bunch grasses. It will not use dense, overly tall grasslands or grasslands with mixed with woody vegetation. This species was last observed in 2003 at the Old Derry Landfill, and no suitable habitats for this species appear to exist within or near any of the Alternative alignments. Previous Project-related surveys conducted for this species, when open habitats were more available in and around the Alternative footprints, did not detect this species. Grasshopper sparrow is not expected to be present within or in the vicinity of any of the Alternatives. No impacts on it as a result of the Project are expected, and it is not discussed further in the Alternatives review later in this section.

New England Cottontail

The state-endangered New England cottontail depends on early successional and shrubland habitats with a high density of woody stems to provide browse and cover from predators. Although individuals require only a small area of suitable habitat, these areas must be well interconnected by suitable cover to maintain a viable population. This species has been documented in Derry north of Beaver Lake in 2002; in Londonderry south of Moose Hill in 2002; and near little Cohas Brook in 2011, 2013 and 2015 (Table 4.17-3). The Londonderry locations are both over 2 miles from the Project area and separated from it by I-93. The Derry location is separated from the Project footprint by a substantial area of unsuitable habitat (row crops and suburban development). Suitable habitat is insufficient within the footprint of Alternative A or D to support New England cottontail. The powerline ROW in Alternatives B and C does have suitable habitat during certain parts of its vegetation maintenance cycle, but this habitat is ephemeral, narrow, and fragmented by roads and residential developments and isolated from other suitable habitats and known populations. New England cottontail is not expected to be present within or in the Project area. No impacts on New England cottontail as a result of the Project are expected.

Fish

As discussed in Section 4.17-1 (Table 4.17-3), based on available habitat and recent records, two Species of Special Concern fish have been documented in the Project area: the banded sunfish and the redfin pickerel. Banded sunfish prefer stands of submerged aquatic vegetation along the margins of lakes, ponds, and slow flowing rivers. They are often found far upstream in beaver ponds and small wetlands in the headwaters streams of a watershed and are highly tolerant of acidic water. The redfin pickerel prefers shallow weedy backwaters in stands of aquatic vegetation or thick overhanging grasses and shrubs, and it is frequently found in streams flowing through abandoned beaver ponds in very small watersheds that may dry up in some years. Both of these species have been recently confirmed as present in Shield Brook, in the vicinity of Alternatives C and D.

Species of Greatest Conservation Need

Based on the habitat available in the Project area, 4 insects, 2 amphibians, 1 reptile, 11 birds, and 4 bat SGCNs could be present. Note that the acoustic survey conducted for the NLEB recorded probable calls of all the SGCN bat species. Broadly, three insect species use open meadow-type habitats, five bird species use shrublands, four bird species use forests, one bird species is associated with built environments, the bat species use field and forest edges, and the remaining four species are wetland associated (Table 4.17-5). Alternatives A through D affect all these types of habitats to varying degree, and the potential impact of each Alternative on SGCNs is briefly summarized below.

Table 4.17-5. Potential for Impacts on State Endangered, Threatened, Special Concern, and Greatest Conservation Need Species

Species	Preferred Habitat	Alternative				
		A	B	C	D	F
State Endangered						
Blanding's Turtle	Wetlands with permanent shallow water and emergent vegetation, vernal pools, may use slow rivers and streams for travel and terrestrial habitats for nesting and travel among wetlands	low	high	high	mod	low
New England Cottontail	Dense shrubs and regenerating clear cuts	low	low	low	low	low
State Threatened						

Species	Preferred Habitat	Alternative				
		A	B	C	D	F
Northern Black Racer	Dry brushy pastures, powerline corridors, rocky ledges, and woodlands	high	high	mod	mod	low
Spotted Turtle	Wetlands with shallow, permanent water bodies and emergent vegetation	low	low	low	low	low
Grasshopper Sparrow	Sites at least 30 acres. Dry upland sites, with short native bunch grasses, minimal litter cover, patches of bare ground, scattered forbs, and short shrubs.	low	low	low	low	low
Special Concern Species						
Smooth Greensnake	Found in upland grassy fields, pastures, meadows, and forest openings	low	mod	mod	mod	low
Wood Turtle	Slow-moving streams and channels with sandy bottoms	low	low	low	low	low
Banded Sunfish	Acidic, heavily vegetated waters small and large rivers	low	low	high	high	low
Redfin Pickerel	Streams with dense vegetation and/or decaying matter	low	low	high	high	low
Species of Greatest Conservation Need						
Monarch	Open habitats with milkweed	low	mod	mod	low	low
American Bumble Bee	Open farmland, hay, old fields	low	low	low	low	low
Yellowbanded Bumble Bee	Meadows, wetlands, woodlands, urban areas	low	mod	mod	low	low
Coppery Emerald	Breeds in sluggish forest streams, feeds in open habitats	low	low	low	low	low
Northern Leopard Frog	Wetlands, wet meadows	low	mod	mod	low	low
Blue-Spotted/Jefferson Salamander	Palustrine wetlands including (but not limited to) vernal pools, forested uplands	mod	mod	mod	mod	low
Eastern Ribbonsnake	Wetlands, wet meadows	low	mod	mod	low	low
American Woodcock	Field edges, shrublands	low	low	low	low	low
Black-billed Cuckoo	Deciduous and mixed forests	low	low	low	low	low
Brown Thrasher	Shrublands	low	low	low	low	low
Chimney Swift	Various, nests in chimneys	low	low	low	low	low
Eastern Towhee	Shrublands	low	mod	mod	low	low
Field Sparrow	Shrublands	low	mod	mod	low	low
Prairie Warbler	Shrublands	low	mod	mod	low	low

Species	Preferred Habitat	Alternative				
		A	B	C	D	F
Purple Finch	Mixed and coniferous forest	mod	mod	mod	low	low
Scarlet Tanager	Mixed and deciduous forest	mod	mod	mod	low	low
Veery	Forested wetland and stream edges	mod	mod	mod	low	low
Wood Thrush	Mixed and deciduous forest	mod	mod	low	low	low
Big Brown Bat	Fields, forest edges	low	low	low	low	low
Eastern Red Bat	Fields, forest edges	low	low	low	low	low
Hoary Bat	Fields, forest edges	low	low	low	low	low
Silver-haired Bat	Fields, forest edges	low	low	low	low	low
Tricolored Bat	Fields, forest edges	low	low	low	low	low

Alternative A

Although Alternative A primarily follows an existing roadway in highly developed residential and commercial areas, it also crosses an undeveloped parcel that supports the largest unfragmented habitat block potentially affected by any of the Alternatives. Alternative A would impact a total 4.1 acres of wetlands, including 1.1 acres of vernal pool habitat. No nearby records for any listed turtle species were found in the vicinity of Alternative A, but there are recent records for northern black racer within the footprint of Alternative A. Because racers use a wide variety of habitats, the entire undeveloped parcel potentially provides suitable habitat, and the section of Alternative A that would cross it would result in habitat loss, habitat fragmentation, and increased potential for road mortality.

Because the majority of the natural habitat that would be impacted by Alternative A is forested, the forest-dependent avian SGCNs (Table 4.17-5) are also likely to be affected by this alignment. This impact would be magnified because the alignment bisects a large Unfragmented Habitat Block, and forest-dependent species are typically sensitive to fragmentation effects. However, this Alternative would impact the least amount of forest cover type of Alternatives A through D, would have the smallest wetland impact, and would affect only a small amount of shrubby habitat, minimizing its impacts on SGCNs that depend on these habitat types.

Alternative B

Alternative B would create the most new roadway footprint of all the Alternatives, with only 7,716 of 29,536 linear feet (26 percent) following existing roadway, and would affect a total of about 8.7 acres of wetlands, including 1.1 acres of vernal pool habitat directly, the most of any Alternative. West of NH 28, Alternative B shares the same footprint as Alternative A across the large, unfragmented habitat block and would have the same potential impacts on the northern black racer and forest-dependent birds. East of NH 28, Alternative B would impact three smaller Unfragmented Habitat Blocks as well as shrubby habitats associated with a powerline ROW. There are recent records for Blanding's turtle within the Alternative B footprint, and recent spotted turtle and smooth greensnake records in the vicinity, that are connected to the roadway footprint by undeveloped habitats areas.

In addition to consuming and fragmenting habitat, Alternative B would increase the potential of road mortality for Blanding's turtle, spotted turtle, and smooth greensnake. Indirect impacts on listed reptiles also include increased exposure to collection and entrapment in catch basins and other roadway drainage structures. Impacts on shrubby habitats potentially affect shrubland bird SGCNs (Table 4.17-5). Additionally, this Alternative would also affect the greatest amount of wetland habitat of all the Alternatives. Because it would affect the shrubby habitat of a powerline ROW east of NH 28, it could affect wetland- and shrubland-dependent SGCNs as well (Table 4.17-5).

Alternative C

Moving eastwards from I-93, Alternative C bisects a small Unfragmented Habitat Block, than follows NH 28 until it turns to the northeast and follows the same footprint as Alternative B. Alternative C would impact a total of about 7.9 acres of wetlands, including about 0.3 acre of vernal pool habitat directly, and there are records for Blanding's turtle, spotted turtle, and northern black racer in the vicinity of the initial portion of Alternative C, as well as the listed species records described above for the portion of the footprint that Alternative C shares with Alternative B. Suitable, undeveloped habitats provide a connection between all the recorded locations and Alternative C. Therefore, Alternative C would have the same type of impacts as Alternative B on listed turtles and snakes, including habitat loss and increasing the potential for road mortality, collection, and entrapment in drainage structures. Additionally, the interchange footprint of Alternative C west of I-93 is in the vicinity of a recent record for box turtle, and the new interchange could have all the same impacts on this species west of I-93.

Alternative C also crosses Shields Brook in the vicinity of recent records for banded sunfish and redfin pickerel. If changes to this stream crossing decrease water quality or impede fish passage, these species could be affected by the Project.

Because the majority of the natural habitat that would be affected by Alternative C is forested, forest-dependent avian SGCNs have the greatest potential to be affected by it. Some of the impacts on forest species would be minimized because this Alternative crosses the Unfragmented Habitat Blocks through existing powerline ROWs. However, this in turn increases impacts on shrubland habitats and shrubland-dependent SGCNs. This Alternative also would affect nearly as much wetland habitat as Alternative B and would therefore potentially impact wetland-dependent SGCNs (Table 4.17-5).

Alternative D

Alternative D initially follows the same footprint as Alternative C, with part of the interchange footprint located west of I-93, bisecting a small unfragmented habitat block as it departs from I-93, then following NH 28. Unlike Alternative C, the remainder of Alternative D continues to follow existing roadways. However, the portion of Alternative D that follows the Alternative C footprint would impact a total of about 5.0 acres of wetland including about 0.3 acre of vernal pool habitat directly, and would have the same potential impacts on Blanding's, spotted, and box turtles; northern black racers; banded sunfish; and redfin pickerel as described above for Alternative C.

Although the majority of the natural habitat that would be affected by this Alternative is forested, impacts on forest-dependent SGCNs would be minimized because the route of this Alternative primarily follows existing roadways and would create a minimal amount of new forest habitat fragmentation. This Alternative also affects wetland habitat and would therefore result in impacts on wetland-dependent SGCNs (Table 4.17-5).

Alternative F

Alternative F would upgrade an existing roadway surrounded entirely by developed cover types. Alternative F is separated from existing records of listed wildlife species in the vicinity by unsuitable, developed cover types, and impacts on listed species as a result of this Alternative are unlikely. There is a small possibility that species associated with waterways could be affected by the stream crossings (Table 4.17-5).

Mitigation

Impact minimization and mitigation for all species and all Alternatives would be determined in consultation with NHFGD, NHNHB, NHDES, USFWS, USACE, and EPA to identify actions that reduce impacts associated with construction and operations. Potential actions include, but are not limited to, conducting surveys within the construction limit of work for listed animals and relocating them to safe, appropriate locations prior to initiating construction activities; fencing work areas to prevent re-entry by listed species during construction; and time of year restrictions on construction activities. It is anticipated all stream crossings would be designed to protect water quality, maintain or improve stream habitat quality, and promote passage by aquatic and terrestrial wildlife. Unavoidable impacts would be mitigated as part of the wetlands mitigation for the Project, further discussed in Section 4.12.2.

To reduce the potential for black racer mortality in the portion of the Project area from I-93 to Folsom Road due to Project construction, searches for reptiles would be conducted in the Project footprint, and all materials storage areas would be fenced to exclude reptiles. All fencing would be in place by September 15 to exclude snakes returning to potential hibernacula within the project site. The searches would be conducted in the Project footprint prior to initial ground-disturbing activities, because racers have the highest potential to be present when undisturbed habitat is still present. Once the new roadway alignment has been graded and compacted, the potential for racers to shelter in the work zone would be significantly reduced, and the potential to crush a hidden racer would be likewise reduced.

Searches for black racers would occur immediately before any heavy machinery enters the work zone or any soil alteration begins. They would be conducted under the supervision of a qualified biologist, during appropriate weather conditions, and the effort would be sufficient to ensure that work area is completely searched. All non-state-listed threatened or endangered reptile species, including listed species, encountered during these searches would be captured and released in appropriate habitat on site, but outside of the construction areas. NHFGD would be contacted immediately if any threatened or endangered species are encountered or captured, and species would not be released until after consultation with NHFGD. Depending on the sequence and timing of ground-disturbing activities, some or all of the Project area may require repeated sweeps.

Materials storage areas would be fenced to exclude reptiles, because materials being stored have a high potential to provide suitable shelter for snakes even after natural habitats have been removed from the area. Reptile-proof fencing would be used and maintained for the duration of the Project, and the fencing would be removed when the Project is complete.

In addition to the sweeps and fencing of materials storage areas, all erosion control materials used for slope and winter stabilization would be wildlife-friendly, made from natural woven fibers (no plastic mesh products) without fixed knots and without welded plastic components. Additionally, construction personnel would receive training for recognizing black racers and to take the appropriate actions to protect them. All project personnel would understand and implement the appropriate protective actions and notifications to protect listed species.

Coordination would continue with NHFGD during the permitting process to ensure that there are no additional concerns about records of listed wildlife species.

4.18 Cultural Resources

4.18.1 Regulatory Overview

Federal Regulations

Archaeological and historic architectural resources are protected by federal laws, including Section 106 of the National Historic Preservation Act (1966, as amended) (NHPA) and Section 4(f) of the Department of Transportation Act. The requirements of Section 4(f) are discussed in detail in Chapter 7*, Section 4(f) Resources*.

Section 106 of the NHPA requires federal agencies to take into account the effects of their undertakings on historic properties and allow the Advisory Council on Historic Preservation (ACHP) an opportunity to comment. Before the ACHP comments on a project, the resources and effects on those resources are evaluated by the State Historic Preservation Officer (SHPO). In NH, the Director of the New Hampshire Division of Historical Resources (NHDHR) is the SHPO. A review by the SHPO is required by 36 CFR 800 (Section 106 process) and 23 CFR 771 (Section 4(f) process). Under Section 106, provisions are made by ACHP regulations (36 CFR 800) for review and input from interested consulting parties (e.g., historical societies or advocacy groups), including local governments, Native American tribes, the public, and adjacent and affected landowners.

Section 110(f) of the NHPA requires federal agencies to account for and minimize harm to any National Historic Landmark that may be directly and adversely affected by a project.

In addition to the federal requirements, state and local cultural resources regulations are relevant to the Proposed Project.

State Requirements

With the implementation of RSA 227-C:9, Directive for Cooperation in the Protection of Historic Resources, the SHPO is responsible for overseeing the identification and evaluation of cultural resources within the state relative to the work of other state agencies.

Local Requirements

The National Historic Preservation Program operates as a partnership between the federal government, states, and local communities. Program participation by local governments is possible under the Certified Local Government Program. A community that meets requirements for enforcing appropriate state and local legislation for designating and protecting historic properties may be assigned the responsibility of reviewing and approving nominations of local properties to the NRHP and may also become eligible to apply for special matching funds. The SHPO and the Secretary of the Interior certify qualifying local governments.

The Town of Derry has been a Certified Local Government[19] since 1986. Town planning efforts in 1986 included a reconnaissance-level cultural resources survey of the entire town, funded by a grant from NPS and the SHPO. Historic and cultural resources continue to be included in Derry's planning efforts, including a Historic and Cultural Resources chapter in the 2010 Master Plan.

Derry has a Heritage Commission, but it does not have a local historic district. The East Derry Historic District was listed on the NRHP in 1982.

Londonderry has been a Certified Local Government since 2007. Londonderry has a Heritage/Historic District Commission with a small Historic Overlay District.

4.18.2 Methodology

Archaeological Resources

Area of Potential Effect

The Area of Potential Effect (APE) is the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. "The APE is influenced by the nature and scale of an undertaking and may be different for different kinds of effects caused by the undertaking" (36 C.F.R. § 800.16(d)). The initial data collection for archaeological resources was undertaken for a 26-square mile study area to identify potential constraints. The APE for archaeological resources includes the area of ground disturbance for each alternative alignment (see Figures 3.6-1 through 3.6-12 for the footprints of each Build Alternative).

Data Collection

Pre-contact Native American and post-contact European American sites and areas of archaeological sensitivity have been identified in the study area. Archaeological sensitivity areas refer to locations which exhibit the potential for archaeological resource occurrence related to either pre-contact Native American or post-contact European American occupation or activities preserved in an archaeological context.

As outlined in Appendix N, additional documentary research was completed in 2016 using information from a variety of sources, including: previous archaeological studies conducted in the Project locale since 1999; the SHPO's state-wide site files, an inventory of previously recorded archaeological sites within or in proximity to the Alternatives; the SHPO's Project review and compliance files for undertakings within the Project area that have undergone Section 106 review; the NH Old Graveyards database for any known graveyards or cemeteries within the Proposed Project alternatives; the NH State Register and NRHP files to define any significant properties within the Project area; and background information on file at Victoria Bunker, Inc.

[19] The Certified Local Government program is administered jointly by NPS and the SHPOs.

Historic Resources

Area of Potential Effect

The initial identification of historic resources was undertaken in 1998 for a 26-square-mile study area. For this SDEIS, a records search was conducted to determine if any additional historic resources were identified since the 2007 DEIS. In addition, an APE for Alternative A was identified and includes the parcels that abut the Alternative alignment (Figure 4.18-1 through 4.18-3).

Data Collection

The historic resources assessment for the I-93 Exit 4A Interchange Study was first undertaken by Preservation Company in 1998. After delays, the Project resumed in 2005, and historic resources findings were updated. However, the Project was again delayed until the effort resumed in 2016. Adding to the complexity, the Exit 4A Project area overlaps with two other NHDOT projects: the Bedford-Manchester-Londonderry Project DPR-F-0047-(001), 11512, and the I-93 Improvement Project: Salem-Manchester 10418C. These two projects were completed during the same time period, and their APEs overlapped with each other and with the APE for Exit 4A. Therefore, some of the information and survey products created for each of these projects was used to create the historic resources assessments for the Exit 4A Project, in all of its phases.

1998–2005

The initial historic resources survey for the Exit 4A Project took place from 1998–2002. Five Alternative routes (see Appendix N) were studied in the Towns of Derry and Londonderry. Work included survey of individual properties and historic districts. SHPO survey forms were completed for all resources that were over 50 years old (i.e., built before 1948) within the APE for each of the five Alternatives.

The 1998–2002 Survey of Historic Resources was undertaken according to direction from the SHPO, using the standards for survey and forms in use at that time. Field survey in Derry produced 155 Individual Survey Forms, one Historic District Form, and a Townwide Area Form; six Individual Survey Forms were completed in Londonderry.

Prior to that effort, in 1995, Preservation Company had completed a Townwide Area Form for Londonderry as part of the Bedford-Manchester-Londonderry Project DPR-F-0047-(001), 11512. In 2001, the Londonderry survey was undertaken for the I-93 Improvement Project: Salem-Manchester. It included identification of eligible properties for the Exit 4A: Derry-Londonderry Project Area: five Individual Survey Forms and one Historic District in the APE.

2007 DEIS

For the 2007 DEIS, the 2001 survey of historic properties was updated to reflect the current conditions, integrity, and eligibility of the properties that had been found eligible for the NRHP in 2002. The survey included all properties in the APE for all five Project alternatives. No properties were reevaluated in Londonderry.

2018 SDEIS

For the 2018 SDEIS, the identification of historic resources required two efforts: (1) a reevaluation of all resources that were found eligible as presented in the 2007 DEIS for Build

Alternatives A, B, C, D, and F; and (2) an evaluation along the alignment for Alternative A of any resources that had now reached sufficient age to be considered for NRHP eligibility (now 50 years or older, i.e., constructed between 1955 and 1968).

Fieldwork was completed in August 2016 to update the previous surveys in Derry and Londonderry. A windshield survey was conducted to reassess the formerly eligible properties, and any changes in their integrity were noted. Updates to the survey forms were submitted to the SHPO on continuation sheets. The evaluation of properties that had not reached sufficient age to be considered for NHRP eligibility was conducted in June 2018.

4.18.3 Cultural Context

Pre-Contact Native American Period Context

The Derry-Londonderry area, where the Project is situated, is located within the central Merrimack River drainage, which was once a focal point for Native American settlement. Pre-contact Native American archaeological resources, ranging from large habitation sites to smaller short-term habitation or special activity sites, are present along the Merrimack River, its tributaries, and the wetlands, lakes, and ponds within the Merrimack Valley. I-93 Exit 4, located at the western extent of Derry’s Broadway (NH 102), is located approximately six miles east of the Merrimack River. Known pre-contact Native American sites are located on a variety of landforms, with numerous sites occurring in proximity to the Merrimack River, tributary streams, or other landscape features (Kenyon and McDowell, 1983; Potter and Bunker, 1991; Potter and Ohl, 1992). Available evidence suggests that Native American site setting and location changed over time in response to evolving landscapes and biotic communities.

Pre-Contact Native American Existence in Merrimack Valley

11,500 to 10,000 Years Before Present

Pre-contact Native American peoples first entered the Merrimack Valley during the Paleo-Indian period (11,500-10,000 years before present [BP]), a time of rapid environmental change and instability. The Merrimack River was beginning to form from the draining of a series of glacial lakes after 13,000 BP, leaving behind high sandy terraces that became the focal point of pre-contact settlement (Potter, 1994). The archaeological record for Paleo-Indian habitation in the central Merrimack Valley, while limited, clearly indicates that the area was inhabited and suggests sites are found in relation to glacial lake shore margins and outwash terraces (Bunker and Potter, 1994).

10,000 to 8,000 Years BP

The Paleo-Indian cultures were replaced by, or evolved into, the cultures of the Archaic period that are well-represented in the archaeological record throughout the Merrimack drainage. The river itself meandered widely as it eroded through glacial sediments and did not stabilize in its present course until 8000 BP (Potter, 1994). The Archaic period marks the beginning of economic systems geared toward local environments during which increasingly stable settlement patterns developed around predictable, seasonally available resources including anadromous fish, game, and plant resources.

8,000 to 5,500 Years BP

Aside from possible Middle Archaic sites attributable to the Gulf of Maine Archaic Tradition, the Middle Archaic period (8,000-5,500 BP) is well-represented by more typical flaked-stone tool complexes in the central Merrimack Valley (Bunker, 2006). Smaller Middle Archaic sites occur in interior locations, including one site (Site #27RK69) within the study area on Ezekiel Pond in Derry, where a Neville point, stone axe, pestle, and whetstone were recovered (Proctor, 1938).

5,500 to 3,000 Years BP

The Late Archaic period (5,500-3,000 BP) is well-represented throughout the Merrimack drainage (Bunker and Potter, 1994). Settlement during this period followed the broad patterns established during the Middle Archaic period, and sites with both Middle and Late Archaic components are frequently encountered along the Merrimack River. Within the study area, a single Late Archaic site, located west of I-93 in Londonderry (Site #27RK107) is recorded in the archaeological site files.

3,000 to 500 Years BP

The beginning of the Woodland period at 3000 BP did not bring about sudden or profound shifts in Native American life in the Merrimack Valley. The transition from the Late Archaic period to the Early Woodland period (3,000-2,000 BP) is marked by the addition of ceramics to the material culture inventory, while use of some other artifact types, such as the projectile points of the Small Stem tradition, continued (Goodby, 1988). Unlike other areas of eastern North America, there is no indication of agriculture until the end of the Woodland period.

The beginning of the Late Woodland period marks a number of changes in the cultures of the Merrimack Valley that are clearly reflected in the archaeological record. There is a change in projectile point forms, as Jack's Reef points are replaced by triangular Levanna points. Ceramics gradually become more elaborate in decoration and form. Exotic lithics decreased in frequency, with a return to more locally available lithic materials. Additionally, the period marks the first appearance of maize agriculture in New England. While ceramics and projectile points from this period are encountered throughout the Merrimack Valley, including the large sites at Amoskeag Falls, many Late Woodland sites are shallow and have suffered considerable disturbance from historic plowing. Therefore, there is less known about this most recent period of pre-history than about many earlier periods. Within the study area, a single Late Woodland site, located near King Arthur Drive in Londonderry (Site #27RK106) is known from a location west of Hardy Road in Derry where a felsite Levanna point was recovered.

By 500 years ago, European travelers, explorers, surveyors, traders, soldiers, missionaries and settlers had arrived, coming into contact with the Native American occupants of the Merrimack Valley. The next centuries (1600s–1700s) were characterized by profound culture change as native peoples were displaced and populations were ravaged by warfare and disease.

Expectations

People occupied the central Merrimack Valley, including the Exit 4A study area, throughout the entire pre-contact Native American period beginning circa 11,500 BP. While sites are known and expected to occur in a variety of environmental settings, they have typically been recorded in areas of well-drained soils on level or moderately sloping terrain in association with rivers, streams, wetlands, and other surface water features. Sites may range in size and nature, reflecting their place in shifting patterns of settlement, differences in site function, or other factors. With the exception of alluvial floodplain settings, sites are expected to be shallow, and some may have suffered disturbance from historic plowing or historic and modern development. Sites within the Exit 4A study area would most likely be related to other sites within the central Merrimack drainage and are expected to reflect a larger system of settlement and economic activity practiced by pre-contact Native American period cultures.

Post-Contact European American Context

Derry and Londonderry are located in the southwestern corner of Rockingham County, southeast of Manchester and north of the Massachusetts State line. Until 1827, the two towns together comprised the Town of Londonderry.

Major Transportation Routes in Area

The historical development of Derry and Londonderry is directly linked to its proximity to major industrial cities, including Manchester, Nashua, Lowell, Lawrence, and Haverhill. Major transportation routes parallel each other and run southeast/northwest. These routes include:

- Londonderry Turnpike—Built in 1806 and later rebuilt as the NH 28 Bypass
- NH 28 (Rockingham Road)—Follows a series of older roads and created as a state highway in 1915
- Mammoth Road—Built in 1831 between Lowell and Concord and passes through Londonderry
- M&L Railroad—Built in 1849 and now abandoned
- I-93 (Alan B. Shepard Highway)—Built in the 1960s with interchanges at NH Routes 28 and 102 (Exits 5 and 4, respectively)
- NH 102 (Nashua Road)—Established as a state highway between Hudson and Derry in 1915 and between Derry and Raymond in 1919.

Many of the principal roads through Londonderry (including Derry) were laid out in the 1720s, including East Derry Road, the road between the current center of Londonderry and Derry Village, along East Pillsbury Road, Pond Road, Kendall and Island Pond Roads, Old Chester Road, and a road from Derry Village to the Amoskeag Falls, along what is now Old Derry Road. The section of road between what are now Derry Village and West Derry was laid out in 1737, as was a road connecting Derry Village and what would later become North Londonderry. The main east-west road through Londonderry (now Stonehenge and Litchfield Roads) was built in 1744 (Monroe and Federer, 1993; Hurd, 1892; Derry Historic Research Committee, 1977).

Village Centers

Village centers developed around these various routes and their intersections. The earliest center in the original Town of Londonderry was East Derry (Upper Village) on Hampstead Road, a very early east-west route through the region. Derry Village (Lower Village) then developed in the late 18th and early 19th centuries. It centered around mills on Beaver Brook and the Londonderry Turnpike, at the turnpike junction with roads connecting Exeter, Chester, and

Hampstead with the Merrimack River. West Derry developed on what is now NH 102 during the second half of the 19th century around the railroad depot and adjacent industries. It replaced Derry Village as the town center.

Londonderry, the present town center, was established in the early 19th century at the intersection of Mammoth and East and West Pillsbury Roads. The largest village within Londonderry is North Londonderry, which developed in the late 19th century in the northwest corner of the study area. Between West Derry and North Londonderry, a secondary railroad depot developed at Wilson's Crossing on the north side of NH 28, just east of I-93 Exit 5. The area shown as Londonderry Post Office on late 19th century maps developed around the intersection of Mammoth (NH 128) and Nashua Roads (NH 102) as a cluster of several residences, a tavern, and a store and post office. Crowell's Corner is a small population center around the five-corner intersection of Mammoth Road (NH 128), South Litchfield, Stonehenge, and Bartley Hill Roads (Monroe and Federer, 1995).

The Town of Londonderry began constructing the necessary public buildings immediately following settlement. A meeting house was built between 1720 and 1722 and stood just north of the present First Parish Church in East Derry. The first schoolhouse was constructed in 1723 (Historical Booklet Committee, 1969; Hurd, 1882).

Town of Derry Formation

In 1827, due to the size of the town and its population, the original Town of Londonderry was divided in half. The eastern part, although it was the older section of town, received a new name when it was incorporated as Derry on July 2, 1827. The western half retained the name Londonderry. Derry received three-fifths of the valuation of the old town and three-fifths of the population (Hurd, 1892). In size, Derry was 22,600 acres and Londonderry 25,870 acres. In August of 1827, the name of the old post office was changed to Derry (Hurd, 1892). As of 1830, Londonderry had a population of 1,467, while Derry had 2,178 (U.S. Census Bureau, 1909).

Historical Development of Londonderry and Derry

The historical development of Londonderry, and later Derry, was driven by several factors, such as early industrial growth (i.e., sawmills) in the early 18th century; farming, which focused on delivering fresh produce and dairy to urban markets in the late 19th century, including apple orchards; electric railways constructed in 1896 (Chester to Derry) and 1907 (Derry to Manchester), which promoted summer tourism and allowed more convenient commuting; and post-World War II development, which led to a period of high population growth in Londonderry and Derry that was sustained until the early 1990s.

4.18.4 Affected Environment

Archaeological Resources

A Phase I-A Archaeological Survey was conducted in 2009 for the Proposed Project (Goodby, 1999). The survey used a 26-square mile study area and identified three types of locations: previously recorded pre-contact Native American sites (PCNA); areas of pre-contact Native American archaeological sensitivity; and post-contact European American sites (PCEA). A total of 5 previously recorded PCNA sites, 13 areas of pre-contact Native American archaeological sensitivity, and 10 previously recorded PCEA archaeological sites were identified within the overall study area (Table 4.18-1).

Table 4.18-1. Archaeological Resources within the Study Area

Identification Number	Constraint	Description
27-RK-0021	Previously Recorded PCEA Site	Aiken's Sawmill Site, 18th–19th century mill complex
27-RK-0039	Previously Recorded PCEA Site	Adams Farmstead Complex, a 19th century farm site
27-RK-0040	Previously Recorded PCEA Site	Mammoth Road Foundation, a 19th century house site
27-RK-0045	Previously Recorded PCEA A Site	F. Griffin cellar hole, a 19th century fieldstone site
27-RK-0046	Previously Recorded PCEA Site	W. Plumer Foundation, a 19th century house site
27-RK-0050	Previously Recorded PCEA A Site	Bailey Farm Complex, a 19th century farm site
27-RK-0068	Previously Recorded PCEA Site	Original settlement of Londonderry by Scotch-Irish immigrants
27-RK-0079	Previously Recorded PCEA Site	Piskorski Site, a 19th century house/farm site
27-RK-103	Previously Recorded PCEA A Site	Historic foundation, brick-lined well, and stone walls
Unconfirmed Lead	Previously Recorded PCEA Site	A colonial period dugout canoe recovered from Beaver Lake in 1972
27-RK-0069	Previously Recorded NA Site	Prehistoric site on Ezekiel Pond includes Middle Archaic Neville Point
270RK-0106	Previously Recorded PCNA Site	Viner Site, location of the find of a Late Woodland Levanna point
27-RK-0107	Previously Recorded PCNA Site	"Eric's site", location of the find of a Late Archaic Brewerton point
27-RK-0355	Previously Recorded PCNA Site	Nisula Site, with alleged inscriptions, rock carvings, and flaked stone tools
Unconfirmed Lead	Previously Recorded PCNA Site	Native American dugout canoe recovered from Scobie Pond in 1936
P1	Area of PCNA Sensitivity	Ezekiel Pond, including all pond margins and the location of site 27RK69
P2	Area of PCNA Sensitivity	Unnamed stream draining Ezekiel Pond
P3	Area of PCNA Sensitivity	Beaver Brook and associated wetlands and larger tributaries; includes large area of wetlands southwest of Derry Village
P4	Area of PCNA Sensitivity	Tops of knolls and margins of adjacent wetlands

Identification Number	Constraint	Description
P5	Area of PCNA Sensitivity	Area near the southwest shore of Beaver Lake, adjacent to prehistoric site NH 45-7
P6	Area of PCNA Sensitivity	Northwestern shore of Beaver Lake; area has been extensively disturbed by the construction of lakefront cottages, but intact portions remain
P7	Area of PCNA Sensitivity	Unnamed stream flowing into Beaver Lake
P8	Area of PCNA Sensitivity	Horn's Pond; extensive disturbance is associated with roadways and railroad grades and only north and northwestern banks exhibit sensitivity.
P9	Area of PCNA Sensitivity	Horn's Pond; undisturbed portions between Lower Shields Pond and the confluence with Beaver Brook.
P10	Area of PCNA Sensitivity	Shields Brook; undisturbed portions between Lower Shields Pond and the confluence with Beaver Brook.
P11	Area of PCNA Sensitivity	Lower Shields Pond; pond is surrounded by wetlands, and a small cedar swamp is present on the northern shore. Extensive disturbance on the western shore is associated with the electrical transmission corridor.
P12	Area of PCNA Sensitivity	Scobie Pond; area of sensitivity includes an unnamed drainage connecting Scobie Pond and Shields Brook.
P13	Area of PCNA Sensitivity	Little Cohas Brook; area includes the headwaters of the brook and associated wetlands.

The 2016 research revealed no new recorded resources for Alternatives A, B, C, D, or F. Known archaeological sites and areas recognized as sensitive for archaeological resources in the Phase I-A study (Goodby, 1999) continue to be considered sensitive. No archaeological sites and no graveyards have been recorded within the footprints for Alternatives A, B, C, D, and F. However, the SHPO has recommended a Phase I-B archaeological survey to identify resource presence or absence for any sites or sensitive areas that would be affected by the Proposed Project.

Historic Resources

<u>1998–2005</u>

The 1998–2002 Survey of Historic Resources in Derry produced 155 Individual Survey Forms, one Historic District Form, and a Townwide Area Form; six Individual Survey Forms were completed in Londonderry.

The 2001 Londonderry survey included identification of eligible properties for the Exit 4A: Derry-Londonderry Project Area: five Individual Survey Forms and one Historic District in the APE (see Table 4.18-2).

FHWA, in consultation with NHDOT and the SHPO, determined which properties were eligible for the NRHP in 2002 (see Table 4.18-2 and Figures 4.18-4 and 4.18-5).

2007 DEIS

Resources within the study area were reviewed in March and December 2006 and April 2007. The SHPO recommended that 4 of the 26 eligible properties in Derry had changed to such a degree that they were no longer eligible for the NRHP. One historic district was determined eligible, and a preliminary determination of eligibility (DOE) was made for two additional districts in Derry with the condition that further investigation would be required if they were to be affected (see Table 4.18-2).

2018 SDEIS

For the 2018 SDEIS, all resources that were found eligible as presented in the 2007 DEIS for Build Alternatives A, B, C, D, and F were reevaluated. Table 4.18-2 presents the formerly eligible properties and identifies any changes in integrity.

Resources along the alignment for Alternative A that had now reached sufficient age to be considered for NRHP eligibility (now 50 years or older, i.e., constructed between 1955 and 1968) were evaluated. Seventeen properties, all in Derry, were identified (see Table 4.18-3).

The SHPO DOE Committee reviewed these submissions and concurred with FHWA's recommendation that three properties in Derry and one property in Londonderry no longer retained sufficient integrity to meet the standards of eligibility for the NRHP. The remaining properties retained integrity and eligibility.[20]

[20] In Londonderry, one property (LON0105, 117 Rockingham Road) became eligible in 2005 once it reached the 50-year benchmark for age. A second property, 118 Rockingham Road (LON0107), was determined ineligible because of age but should be reevaluated for eligibility if it were to be affected in the future (see Table 4.18-2)

Table 4.18-2. Historic Resources within the 2007 DEIS Study Area

Survey #	Street Address	Map-Lot	Acreage	2002 Determined Eligible	2005 Retained Integrity/ Eligibility?	2016 Retained Integrity/ Eligibility?	2016 Changes Noted in Windshield Survey
DER0025	80 West Broadway	26-042	0.44	Eligible Individually (C)	No longer eligible	--	Synthetic siding, replacement windows and doors, change to commercial use (2005)
DER0029	49 West Broadway	26-114	0.50	Eligible Individually (C)	Yes	Yes	No changes
DER0036	60-62 West Broadway	26-146	1.64	Eligible Individually (C)	Yes	No longer eligible	Vinyl siding has been added to the exterior, windows have been replaced with vinyl replacement windows in a different configuration (3/1 instead of 2/1). No other changes.
DER0038	52-54 West Broadway	26-145	0.25	Eligible Individually (C)	No longer eligible	--	Synthetic siding, replacement windows and doors (2005)
DER0044	31 West Broadway	29-141	0.26	Eligible Individually (A, C)	Yes	Yes	Windows have been replaced with combination of fixed and awning, changing the earlier double-hung style. No other changes.
DER0047	32 West Broadway	29-195	0.26	Eligible Individually (A)	Yes	Yes	Use has changed to a restaurant, windows and garage doors have been replaced, awning installed. Retains sufficient form and integrity to remain eligible.
DER0048	29 West Broadway	29-189	0.47	NR listed (A)	Yes	Yes	No changes
DER0052	Manning Street	30-051	0.72	More Information Requested	--	--	
DER0054	1 East Broadway	30-022	0.19	Eligible Individually (A)	Yes	Yes	No changes

Survey #	Street Address	Map-Lot	Acreage	2002 Determined Eligible	2005 Retained Integrity/ Eligibility?	2016 Retained Integrity/ Eligibility?	2016 Changes Noted in Windshield Survey
DER0055	8 East Broadway	30-053	0.06	Eligible Individually (C)	Yes	Yes	No changes
DER0062	20 East Broadway	30-059	1.26	Eligible Individually (A, C)	Yes	Yes	No changes; more information needed if the area is impacted.
DER0070	44 East Broadway	30-075	0.69	Eligible Individually (C)	Yes	Yes	Vinyl siding added to the exterior, accessibility ramp added to front entrance. No other changes.
DER0073	48 East Broadway	30-101	1.18	Eligible Individually (A, C)	Yes	No longer eligible	Building was demolished 2005, replaced by a pharmacy.
DER0075	52 East Broadway	30-103	0.59	More Information Requested	--	--	
DER0078	58 East Broadway	30-105	0.31	Eligible Individually (A, C)	Yes	Yes	Entry doors and sidelights have been replaced. No other changes.
DER0080	63 East Broadway	30-206	0.55	Eligible Individually (A, C)	Yes	Yes	No changes
DER0083	69 East Broadway	30-210	0.39	Eligible Individually (C)	Yes	No longer eligible	Vinyl siding added to the exterior, wood brackets and details removed, new vinyl replacement windows, new front porch constructed.
DER0084	71 East Broadway	30-209	0.47	More Information Requested	--	--	
DER0085	72 East Broadway	32-105	0.88	Eligible Individually (C)	Yes	Yes	No changes
DER0089	80 East Broadway	32-099	0.43	More Information Requested	--	--	
DER0090	81 East Broadway	32-079	0.40	Eligible Individually (C)	Yes	Yes	Vinyl replacement windows have been added. No other changes.

Survey #	Street Address	Map-Lot	Acreage	2002 Determined Eligible	2005 Retained Integrity/ Eligibility?	2016 Retained Integrity/ Eligibility?	2016 Changes Noted in Windshield Survey
DER0099	98 East Broadway	32-065	0.38	Eligible Individually (C)	Yes	Yes	New metal picket fence with granite posts has replaced wood fence. No other changes.
DER0100	102 East Broadway	32-063	0.53	Eligible Individually (C)	Yes	Yes	Upper story windows replaced. No other changes.
DER0102	116 East Broadway	33-014	1.16	Eligible Individually (B)	Yes	Yes	Attached garage in rear has been redesigned, new construction Carriage House style building added in rear. No longer single family use. No other changes.
DER0114	70 Chester Road	55-018	0.42	Eligible Individually (C)	No longer eligible	--	Synthetic siding, change in windows and exterior details (2005)
DER0121	101 English Range Road	08-045	2.0	More Information Requested	--	--	
DER0129	102 Chester Road	12-014	3.0	More Information Requested	--	--	
DER0132	120 Chester Road	12-023	13.77	Eligible Individually (A)	Yes	Yes	No changes
DER0134	76 Tsienneto Road	08-041-001	1.52	Eligible Individually (C)	Yes	Yes	Metal roof added to main house. No other changes.
DER0135	72 Tsienneto Road	55-008	1.05	Eligible Individually (C)	Yes	Yes	No changes
DER0141	104 East Broadway	32-064	0.42	Eligible Individually (C)	Yes	Yes	Bay window has been modified and replaced. No other changes.
DER0150	55 Route 28 Bypass	08-096	2.2	Eligible Individually (C)	No longer eligible	--	Building demolished (2005)
DER0161	North High Street and Franklin Street Ext.	31-014	12.5	More Information Requested	--	--	Building demolished (circa 2002)

Survey #	Street Address	Map-Lot	Acreage	2002 Determined Eligible	2005 Retained Integrity/ Eligibility?	2016 Retained Integrity/ Eligibility?	2016 Changes Noted in Windshield Survey
DER0164	131 Chester Road	12-022	4.62	More Information Requested	--	--	
DER0165	124 Chester Road	12-024	19.0	More Information Requested	--	--	
Area DV	126 East Broadway	37-009	0.96	Contributing to NR-eligible district	Yes	Yes	Vinyl siding has been added, vinyl replacement windows on upper floor, gutters added.
Area DV	128 East Broadway	37-010	0.49	Contributing to NR-eligible district	Yes	Yes	New driveway in front, new front porch with accessibility ramp, gutter added to first floor roofline.
Area DV	130 East Broadway	37-030	0.24	Contributing to NR-eligible district	Yes	Yes	Vinyl replacement windows have been added to the second floor. No other changes.
Area DV	130½ East Broadway	37-031	0.21	Contributing to NR-eligible district	Yes	Yes	No changes
Area DV	132 East Broadway	37-032	0.55	Contributing to NR-eligible district	Yes	Yes	Synthetic shutters added to more of the windows.
Area DV	East Broadway, Chester Road, North and South Main Street	--	80	Eligible as a District (A)	Yes	Yes	
Area B	NH 102/Broadway	--	--	More Information Requested	--	--	District may be eligible.
Area BI	Birch Street	--	--	No determination made	--	--	District may be eligible.
None yet	7 South Range Road	02-146	16.16	Survey to be completed	--	--	

Survey #	Street Address	Map-Lot	Acreage	2002 Determined Eligible	2005 Retained Integrity/ Eligibility?	2016 Retained Integrity/ Eligibility?	2016 Changes Noted in Windshield Survey
Area LON-WO	Pillsbury Road	Map 10	196.003	Eligible as a District (A,B)[a]	N/A	No longer eligible	Buildings have been mostly abandoned and are dilapidated, the sites are overgrown, but none had been demolished as of August 2016.
LON0100	15 Appletree Lane	10/41-1	5.0	Contributing to NR-eligible district (A)	N/A	Yes	Building uninhabited and overgrown, no changes.
LON0103	99 Rockingham Road	16/43	8.26	Eligible Individually (C)[a]	N/A	No longer eligible	Queen Anne style turned posts added to overhanging eave on façade, changing feeling and design.
LON0105	117 Rockingham Road	16/88	1.50	Eligible Individually (C as of 2005)[a]	N/A	Yes	No changes noted
LON0107	118 Rockingham Road	16/82	1.84	Not Eligible (Age)	N/A	--	No changes noted, should be re-evaluated if there are potential impacts now that the age threshold has been reached.
LON0114	79 Stonehenge Road (corner of Perkins Rd)	13/21, 22	114.39	Eligible Individually (A,C)[a]	N/A	Yes	New storm doors added, no other changes.
LON0116	Ash Street over I-93	10/00	Bridge footprint/ approach es	Eligible Individually (2003) (C,E)[a]	N/A	Yes	No changes
LON0117	113 Rockingham Road	16/93	1.40	Eligible Individually (C)[a]	N/A	Yes	No changes noted

[a] Survey forms completed for the I-93 widening project.

Individual Properties and Historic Districts Found Eligible for the National Register of Historic Places

The following section describes the resources that have been found eligible for the NRHP in previous surveys. They are identified by their historic name and NHDHR survey number. Changes to their integrity that were recorded in the windshield survey are noted in Table 4.18-2.

Derry Properties (Arranged Geographically West to East)

Broadway Historic District (Area B). This large area, also known as West Derry or Derry Depot, was identified in 1998 as a potentially eligible historic district by FHWA, in consultation with NHDOT and the SHPO. However, no formal determination of eligibility has ever been made for this district. The potential district extends along Broadway, from High Street on the north side and Fordway Street on the south side, and continues east past Hood Road.

The following properties are within the potential Broadway Historic District Area and are individually eligible for the NRHP.

Benson/Warren House (DER0029). The Benson/Warren House is individually eligible for the NRHP under Criterion C as "an excellent typical and well preserved example of a popular local house type of the early 1900s…among the most intact…" The eligible boundary is set to the 0.50-acre parcel where the house is located.

Veterans Memorial Building (DER0044). Located on the corner of West Broadway and Maple, the Veteran's Memorial Building was constructed by the Town of Derry in 1928 as a memorial to the veterans of World War I. This building "incorporates all the key hallmarks of the (Classical Revival) style in a relatively modest structure, and it has a high degree of integrity." This property is individually eligible for the NRHP under Criteria A and C. The 0.26-acre parcel that the building is set on is the eligible boundary.

Central Fire Station (DER0047). The Central Fire station is individually eligible for the NRHP under Criterion A for its associations with firefighting in Derry during the first half of the 20th century, even though the current building has changed functions to now house a restaurant. The eligible boundary is the 0.26-acre parcel limits of the fire station.

Adams Memorial Building (DER0048). The property was listed in the NRHP on January 11, 1982. "It is significant in the areas of community planning, law, politics and government, social/humanitarian, and theater." This property is individually eligible for the NRHP under Criterion A. The eligible boundary is the 0.47-acre parcel limits.

First National Bank (DER0062). The First National Bank, located at 20 East Broadway, "retains sufficient integrity to be eligible for the NRHP both for its architectural and historical significance within the village of Derry Depot. Its massing and corner siting make it a particularly prominent anchor in the village." This property is individually eligible for the NRHP under Criterion A and C. The 1.26-acre parcel of this site is the eligible boundary.

First Baptist Church (DER0070). The First Baptist Church, built on the corner of East Broadway and Crystal Avenue in 1884, is individually eligible for the NRHP under Criterion C. The church building "has a high degree of integrity of design, materials, workmanship and feeling." The 0.667-acre lot boundary is the eligible limit for this resource.

Masonic Temple (DER0078). The Masonic Temple, located at 58 East Broadway, is individually eligible for the NRHP under Criterion A and C. It "retains sufficient integrity to be eligible for the NRHP for its historical role as the clubhouse of an influential fraternal organization in Derry and for its architectural significance as a type of construction (Masonic remodeling of a residential building)." The eligible boundary encompasses the 0.31-acre parcel on which the temple is located.

St. Luke's Methodist Episcopal Church (DER0080). Located at 63 East Broadway, St. Luke's Methodist Church is the result of multiple building campaigns. The "property retains sufficient integrity for the post-1894 period to be eligible for the NRHP under Criteria A and C for its architectural significance as a Queen Anne style building." The 0.55-acre parcel limits are the eligible bounds.

Greenough House (DER0085). The Greenough House, on the corner of East Broadway and Boyd Road, is a large Colonial Revival style house with matching carriage barn, built circa 1896. The property is individually eligible for the NRHP under Criterion C "as the most intact and fully developed example of the style and period in Derry." The eligible boundary is the 0.88-acre parcel.

Abbott/Cutlip House (DER0090). The Abbott/Cutlip House, located at 81 East Broadway, is individually eligible for the NRHP under Criterion C. It is a "relatively early example" of the Bungalow style architecture "which was very popular in Derry, particularly in West Derry." The eligible boundary is the 0.40-acre parcel.

Arthur Greenough House (DER0099). Built circa 1910, the Arthur Greenough House is individually eligible for the NRHP under Criterion C as "an excellent, well-preserved example of the Colonial Revival style." The eligible boundary is encompassed by the 0.38-acre parcel.

Proctor House (DER0100). The Proctor House, built circa 1911, is set back from the north side of East Broadway (102 East Broadway), on the west edge of the village of East Derry. This building is individually eligible for the NRHP under Criterion C, as "a very good example of a large Colonial Revival residence, reflecting a significant period of building in Derry at the height of growth and prosperity." The eligible boundary is the 0.53-acre parcel limits.

Derry Properties outside the Broadway Historic District Area

Birch Street Residential Historic District (Area BI). This district, located immediately south of NH 102 along Birch Street (NH 28), was reviewed for a separate NHDOT project in the area. This district covers 20 properties and contains 16 buildings. The district's boundaries exist from south of NH 102 to the north and South Avenue to the south.

Gilbert and Helen Hood House (DER0102). The Gilbert and Helen Hood House is located at 116 East Broadway. The house, built circa 1892, is individually eligible under Criterion A and B for its associations with the roles of the Hood family (Gilbert was one of the sons of the founder of H.P. Hood Dairy) in the community and with Helen D. Hood (philanthropy and involvement with civic groups). The eligible boundary is set to the limits of this 0.16-acre parcel.

Derry Village Historic District (Area DV). This district was found eligible for the NRHP under Criterion A for documenting the development and prosperity of the village as a center of transportation, commerce, and education in Derry throughout the 19th century and into the 20th. The village contains approximately 70 resources, including 18th, 19th, and early 20th century residences; commercial and industrial properties; and Pinkerton Academy. The modern focal point of the village is the traffic circle, built in 1937, that bisects the area and affects its integrity to some degree. The district extends along NH 102 (East Broadway and Chester Road). It includes portions of East Derry Road, South Main Street (NH 28), North Main Street (NH 28 Bypass), Pinkerton Street, Crescent Street, and other side streets.

J&F Farms (DER0132). This property, located at 120 Chester Road, has been the site of an active farm since the 19th century. A farmhouse was constructed on the property in 1918 to replace the original house that burned during World War I. The farm has been owned by the Ferdinando family since 1944. The property is individually eligible for the NRHP under both Criterion A and C. "The active participation of the Ferdinando family members has been an important element in the continued success of J&F Farms, and this property is the visible and physical place that embraces the family history and its business growth, linking both to the land and buildings." The eligible limit is the 13.77 acres make up the parcel's boundary.

Palmer Homestead (DER0134). The Palmer Homestead, located at 76 Tsienneto Road, is individually eligible for the NRHP under Criterion C. The property contains "an intact mid-19th century farm complex (circa 1840), including Greek Revival style house, carriage shed, New England barn, milk house and garage." The eligible boundary for this property is the 1.52-acre parcel.

E.F. Adams House (DER0135). The E.F. Adams House, located at 72 Tsienneto Road, is individually eligible for the NRHP under Criterion C "as an example of the Greek Revival style, in the wide gable front form…distinctive for its fully pedimented gable end." The 1.05-acre parcel encompasses the eligible boundary of this resource.

Amedee Cote House (DER0141). A ranch house built circa 1947 at 104 East Broadway, the Amedee Cote House is individually eligible for the NRHP under Criterion C "as an early and fully developed example of the ranch house type. This house is also notable for its use of 'Perma-Stone', manufactured by NH Perma-stone Company in Londonderry." The limit of the eligible boundary is set to the 0.42-acre parcel. After this inventory work was completed, a group of Perma-stone ranch houses was identified in Londonderry. Any further research on this property should also consider the graphic and bibliographic material developed in the study of the Londonderry houses, as possible connections may exist.

<u>Londonderry Properties</u>

The Woodmont Orchards Historic District (LON-WO). This site was reviewed during the I-93 widening project and found eligible for the NRHP under Criterion A for its historic associations with the commercial apple growing industry and with the significant contributions of Rosencrans Pillsbury and William Lievens to the industry. The eligible boundary for the orchard covers 196 acres on both sides of Pillsbury Road west of I-93. However, since that time, the site has been designated for a large, planned development called Woodmont Commons, and the historic resources have been allowed to deteriorate and many have been demolished. Therefore, it has been determined not eligible for the NHRP by NHDHR.

The Gearty House (LON0105). Located on the west side of Rockingham Road (117 Rockingham Road), this house was reviewed during the I-93 widening project to be of such exceptional significance that it is eligible for the NRHP under Criterion C and Criterion Exception G (because it was less than 50 years old when surveyed) as a well-defined example of ranch style form. The eligible boundary covers the entire 1.5-acre Gearty House lot.

Reed Paige Clark Homestead (LON0114). Reviewed under the I-93 widening project, this property located on the west side of I-93 (79 Stonehenge Road) was found to be individually eligible for the NRHP (under Criterion A and C) “both for its significant agricultural history and as an extremely well preserved example of connected farm architecture, executed in stone and in the Greek Revival style.”

The Robert J. Prowse Memorial Bridge (LON0116). This bridge was found eligible for the NRHP under Criterion C through Criterion Exception G for its importance in the history of NH bridge engineering. The bridge carries Ash Street/Pillsbury Road over I-93 between Exits 4 and 5. Only four steel rigid frame bridges have been identified in NH. This structure was designed as early as 1958 and built circa 1962. The eligible boundaries for the Robert J. Prowse Bridge are limited to the bridge footprint. This bridge is currently being demolished as part of the I-93 widening project.

The Moody House (LON0117). Built circa 1952 at 113 Rockingham Road, this house was reviewed during the I-93 widening project and found individually eligible for the NRHP under Criterion C as a well-defined and extremely well preserved example of the Ranch style and form, as its period landscaping and setting remain. Even its period landscaping and setting are intact. The eligible boundary covers the entire 1.4-acre lot.

Properties that have Now Reached Sufficient Age to Be Considered for NRHP Eligibility

A total of 18 properties are in Derry along the alignment for Alternative A that are now 50 years old; there are none in Londonderry (Table 4.18-3). Several of these individual properties are found in residential areas and neighborhoods with potential eligibility as historic districts. Franklin Terrace is a neighborhood south of Folsom Road that evolved over a period of time and is not necessarily a planned development. Barkland Acres, the residential development on the north side of Tsienneto Road, was laid out with a particular design intent for the plan of the roads and lots. The properties were developed in a condensed time period and share a fairly consistent style of house and lot. Based on coordination with NHDHR, five properties were surveyed in June 2018. Individual survey forms were prepared, and NHDHR concurred on July 12, 2018, that, of the five properties surveyed, only 3 Manchester Road is considered eligible (see Appendix N). In addition, the former M&L Railroad that is eligible for the NRHP.

3 Manchester Road (DER0196). Originally the building for the Knapp Brothers Shoe Manufacturing Company, located at 3 Manchester Road, is individually eligible for the NRHP under Criterion A for its associations with shoe manufacturing in Derry and under Criterion C for its architecture as a representative example of a mid-twentieth century manufacturing and office building in the modernist style that employs tilt-up construction, a common construction method of the period for industrial buildings. The property’s eligible boundary would include the entire 8.97-acre tax parcel as it is the remaining portion of the original approximately 9.38-acre parcel acquired by the Derry Realty Corporation in 1959 and developed with the current building, occupied initially by the Knapp Brothers Shoe Manufacturing Corporation.

Table 4.18-3. List of Properties on Alternative A Dating 1958-1968

Street Address	Map-Lot	Est. Construction Date	Description/ Notes on Integrity	Individual Survey Forms Completed	2018 Determined Eligible
11 Madden Road	31/12	1958	Ranch, vinyl siding and shutters	Yes	No
2.5 Folsom Road	35/08/A	1967	Mobile home in rear of 4 Folsom Rd	No	--
7 Folsom Road	35/49	1959	Ranch, vinyl siding and shutters	No	--
9 Folsom Road	35/41	1957	Ranch, front portico a later addition, vinyl siding and shutters	No	--
12 Folsom Road	35/12	1959	Raised ranch with underground garage, vinyl siding and shutters	Yes	No
16 Folsom Road	35/13	1961	Garrison (2nd story recently added) with cabin/bathhouse, recent freestanding garage in rear, vinyl siding and shutters	No	--
20 Manchester Avenue	35/48	1966	Midcentury Cape with attached garage, vinyl siding and shutters	No	--
3 Manchester Road	08/269	1960	Large industrial building, former shoe factory, currently Fireye, Inc.	Yes	Yes
50 No. Main Street	08/73/1	circa 1962	Car dealership, significantly renovated and enlarged circa 1990 and 2000.	No	--
1 Horseshoe Drive	54/94	1965	Raised ranch with underground garage, vinyl siding and windows	No	--
60 Tsienneto Road	54/95	1966	Ranch with full dormer on façade, underground garage	No	--
64 Tsienneto Road	54/97	1966	Raised ranch with underground garage	No	--
66 Tsienneto Road	54/98	1965	Raised ranch with underground garage, vinyl siding and shutters	No	--
83 Tsienneto Road	55/13	1960	Ranch, vinyl siding, pool added circa 1970	No	--

Street Address	Map-Lot	Est. Construction Date	Description/ Notes on Integrity	Individual Survey Forms Completed	2018 Determined Eligible
84 Tsienneto Road	08/42/1	1960	Ranch, garage added circa 1980, vinyl siding	No	--
91 Chester Road	55/44	1959	Mobile home	No	--
80 Chester Road	55/11/1	circa 1968	Garage/auto repair shop	Yes	No
2 Ferland Drive	31/15	1967	Ranch, vinyl siding and replacement windows (date unknown)	Yes	No

Manchester and Lawrence Railroad (MLT-MLRR): The segment of the former M&L Railroad that is eligible for the NRHP extends from the New Hampshire state line in Salem to the Manchester airport in Londonderry. The M&L Railroad was determined eligible for the NRHP in 2009. It is significant under Criterion A for its contribution to the history and development of the five communities that it passed through and under Criterion C for its significance of railroad engineering and architecture. The period of significance is 1849–1968, which extends from the railroad's opening in 1849 to the 50-year cutoff date for eligibility. Additional information is provided in Appendix N.

4.18.5 Environmental Consequences

Archaeological Resources

No Build Alternative

The No Build Alternative would not result in new construction; therefore, no impacts on archaeological resources would occur.

Build Alternatives

The findings of the archaeological resources review indicate that none of the proposed Build Alternatives would have an adverse effect on archaeological resources. Original and subsequent archaeological surveys have indicated that archaeological sites and sensitivity areas are absent from the Alternative routes; thus, there would be no impact on archaeological resources from the Project.

Mitigation

Because no impacts are anticipated from the Build Alternatives, no mitigation measures have been proposed.

Historic Resources

No Build Alternative

The No Build Alternative would not affect any identified historical resources because no construction would occur under this Alternative.

Build Alternatives

The five Build Alternatives were reviewed to determine whether or not they impact any known historical resources, and the results are summarized in the following subsections. Effects tables are provided in Appendix N. Section 4(f) historic resource impacts are addressed in Chapter 7.

<u>Alternative A</u>

Effects tables were prepared for the following historic resources: Palmer Homestead, 76 Tsienneto Road (DER0134); E.F. Adams House, 72 Tsienneto Road (DER0135), Knapp Brothers Shoe Manufacturing, 3 Manchester Road (DER0196); and Manchester and Lawrence Railroad (MLT-MLRR).

Palmer Homestead: Construction of Alternative A would be confined to the front (southern) edge of the property along Tsienneto Road, and there would be no change in use. There is a short stone wall on the western front edge of the property that would not be impacted because the fill slope would tie in on the street side of the wall. The Project would introduce a slight increase in noise from an increase in traffic, but this would not diminish the integrity of the design, materials, and workmanship, which are contributing features of the property under Criterion C. As a result, the recommended finding is No Adverse Effect.

E.F. Adams House: Construction of Alternative A would be confined to the front (southeastern) edge of the property along Tsienneto Road and the side (southwestern) edge along Scenic Drive. There would be no change in use, and the proposed back of sidewalk would be in the approximate same location as the existing back of sidewalk. The roadway grade would be lowered in this area resulting in the need to construct a 1- to 3-foot high retaining wall along the frontage beginning at the driveway at minimal height to the east where it would be at maximum height. At the corner of Tsienneto Road and Scenic Drive, a triangular section of brush would be removed to provide safe sight distance; however, this brush removal would not impact the integrity of the setting. The Project would introduce imperceptible audible elements with the increase in traffic, but this would not diminish the integrity of the design, materials, and workmanship, which are contributing features of the property under Criterion C. As a result, the recommended finding is No Adverse Effect.

Knapp Brothers Shoe Manufacturing: Construction of Alternative A would be confined to the frontage of the property that abuts Tsienneto Road and Manchester Road (NH 28), and there would be no change in use. There are no historic physical features within the edge of the property, and vegetation removal would not impact any landscaping that dates to the period of significance. A few bushes would need to be removed. The flagpole would not be impacted. The Project would introduce audible elements with the increase in traffic, but this would not diminish the integrity of feeling and association as a mid-twentieth-century manufacturing and office space, which are contributing features of the property under Criterion A. As a result, the recommended finding is No Adverse Effect.

Manchester and Lawrence Railroad: Construction of Alternative A would be within the ROW and the path of the former railroad to expand the width of North High Street and create a new intersection at the new connector road as well as to accommodate the proposed trail with a culvert under the connector road rather than allowing an at-grade crossing. There is no existing railway hardware in this section because the rails and ties were removed in the late twentieth century.

There would be no change in use because the rail line has been abandoned and is unused. The existing off-road Derry Rail Trail informally terminates at its existing intersection of the railroad ROW with North High Street from the south. As part of the Project, the off-road rail trail would be extended for about 900 feet to the north, so as to allow it to cross under the connector road and back to the former railroad ROW about 300 feet north of the connector road. There are no historic physical features relating to the railroad within the area of construction for the Project. The Project would introduce audible elements with the increase in traffic, but this would not diminish the integrity of the railroad and its path as a whole. As a result, the recommended finding is No Adverse Effect.

Alternative B

Similar to Alternative A, construction of Alternative B would affect the Manchester and Lawrence Railroad (MLT-MLRR). Effects would be similar to those described under Alternative A, and Alternative B is not anticipated to result in an adverse effect. Based on the other known historic resources in the study area, Alternative B would have no effect on any other historic resources.

Alternative C

As discussed in the 2007 DEIS, it was determined that the west side of the Alternative C interchange would have an adverse effect to the Reed Paige Clark Homestead properties (LON0114) located immediately west of the I-93 corridor and south of Stonehenge Road) (see Figure 4.18-4). The adverse effect on the property would be for both the need to acquire land to build the Northern Interchange [specifically the associated former potato field (Londonderry Map 13/Lot 20)] and also the visual impact a major raised interchange would have on the Reed Paige Clark Homestead (Londonderry Tax Map 13/Lot 21) located on the north side of Stonehenge Road. The total estimated property taking on Lot 20 required for the ROW for the Alternative C interchange would be approximately 2.4 acres. Of this, approximately 1.4 acres would be located within the roadway footprint. Other than the Reed Paige Clark Homestead properties, no other known historic resources would be affected by Alternative C.

Alternative D

Similar to Alternative C, construction of the new Alternative D Interchange would require identical impacts on the same two Reed Paige Clark Homestead properties (Lots 20 and 21), resulting in an adverse effect. The adverse effect on these properties would be for both the need to acquire land to build the Northern Interchange and also the visual impact a major raised interchange would have on the Reed Paige Clark farmstead located on the north side of Stonehenge Road. No other historic resources would be affected by Alternative D.

Alternative F

As discussed in the 2007 DEIS, it was determined that Alternative F would have an adverse effect upon historic resources through the Broadway Historic District (Area B) located along

NH Route 102. This district covers 102 properties and contains 89 buildings with mixed uses, from residential to commercial business. The removal of 110 on-street parking spaces on NH Route 102/Broadway through downtown Derry would have a detrimental impact to the local businesses that are located in NRHP-eligible historic buildings or those that contribute to the Broadway Historic District. This economic impact would not support the project's purpose and need of improving economic benefits within the Town, and could make the historic resources in the downtown area more vulnerable to falling in disrepair or demolition and replacement with new buildings. Because other alternatives exist that meet the project purpose and need and do not involve these historic resource impacts, the requirements of Section 106 would not be satisfied if Alternative F were selected.

Alternative F would extend alongside the Derry Village Historic District and near the Birch Street Historic District but would have no adverse effect on these resources. The Alternative would also traverse adjacent to one NRHP individually eligible property along NH Route 102 (Gilbert and Helen Hood House, DER0102), with no effect to the property.

4.19 Parks, Recreation, and Conservation Lands

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 Department of Transportation Act as amended by the Federal-Aid Highway Act of 1968 (Public Law 90-495, 49 USC 1653). Under Section 4(f), the Secretary of Transportation shall not approve any program or project that "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."

Parks and recreational lands include all public and private parcels that are expressly reserved for recreational purposes, such as neighborhood parks, golf courses, school playgrounds and ball fields, and similar facilities.

In addition, properties that have received funding under the Land and Water Conservation Fund (LWCF), as administered by the U.S. Department of the Interior, require special evaluation including specific requirements for mitigation under Section 6(f) of the LWCF. Section 6(f) lands are those that have been acquired or improved with LWCF funds, and NPS 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 New Hampshire Department of Resources and Economic Development (NHDRED), Division of Parks and Recreation, maintains a list of lands acquired or improved with LWCF funds in NH. NH RSA 4:30-a requires replacement of impacted municipally owned recreation or conservation lands. The RSA states that, when NH 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.

4.19.1 Affected Environment

The study area for parks, recreation, and conservation lands is a 1,000-foot buffer around the Build Alternative alignments to encompass any properties that could experience potential impacts from the Project, including any visual, noise, or constructive use/access impacts. As Table 4.19-1 and Figure 4.19-1 show, the study area contains 49 properties and trails in recreation and conservation use, of which 35 are potentially subject to the provisions of Section 4(f) of the USDOT Act of 1966. Section 4(f) resources are discussed in more detail in Chapter 7, *Section 4(f) Resources*. Additionally, there are three separate sites within the general area that were funded under LWCF project #33-00166 “Derry Three Parks”: Veteran's & O’Hara Ball Fields (Site #2), Hood Park, and Smith Field, and as such are subject to the provisions of Section 6(f) of the LWCF. Hood Park and Smith Field, which are labeled on Figure 4.19-1 are more than 1,000 feet from any of the Build Alternatives.

Table 4.19-1. Parks, Recreation, and Conservation Lands

Parcel ID	Name	Location	City	Ownership	Designation	Type of Use
1	Hoodkroft Golf Course	NH 102 (Chester Road)	Derry	Semi-Private	4(f)	Golf course. Partially owned by Town of Derry, open members, and the general public
2	Veteran's & O'Hara Ball Fields	Wilson Avenue	Derry	Town of Derry	4(f) and 6(f)	Baseball, soccer, playground, tennis, various recreational leagues
3	MacGregor Park	Birch Street	Derry	Town of Derry	4(f)	Small park downtown, picnic area, benches, veterans memorial
4	Buckley Field	Hood Road	Derry	Town of Derry	4(f)	Baseball, recreational areas, small playground
5	Pinkerton Academy Athletic Field	Crescent Street	Derry	Town of Derry	4(f)	Recreational field
6	Pinkerton Academy Fields	Pinkerton Street	Derry	Pinkerton Academy	4(f)	Baseball field, tennis courts
7	Pinkerton Academy Fields East	Pinkerton Street	Derry	Pinkerton Academy	4(f)	Baseball field, football field, track
8	Rider Fields	Tsienneto Road	Derry	Town of Derry	4(f)	Baseball, recreational areas, small playground, open space
9	Hovey Road Viewshed Easement	Pillsbury Road	Londonderry	Town of Londonderry	Conservation Land	Preservation
10	Dumont	North and east of Trolley Car Lane, bisected by Old Trolley Line Trail	Londonderry	Private and Town of Londonderry	4(f)	Hiking, cross-country skiing, nature observation
11	Rockingham Rd	Rockingham Rd	Londonderry	Town of Londonderry	Conservation Land	Preservation
12	Woodhenge Cir	Rockingham Rd	Londonderry	Town of Londonderry	Conservation Land	Preservation
-	Old Trolley Line Trail	Various west of I-93	Londonderry	Town of Londonderry	4(f)	Public recreational trail
-	Londonderry Rail Trail	Various east of I-93	Londonderry	Town of Londonderry	4(f)	Public recreational trail

Parcel ID	Name	Location	City	Ownership	Designation	Type of Use
-	Rail Trail Path	Various east of I-93	Derry	Town of Derry	4(f)	Public recreational trail
-	Derry Rail Trail	Various east of I-93	Derry	Town of Derry	4(f)	Public recreational trail
-	Derry Bicycle Path	Downtown Derry	Derry	Town of Derry	4(f)	Public recreational trail circles the downtown area
-	Rider Fields Trail	Near Rider Fields	Derry	Town of Derry	4(f)	Public recreational trail

Sources: Town of Derry (2016c; 2017a; 2017b; 2017c); Derry Rail Trail Alliance (2017); NHFGD (2016c); Londonderry Conservation Commission (2014)

Conservation Lands

The Town of Londonderry has three conservation areas within the study area: two preservation areas along Rockingham Road (#11) and Woodhenge Circle (#12) and the Dumont Conservation area (#10), which is bisected by the Old Trolley Line Trail. The Old Trolley Line Trail and Londonderry Rail Trail traverse the study area.

The Londonderry Rail Trail is a cooperative effort between the Town of Londonderry and the Londonderry Trailways organization to complete about 6 miles of trail on an abandoned rail corridor (Londonderry Trailways, 2016). This will link the Derry and Manchester Rail Trails and be part of the 20-mile Granite State Rail Trail that runs from Salem to Manchester. Currently, the Rail Trail is paved from Rockingham Road (NH 28) near North School west of I-93 to the intersection of Rockingham Road near Seasons Lane on the east side of I-93. The North Village, Little Cohas, and Airport segments are currently planned to pave the existing western terminus of the trail to the Manchester town line (2.3 miles). In addition, the Southeastern Border segment is planned to connect the existing eastern terminus of the trail to the Derry town line (0.6 mile). From the Derry town line to a point north of Hood Park, there is a gap in the Rail Trail (Figure 4.19-1). This planned segment will be completed in future years as Londonderry completes the Southeastern Border segment. Although this gap in the Rail Trail is passable on foot or mountain bike, the trail ROW north of North High Street is private property; therefore, it is not currently part of the trail network.

The Old Trolley Line Trail currently exists as a well-used trail by hikers and mountain bikers along an old trolley line, and the Londonderry Conservation Commission has identified the trail as a long-term opportunity to help complete an extensive loop trail originating at the town center (Londonderry Conservation Commission, 2014).

No wildlife or waterfowl refuges subject to Section 4(f) have been identified in the study area (see Chapter 7).

Recreational Resources

In the Town of Derry, the study area contains a variety of parks, recreational areas, and trails, most of which have a Section 4(f) designation. Examples of public recreational resources include Rider Fields (#8) and Trail, which includes baseball, recreational areas, a small playground, and open space, and Hoodkroft Country Club (#1), a golf course partially owned by the Town of Derry that is open to the public and abuts a large wetland area associated with Beaver Brook. Trails within the study area include the Rider Fields Trail, as well as the Derry Bicycle Path, the Rail Trail Path, and the Derry Rail Trail. The Derry Bicycle Path encircles the downtown Derry area and overlaps with the Rail Trail Path, which connects the Londonderry and Derry Rail Trails.

In the Town of Londonderry, the study area contains Apple Way is an important cultural resource and a part of the statewide Scenic Byways program. In Londonderry, it connects several of the Town’s remaining apple orchards and community open spaces. While the byway affords an enjoyable motoring experience, it is not conducive to pedestrian or bicycle activities. The road is relatively narrow and in some areas, the shoulder is non-existent. A Class Six road runs between Trolley Car Lane and Kitt Lane. The road has not been maintained in many years, but the ROW is still in force. Local residents named the road “Dragonfly Way” when the town was developing the emergency response system. The route provides an excellent opportunity to connect several neighborhoods while at the same time offering a pleasant walking and biking experience. Due to its proximity to the future Woodmont development, Dragonfly Way would play an important role in keeping pedestrian and bicyclists off of Pillsbury Road, which can be hazardous to pedestrian passage.

Section 6(f)

According to information provided by NHDRED and the Derry Conservation Commission (Town of Derry, 2016b), the study area contains one publicly owned Section 6(f) property, Veteran's Field (#2). No additional Town-owned conservation lands were identified.

Veteran's Fields offers a variety of facilities and programs. It contains one building with public restrooms, a shed, a softball diamond, a soccer field, two tennis courts, a playground, and bleachers. Activities include youth and adult softball leagues with softball tournaments, as well as soccer practices, youth football practices, and tennis lessons and tournaments.

Based on coordination with NHDRED (Appendix K), no impacts on any properties encumbered under the LWCF State and Local Assistance Program are expected.

4.19.2 Environmental Consequences

As described above, publicly owned recreation land is protected by regulations that include Section 4(f) of the USDOT Act of 1966. In addition, recreation properties that have received funding under the LWCF, as administered by the U.S. Department of the Interior, are protected under Section 6(f) of the LWCF. In general, impacts on these types of resources can result from several different activities arising from a transportation project as listed below.

- Direct acquisition of land currently designated as public park or recreation land to provide a sufficient ROW for the proposed transportation project. Direct land acquisition can result in a reduction in the size of the resource, and/or could eliminate or curtail its use for certain activities.
- Creation of a change or reduction in access to the resource.
- Changes in existing noise levels or visual resources resulting from increased traffic volumes or road proximity.

The potential effects on park and recreation resources associated with each of the Build Alternatives were determined by overlaying their respective Proposed Project footprints on the Project mapping depicting existing public parks, recreation areas, and conservation lands (Figure 4.19-1). Each of the impacts associated with the Build Alternatives is described below.

No Build Alternative

The No Build Alternative would not impact open space or recreational facilities.

Build Alternatives

Impacts to Section 4(f) properties, including public parks, recreational areas, and conservation lands associated with the Build Alternatives, are discussed below. A complete Section 4(f) evaluation for recreational properties is included in Chapter 7 of this document. No Section 6(f) properties are affected by any of the Alternatives.

Alternative A

Alternative A would permanently impact 0.02 acre of the Rider Fields property (Site #8 on Figure 4.19-1), a 21-acre Section 4(f) resource owned by the Town of Derry that includes athletic fields, parking facilities, and undeveloped land. Within the 0.02 acre, the improvements to Tsienneto Road would result in the need to move the mailbox and sign for the Upper Room Family Resource Center. None of the recreational facilities within Rider Fields would be impacted. Additional information related to the impacts on Rider Fields is provided in Chapter 7, *Section 4(f) Evaluation*. Alternative A would not impact any other existing parks, recreation, or conservation lands. Alternative A would cross a planned trail corridor, and the design would accommodate an underpass for the planned trail corridor.

Alternative B

Alternative B would impact 0.96 acre of an undeveloped portion of Rider Fields (Site #8). The Alternative B alignment would cross this resource near its northern undeveloped edge, avoiding direct impacts to the athletic fields and parking facilities. This Alternative would require impacts to1 acre to provide needed ROW for the proposed roadway. An additional 0.35 acre of the property would be left as a remnant that would be separated from the athletic fields by the roadway and would be left inaccessible. An informal path used by locals traverses north-south across the northwest corner of the property. The path is used to access the site from residential properties and the power line corridor located to the north. Along with the direct impacts to the park, there would be increased noise levels and a decrease in scenic value. Alternative B would cross a planned trail corridor, and the design will accommodate an underpass for the planned trail corridor.

Alternative C

Alternative C would result in impacts to two conservation lands—it would impact 0.05 acre of the Dumont conservation area (Site #10) and 0.04 acre of the Rockingham Road conservation area (Site #11). The impacts to the Dumont conservation area are related to the I-93 southbound entrance ramp, and the impacts to the Rockingham Road conservation area are limited to the small conservation lot along NH 28 near Seasons Lane. Alternative C would also impact Rider Fields near its northern property line. Impacts to Rider Fields would be identical to those already described for Alternative B.

Alternative D

Alternative D would impact the Dumont and Rockingham Road conservation areas. Impacts are identical to those already described for Alternative C. Alternative D would also impact 0.2 acre of Rider Fields. Impacts to Rider Fields would be identical to those already described for Alternative A.

Alternative F

Alternative F would impact one recreational area. The Derry Bike Path, a Section 4(f) resource, crosses NH 102 in downtown Derry. Because Alternative F would involve improvements to NH 102, it would require construction activities within the existing road crossing for the Derry Bike Path. It is expected that any impacts on this existing crossing would occur during construction, and they would be temporary. Acquisition of property in the area of the existing crossing of the Derry Bike Path would not be required. In addition, the existing crossing and access to the Bike Path at this location would be maintained, including during the construction phase where practicable. Farther to the east on NH 102, and on the south side of the road, is Hoodkroft Country Club, a semi-private golf course. Alternative F would impact 0.18 acre of the golf course property but would not affect any of the facilities at the golf course.

5.0 INDIRECT EFFECTS AND CUMULATIVE IMPACTS

This chapter provides an overview of the regulatory framework and definitions of indirect and cumulative impacts, the methodologies used to develop future land use forecasts with and without the Project, and an assessment of indirect and cumulative impacts to environmental resources.

5.1 Regulatory Framework

CEQ regulates implementation of NEPA and defines three types of effects: direct, indirect, and cumulative.

"**Direct impacts** are caused by the action and occur at the same time and place (40 Code of Federal Regulations [CFR] 1508.8)." Examples of direct impacts include displacements resulting from the acquisition of ROW or the fill placed in wetlands in order to construct a roadway improvement. The uncertainty associated with assessing direct impacts is very low relative to indirect and cumulative impacts.

"**Indirect effects** are caused by the action and are later in time or farther 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 (40 CFR 1508.8)."

The National Cooperative Highway Research Program Report 403: *Estimating the Indirect Effects of Proposed Transportation Projects* identifies three types of indirect effects:

- Encroachment-Alteration Effects—alteration of the behavior and functioning of the affected environment caused by project encroachment (physical, chemical, or biological) on the environment.
- Induced Growth Effects—changes in the intensity of the use to which land is put that are caused by the action/project. These changes would not occur if the action/project does not occur. For transportation projects, induced growth is attributed to changes in accessibility caused by the project.
- Induced Growth-related Effects—alteration of the behavior and functioning of the affected environment attributable to induced growth.

"**Cumulative impact** is the impact on the environment, which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7)." According to Federal Highway Administration's (FHWA's) *Interim Guidance: Questions and Answers Regarding the Consideration of Indirect and Cumulative Impacts in the NEPA Process,* cumulative impacts include the total of all impacts to a particular resource that have occurred, are occurring, and will likely occur as a result of any action or influence, including the direct and reasonably foreseeable indirect impacts of a proposed project (FHWA, 2003).

5.2 Land Use Forecasting

5.2.1 Overview

A land use forecasting process was undertaken as an essential element of the assessment of indirect and cumulative impacts for this Project. The end product of the land use forecast was local-level population and employment inputs used in the travel demand modeling for the 2040 No Build and Build conditions. SNHPC's regional travel demand model was used to assess how the Project and alternatives may affect travel patterns in the 2040 design year. The travel demand model requires information on local-level population and employment patterns to forecast the number of trip origin and end points in the future. In addition to estimating the number of trips, type of trips, and destination of trips, the travel demand model includes a representation of the roadway network (including highway capacity and speed). The travel demand model assigns trips to specific routes, which forms the basis for the total traffic volumes forecasted for each roadway. Separate model runs are required to represent the 2040 roadway network without the Project (2040 No Build) and with the Project completed (2040 Build). The travel demand model output is used in the Supplemental Draft EIS (SDEIS) traffic analyses, which in turn provide key inputs to analyses of traffic noise and air quality.

The land use forecasting methodology explicitly accounts for potential changes in the quantity and/or location of future development potentially caused by the Project and incorporates those growth changes within the SNHPC travel demand model. As a result of including potential induced growth impacts in the travel demand model for the 2040 Build condition, the approach used for this SDEIS ensures consistency between the traffic analysis and the other land use-related portions of the SDEIS, including indirect and cumulative impacts. The overall land use forecasting process used is consistent with the recommendations of FHWA's *Interim Guidance on the Application of Travel and Land Use Forecasting in NEPA* (FHWA, 2010). Specifically, the forecasting effort included reviewing the suitability of existing forecasts; collaborating with land use/socioeconomic forecast experts, local planners, and the development community; and documenting the basis for assumptions.

5.2.2 Methodology

The methodology used to develop the 2040 No Build and Build conditions land use forecasts included obtaining existing population and employment forecasts and interviewing local land use planners, socioeconomic data experts, and representatives of the development community. Appendix B, *Land Use Scenarios Technical Report*, provides the detailed methods used to develop the 2040 No Build and Build conditions.

Study Area

The study area for the Build and No Build conditions is the "economic study area" described in the 2007 Draft EIS (DEIS), as shown in Figure 5.2-1. This study area encompasses 143 square miles within the two Towns of Derry and Londonderry, as well as Auburn, Chester, and Sandown. The five-town study area was determined by considering the likely geographic extent of potential direct, indirect, and cumulative effects related to land use and development—Derry and Londonderry would be directly affected, and Auburn, Chester, and Sandown may experience indirect effects from improved access and travel time to I-93. The limits of the economic study area were agreed upon in consultation with state and federal agency staff at a meeting held on

August 25, 2005. Given that there are no major changes in the basic alignment of the alternatives under consideration since the 2007 DEIS, the previously agreed-on study area remains reasonable for this SDEIS.

Analysis Timeframe

The temporal scope of analysis for the land use scenarios is based on past development trends and a future-planning horizon for which information on reasonably foreseeable future development is available. The Towns of Derry and Londonderry experienced rapid growth beginning in the 1960s and 1980s, respectively, based on available and affordable housing and favorable schools. Londonderry adopted a growth management ordinance (a subset of its zoning ordinance) in 1988 and readopted it in 1998. The ordinance was allowed to expire in 2015. Derry adopted a growth management ordinance (also a subset of its zoning ordinance) in 1999, which is still active. As a result, the past time horizon for consideration of development trends is 1990, the point at which the rapid growth began to be controlled (see Appendix B, Section 3.1, *Past Population and Employment Trends*). The future time horizon is 2040, which is the design year for the Project as well as a time horizon that encompasses the long-range comprehensive plans and long-range transportation plans for the study area. The 2040 future analysis year is also the analysis year that will be used for the transportation and air quality/noise impact analyses for the Project. The baseline or existing conditions model year for the transportation analyses for the Project is 2015; consequently, 2015 land use and socioeconomic data are also reviewed in this analysis.

Data Reviewed

Existing population and employment forecasts, comprehensive plans, and available development data were reviewed, including the following:

- U.S. Census Bureau 1990, 2000, and 2010 Decennial Census data (U.S. Census Bureau, 1990, 2000, and 2010)
- New Hampshire Employment Security (NHES) Economic and Labor Market Information Bureau employment data from 2004 and 2014 (NHES, 2015)
- New Hampshire Office of Energy and Planning (OEP)[21] County and Municipal Populations Projections 2010–2040 (OEP, 2016a, 2016b)
- SNHPC's Moving Southern New Hampshire Forward: 2015-2035 Regional Comprehensive Plan (SNHPC, 2014) and letter to the Director of Derry Planning Department regarding population and dwelling unit projections (SNHPC, 2012a)
- SNHPC Population and Household Projections 2010-2050 (SNHPC, 2012b), and updated 2015-2040 Household Projections based on OEP Population Projections (SNHPC, 2016a)
- SNHPC Employment Projections for 2010-2050 based on New Hampshire Employment Security and NHDOT data (SNHPC, 2012c), SNHPC Updated Employment Estimates for 2015 (SNHPC, 2016b), and SNHPC Updated Employment Projections for 2020-2040 (SNHPC, 2016c)

[21] As of 2017, OEP is now the Office of Strategic Initiatives (OSI).

- Rockingham Planning Commission (RPC) 2015 Regional Master Plan (RPC, 2015)
- Woodmont Commons PUD Application Materials (Pillsbury Realty Development, LLC, 2013)
- Master Plans of Derry and Londonderry (Town of Derry, 2010; Town of Londonderry, 2013)
- Master Plans of Chester, Auburn, and Sandown (Chester Planning Board, 2015; SNHPC, 2007; Sandown Master Plan Steering Committee et al., 2013)
- SNHPC Regional Comprehensive Plan (SNHPC, 2010)
- Regional Economic Development Center of Southern New Hampshire 2016 Comprehensive Economic Development Strategy (Regional Economic Development Center of Southern New Hampshire, 2016)
- Environmental constraints on development and local land use controls

Land Use Interviews

The purpose of these structured interviews and outreach was to inform and support the analysis of reasonably foreseeable future growth, identify predicted future growth areas under No Build and Build conditions, and estimate the indirect land use effects of the Project and alternatives.

Interviews were conducted on July 25–26, 2016, with planners from the Towns of Derry and Londonderry, SNHPC, and OEP. In addition, because the Woodmont Commons Project is planned adjacent to Exit 4A, a representative of Pillsbury Realty Development was interviewed. Finally, to gather information from municipalities identified in the economic/secondary impacts study area in the 2007 DEIS, telephone interviews were conducted with local planners from the Towns of Auburn, Chester, and Sandown. Materials, including maps and interview summaries, used to gather information via in-person and telephone interviews are included in Appendix B.

In conjunction with the information gathered through the interviews, data in Section 5.2.3 were reviewed to develop the forecasts associated with the 2040 No Build and Build conditions.

Uncertainty/Limitations

As with any attempt to forecast future growth or development, there are limitations to the accuracy and certainty of the results of the land use forecasts. This uncertainty is impossible to quantify given that land use change occurs as result of numerous individual private land use decisions and other factors such as global and local economic conditions, housing trends and costs, availability of public water and sewer service, fuel prices, and long-term technological changes. The 2040 No Build and Build conditions were developed through consideration of the latest available population and employment projections from state and regional agencies as well as input from planners and others knowledgeable of local conditions and trends. The forecasting process was consistent with the best practices recommended in FHWA’s interim guidance on travel and land use forecasting. As a result, the land use forecasts provide a reasonable basis for comparing alternatives in the SDEIS and assessing potential indirect and cumulative impacts as required by CEQ’s NEPA regulations. The land use forecasts also provide a logical construct and ensure consistent SDEIS evaluation of transportation and land use impacts.

The No Build and Build land use forecasts developed as a result of this analysis should be considered as possible outcomes, and the addition and/or shift in type of development anticipated with the Proposed Project should be considered as trends rather than absolute predictions that a certain number of residential units or gsf of commercial or industrial development would occur in a specific location. Ultimately, development within the study area under the No Build and Build conditions will be based on what the Towns will permit and what the market can support.

5.2.3 Population, Household, and Employment Projections

This section includes a summary of the 2040 projections for population, household, and employment that were used as the basis for the No Build condition. Appendix B contains detailed information on past population, household, and employment trends as well as the development of the 2040 projections by SNHPC and OSI (formerly OEP).

Population and Household Projections

SNHPC develops whole-town and zonal (TAZ) population, household, and employment projections for the towns within its region to coordinate regional and local planning. Because SNHPC is also the official Metropolitan Planning Organization of the region, its future projections are also used in the travel demand modeling for the regional long-range transportation plan. For this analysis, SNHPC used the more recent (2016) OSI (formerly OEP) population projections for Derry, Londonderry, and Auburn. As discussed in Appendix B, the population projections for the Town of Chester were adjusted based on additional input from land use interviews. Finally, because Sandown is in the RPC area and not the SNHPC area, information on Sandown households was derived from the RPC 2015 Master Plan (RPC, 2015). Table 5.2-1 and Table 5.2-2 provide population projections by municipality and revised Chester population projections, respectively. Table 5.2-3 shows the household projections through 2040.

Employment Projections

SNHPC also makes TAZ-level projections for employment based on quarterly employment averages from NHES that it compares to building permit data to estimate the number of jobs per square foot of non-residential development. The method used by SNHPC to generate updated TAZ-level projections is detailed in memoranda provided in Appendix B.

Table 5.2-4 includes updated 2015 projections based on state data adjusted to reflect the fact that SNHPC's 2010 employment information calculated directly from the employer database is slightly higher than the state data. Table 5.2-4 then uses the 5-year percent increases from SNHPC's 2012 employment projections to recalculate projections for 2020‒2040 using the updated 2015 projections. Appendix B includes a memorandum outlining the methodology used to project employment. The notable decline in Chester employment in 2015 is due to the closing of Chester College in 2012, and the rebound in employment in 2020 is projected based on the opening of Busche Academy at the old Chester College (Jaschik, 2012; Williams, 2015). Busche Academy was approved and officially recognized as a non-public (private) school in October 2017. This dip in Chester employment values creates an elevated average annual growth rate for the town for 2015‒2040 (2.21 percent); for comparison, the average annual growth rate from 2010‒2040 was 0.62 percent.

Table 5.2-1. OEP 2016 Population Projection by Municipality for 2015–2040

Municipality	2015[a]	2020	2025	2030	2035	2040	Average Annual Growth Rate 2015–2040
Derry	32,948	32,459	32,018	32,733	33,144	33,222	0.03%
Londonderry	24,891	25,434	26,057	26,639	26,973	27,036	0.33%
Auburn	5,315	5,560	5,828	5,959	6,033	6,048	0.52%
Chester	4,887	5,199	5,536	5,660	5,731	5,744	0.65%
Sandown	6,255	6,604	6,984	7,140	7,229	7,246	0.59%
Study Area Total	74,296	75,256	76,423	78,131	79,110	79,296	0.26%
Rockingham County	300,569	307,013	314,418	321,441	325,474	326,238	0.33%

Source: OEP (2016a)
[a] 2015 data are an estimate.

Table 5.2-2. Revised Chester Population Projection for 2015–2040

Municipality	2015[a]	2020	2025	2030	2035	2040	Average Annual Growth Rate 2015–2040
Chester	4,887	5,457	6,027	6,101	6,177	6,253	0.99%

Source: Town of Chester (see Appendix B)
[a] 2015 data are the estimates provided by OSI (formerly OEP).

Table 5.2-3. SNHPC and RPC Household Projections

Municipality	2010[a]	2015[b]	2020	2025	2030	2035	2040	Average Annual Growth Rate 2015–2040
Derry	12,537	12,656	12,436	12,236	12,496	12,645	12,673	0.01%
Londonderry	8,438	8,628	8,812	9,022	9,219	9,332	9,353	0.32%
Auburn	1,765	1,923	2,012	2,108	2,156	2,182	2,188	0.52%
Chester	1,534	1,621	1,811	2,001	2,026	2,051	2,077	0.99%
Sandown[c]	2,072	2,193	2,321	2,457	2,601	2,753	2,914	1.14%
Study Area Total	26,346	27,021	27,392	27,825	28,497	28,963	29,205	0.31%

Source: SNHPC (2016a; 2017), RPC (2015)

[a] 2010 households were provided by SNHPC and based on U.S. Census Bureau information.

[b] 2015 data are an estimate.

[c] Data are from the RPC 2015 Regional Master Plan, with 2040 projections based on the "strong, dispersed growth" scenario. Household data were not available for 2015-2035; therefore, this table includes straight-line growth between 2010 and 2040.

Table 5.2-4. SNHPC and RPC Employment Projections (Number of Jobs)

Municipality	2010	2015	2020	2025	2030	2035	2040	Average Annual Growth Rate 2015–2040
Derry	7,825	8,384	8,373	8,785	9,254	9,760	10,322	0.84%
Londonderry	13,624	13,517	14,008	14,961	16,000	16,751	17,550	1.05%
Auburn	1,651	1,846	1,960	2,135	2,331	2,534	2,760	1.62%
Chester[a]	528	368	418	459	506	565	635	2.21%
Sandown[b]	399	419	440	463	486	510	536	0.99%
Study Area Total	24,027	24,534	25,199	26,803	28,576	30,121	31,802	1.04%

Source: SNHPC (2012c, 2016b, 2016c), RPC (2015)

Notes: 2010 values were developed in 2012. 2015 projections were updated in 2016. 2020 through 2040 projections were then adjusted to reflect the 2012 5-year projection increases based on the updated 2015 projections.

a The notable decline in Chester employment in 2015 is due to the closing of Chester College in 2012, while the rebound in employment in 2020 is projected based on the opening of Busche Academy at the old Chester College (Jaschik, 2012; Williams, 2015). Busche Academy was approved and officially recognized as a non-public (private) school in October 2017. For reference, average annual growth rate in Chester between 2010 and 2040 is 0.65% compared to the elevated 2.24% shown in the table.

b Data from the RPC 2015 Regional Master Plan, with 2040 projections based on the "strong, dispersed growth" scenario. Employment data were not available for 2015-2035; therefore, this table includes straight-line growth between 2010 and 2040.

5.2.4 Land Use Interviews

Interviews with local land use planners assisted with the development of the No Build and Build land use forecasts by identifying development trends in their respective towns and providing spatial and temporal information on planned and proposed developments. The following summaries of development trends are based on these interviews. More detailed summaries of these interviews are provided in Appendix B. The draft interview summaries were provided to all participants for review and comment, and the final interview summaries were approved by the participants.

Derry

Since 1990, the rapid growth that Derry experienced from the 1960s through the 1980s has slowed. Derry's growth management ordinance was instituted in the mid-1990s along with changes in zoning to control density of residential development. In addition, the segmented ownership in the central business district and lack of large parcels of available land for development make substantial future growth impracticable. Currently, Derry is experiencing a trend of population decline related to an aging population and an outward migration of young adults as they seek employment and educational opportunities elsewhere.

The area immediately to the east of I-93, along Folsom Road north of North High Street, has been rezoned to encourage higher quality industrial and commercial development near the Proposed Project. Additionally, residential areas south of Folsom Road and North High Street might be re-zoned to Industrial/Commercial zoning. The Derry planning staff indicated that the Project could have an effect on the timing and intensity of development/redevelopment in this small, industrial-zoned area. Effects on commercial/industrial development in other areas of the town are not anticipated. The commercial zoning district along the southern end of Rockingham Road (Route 28) was revised in 2013, and some commercial development has occurred in that area. In addition, water and sewer services are being expanded along Rockingham Road to continue to encourage commercial development along that corridor.

Although no large parcels are suitable for large-scale developments, a 13-unit market-rate apartment building is planned near the central business district. An area along South Main Street/Rockingham Road is zoned for commercial development, and the town is extending water and sewer service to allow the area to develop at a higher density.

The limits of water and sewer service, the lack of large parcels, and the topography in the eastern portion of Derry serve to limit development. Lot size requirements and conserved land are also factors constraining any major single-family home developments in Derry. Because of the large number of development constraints, Derry planning staff suggested that the Project would be unlikely to induce additional residential development in Derry. However, the Project would encourage areas recently rezoned as industrial and commercial to develop by providing direct access to I-93.

Londonderry

Since 2000, the rapid growth experienced in the 1980s and 1990s has slowed, and the current development trends are based on access to undeveloped or underdeveloped land and the presence or absence of municipal services (water/sewer), which affects the density of development. For example, the industrial development on Pettengill Road is driven by undeveloped land with access to Raymond Wieczorek Drive (Manchester Airport Access Road). The Project would not affect this industrial development in northwest Londonderry. Although a few parcels are available in west Londonderry, the Proposed Project would not likely affect their future development because the Project would provide access only to the east of I-93.

On the east side of I-93, the Project would affect the timing and type of growth in Londonderry—the interchange and connector road would provide access and opportunity for commercial, institutional, and higher density residential development.

Woodmont Commons is a planned mixed-use urban village in the Town of Londonderry. The developer, Pillsbury Realty Development, LLC, owns approximately 630 acres bordering the east and west sides of I-93. Based on the PUD Master Plan (Pillsbury Realty Development, LLC, 2013), Woodmont Commons is divided into several phases, and development will occur over a 20-year period. The Town of Londonderry issued a conditional approval for the Phase I design plans in November 2016.

The Woodmont Commons development density with and without the Project is presented in the PUD Master Plan (Pillsbury Realty Development, LLC, 2013), and town planning staff indicated that the "without Exit 4A" scenario presented in the approved 2013 PUD Master Plan was based on design review meetings that included town staff, Project engineers/planners, and the town's review consultant. Thus, the "with" and "without" Exit 4A scenarios (i.e., with Project and without Project scenarios) presented in the PUD Master Plan should not be construed as projections of growth, but rather should provide an upper cap on the maximum amount of development that could occur. This explains why less commercial development is allowed on the west side of I-93 without the Project than with it, even though the Project would provide no westerly access.

Without the Project, the Woodmont Commons development on the east side of I-93 would likely be a residential development model (up to 330 units as allowed by the PUD). The Londonderry planning staff agreed that the 400,000 gsf of office development potentially allowed according to the PUD east of I-93 without the Project would likely not occur given the amount of traffic mitigation that would be required. Instead, a more realistic development scenario without the Project would be the aforementioned residential development with a small number of commercial businesses serving the needs of the 330 residential units (such as a convenience store or pharmacy).

With the Project, the current programming for the east side, which is also preferred by the Town of Londonderry, is for commercial land use accessed via Exit 4A. The developer expects a mixed-use build-out on the east side of I-93 to the level indicated by the caps in 2013 PUD Master Plan by 2040. In other words, the PUD caps represent a reasonable "Build" scenario for the Project. No development would be expected to start until after the completion of the Project (currently expected by 2022). No potential development east of I-93 has been pre-sold or pre-leased (see Woodmont Commons Land Use Interview Summary, Appendix B).

With regard to development associated with Build Alternatives A, B, C, D, and F (from the 2007 DEIS), planners stated that growth in Londonderry under Alternatives C and D would be more in line with a No Build Alternative (or without the Project) because these alternatives would not provide access to the parcels that Woodmont Commons plans to develop for commercial and/or institutional use. Given the easterly only access of the Project, development of the interchange would likely have little effect on the job growth or attraction of industries west of I-93.

Auburn, Chester, and Sandown

Auburn

Auburn is largely a bedroom community of about 16,000 acres with limited businesses. About a quarter of its area (4,200 acres) is the watershed for Massabesic Lake, which is the water supply for the City of Manchester. This limits the area available for development.

The primary drivers of growth are location and, more recently, the change in high school from Manchester to Pinkerton Academy. Auburn is located near Exits 1 and 2 of NH 101, which provides convenient access to I-93. Auburn's development has been different from most of the surrounding communities because it did not experience a decrease in development associated with the 2007–2008 recession. Auburn has issued approximately 35 new home building permits per year, and that did not change after 2007–2008. The Town Administrator stated that these new home permits are typically for custom homes on larger lots, and this trend of type and rate of residential development is expected to continue.

The Town Administrator indicated that the Proposed Project is not likely to affect development and population growth in Auburn. Travel time may improve if some of the traffic on I-93 is pulled off the interstate by the Project, but this effect would likely be minor. Auburn residents would not be likely to use Exit 4A to travel from I-93 to Auburn because NH 101 already provides convenient access to the northern portion of the town, and the southern portion is closer to the existing Exit 5 than to Exit 4A.

Chester

Chester is a rural community east of Derry. Access to I-93 is primarily through the Town of Derry. Chester is currently experiencing significant growth pressure in the form of a recent resurgence (spring 2016) of single-family residential development. Development activity has recently restarted on many of the subdivisions that have been dormant or partially complete since the 2007–2008 recession. Chester currently has approved or pending permits to develop about 300 lots, which are anticipated to be developed in the next 5 to 7 years (2022–2024) (Appendix B). In addition, the town has two 30-lot and three 5-lot subdivisions that will be approved in the near future. One of the 30-lot subdivisions is a Phase I–there will likely be an additional 90 lots in that 550-acre subdivision. The Chester Master Plan 2015 also recognizes this trend for residential growth in Chester. The plan notes that SNHPC projects that approximately 96 dwelling units would be constructed every 5 years through 2050 based on the town's historic growth rate and past building permit trends (Chester Planning Board, 2015). This long-term projection equates to an average of about 19 new home permits per year.

The primary drivers for additional residential development in Chester are good schools and the desire for rural living. Because the resurgence of residential/subdivision development is recent, it will likely be a year or two before Chester experiences a significant increase in elementary school enrollment. It is too early to determine whether a commensurate increase in school-age population or a shift in demographics of the population would occur; however, an increase is expected because most of the new homebuyers in Chester have one or more children.

Given Chester's access to I-93 through Derry, the planning coordinator indicated it was likely that the Project would induce additional residential development in Chester because of improved access to I-93.

Although the Project would enable additional growth in Chester, the town has a growth management provision in its zoning ordinance that would go into effect if pressure on school, fire, and police services outstrips the town's ability to keep pace with development. An open space subdivision provision is in place to encourage subdivisions to be creatively designed in a way that reduces sprawl and protects natural resources and rural character.

Sandown

Sandown is a rural community east of Derry, and highway access to the town is either by I-93 (via NH 102 through Derry) or by I-495 (via 121A through Plaistow). The primary driver for growth in Sandown is affordable housing—the bulk of housing in Sandown would be considered starter homes with regard to price and size. In addition, the Planning Board member interviewed indicated that transportation access to I-495 and an increase in telecommuting have contributed to population growth due to an increase in people seeking affordable housing. Sandown experienced a major influx of people during the 1990s until the recession in 2007–2008; however, Sandown is experiencing a resurgence of development similar to Chester. A 50-unit apartment building was recently approved, and two developments initially planned for residents ages 55 and older are now being developed for individuals of any age.

Although Sandown has had growth management ordinances in the past, these ordinances are no longer in place because of lawsuits by developers. Sandown is now focused on buying and conserving land to reduce the available developable land in the town. Sandown purchased 200 acres for conserved open space that had been approved for 154 dwellings for residents ages 55 and older, resulting in a reduction of housing potential in Sandown. The Planning Board is considering applying for another Community Technical Assistance Project grant to acquire and conserve more land. Most of the larger tracts have been developed, and Sandown has only a few 100-acre tracts left that could be developed as larger subdivisions.

Sandown has numerous wetlands and rivers, and in addition to purchasing land for conservation purposes, the town has a vernal pool protection provision in its zoning ordinance that includes a 25-foot buffer around vernal pools and a building setback requirement of 50 feet. In addition, the Planning Board has passed variable road width and stormwater regulations to reduce impervious surface and promote low impact development. The conservation measures are designed to improve the quality of natural resources and allow the town to reduce the amount of development and associated increase in school enrollment.

The Planning Board member stated during the interview that the widening of I-93 is having a substantial effect on growth in Sandown by reducing travel times on I-93, which makes Sandown more attractive for young homebuyers. The Planning Board member believes the Proposed Project has the potential to induce additional residential development in Sandown by providing better access and reduced travel time to I-93.

5.2.5 Summary of Indirect Land Use Impacts

The 2040 Build condition was developed by adding population, households, and employment growth from development anticipated to be induced by the Proposed Project to 2040 No Build condition values. Induced development presented for the 2040 Build condition is based on Alternative A. Alternatives A and B would induce the greatest amount of development relative to the other Build Alternatives. A comparison of Alternatives B, C, D, and F to the 2040 Build condition (Alternative A) follows the presentation of the anticipated growth for Alternative A.

Alternative A

This section first discusses the incremental impact of Alternative A (e.g., indirect land use effects) and then provides a summary of the total 2040 Build condition land use forecast.

Indirect Land Use Effects

The additional reasonably foreseeable future development under Alternative A was identified through the land use planner interviews. Table 5.2-5 provides a summary of the incremental growth anticipated to be induced by Alternative A, which includes changes in the density and type of development anticipated for Woodmont Commons, as well as commercial and industrial growth in Derry induced by improved access to I-93. Detailed explanations of the induced development anticipated for Woodmont Commons, commercial and industrial growth in Derry, and induced residential development in Chester and Sandown and the population, household, and employment projections as a result of this induced development are provided in Appendix B. The Pettengill Road industrial area and the Market Basket redevelopment area are not anticipated to be affected by the Proposed Project. Also, through the land use interviews, it was determined that the Proposed Project would not induce development in Auburn (see Appendix B).

Table 5.2-5. Summary of Indirect Land Use Effects of Alternative A

Development Name	Type/Land Use	Residential Units	Hotel Rooms	Commercial Area (gsf)	Institutional (gsf)	Industrial Area (jobs)
Derry	Commercial/ Industrial	NA	NA	0	NA	168[b]
Woodmont Commons– West of I-93	Mixed Use– Commercial/ Residential	6	0	322,000	40,000	NA
Woodmont Commons– East of I-93[a]	Mixed Use– Commercial/ Residential	3	200	693,400[a]	420,000	NA
Chester	Residential	371	NA	NA	NA	NA
Sandown	Residential	9	NA	NA	NA	NA
Total		**389**	**200**	**1,015,400**	**460,000**	**168**

Source: Pillsbury Realty Development, LLC (2013), Interviews with the Towns and a Woodmont Commons representative (see Appendix B).

[a] Based on the interview with the representative of Pillsbury Realty Development on August 7, 2016, it was agreed that developing the upper cap of 400,000 gsf of commercial uses on the East side of I-93 for Phase 1 was unlikely without Exit 4A due to the traffic mitigation that would be required (see Appendix B and footnotes to Table 8). This Build condition value total assumes the difference between the likely No Build Phase 1 commercial development (400,000 gsf–6,600 gsf) plus the remainder of the East side development that would be anticipated as a result of the access provided by Exit 4A (300,000 gsf).

[b] Because it is not possible to predict which type of jobs would result from Derry's industrial rezoning and redevelopment due to the flexible nature of the Industrial District IV zoning that allows retail, commercial, and industrial development, all jobs were assumed to be in the industrial category.

2040 Build Condition Land Use Forecast Summary

Based on the information presented above and in Appendix B, the 2040 Build condition population for the study area is estimated to be 83,654, as outlined in Table 5.2-6, an increase of 1,163 people over the No Build condition. Table 5.2-7 and Table 5.2-8 show the total households and employment (jobs), respectively, for the study area under the 2040 Build condition. The total number of 2040 Build households for the study area is estimated to be 34,190, an increase of 389 households over the No Build condition (Table 5.2-7), and the 2040 Build employment for the study area is estimated to be 39,975 jobs, an increase of 4,681 jobs over the No Build condition (Table 5.2-8). The large increase in employment under the Build condition is primarily attributable to the additional build out of Woodmont Commons that Londonderry will permit with the completion of Exit 4A.

Table 5.2-6. Total 2040 Build Condition Population for Study Area

Municipality	2040 No Build Population	2040 Build Incremental Development Project Population	Total 2040 Build Population	Percent Difference between No Build and Build
Derry	33,222	0	33,222	0.00%
Londonderry	30,885	25	30,910	0.08%
Auburn	6,048	0	6,048	0.00%
Chester	6,253	1,117	7,370	16.40%
Sandown	7,246	21	7,267	0.29%
Study Area Total	83,654	1,163	84,818	1.38%

Table 5.2-7. Total 2040 Build Condition Households for Study Area

Municipality	2040 No Build Households	2040 Build Incremental Development Project Households	Total 2040 Build Households	Percent Difference between No Build and Build
Derry	12,673	0	12,673	0.00%
Londonderry	10,695	9	10,704	0.08%
Auburn	2,187	0	2,187	0.00%
Chester	2,077	371	2,448	16.40%
Sandown	2,914	9	2,923	0.29%
Study Area Total	30,546	389	30,935	1.26%

Table 5.2-8. Total 2040 Build Condition Employment for Study Area

Municipality	2040 No Build Employment	2040 Build Incremental Development Employment	Total 2040 Build Employment	Percent Difference between No Build and Build
Derry	10,479	346	10,825	3.25%
Londonderry	20,875	4,335	25,210	18.81%
Auburn	2,764	0	2,764	0.00%
Chester	641	0	641	0.00%
Sandown	536	0	536	0.00%
Study Area Total	35,294	4,681	39,975	12.44%

Alternative B

Compared to Alternative A, Alternative B would be expected to result in similar commercial and industrial growth in Derry. Although the exact location of the connector road would be different from that proposed for Alternative A, Alternative B would provide access to the area zoned as Industrial IV and the area being considered for rezoning. The development associated with Woodmont Commons and Chester would be similar under Alternatives A and B. As previously mentioned, the Proposed Project is not expected to affect the industrial developments in the northwest portion of Londonderry or residential development in Auburn. Finally, the anticipated increased rate of residential development in Chester and Sandown would be similar under Alternatives A and B.

Alternative C

The commercial and industrial development anticipated in Derry under Alternative A would not be realized under Alternative C because the rezoned parcels along Folsom Road north of North High Street would not have direct access to the interchange. The alignment of Alternative C would constrain additional commercial/industrial development due to lack of available land adjacent to the ROW. As the alignment approaches I-93, a transmission line and conservation areas limit the available land for development. Where the alignment follows NH 28, the adjacent land is largely built out with commercial and industrial uses. Although it is possible that some of the commercial and industrial parcels could be redeveloped, it is unlikely to result in a substantive net gain of commercial or industrial space because of the size of the individual parcels.

Londonderry planning staff and the Woodmont Commons representative indicated that Alternative C would limit access to the area available for development near I-93 to an extent that, if this alternative were selected, the Woodmont Commons area on the east side of I-93 would be developed as detailed under the No Build condition (e.g., primarily residential, 330 households). As previously mentioned, the Proposed Project is not expected to affect the industrial developments in the northwest portion of Londonderry or residential development in Auburn. Finally, the anticipated increased rate of residential development in Chester and Sandown would be similar under Alternatives A and B given that the Alternative C interchange/roadway improvements would still provide a bypass of downtown Derry (although with a less direct route than Alternative A).

Alternative D

Development under Alternative D would be the same as that anticipated under Alternative C because the interchange would be located in the same location as Alternative C. Roadway improvements would follow Tsienneto Road to connect with NH 102 (similar to Alternative A).

Alternative F

Alternative F would involve an upgrade of NH 102 between Londonderry Road and the NH 28 Bypass. Development under Alternative F in the area of Woodmont Commons and the industrial area of Derry would be the same as that anticipated under the No Build condition. Indirect land use impacts on Chester and Sandown are not anticipated. Although the improvements on NH 102 would reduce congestion through downtown Derry, Alternative F does not include improvements that would enable commuters to bypass downtown Derry, thereby encouraging growth in Chester or Sandown.

5.3 Development under the 2040 No Build and Build Conditions

The 2040 No Build condition is the reasonably foreseeable future development anticipated without construction of the Proposed Project. The 2040 Build condition is the reasonably foreseeable future development anticipated if the Proposed Project is built and includes both the growth that is attributable to the improved transportation access created by the Project, as well as growth that is independent of the Project. The difference between the No Build and Build conditions is the indirect land use–or incremental–impact of the Project. As noted in section 5.2.5, Alternatives A and B are anticipated to induce similar amounts development relative to each other and greater amounts development relative to Alternatives C, D, and F. Therefore, the induced development presented for the 2040 Build condition is based on Alternatives A and B to identify maximum potential indirect effects from the Project.

Both the 2040 No Build and 2040 Build conditions were developed after analyzing a variety of data sources and based on interviews with planners in local jurisdictions to ensure a collaborative process for land use and travel forecasting assumptions. Forecasting assumptions were also developed for the alternatives, as discussed in Section 5.2.5. The overall process was guided by FHWA's *Interim Guidance on the Application of Travel and Land Use Forecasting in NEPA* (FHWA, 2010).

The *Land Use Scenarios Technical Report* (Appendix B) defined the No Build and Build conditions and provided socioeconomic inputs (i.e., population, households, and jobs) associated with each development. The socioeconomic inputs were used in the traffic modeling and analysis. For this analysis, additional information on the area of potential land disturbance associated with reasonably foreseeable future development is required to assess the indirect and cumulative impacts of this future development on environmental resources. Detailed information on each of these developments is provided in Appendix B.

The following sections present the development footprints for the known developments identified in the *Land Use Scenarios Technical Report* and a summary of the incremental development anticipated to be induced by the Proposed Project.

5.3.1 Development Footprints for Known Developments

This section includes a summary of assumptions made regarding the development footprints for each major development as well as the identification of a range of footprints under the No Build and Build conditions, as applicable. The “footprint” refers to assumed area of land disturbance associated with each development. Within each development discussion, assumptions used to generate the range of footprints are identified. The purpose of defining the footprints of each development is to aid in the quantification of potential indirect and cumulative impacts to environmental resources. Development footprints have been created for the following developments:

1. Market Basket Redevelopment
2. Woodmont Commons West—Phase I
3. Woodmont Commons West—Remainder
4. Woodmont Commons East
5. Derry Industrial Development
6. Chester Residential

Figure 5.3-1 shows the approximate locations of each of these developments. These footprints are used in the indirect effects and cumulative impacts analyses.

The Pettengill Road industrial development (Map ID 7 on Figure 5.3-1) would not be affected by the Proposed Project; therefore, developing detailed development footprint assumptions was not warranted. Access to those parcels is provided by Pettengill Road and Raymond Wieczorek Drive (Manchester Airport Access Road). As outlined in the *Land Use Scenarios Technical Report* (Appendix B), employment projections by TAZ for the Pettengill Road industrial area under the No Build condition were obtained from SNHPC. The Build Alternatives would not alter future employment in this area.

Market Basket Redevelopment

The new Market Basket was constructed on the other side of the plaza from the original grocery store. The 26.7-acre redevelopment approved by the Town of Londonderry in 2015 involved the demolition of about 74,000 gsf of commercial space and the addition of about 42,000 gsf of commercial development (Town of Londonderry, 2015). Construction is complete, and the 42,000 gsf is occupied (Figure 5.3-2).

In addition, there are four commercial pads available for development within the redevelopment area along John R. Michels Way, the roadway running through the Woodmont Commons development area connecting Garden Lane and Pillsbury Road. Although the four pad sites have not been approved for development, it is possible that they could provide an additional 20,000 to 30,000 gsf of commercial development. As such, 30,000 gsf of potential additional commercial development has been included in the 2040 No Build condition.

The development footprint considered for the cumulative impacts analysis includes the four pad sites that could accommodate 30,000 gsf within the larger Market Basket Redevelopment area. These sites as well as parking are assumed to be accommodated by the larger Market Basket

Redevelopment area (Figure 5.3-2). The development footprint would not change under the Build condition.

Woodmont Commons West—Phase I

Construction for Woodmont Commons West, Phase I began in June 2017 and includes mixed use residential and commercial space, with about 60 percent retail space and 40 percent office space; five restaurants, including one restaurant/brewery; a hotel; a concert venue; and individual elderly living. Phase I is anticipated to be completed by 2020 regardless of whether or not Exit 4A is constructed. The development footprint considered for the cumulative impacts analysis is based on the approved site plan and includes about 52.4 acres (Figure 5.3-2). Parking in included within the site plan. The development footprint would not change under the Build condition.

Woodmont Commons West—Remainder

The remainder of Woodmont Commons West is anticipated to be completed by 2040. The maximum growth caps outlined in the Woodmont Commons PUD Master Plan were used in the development of the No Build and Build conditions to provide a conservative estimate of indirect impacts (i.e., using the upper bound allowable growth results in predicting greater environmental impacts). The PUD includes a proposed pond within the remainder of the Woodmont Commons West development, which appears to be based on expansion and enhancement of the existing Duck Pond. The Duck Pond is mapped as a 30.14-acre prime wetland. The PUD states that the proposed residential and commercial development is not dependent on the proposed pond expansion; page 19 of the PUD shows a possible alternative plan to leave the area in its natural state “if the proposed pond in WC-3 is not approved by State or Federal authorities having jurisdiction.” As a result, the proposed pond is not included in the development footprint.

For analysis of indirect effects and cumulative impacts to resources, the minimum and maximum development footprints are considered to be the area of disturbance. The development densities proposed in the PUD do not lend themselves to having large areas of undisturbed land. The actual development that occurs within the Woodmont Commons PUD by 2040 may be less than this maximum depending on economic conditions and regulatory approvals.

No Build Condition

Table 5.3-1 and Figure 5.3-3 show the range of potential development footprints under the No Build condition.

Table 5.3-1. Woodmont Commons West—Remainder Development Footprints under the No Build Condition

<table>
<tr><th colspan="2" rowspan="2">Development</th><th colspan="2">2040 No Build Condition</th></tr>
<tr><th>Minimum Footprint (acres)</th><th>Maximum Footprint (acres)</th></tr>
<tr><td>Residential (units)</td><td>570</td><td>52.3</td><td rowspan="5">Based on the concept in the PUD Master Plan</td></tr>
<tr><td>Hotel (rooms)</td><td>215</td><td>0.5</td></tr>
<tr><td>Commercial Area (gsf)</td><td>519,926</td><td>3.0</td></tr>
<tr><td>Institutional (gsf)</td><td>0</td><td>0.0</td></tr>
<tr><td>Parking (spaces)</td><td>2,784</td><td>19.2</td></tr>
<tr><td colspan="2">Total</td><td>75.0</td><td>103.2</td></tr>
</table>

Source: Pillsbury Realty Development, LLC (2013)

The maximum footprint is based on the concept shown in the PUD Master Plan (page 21) and includes parking. The minimum footprint of development was based on the following assumptions:

- The PUD Master Plan development standards include a minimum lot size for single-family residential use of 3,200 square feet. Assuming the minimum lot size, the anticipated 570 residential units would require approximately 42 acres of disturbance. The minimum footprint for residential areas has been increased by 25 percent to include other aspects associated with the residential development, such as utilities, stormwater treatment, and internal circulation. The PUD is designed to encourage higher density development compared to the typical development within the Town of Londonderry.
- The 215 hotel rooms are anticipated to require about 0.5 acre. A Sleep Inn hotel near Manchester Airport was used as a reference property–this hotel had 100 rooms and occupied 40,976 square feet, including common areas and work spaces (Town of Londonderry, 2017b). The footprint is based on a 4-story building (the maximum height for buildings outlined in the Master Plan).
- The 519,926 gsf of commercial development outlined in the PUD Master Plan is assumed to be built in 4-story buildings, which is the maximum height for commercial buildings as outlined in the Master Plan.
- Parking space standards are outlined in the Woodmont Commons PUD Master Plan (page 150). About 2,784 spaces are anticipated to accommodate the hotel and other commercial development. Although parking space dimensions are assumed to be an average of 8-feet wide and 18-feet long, 300-square-feet per parking space was used to account for circulation.

Build Condition

Table 5.3-2 and Figure 5.3-4 show the range of development footprints under the Build condition. The maximum footprint is based on the concept shown in the PUD Master Plan (page 21) and includes parking. The minimum footprint of development was based on the minimum lot standards for residential and all commercial and institutional development contained in 4-story buildings.

Table 5.3-2. Woodmont Commons West—Remainder Development Footprints under the Build Condition

Development		2040 Build Condition	
		Minimum Footprint (acres)	Maximum Footprint (acres)
Residential (units)	576	52.9	Based on the concept in the PUD Master Plan
Hotel (rooms)	215	0.5	
Commercial Area (gsf)	841,926	4.8	
Institutional (gsf)	40,000	0.2	
Parking (spaces)	3,949	27.2	
Total		**85.7**	**228.1**

Source: Pillsbury Realty Development, LLC (2013)

Woodmont Commons East

No Build Condition

Under the No Build condition, Woodmont Commons East is anticipated to include 330 residential units and about 6,600 gsf of ancillary commercial space. Under the Build condition, the development is anticipated to be consistent with the maximum permissible development outlined in the September 2013 PUD Master Plan (see subarea WC-12), which includes 330 residences, a 200-room hotel, 420,000 gsf of institutional uses (such as a hospital or assisted living facilities), and 700,000 gsf of commercial/office uses.[22]

Table 5.3-3 and Figure 5.3-5 show the range of development footprints under the No Build condition. Under the No Build condition, Franklin Street and Ash Street were assumed as access points for circulation and fire department access (based on the PUD Master Plan).

Table 5.3-3. Woodmont Commons East Development Footprints under the No Build Condition

Development		2040 No Build Condition	
		Minimum Footprint (acres)	Maximum Footprint (acres)
Residential (units)	330	30.3	60.6
Hotel (rooms)	0	0.0	0.0
Commercial Area (gsf)	6,600	0.2	0.2
Institutional (gsf)	0	0.0	0.0
Parking (spaces)	682	4.7	4.7
Subtotal		35.2	65.5
Connecting Roads		6.6	4.0
Total		**41.8**	**69.5**

Source: Pillsbury Realty Development, LLC (2013)

The No Build condition development footprints (Figure 5.3-5) are based on the following assumptions:

- The developer has an incentive to minimize direct vernal pool/wetland impacts to lower mitigation costs. Therefore, unconstrained uplands would be developed first.
- The PUD Master Plan assumes a minimum lot size for single-family residential use of 3,200 square feet. Under the low range footprint, the anticipated 330 residential units would require a minimum of 24 acres of disturbance. The minimum footprint was increased by 25 percent to include other aspects associated with residential development, such as utilities, stormwater treatment, and internal circulation.
- The maximum footprint assumes that the developer uses much larger lot sizes than the minimum outlined in the PUD Master Plan more typical of suburban

[22] The Master Plan specifically allows for flexibility on the specific mix of uses between Nursing Homes and Assisted Living, Accommodations and Commercial Uses on a per square foot basis.

residential development. Given the wetland and vernal pool constraints on the parcel, it is possible that the lot size used for residential development could be up to two times the minimum lot size listed in the PUD Master Plan (i.e., 6,400 square feet). Using this assumption, the maximum footprint for 330 residential units would require about 48 acres of disturbance. As with the minimum footprint, the maximum footprint has been increased by 25 percent to accommodate the aforementioned additional aspects of residential development.

- The 6,600 gsf of supporting commercial development would be constructed as a one-story building.
- Parking space standards outlined in the Woodmont Commons PUD Master Plan (page 150). About 682 spaces are anticipated under the No Build condition. Although parking space dimensions are assumed to be an average of 8-feet wide and 18-feet long, 300 square feet per parking space was used to account for circulation.
- Connecting roads were based on the PUD Master Plan. The maximum footprint connecting roads occupy less area than the connecting roads for the minimum footprint because the development for the maximum footprint encompasses some of the road area.

Build Condition

Table 5.3-4 and Figure 5.3-6 show the range of development footprints under the Build condition.

Table 5.3-4. Woodmont Commons East Development Footprints under the Build Condition

Development		2040 No Build Condition	
		Minimum Footprint (acres)	**Maximum Footprint (acres)**
Residential (units)	333	30.6	Based on the concept in the PUD Master Plan
Hotel (rooms)	200	0.5	
Commercial Area (gsf)	693,400	4.0	
Institutional (gsf)	420,000	2.4	
Parking (spaces)	3,831	26.4	
Subtotal		63.8	105.5
Connecting Roads		4.1	2.8
Total		**67.9**	**108.3**

Source: Pillsbury Realty Development, LLC (2013)

The Build condition maximum footprint is based on the concept shown on page 35 of the PUD Master Plan. The minimum footprint is derived from the PUD Master Plan concept with the following assumptions (Figure 5.3-6).

- The PUD Master Plan assumes a minimum lot size of 3,200 square feet. Under the minimum footprint, the anticipated 333 residential units would require about 31 acres of disturbance. The minimum footprint for residential areas has been increased by 25 percent to include other aspects associated with the residential development, such as utilities, stormwater treatment, and internal circulation.

- The 200 hotel rooms are anticipated to require about 2 acres. A Sleep Inn hotel near Manchester Airport was used as a reference property–this hotel had 100 rooms and occupied 40,976 square feet, including common areas and work spaces (Town of Londonderry, 2017b). The footprint is based on a 4-story building, which is the maximum height for buildings outlined in the Master Plan.
- The 693,400 gsf of commercial development and 420,000 gsf of institutional development outlined in the PUD Master Plan is assumed to be built in 4-story buildings, which is the maximum height for commercial and institutional buildings as outlined in the Master Plan.
- Parking space standards outlined in the Woodmont Commons PUD Master Plan (page 150). About 3,831 spaces are anticipated to accommodate the hotel and other commercial development. Although parking space dimensions are assumed to be an average of 8-feet wide and 18-feet long, 300 square feet per parking space was used to account for circulation.
- As noted in Section 5.2.5, under Alternatives C, D, and F, Woodmont Commons East would develop as anticipated under the No Build condition.

Derry Industrial Development

The Derry industrial development is a combination of the potential for redevelopment of existing lower density industrial development and rezoning of parcels currently zoned as medium high density residential to industrial. Under the No Build condition, the Town of Derry is unlikely to take measures to rezone the parcels to industrial use. In addition, the No Build condition does not offer improved access as an incentive for redevelopment. As a result, a development footprint has not been created for the No Build condition.

As outlined in the *Land Use Scenarios Technical Report*, the anticipated Derry industrial redevelopment and rezoning is anticipated to result in jobs 346 jobs. The redevelopment and rezoning would include 346 parking spaces.

The Industrial zoning Districts IV and VI permit a range of commercial and industrial uses, including general retail, industrial office, and industrial/manufacturing. The employees per gsf for each of these uses ranges from 300 gsf/employee for industrial office to 800 gsf/employee for industrial/manufacturing (RKG, 2016). The maximum footprint under the Build condition assumes that 800 gsf/employee would be required, while the minimum footprint assumes 300 gsf/employee would be required. In addition, parking was estimated to require 300 square feet per employee to account for an average parking space size of 8 feet by 18 feet and circulation within the lot. Table 5.3-5 and Figure 5.3-7 show the range of development footprints under the Build condition.

Table 5.3-5. Derry Industrial Development Footprints under the Build Condition

Development		2040 Build Condition	
		Minimum Footprint (acres)	Maximum Footprint (acres)
Industrial Office	300 gsf/employee	2.4	
Industrial/Manufacturing	800 gsf/employee		6.3
Parking (spaces)	346	2.4	2.4
Total		**4.8**	**8.7**

Chester Residential

Under the No Build condition for the Proposed Project, about 2,029 households are anticipated in Chester by 2040. Under the Build condition, about 2,400 households are anticipated by 2040, an increase of 371 households. To calculate the land conversion for the indirect effects and cumulative impacts analysis, the following additional metrics were used: available land, housing supply, minimum lot size as outlined in the zoning ordinance.

A build out study was prepared for Chester as part of the NHDOT Community Technical Assistance Project considering future growth impacts to the region as related to I-93 widening project. The purpose of a build out study is to assess a town's future growth and development given the amount and capacity of available developable land and then estimates what the ultimate growth and development of the town could be considering various zoning standards. It is not intended to be a prediction of actual development that would occur by a particular date; rather, it is a hypothetical development capacity analysis. Using geographic information systems (GIS)-based Community Viz software and the town's existing zoning standards and the Generalized Future Land Use Map, the study estimated that the Town of Chester could experience a build out of 5,762 homes resulting in a future population of around 14,751 (Town of Chester, 2015). Based on the 2015 Chester Master Plan, about 5,471acres of developable land are available in Chester. The calculation of developable land is based on the amount of land zoned as General Residential/Agricultural less the natural constraints identified through a GIS analysis. Natural constraints include: hydric soils; steep slopes; Federal Emergency Management Agency-mapped floodplains; farm soils, and conservation lands. Based on the 2015 Chester Zoning Ordinance, the minimum lot size for single-family residences is 2 acres.

Table 5.3-6 shows the anticipated development footprints under the No Build and Build conditions. No range in footprint is provided under the No Build condition. Under the Build condition, the maximum footprint is based on the high growth scenario as outlined in the *Land Use Scenarios Technical Report*, and the minimum footprint is based on the moderate growth scenario as outlined in the *Land Use Scenarios Technical Report* (Appendix B).[23]

Table 5.3-6. Chester Residential Development Footprints

Scenario	Range	Households	Land Required (acres)
2040 No Build Condition	NA	2,029	4,058.0

[23] The population and households calculated for the high growth scenario are anticipated to be the incremental effect of the Proposed Project, and these numbers are used in the population and household projections for the 2040 Build condition.

Scenario	Range	Households	Land Required (acres)
2040 Build Condition Incremental Effect of Exit 4A	Low	178	356.0
	High	371	741.9
2040 Build Condition – Total	Low	2,207	4,414.0
	High	2,400	4,799.9

The maximum footprint of the 2040 Build condition footprints could be accommodated by the available, developable land in Chester (Town of Chester, 2015). Although the development footprints assumed using the minimum lot sizes, it is not possible to determine the limits of disturbance within each lot. As a result, spatial representations of the potential development footprints have not been created due to the variability of location of and disturbance required by these developments. For impact assessment purposes, the entire 2-acre lot is assumed to be disturbed. With larger lot development, some land would presumably not be disturbed; therefore, 2 acres of disturbance per household remains a reasonable assumption for larger lot sizes.

5.4 Indirect Effects and Cumulative Impacts

5.4.1 Methodology

Study Area Boundaries and Analysis Year

The study area for assessing cumulative impacts consists of the Towns of Derry, Londonderry, Chester, Auburn, and Sandown (Figure 5.2-1). This study area is appropriate for cumulative impact assessment because it encompasses the extent of direct and indirect impacts of the Project, as well as the surrounding areas and associated environmental resources.

Resources for Analysis

The detailed analysis of indirect and cumulative impacts is focused on those resources that could be substantially affected by the Project in combination with other past, present, and reasonably foreseeable future actions, and resources currently in poor or declining health or at risk even if Project effects are relatively small. The following resources were identified for inclusion in the indirect and cumulative impact analysis based on consideration of the status of each resource, the potential direct and indirect effects of the Project and areas of concern identified through previous Project public involvement and agency coordination:

- Streams, Wetlands, and Vernal Pools
- Water Quality
- Wildlife Habitat
- Cultural Resources

Because this Project incorporates indirect land use effects directly in the SNHPC transportation model, the traffic analysis presented in Section 4.2 constitutes a complete assessment of cumulative impacts on traffic (including indirect land use effects and background growth that would occur regardless of the Project). The air quality and noise assessments used the traffic study outputs as inputs. Therefore, the air quality and noise assessments presented in Sections 4.4 and 4.5, respectively, constitute complete cumulative impact assessments.

Detailed Analysis Methodology

Indirect effects and cumulative impacts to resources were identified based on the aforementioned development footprints under the Build and No Build conditions. Direct impacts summarized in the resource sections include a range based on Build Alternatives. More detailed information on direct effects associated with each Build Alternative is provided in Chapter 4, *Affected Environment and Environmental Consequences*. In addition, cumulative impacts related to background growth under the No Build Alternative were considered qualitatively, taking into account the applicable regulatory framework for each environmental resource.

Resource Condition and Trends

For each resource selected for analysis, information on health, status, and trends was gathered from published reports and data available from USGS, USFWS, EPA, NHDES, NHFGD, and USDA, among others. This inventory meets the NEPA requirement to consider the impacts of past and present actions on resources as part of the cumulative impact analysis.

Impacts of Other Reasonably Foreseeable Future Actions

Cumulative impact analysis includes consideration of the impacts of the other reasonably foreseeable transportation projects and land development attributable to population and employment growth. Other projects and developments need to be included in the analysis if they are “reasonably foreseeable.” Section 3.6.1 outlines the other transportation projects included as part of the 2040 No Build condition transportation network, and Section 5.3.1 lists the key major land development projects included in the No Build condition. The cumulative impact analysis considers other reasonably foreseeable public and private developments by using population and employment forecasts for the No Build and Build conditions. In addition, the reasonably foreseeable development within the immediate vicinity of Alternative A was quantified through the development footprints analysis (summarized in the “No Build Impact” columns in Table 5.4-1).

Table 5.4-1. Anticipated Development Footprints under the No Build and Build Conditions

Development	Minimum Footprint				Maximum Footprint			
	No Build Impact (acres)	Incremental Build Condition Impact		Build Condition Total Impact (Cumulative Impact [acres])	No Build Impact (acres)	Incremental Build Condition Impact		Build Condition Total Impact (Cumulative Impact [acres])
		Direct Effect (acres)	Indirect Effect (acres)			Direct Effect (acres)	Indirect Effect (acres)	
Exit 4A (footprint)	0	21.51-89.91	-	21.51-89.91	0	21.51-89.91	-	21.51-89.91
Woodmont Commons Phase I and Market Basket	79.1	-	-	79.1	79.1	-	-	79.1
Woodmont Commons West (Remainder)	75.0	-	10.7	85.7	103.2	-	124.9	228.1
Woodmont Commons East[1]	41.8	-	26.1	69.9	69.5	-	38.8	108.3
Derry Industrial Development	-	-	4.8	4.8	-	-	8.7	8.7
Total	**195.9**	**21.51-89.91**	**41.6**	**259.01-327.41**	**251.8**	**21.51-89.91**	**172.4**	**445.71-514.11**

Note: 1. For Woodmont Commons East, the Build condition is used for the analysis of Alternatives A and B. As discussed in Section 5.2.5, under Alternatives C, D, and F, Woodmont Commons East is anticipated to develop as outlined under the No Build condition.

Direct Impacts

Because direct impacts are considered as part of the Project contribution to cumulative impacts, a summary of these impacts is provided for each resource (based on the information presented in Chapter 4).

Indirect Effects

Section 5.2, *Land Use Forecasting*, provides a detailed review of the methods used to assess indirect land use effects of the Project. As detailed in Section 5.2.5 and Table 5.2-5, changes in land use associated with Alternative A include an increase in commercial and industrial development in Derry; additional residential, commercial, and institutional development associated with Woodmont Commons west and east of I-93 in Londonderry; and increased residential development in Chester and Sandown. Nearly all of these land use changes involve the conversion of undeveloped land to developed uses. The additional commercial and industrial development in Derry would involve redevelopment of currently developed land. Table 5.4-1 provides a summary of the minimum and maximum development footprints associated with known developments in the study area. The footprints associated with the conversion in land use were used to calculate impacts to other resources within the study area. In all cases, development permits from the towns would be required, which would ensure that land use changes are compatible with existing and planned land use and zoning.

Potential for Cumulative Impacts

The cumulative impact assessment for each resource draws conclusions about the aggregate or total impact on each resource as a result of all the actions included in the No Build condition, plus the direct and indirect impacts of the Proposed Project. These conclusions regarding cumulative impacts take into account the status of each resource (the result of past and present actions), and countervailing trends, such as restoration programs and environmental regulations, that could lead to overall improvements in the status of a resource, even though it is being impacted by development.

5.4.2 Streams, Wetlands, and Vernal Pools

Resource Condition and Trends

Methodological issues exist with comparing historical wetland acreage between various studies to form a comprehensive timeline of past resource conditions. One study (Economic Research Service/USDA, 1998) that attempted to adjust for these differences estimated that there were about 599,400 acres of wetlands in New Hampshire in 1780, and 132,800 acres or 22 percent of these were converted to other uses between 1780 and 1954. During this time period, most wetland conversion was for agriculture and encouraged by federal policy. From 1954 to 1982, the acreage of wetlands in New Hampshire is estimated to have increased by about 23,100 acres to 489,700 acres. This increase was likely the result of the abandonment of less productive agricultural land. Between 1982 and 1992, the area of wetlands in New Hampshire is estimated to have decreased by about 13,600 acres or 2.7 percent. These wetland impacts were primarily associated with urban development. Wetland losses in more recent years have been greatly slowed in comparison to past impacts by regulatory protections, including Section 404 of the CWA and the New Hampshire Wetland Rules.

The NWI estimates that there are 12,098 acres of wetlands (including waterbodies/streams) in the study area, covering 12.8 percent of the total area. No similar study area-wide data are available on the presence of vernal pools. However, vernal pools have been delineated in the Woodmont Commons East area (see Figures 4.12-8 and 4.12-9 in Chapter 4).

Impacts from Other Actions

Development activity unrelated to the Proposed Project at Woodmont Commons Phase I and Market Basket, and Woodmont Commons West (Remainder) would not result in impacts to streams, wetlands, or vernal pools. Development activity unrelated to the Proposed Project at Woodmont Commons East could impact 0.16 to 0.17 acre of non-prime, non-vernal-pool wetlands, 0.007 to 0.009 acre of vernal pools, and 302 linear feet of streams (Tables 5.4-2–5.4.10). No prime wetlands would be affected by this development activity.

Of the parcels containing the known developments considered in this analysis, vernal pools are only mapped on property identified as the Woodmont Commons East development. In addition to the potential vernal pool impacts, potential impacts to terrestrial habitat adjacent to vernal pools were evaluated. Development unrelated to the Proposed Project could impact 0.62 to 1.05 acres of terrestrial habitat within 100 feet of vernal pools and 38.56 to 65.52 acres of terrestrial habitat within 750 feet of vernal pools (Tables 5.4-11–5.4-13).

Direct Impacts

As detailed in Section 4.12, the Project would impact between 152 and 1,341 linear feet of streams; Alternative A would impact 1,268 linear feet of streams. The Project would directly impact between zero and 8.85 acres of non-prime, non-vernal-pool wetlands; Alternative A would fill 2.31 acres. The Project would directly fill between zero and 0.06 acre of prime wetlands; Alternative A would fill 0.03 acre. The Project would directly impact between 0 and eight vernal pools, totaling 0 to 1.12 acres; Alternative A would impact seven vernal pools, totaling 1.12 acres. Direct impacts to upland habitat within 100 feet and 750 feet that would be affected around each vernal pool were quantified for each Alternative and are provided in Section 4.12. Alternative A would impact upland within 100 feet of five vernal pools and upland within 750 feet of 25 vernal pools (many of which are overlapping).

Indirect Effects

Induced Development

Depending on the Build Alternatives and range of footprints for future development projects, additional development induced by the Project at Woodmont Commons East and West (Remainder) would impact 2 to 73 linear feet of streams, 0.01 to 0.65 acre of non-prime, non-vernal-pool wetlands, and zero to 0.435 acre of vernal pools. No prime wetlands would be affected by development induced by the Proposed Project.

Within a 100-foot buffer of the vernal pools, development induced by the Project within Woodmont Commons East could impact between zero and 6.75 acres of adjacent terrestrial habitat. Within a 750-foot buffer of the vernal pools, development induced by the Project within

Woodmont Commons East could impact between 22.10 and 33.38 acres of adjacent terrestrial habitat.

The Derry industrial development anticipated to be induced would not impact streams, wetlands, or vernal pools. Additional indirect effects could occur as result of increased residential development in Chester, but insufficient detailed information is available to quantify the impact in Chester. Most mapped wetlands would be avoided in Project planning and permitting. Any effect would be small in comparison to the land development expected in the study area under the No Build condition. In addition, any additional impacts would be subject to compensatory mitigation to offset impacts.

Habitat Alteration and Encroachment

In addition to development that could be induced by the Project, other indirect effects include habitat alteration and encroachment related to the direct impacts resulting from the Project. Impacts to wetlands, including vernal pools, may result from changes in hydrology from stormwater directed to wetlands from the Project, fragmentation of habitat used by wetland-dwelling wildlife, edge effects from removal of vegetation next to wetlands, and noise and light disturbance once the road is operational. Impacts to the 100-foot VPE and 750-foot CTH for each vernal pool are quantified in Section 4. Fragmentation of habitat is included as an impact in the vernal pool habitat analysis.

Potential for Cumulative Impacts

No direct impacts to surface waters (i.e., ponds, lakes) would occur under any of the Alternatives or as a result of the known developments. Woodmont Commons West (Remainder) involves the creation of a pond within the minimum and maximum development footprints under the Build and No Build conditions. The following tables show the range of indirect effects and cumulative impacts on streams, wetlands, and vernal pools based on the Build Alternatives:

- Tables 5.4-2 through 5.4.4—streams
- Tables 5.4-5 through 5.4-7—non-vernal pool wetlands
- Tables 5.4-8 through 5.4-10—vernal pools
- Tables 5.4-11 through 5.4-13—terrestrial habitat adjacent to vernal pools

Under the No Build condition, considering maximum footprints, reasonably foreseeable development could impact about 302 linear feet of streams; 0.16 to 0.17 acre of non-prime, non-vernal-pool wetlands; and 0.007 to 0.009 acre of vernal pools. Additionally, within a 100-foot buffer of the vernal pools, development under the No Build condition could impact 1.05 acres of adjacent terrestrial habitat. Within a 750-foot buffer of the vernal pools, development induced by the Project within Woodmont Commons East could impact 65.52 acres of adjacent terrestrial habitat.

Depending on Build Alternative, considering maximum footprints, the incremental impact of induced development from the Project could impact 20 to 73 linear feet of streams, 8.46 to 8.66 acres of wetlands (1.61 to 1.81 acres of non-prime, non-vernal-pool wetlands and 6.85 acres of prime wetlands), and zero to 0.76 acre of vernal pools.

Cumulative impacts from reasonably foreseeable development under the Build condition, considering maximum footprints, could impact between 475 and 1,665 linear feet of streams; 1.23 and 10.23 acres of non-prime, non-vernal-pool wetlands; zero to 0.06 acre of prime wetlands); and 0.009 to 1.57 acres of vernal pools.

Additionally, within a 100-foot buffer of the vernal pools, considering the maximum footprint of development induced by the Project within Woodmont Commons East and Derry Industrial could impact between 1.05 and 87.80 acres of adjacent terrestrial habitat. Within a 750-foot buffer of the vernal pools, development induced by the Project within Woodmont Commons East could impact between 68.44 and 98.90 acres of adjacent terrestrial habitat. Under Alternative A, considering the maximum footprints, the cumulative impact on streams, wetlands, and vernal pools includes:

- 1,643 linear feet of streams;
- 3.74 acres of non-prime, non-vernal-pool wetlands;
- 0.03 acre of prime wetlands;
- 1.57 acres of vernal pools;
- 7.80 acres of terrestrial habitat within 100 feet of vernal pools; and
- 97.90 acres of terrestrial habitat within 750 feet of vernal pools.

In addition, development projects can result in impacts on adjacent water bodies and the areas surrounding water bodies from alteration of stream geomorphology, loss of structural complexity, changes to stream hydraulics, reduction of stream flow, shading by engineered structures, vegetation clearing, changes in water temperature and DO, and increased pollutant loading. These impacts can result in loss or degradation of aquatic habitat.

A Section 404 permit would be required for developments impacting streams, wetlands, and vernal pools. Developers would have to obtain separate Section 404 permits for each individual development and demonstrate that their development proposal avoids and minimizes impacts to the extent practicable in accordance with Section 404 (b)(1) guidelines. Mitigation measures commensurate with the level of impacts to wetland resources would be developed to compensate for unavoidable impacts to water resources. Mitigation would be in accordance with NH RSA 482-A:28 and NHDES Wetland Rules and with federal Section 404 guidelines in 40CFR (b)(1).

Table 5.4-2. Indirect Effects and Cumulative Impacts to Streams Based on Alternative A

Development		No Build Condition Impact (linear feet)	Incremental Build Condition Impact		Build Condition Cumulative Impact (linear feet)
			Direct Effect (linear feet)	Indirect Effect (linear feet)	
Exit 4A (Alternative A Footprint)		-	1,268	-	1,268
Woodmont Commons Phase I and Market Basket		-	-	-	0
Woodmont Commons West (Remainder)	Minimum Footprint	-	-	-	0
	Maximum Footprint	-	-	20	20
Woodmont Commons East	Minimum Footprint	302	-	2	304
	Maximum Footprint	302	-	53	355
Derry Industrial	Minimum Footprint	-	-	-	0
	Maximum Footprint	-	-	-	0
Total	**Minimum Footprint**	**302**	**1,268**	**2**	**1,572**
	Maximum Footprint	**302**	**1,268**	**73**	**1,643**

Table 5.4-3. Indirect Effects and Cumulative Impacts to Streams Based on Alternative B

Development		No Build Condition Impact (linear feet)	Incremental Build Condition Impact		Build Condition Cumulative Impact (linear feet)
			Direct Effect (linear feet)	Indirect Effect (linear feet)	
Exit 4A (Alternative B Footprint)		-	1,341	-	1,341
Woodmont Commons Phase I and Market Basket		-	-	-	0
Woodmont Commons West (Remainder)	Minimum Footprint	-	-	-	0
	Maximum Footprint	-	-	20	20
Woodmont Commons East	Minimum Footprint	302	-	2	304
	Maximum Footprint	302	-	2	304
Derry Industrial	Minimum Footprint	-	-	-	0
	Maximum Footprint	-	-	-	0
Total	**Minimum Footprint**	**302**	**1,341**	**2**	**1,645**
	Maximum Footprint	**302**	**1341**	**22**	**1,665**

Table 5.4-4. Indirect Effects and Cumulative Impacts to Streams Based on Alternatives C, D, and F

Development		No Build Condition Impact (linear feet)	Incremental Build Condition Impact		Build Condition Cumulative Impact (linear feet)
			Direct Effect (linear feet)	Indirect Effect (linear feet)	
Exit 4A (Alternative C Footprint)		-	562	-	553
Exit 4A (Alternative D Footprint)		-	557	-	575
Exit 4A (Alternative F Footprint)		-	153	-	152
Woodmont Commons Phase I and Market Basket		-	-	-	0
Woodmont Commons West (Remainder)	Minimum Footprint	-	-	-	0
	Maximum Footprint	-	-	20	20
Woodmont Commons East	Minimum Footprint	302	-	-	302
	Maximum Footprint	302	-	-	302
Derry Industrial	Minimum Footprint	-	-	-	0
	Maximum Footprint	-	-	-	0
Alternative C Total	**Minimum Footprint**	**302**	**562**	**0**	**864**
	Maximum Footprint	**302**	**562**	**20**	**884**
Alternative D Total	**Minimum Footprint**	**302**	**557**	**0**	**859**
	Maximum Footprint	**302**	**557**	**20**	**879**
Alternative F Total	**Minimum Footprint**	**302**	**153**	**0**	**455**
	Maximum Footprint	**302**	**153**	**20**	**475**

Table 5.4-5. Indirect Effects and Cumulative Impacts to Non-prime, Non-vernal-pool Wetlands Based on Alternative A

Development		No Build Condition Impact (acres)	Incremental Build Condition Impact		Build Condition Cumulative Impact (acres)
			Direct Effect (acres)	Indirect Effect (acres)	
Exit 4A (Alternative A Footprint)		-	2.31	-	2.31
Woodmont Commons Phase I and Market Basket		-	-	-	0.00
Woodmont Commons West (Remainder)	Minimum Footprint	-	-	-	0.00
	Maximum Footprint	-	-	0.65	0.65
Woodmont Commons East	Minimum Footprint	0.16	-	0.01	0.17
	Maximum Footprint	0.17	-	0.20	0.37
Derry Industrial	Minimum Footprint	-	-	-	0.00
	Maximum Footprint	-	-	0.41	0.41
Total	**Minimum Footprint**	**0.16**	**2.31**	**0.01**	**2.48**
	Maximum Footprint	**0.17**	**2.31**	**1.26**	**3.74**

Table 5.4-6. Indirect Effects and Cumulative Impacts to Non-prime, Non-vernal-pool Wetlands Based on Alternative B

Development		No Build Condition Impact (acres)	Incremental Build Condition Impact		Build Condition Cumulative Impact (acres)
			Direct Effect (acres)	Indirect Effect (acres)	
Exit 4A (Alternative B Footprint)		-	8.85	-	8.85
Woodmont Commons Phase I and Market Basket		-	-	-	0.00
Woodmont Commons West (Remainder)	Minimum Footprint	-	-	-	0.00
	Maximum Footprint	-	-	0.65	0.65
Woodmont Commons East	Minimum Footprint	0.16	-	-	0.16
	Maximum Footprint	0.17	-	0.15	0.32
Derry Industrial	Minimum Footprint	-	-	-	0.00
	Maximum Footprint	-	-	0.41	0.41
Total	**Minimum Footprint**	**0.16**	**8.85**	**0.00**	**9.01**
	Maximum Footprint	**0.17**	**8.85**	**1.21**	**10.23**

Table 5.4-7. Indirect Effects and Cumulative Impacts to Non-prime, Non-vernal-pool Wetlands Based on Alternatives C, D, and F

Development		No Build Condition Impact (acres)	Incremental Build Condition Impact		Build Condition Cumulative Impact (acres)
			Direct Effect (acres)	Indirect Effect (acres)	
Exit 4A (Alternative C Footprint)		-	8.40	-	8.40
Exit 4A (Alternative D Footprint)		-	3.60	-	3.60
Exit 4A (Alternative F Footprint)		-	0.00	-	0.00
Woodmont Commons Phase I and Market Basket		-	-	-	0.00
Woodmont Commons West (Remainder)	Minimum Footprint	-	-	-	0.00
	Maximum Footprint	-	-	0.65	0.65
Woodmont Commons East	Minimum Footprint	0.16	-	-	0.16
	Maximum Footprint	0.17	-	-	0.17
Derry Industrial	Minimum Footprint	-	-	-	0.00
	Maximum Footprint	-	-	0.41	0.41
Alternative C Total	**Minimum Footprint**	**0.16**	**8.40**	**0.00**	**8.56**
	Maximum Footprint	**0.17**	**8.40**	**1.06**	**9.63**
Alternative D Total	**Minimum Footprint**	**0.16**	**3.60**	**0.00**	**3.76**
	Maximum Footprint	**0.17**	**3.60**	**1.06**	**4.83**
Alternative F Total	**Minimum Footprint**	**0.16**	**0.00**	**0.00**	**0.16**
	Maximum Footprint	**0.17**	**0.00**	**1.06**	**1.23**

Table 5.4-8. Indirect Effects and Cumulative Impacts to Vernal Pools Based on Alternative A

Development		No Build Condition Impact (acres)	Incremental Build Condition Impact		Build Condition Cumulative Impact (acres)
			Direct Effect (acres)	Indirect Effect (acres)	
Exit 4A (Alternative A Footprint)		-	1.122	-	1.122
Woodmont Commons Phase I and Market Basket		-	-	-	0.000
Woodmont Commons West (Remainder)	Minimum Footprint	-	-	-	0.000
	Maximum Footprint	-	-	-	0.000
Woodmont Commons East	Minimum Footprint	0.007	-	0.000	0.007
	Maximum Footprint	0.009	-	0.435	0.444
Derry Industrial	Minimum Footprint	-	-	-	0.000
	Maximum Footprint	-	-	-	0.000
Total	**Minimum Footprint**	**0.007**	**1.122**	**0.000**	**1.129**
	Maximum Footprint	**0.009**	**1.122**	**0.435**	**1.566**

Table 5.4-9. Indirect Effects and Cumulative Impacts to Vernal Pools Based on Alternative B

Development		No Build Condition Impact (acres)	Incremental Build Condition Impact		Build Condition Cumulative Impact (acres)
			Direct Effect (acres)	Indirect Effect (acres)	
Exit 4A (Alternative B Footprint)		-	1.091	-	1.091
Woodmont Commons Phase I and Market Basket		-	-	-	0.000
Woodmont Commons West (Remainder)	Minimum Footprint	-	-	-	0.000
	Maximum Footprint	-	-	-	0.000
Woodmont Commons East	Minimum Footprint	0.007	-	0.000	0.007
	Maximum Footprint	0.009	-	0.315	0.324
Derry Industrial	Minimum Footprint	-	-	-	0.000
	Maximum Footprint	-	-	-	0.000
Total	**Minimum Footprint**	**0.007**	**1.091**	**0.000**	**1.098**
	Maximum Footprint	**0.009**	**1.091**	**0.315**	**1.415**

Table 5.4-10. Indirect Effects and Cumulative Impacts to Vernal Pools Based on Alternatives C, D, and F

Development		No Build Condition Impact (acres)	Incremental Build Condition Impact		Build Condition Cumulative Impact (acres)
			Direct Effect (acres)	Indirect Effect (acres)	
Exit 4A (Alternative C Footprint)		-	0.274	-	0.274
Exit 4A (Alternative D Footprint)		-	0.286	-	0.286
Exit 4A (Alternative F Footprint)		-	0.000	-	0.000
Woodmont Commons Phase I and Market Basket		-	-	-	0.000
Woodmont Commons West (Remainder)	Minimum Footprint	-	-	-	0.000
	Maximum Footprint	-	-	-	0.000
Woodmont Commons East	Minimum Footprint	0.007	-	-	0.007
	Maximum Footprint	0.009	-	-	0.009
Derry Industrial	Minimum Footprint	-	-	-	0.000
	Maximum Footprint	-	-	-	0.000
Alternative C Total	**Minimum Footprint**	**0.007**	**0.274**	**0.000**	**0.281**
	Maximum Footprint	**0.009**	**0.274**	**0.000**	**0.283**
Alternative D Total	**Minimum Footprint**	**0.007**	**0.286**	**0.000**	**0.293**
	Maximum Footprint	**0.009**	**0.286**	**0.000**	**0.295**
Alternative F Total	**Minimum Footprint**	**0.007**	**0.000**	**0.000**	**0.007**
	Maximum Footprint	**0.009**	**0.000**	**0.000**	**0.009**

Table 5.4-11. Indirect Effects and Cumulative Impacts to Terrestrial Habitat Adjacent to Vernal Pools Associated with Alternative A

Development		Vernal Pool Buffer	No Build Condition Impact (acres)	Incremental Build Condition Impact		Build Condition Cumulative Impact (acres)
				Direct Effect (acres)	Indirect Effect (acres)	
Woodmont Commons Phase I and Market Basket		100-foot	-	-	-	0.00
		750-foot	-	-	-	0.00
Woodmont Commons West (Remainder)	Minimum Footprint	100-foot	-	-	-	0.00
		750-foot	-	-	-	0.00
	Maximum Footprint	100-foot	-	-	-	0.00
		750-foot	-	-	-	0.00
Woodmont Commons East	Minimum Footprint	100-foot	0.62	-	0.55	1.17
		750-foot	38.56	-	21.75	60.31
	Maximum Footprint	100-foot	1.05	-	6.75	7.80
		750-foot	65.52	-	29.48	95.00
Derry Industrial	Minimum Footprint	100-foot	-	-	-	0.00
		750-foot	-	-	0.35	0.35
	Maximum Footprint	100-foot	-	-	-	0.00
		750-foot	-	-	2.90	2.90
Total	**Minimum Footprint**	**100-foot**	**0.62**	**0.00**	**0.55**	**1.17**
		750-foot	**38.56**	**0.00**	**22.10**	**60.66**
	Maximum Footprint	**100-foot**	**1.05**	**0.00**	**6.75**	**7.80**
		750-foot	**65.52**	**0.00**	**32.38**	**97.90**

Table 5.4-12. Indirect Effects and Cumulative Impacts to Terrestrial Habitat Adjacent to Vernal Pools Associated with Alternative B

Development		Vernal Pool Buffer	No Build Condition Impact (acres)	Incremental Build Condition Impact		Build Condition Cumulative Impact (acres)
				Direct Effect (acres)	Indirect Effect (acres)	
Woodmont Commons Phase I and Market Basket		100-foot	-	-	-	0.00
		750-foot	-	-	-	0.00
Woodmont Commons West (Remainder)	Minimum Footprint	100-foot	-	-	-	0.00
		750-foot	-	-	-	0.00
	Maximum Footprint	100-foot	-	-	-	0.00
		750-foot	-	-	-	0.00
Woodmont Commons East	Minimum Footprint	100-foot	0.62	-	0.55	1.17
		750-foot	38.56	-	23.58	62.14
	Maximum Footprint	100-foot	1.05	-	6.06	7.11
		750-foot	65.52	-	30.53	96.05
Derry Industrial	Minimum Footprint	100-foot	-	-	-	0.00
		750-foot	-	-	0.35	0.35
	Maximum Footprint	100-foot	-	-	-	0.00
		750-foot	-	-	2.85	2.85
Total	**Minimum Footprint**	**100-foot**	**0.62**	**0.00**	**0.55**	**1.17**
		750-foot	**38.56**	**0.00**	**23.93**	**62.49**
	Maximum Footprint	**100-foot**	**1.05**	**0.00**	**6.06**	**7.11**
		750-foot	**65.52**	**0.00**	**33.38**	**98.90**

Table 5.4-13. Indirect Effects and Cumulative Impacts to Terrestrial Habitat Adjacent to Vernal Pools Associated with Alternatives C, D, and F

Development		Vernal Pool Buffer	No Build Condition Impact (acres)	Incremental Build Condition Impact		Build Condition Cumulative Impact (acres)
				Direct Effect (acres)	Indirect Effect (acres)	
Woodmont Commons Phase I and Market Basket		100-foot	-	-	-	0.00
		750-foot	-	-	-	0.00
Woodmont Commons West (Remainder)	Minimum Footprint	100-foot	-	-	-	0.00
		750-foot	-	-	-	0.00
	Maximum Footprint	100-foot	-	-	-	0.00
		750-foot	-	-	-	0.00
Woodmont Commons East	Minimum Footprint	100-foot	0.62	-	-	0.62
		750-foot	38.56	-	-	38.56
	Maximum Footprint	100-foot	1.05	-	-	1.05
		750-foot	65.52	-	-	65.52
Derry Industrial	Minimum Footprint	100-foot	-	-	-	0.00
		750-foot	-	-	0.35	0.35
	Maximum Footprint	100-foot	-	-	-	0.00
		750-foot	-	-	2.92	2.92
Total	**Minimum Footprint**	**100-foot**	**0.62**	**0.00**	**0.00**	**0.62**
		750-foot	**38.56**	**0.00**	**0.35**	**38.91**
	Maximum Footprint	**100-foot**	**1.05**	**0.00**	**0.00**	**1.05**
		750-foot	**65.52**	**0.00**	**2.92**	**68.44**

5.4.3 Water Quality

Resource Condition and Trends

The study area is located within the Lower Merrimack River basin. The Merrimack River forms in New Hampshire from the confluence of the Pemigewasset and the Winnipesaukee Rivers and flows through Massachusetts, where it empties into the Atlantic Ocean in Newburyport.

During the early to mid-20th century, rivers in New England were polluted by untreated municipal and industrial sewage released directly into surface waters. Pulp, paper, and other mills were a major water pollution sources. Water quality in the study area has improved dramatically in the past 50 years as a result of economic changes, the CWA, and other programs that have required the treatment of wastewater, eliminated phosphate in detergents, and reduced use of phosphorus fertilizer by farmers. For example, mean annual total phosphorus concentrations in Merrimack River have decreased 38 percent from 0.13 mg/L (1967–1984 average) to 0.08 mg/L (1985–2000 average) (USGS, 2003). Nitrate concentrations in the Merrimack River, while substantially higher than in the early 1900s, have also decreased in the last 20 years.

Chloride is a pollutant of concern in New England. In the Merrimack River the mean-annual chloride concentration increased 760 percent from 2.9 mg/L (1900−17 average) to 24.9 mg/L (1976–1995 average) (USGS, 2003). This increase is attributed to deicing salt applications to roadways, parking lots and other impervious surfaces. However, chloride concentrations in the Merrimack River are still well below the chronic standard of 230 mg/L.

As discussed in Section 4.11, the Proposed Project lies within the Upper Beaver Brook watershed. Beaver Brook, south of the Proposed Project, flows west under I-93 and then south into Massachusetts where it joins the Merrimack River in Lowell. Upper Beaver Brook has been subject to water quality investigations since 2003 in response to proposed development in the watershed, including widening and improvements to I-93 (NHDES, 2008a).

NHDES oversees regulatory programs and other initiatives designed to protect and restore the quality of the surface and groundwater resources in New Hampshire. These programs include stormwater discharge permits, shoreland protection standards, AoT permits, drinking water source protection, surface water quality assessment, and TMDL programs, among others. A detailed review of the regulatory framework for water resources is provided in Section 4.11.1.

Impacts from Other Actions

Under the No Build Alternative, impacts to water quality from nutrient loading, sediment, and chloride are possible due to other projects and residential and commercial growth, and the corresponding increases in impervious surface cover and stormwater runoff. As noted in Table 5.4-1, the anticipated footprints for known developments under the No Build Alternative range from 228 to 294 acres. A portion of this development would be impervious surfaces. Impacts would be moderated to a large extent by federal and state regulations designed to protect and improve existing water quality.

Direct Impacts

An analysis of impacts to water quality, including pollutant loading in the Beaver Brook watershed directly attributable to the Project is provided in Section 4.11. The increase in impervious surface with the Project is anticipated to be in the range of 3.0−27.4 additional acres, with Alternative A requiring 21.4 additional acres of impervious surface. The additional phosphorous, nitrogen, chloride, and TSS loads that would be incurred by each Alternative are also provided in Section 4.11.

Indirect Effects

Chloride

This analysis assumes a range of footprints of Woodmont Commons with separate accountings for Woodmont Commons East and Woodmont Commons West (including Market Basket expansion) to clearly account for the two related but separate actions. A separate estimate for additional Derry Industrial development is also provided. New private road lane-miles and parking acreage were determined based on the documentation provided in the *Land Use Scenarios Technical Report* (Appendix B). Determinations for parking were made by assuming a 300 square-foot requirement for each expected parking space, including travel aisles associated with the parking spaces. For new private roadways, each divided roadway length was assumed to equal a single lane length, and each non-divided roadway length was assumed to equal two lane lengths. Thus, the total mileage of divided streets was multiplied by one, and non-divided street mileage was multiplied by two to yield total lane-miles. Existing roadways within Woodmont Commons were assumed to receive no additional salt loading, even if those roadways were to be upgraded, except when additional lane-miles were proposed.

Residential development is not included in this calculation because the nature of residential development, including lot size and road layout, is not foreseeable. Chester is anticipated to have the largest proportion of increase in residential development, where approximately 11 percent of the town (1,784 acres) falls into the Upper Beaver Brook watershed.

Total Suspended Solids and Nutrients

As with the chloride analysis, the analysis of TSS and nutrients assumes a range of footprints for Woodmont Commons with separate accountings for Woodmont Commons East and Woodmont Commons West (including Market Basket expansion). A separate estimate for additional Derry Industrial development is also provided. The anticipated development footprints presented in Table 5.4-1 were used to determine pollutant loads resulting under the No Build and Build conditions. The total footprint acreages were entered into the NHDES SIMPLE method spreadsheet model (NHDES, 2015b) to determine an estimated pollutant load. For the SIMPLE model, we assumed annual rainfall of 40 inches, a runoff fraction of 0.9, land use category of “Residential (general)” as this land use category is more conservative (i.e., greater pollutant load impact) than other potentially viable land use categories, and 50 percent impervious area. These criteria result in estimated loading rates of 406.8 lbs/acre/year TSS; 1.6 lbs/acre/year total phosphorous; and 8.9 lbs/acre/year TN.

Results

The new parking and private roadways associated with known future developments are summarized in Table 5.4-14.

Table 5.4-14. Indirect Impacts New Parking and Roadways Summary

Develop-ment Activity	No Build Condition			Build Condition			Incremental Development Attributable to Exit 4A		
	Parking (acres)	Min Footprint Lane Miles	Max Footprint Lane Miles	Parking (acres)	Min Footprint Lane Miles	Max Footprint Lane Miles	Parking (acres)	Min Footprint Lane Miles	Max Footprint Lane Miles
Woodmont Commons East	4.70	4.43	6.18	26.38	6.14	7.53	21.69	1.71	1.35
Woodmont Commons West	19.17	6.14	8.32	27.20	7.11	19.93	8.02	0.97	11.60
Additional Derry Industrial	0	0	0	2.38	0	0	2.38	0	0

The Woodmont Commons West and East developments will contribute to future chloride loading in the Beaver Brook watershed. Chloride loading for parking was determined using the application rate used in the *Data Report for the Total Maximum Daily Loads for Chloride for Waterbodies in the Vicinity of the I-93 Corridor From Massachusetts to Manchester, NH: Policy-Porcupine Brook Beaver Brook Dinsmore Brook North Tributary to Canobie Lake* (NHDES, 2007) of 6.4 tons/acre/year. This rate is in turn based on an analysis of salt use by maintainers of private roads and parking lots that was specifically prepared for the Beaver Brook TMDL titled "Salt Loading Due to Private Winter Maintenance Practices" (Sassan and Kahl, 2007). Sassan and Kahl established a range of 5.7–6.4 tons/acre/year, with 6.4 tons/acre/year being the average rate for educational institutions which had the best records of salt purchases and areas serviced. Sassan and Kahl acknowledge that there is a high degree of variability in salt application rate reporting from private applicators.

Chloride loading for new streets was determined from new lane-miles. Each divided roadway length was assumed to equal a single lane length, and each non-divided roadway length was assumed to equal two lane lengths. Thus, the total mileage of divided streets was multiplied by one, and non-divided street mileage was multiplied by two to yield total lane-miles. Existing roadways within Woodmont Commons were assumed to receive no additional salt loading, even if those roadways were to be upgraded, except when additional lane-miles were proposed. When additional lanes miles were added to existing roadways, the new lane-miles were added to the new lane-miles calculation. New chloride loading was determined using the average FY08–FY16 municipal rates, per methods described in Section 3.3.

Table 5.4-15. Salt Loading Attributable to Indirect Impacts (Tons/Year)

Develop-ment Activity	No Build Condition			Build Condition			Incremental Development Attributable to Exit 4A		
	Parking	Min Footprint	Max Footprint	Parking	Min Footprint	Max Footprint	Parking	Min Footprint	Max Footprint
Woodmont Commons East	30.1	47.0	65.5	168.9	65.1	79.8	138.8	18.2	14.3
Woodmont Commons West	122.7	65.1	88.2	174.1	75.4	211.2	51.3	10.3	123.0
Additional Derry Industrial	0.0	0.0	0.0	15.3	0.0	0.0	15.3	0.0	0.0
Total	**152.8**	**112.1**	**153.7**	**358.2**	**140.6**	**291.0**	**205.4**	**28.5**	**137.3**
Potential Additional Salt Load Range	***264.8–306.5 tons/year***			***498.7–649.2 tons/year***			***233.9–342.7 tons/year***		

Under these scenarios, the salt loading from incremental development attributable to the construction of Exit 4A could range from 233.9 tons/year to 342.7 tons/year.

New development attributable to indirect Project impacts would result in new impervious surface within Upper Beaver Brook watershed. The addition of new impervious surfaces which contribute stormwater runoff to surface waters has the potential to add new TSS and nutrient loads to the watershed. The anticipated development footprints under the no build and build conditions were entered into the NHDES SIMPLE method spreadsheet model (NHDES, 2015b) to determine the potential pollutant load that could result from the foreseeable new actions. The results of the SIMPLE method analysis are presented in Table 5.4-16 for a range of development scenarios including no build, build, and incremental development and for each development activity presented as the range of potential pollutant load based on the anticipated minimum and maximum development footprints.

Table 5.4-16. Pollutant Loading Attributable to Indirect Impacts Based on Anticipated Minimum and Maximum Development Footprints (lbs/Year)

Develop-ment Activity	No Build Condition			Build Condition			Incremental Development Attributable to Exit 4A		
	TP (lbs/ year)	TN (lbs/ year)	TSS (lbs/ year)	TP (lbs/ year)	TN (lbs/ year)	TSS (lbs/ year)	TP (lbs/ year)	TN (lbs/ year)	TSS (lbs/ year)
Woodmont Commons East	191 - 236	1,700 – 2,102	691,664 – 855,022	208 - 436	1,853 – 3,880	753,647 – 1,578,547	17 - 200	152 – 1,779	61,983 – 723,525
Woodmont Commons West	67 - 111	595 - 990	242,140 – 402,602	109 - 173	967 – 1,542	393,333 – 627,364	42 - 62	372 - 553	151,193 – 224,762
Additional Derry Industrial	0 - 0	0 - 0	0 - 0	8 - 14	68 - 124	27,806 – 50,398	8 - 14	68 - 124	27,806 – 50,398
Total	**258 - 347**	**2,295 – 3,092**	**933,805 – 1,257,624**	**324 - 623**	**2,888 – 5,546**	**1,174,786 – 2,256,308**	**67 - 276**	**592 – 2,455**	**240,982 – 998,684**

Notes: TP = total phosphorous, TN = total nitrogen, TSS = total suspended solids

Potential for Cumulative Impacts

Cumulative effects to water quality could occur from the ongoing developments in Woodmont Commons East and West that are planned with or without the Project, the construction of Exit 4A, and the development that is anticipated to occur attributable to the Project (summarized under development scenarios with Exit 4A in Table 5.4-16), and additional development that may occur within the Beaver Brook watershed not yet anticipated. All new development would be subject to state and federal permitting requirements to manage pollutants within the watershed.

5.4.4 Plant Communities and Wildlife

Resource Condition and Trends

During the 1700s and 1800s, a majority of the forested land in New Hampshire was cleared for agriculture. In addition to habitat loss, many fish and wildlife species were extirpated by overhunting and fishing. The condition of forests and many other types of wildlife habitat have greatly improved since the early 1900s, as a result of declines in the area devoted agriculture and the formation of wildlife and conservation agencies, regulatory protections and restoration programs for threatened and endangered species. Current issues facing wildlife habitat quantity and quality include increased low-density development in suburban and rural areas that results in habitat fragmentation. In 1983, the reforestation that followed farming and logging of the 19th and 20th centuries reached its peak, with 87 percent of the state's lands forested. However, by

1997, the state's forest cover dropped three percent, to 84 percent as the result of the conversion of forest land for development (NHFGD, 2005).

As discussed in Section 4.16, NHFGD has developed statewide and regional ranking and identified the highest condition habitat relative to all polygons of a given habitat type in the state. The NH Wildlife Action Plan (WAP) provides an assessment of habitat value, ranking all lands within NH as follows: (1) highest ranked in the state by ecological condition (#1), (2) highest ranked in the biological region by ecological condition (#2), (3) supporting landscapes (#3), and (4) not ranked (all the rest). Rankings are generally based on landscape biological diversity, landscape integrity, minimum human influence, and the presence of documented rare wildlife or significant ecological features. The evaluation of indirect effects and cumulative impacts is based on the potential impact to these ranked habitats.

As discussed in Section 4.17.1, no federally endangered species are known to be present in the Project area, and no federally endangered species occurrence records were associated with the development footprints under the No Build and Build conditions. Therefore, indirect effects and cumulative impacts to federally protected species are not anticipated.

Several state-listed threatened and endangered plant species have been documented within or adjacent to the study area (see Section 4.17.1). None have been specifically documented within the potential area of impact for the Proposed Project. Additionally, none of these plants have been documented within the development footprints under the No Build and Build conditions. Based on available habitat and recent records in the Project area, the northern black racer (state threatened) has been recorded in the vicinity of Alternative A; however, no occurrences of the black racer were recorded within the anticipated development footprints. Because northern black racers use a wide variety of forested and open habitat types, including uplands and wetlands, the potential for indirect effects and cumulative impacts is discussed in the following subsections.

Impacts from Other Actions

Development activity unrelated to the Project at Woodmont Commons Phase I and Market Basket and Woodmont Commons West (Remainder) could impact habitats that are highest ranked in the state. About 52.2 acres of WAP Tier 1 habitat is mapped within the Woodmont Commons Phase I and Market Basked footprint. The minimum and maximum footprints for Woodmont Commons West (Remainder) under the No Build scenario include 18.26 and 36.47 acres of WAP Tier 1 habitat, respectively (Table 5.4-14).

Development activity unrelated to the Project at Woodmont Commons East and Woodmont Commons West (Remainder) could impact 25.01 to 32.72 acres of supporting landscapes (WAP Tier 3) (Table 5.4-15-17). Development activity unrelated to the Project would not impact habitat that is highest ranked in its biological region (WAP Tier 2).

It is possible that northern black racers could use habitat within the development footprints. NH's Endangered Species Conservation Act (1979) makes it unlawful to export, take, possess, sell or offer for sale, deliver, carry, transport, or ship endangered and threatened wildlife species. The NHDES AoT permitting process allows for the NHFG Nongame and Endangered Wildlife Program to provide recommendations to for the protection of special-status species. Through this process, proposed developments could be required to evaluate potential impacts to the northern black racer, including direct mortality due to construction. Effects from development activity related to habitat loss, fragmentation, and road mortality could occur.

Direct Impacts

The Project would directly impact between zero and 22.49 acres of supporting landscapes and between zero and 0.17 acre of habitat that is highest ranked in the biological region. The Project would have no impact on habitats that are highest ranked in the state.

As discussed in section 4.17, recent records exist for northern black racer within the footprints of Alternatives A and B. Because racers use a wide variety of habitats, the entire undeveloped parcel intersected by Alternatives A and B potentially provides suitable habitat, and the sections of Alternatives A and B that would cross it would result in habitat loss, habitat fragmentation, and increased potential for road mortality. Additionally, recent records exist for the northern black racer in the vicinity of Alternatives C and D, near the initial portions of these footprints. No recent records exist for the northern black racer near Alternative F.

Indirect Effects

Additional development induced by the Project at Woodmont Commons West (Remainder) could impact 9.21 to 45.19 acres of habitats that are highest ranked in the state depending on the range of footprints of future development projects. In addition, under Build Alternatives A and B, development induced by the Project at Woodmont Commons East and West (Remainder) could impact 26.07 to 83.11 acres of supporting landscapes depending on the range of footprints of future development projects. Under Build Alternatives C, D, and F, induced development within Woodmont Commons West could impact between 2.13 and 54.36 acres of supporting landscapes. Under these Build Alternatives, there would be no induced development in Woodmont Commons East. Additional development induced by the Project would not impact habitat that is ranked highest in its biological region. Additional indirect effects could occur as result of increased residential development in Chester, but insufficient detailed information is available to quantify the impact in Chester.

As with the potential effects of known developments, it is possible that northern black racers could use habitat within the development footprints induced be the Proposed Project. As noted above, through the NHDES AoT permitting process, proposed developments could be required to evaluate potential impacts to the northern black racer, including direct mortality due to construction. Effects from development activity related to habitat loss, fragmentation, and road mortality could occur.

Potential for Cumulative Impacts

As discussed in Section 4.16, direct impacts on plant communities from the Proposed Project would result from the removal of vegetation and the conversion of undeveloped land to developed land within the footprint of the roadway. Adjacent areas would also be subject to indirect effects of vegetation clearing. Indirect effects can include increased sunlight penetrating forested areas, altered hydrology in wetlands, and a potential increase in sediment and toxicants from the new roadway. The most prevalent undeveloped cover types in the Project area are northern hardwood forests and conifer forests, and these are the most affected plant community types.

Table 5.4-17 shows the anticipated direct, indirect, and cumulative effects on the WAP-highest ranked wildlife habitat in the state. Table 5.4-18 shows the anticipated direct, indirect, and cumulative effects on the WAP-ranked supporting landscapes under the various Build

Alternatives. None of the development footprints under the No Build or Build conditions would impact habitat ranked as highest in the biological region. Woodmont Commons West (Remainder) is the only known development that would impact wildlife habitat ranked highest in the state, and these impacts would be expected under both the No Build and Build conditions.

Cumulative impacts from reasonably foreseeable development under the Build condition, considering maximum footprints, could impact 133.86 acres of habitats that are highest ranked in the state and between 150.23 and 201.47 acres of supporting landscapes, depending on the specific footprints of future development projects.

It is possible that cumulative impacts to the northern black racer population could occur from the Proposed Project and reasonably foreseeable future development. As noted above, through the NHDES AoT permitting process, proposed developments could be required to evaluate potential impacts to the northern black racer, including direct mortality due to construction. Effects from development activity related to habitat loss, fragmentation, and road mortality could occur.

Impacts to wildlife habitat, including habitat for the northern black racer, would be moderated by the countervailing effect of planning efforts that focus growth in existing settled areas, substantive protections under environmental protection laws, and the trend of increased land conservation. Despite additional incremental impacts, the overall health of wildlife habitat in the study area would not be substantially impacted. Forested lands would continue to make up a substantive proportion of land cover in the study area, and many species would continue to recover as a result of improved management and protection.

Table 5.4-17. Indirect Effects and Cumulative Impacts to WAP Highest Ranked Wildlife Habitat in the State (Tier 1)

Development		No Build Condition Impact (acres)	Incremental Build Condition Impact		Build Condition Cumulative Impact (acres)
			Direct Effect (acres)	Indirect Effect (acres)	
Exit 4A (Any Build Alternative)		-		-	0.00
Woodmont Commons Phase I and Market Basket		52.20	-	-	52.20
Woodmont Commons West (Remainder)	Minimum Footprint	18.26	-	9.21	27.47
	Maximum Footprint	36.47	-	45.19	81.66
Woodmont Commons East	Minimum Footprint				0.00
	Maximum Footprint				0.00
Derry Industrial	Minimum Footprint	-	-	-	0.00
	Maximum Footprint	-	-	-	0.00
Total	**Minimum Footprint**	**70.46**	**0.00**	**9.21**	**79.67**
	Maximum Footprint	**88.67**	**0.00**	**45.19**	**133.86**

Table 5.4-18. Indirect Effects and Cumulative Impacts to WAP Supporting Landscapes (Tier 3) under Alternative A

Development		No Build Condition Impact (acres)	Incremental Build Condition Impact		Build Condition Cumulative Impact (acres)
			Direct Effect (acres)	Indirect Effect (acres)	
Exit 4A (Alternative A footprint)		-	15.37	-	15.37
Woodmont Commons Phase I and Market Basket		-	-	-	0.00
Woodmont Commons West (Remainder)	Minimum Footprint[a]	25.01	-	2.13	27.14
	Maximum Footprint	32.72	-	54.36	87.08
Woodmont Commons East	Minimum Footprint	36.10	-	21.99	58.09
	Maximum Footprint	63.15	-	27.48	90.63
Derry Industrial	Minimum Footprint	-	-	-	0.00
	Maximum Footprint	-	-	-	0.00
Total	**Minimum Footprint**	**61.11**	**15.37**	**24.12**	**100.60**
	Maximum Footprint	**95.87**	**15.37**	**81.84**	**193.08**

[a] As shown in Figures 5.3-3 and 5.3-4, there is a shift in the minimum Build condition footprint for Woodmont Commons West (Remainder). The total change in area is 10.7 acres; however, the shift results in an increase in impacts on highest ranked habitat in the state and a decrease in impacts on supporting landscapes.

Table 5.4-19. Indirect Effects and Cumulative Impacts to WAP Supporting Landscapes (Tier 3) under Alternative B

Development		No Build Condition Impact (acres)	Incremental Build Condition Impact		Build Condition Cumulative Impact (acres)
			Direct Effect (acres)	Indirect Effect (acres)	
Exit 4A (Alternative B footprint)		-	22.49	-	22.49
Woodmont Commons Phase I and Market Basket		-	-	-	0.00
Woodmont Commons West (Remainder)	Minimum Footprint[a]	25.01	-	2.13	27.14
	Maximum Footprint	32.72	-	54.36	87.08
Woodmont Commons East	Minimum Footprint	36.10	-	23.94	60.04
	Maximum Footprint	63.15	-	28.75	91.90
Derry Industrial	Minimum Footprint	-	-	-	0.00
	Maximum Footprint	-	-	-	0.00
Total	**Minimum Footprint**	**61.11**	**22.49**	**26.07**	**109.67**
	Maximum Footprint	**95.87**	**22.49**	**83.11**	**201.47**

[a] As shown in Figures 5.3-3 and 5.3-4, there is a shift in the minimum Build condition footprint for Woodmont Commons West (Remainder). The total change in area is 10.7 acres; however, the shift results in an increase in impacts on highest ranked habitat in the state and a decrease in impacts on supporting landscapes.

Table 5.4-20. Indirect Effects and Cumulative Impacts to WAP Supporting Landscapes (Tier 3) under Alternatives C, D, and F

Development		No Build Condition Impact (acres)	Incremental Build Condition Impact		Build Condition Cumulative Impact (acres)
			Direct Effect (acres)	Indirect Effect (acres)	
Exit 4A (Alternative C Footprint)		-	8.69	-	8.69
Exit 4A (Alternative D Footprint)		-	1.85	-	1.85
Exit 4A (Alternative F Footprint)		-	0.00	-	0.00
Woodmont Commons Phase I and Market Basket		-	-	-	0.00
Woodmont Commons West (Remainder)	Minimum Footprint	25.01	-	2.13	27.14
	Maximum Footprint	32.72	-	54.36	87.08
Woodmont Commons East	Minimum Footprint	36.10	-	-	36.10
	Maximum Footprint	63.15	-	-	63.15
Derry Industrial	Minimum Footprint	-	-	-	0.00
	Maximum Footprint	-	-	-	0.00
Alternative C Total	**Minimum Footprint**	**61.11**	**8.69**	**2.13**	**-71.93**
	Maximum Footprint	**95.87**	**8.69**	**54.36**	**158.92**
Alternative D Total	**Minimum Footprint**	**61.11**	**1.85**	**2.13**	**65.09**
	Maximum Footprint	**95.87**	**1.85**	**54.36**	**152.08**
Alternative F Total	**Minimum Footprint**	**61.11**	**0.00**	**2.13**	**63.24**
	Maximum Footprint	**95.87**	**0.00**	**54.36**	**150.23**

5.4.5 Cultural Resources

Resource Condition and Trends

Cultural resources include archaeological resources and historic architectural resources. Section 4.18.3 includes detailed information on the cultural context for the area. Past development, unrelated to the Project, has affected historic resources in southern New Hampshire. Historic resources have been destroyed directly because of deteriorating conditions, development pressures, or both. Numerous regulatory protections and programs at various levels of government have been designed to encourage the preservation of historic resources.

Impacts from Other Actions

Historic properties and districts can be protected from alteration through local designations and design review. Known developments in the study area are not anticipated to result in adverse effects to known historic resources. Archaeological resources are difficult to identify without substantial investigation and are more difficult to protect through local development regulations.

Continued population growth in the study area may place some development pressure on unprotected historic properties and districts and may result in the loss of archaeological resources such as Native American sites.

Direct Impacts

Archaeological resources would not be impacted by the Proposed Project. Section 4.18.5 outlined the direct impacts for the Build Alternatives. Alternative A would not result in adverse effects to historic resources. The effects on historic resources from Alternative B would be expected to be the same as Alternative A. Alternatives C, D, and F would be anticipated to result in adverse effects to historic resources.

Indirect Effects

Specific indirect effects on archaeological resources resulting from land use change cannot be reasonably estimated because of the uncertainty associated with the size, type, and location of resources within the development footprints. When private development requires a federal action, such as a permit to impact waters of the U.S., under Section 404 of the CWA, the potential impacts on archaeological resources would be studied to comply with Section 106 of the NHPA–compliance with Section 106 and other federal laws is a requirement of the Section 404 permit. However, if a permit is not needed, potential effects on archaeological resources would not be evaluated. Therefore, private development, such as the Chester residential development, could result in impacts on unknown archaeological resources.

Historic properties and districts can be protected from alteration through local designations and design review. There are no known NHRP-eligible resources adjacent to Woodmont Commons West, Woodmont Commons East, and Derry Industrial developments. As a result, development anticipated to be induced by the Project is not expected to result in adverse effects to known historic resources in the study area.

Potential for Cumulative Impacts

Historic properties and districts can be protected from alteration through local designations and design review. Regardless of the Project, known developments in the study area are not anticipated to result in adverse effects to known historic resources. Alternatives A and B would not be anticipated to result in adverse effects to historic resources. Alternatives C, D, and F would be anticipated to result in adverse effects to historic resources, with Alternative F resulting in adverse effects to the greatest number of historic resources.

Archaeological resources would not be impacted by the Proposed Project. As noted above, it is not possible to reasonably estimate indirect effects on archaeological resources resulting from land use change because of the uncertainty associated with the size, type, and location of resources within the development footprints. Original and subsequent archaeological surveys have indicated that archaeological sites and sensitivity areas are absent from the Build Alternative alignments; thus, none of the Build Alternatives are expected to result in impacts on archaeological resources.

As noted in the previous section, given the private nature of the known developments considered in this indirect effects and cumulative impacts analysis, unless a Section 404 permit is required, Section 106 of the NHPA would not apply. It is possible that potential impacts to cultural resources could be mitigated through the Section 404 permitting process. Additionally, there are local programs within the Towns designed to maintain these resources (e.g., preservation easements, preservation tax incentives, local historic districts, and local building codes and review standards for historic structures).

6.0 OTHER TOPICS

6.1 Energy Consumption

During construction of any of the Build Alternatives, energy requirements (i.e., diesel and gasoline fuel consumption) would depend on several factors, such as the scope of construction activities (e.g., roadway widening versus new construction); length of the corridor; and number and length of any new bridges. Because these factors are variable among the Build Alternatives, energy consumption during construction would likely also vary. However, the Build Alternatives associated with the construction of the new Interchange Alternatives (i.e., Alternatives A, B, C, and D) are likely to have a greater quantity of energy consumed during construction when compared to the Upgrade Alternative (Alternative F). As noted in Table 3.7-1, the total length of roadway improvements varies from a low of 2.44 lane miles for Alternative F to a high of approximately 6.25 lane miles for Alternative C. Of the new Interchange Alternatives, Alternative A would have the least impact in terms of lane miles of new road and reconstructed road. The only alternative that would require construction of a new bridge would be Alternative B, which would cross Shields Brook on new roadway alignment. All other crossings for all the Build Alternatives are likely to only require improvements to existing structures, or installation of small drainage structures, primarily pipe culverts. Based on the total lane miles of new and reconstructed roadway, as well as the need for a new bridge crossing, Alternative C would have the greatest energy consumption impacts during construction. Other than the No Build Alternative, Alternative F would be expected to have the lowest energy consumption during construction.

Similar to energy use during construction, the greater the length of new roadway, the greater the expected maintenance requirements would be. Any new roadway facility requires expenditures of additional energy for maintenance, which includes plowing, sanding, mowing, bridge maintenance, and maintenance of drainage systems, and repairing roadway surfaces. Thus, it would be expected that the greatest energy consumption impacts would be associated with Alternative C, followed in order of decreasing energy use by Alternative B, Alternative D, Alternative A, and Alternative F.

Construction of any of the Build Alternatives would improve traffic flow between I-93 and the towns of Derry and Londonderry, thus improving fuel efficiency. As discussed in Section 4.2, existing traffic conditions on NH 102 through downtown Derry result in substantial delays during the morning and evening peak hours. These conditions result in decreased fuel efficiency and an increase in fuel consumption. In contrast, the Build Alternatives address these traffic issues and the associated, anticipated delays at key intersections/roadways. By reducing delays and improving the flow of traffic, energy consumption per vehicle would decrease in future years for all Build Alternatives.

6.2 Construction Impacts

The No Build Alternative would not result in any construction impacts. Any of the Build Alternatives would include construction impacts related to air quality, soil erosion and water quality, noise, visual resources, and traffic.

6.2.1 Air Quality

Air pollutants emitted from diesel- and gasoline-powered construction equipment would include oxides of nitrogen, CO, hydrocarbons, 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 (i.e., fugitive dust) can result from movement of construction equipment and transport of materials to and from a construction site. Dust emissions can also occur during site preparation activities such as grading, curb laying, or grubbing and removal of vegetation to prepare a site for construction. Fugitive dust would generally be a problem during periods of intense construction activity and would be accentuated by windy and/or dry conditions.

Dust emitted during most construction activities would 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.

Although New Hampshire has no specific laws regulating emission controls on construction equipment, NHDES recommends that construction contracts for all work to be conducted in the highly populated I-93 corridor include requirements for heavy-duty diesel construction equipment to be retrofitted with particulate filters and other appropriate controls (such as oxidation catalysts) to reduce the impacts of construction equipment emissions on residential neighborhoods adjacent to the Project corridor. Requiring “clean diesel” practices for construction equipment such as Tier 4 standard engines or best available retrofit technology would help mitigate any temporary impacts. In accordance with EPA’s Non-Road Diesel Rule, as ultra-low sulfur diesel fuel is phased in, diesel engines used for the construction equipment will be required to use the fuel to better enhance emission controls.

6.2.2 Soil Erosion and Water Quality

Activities associated with construction would require grading. Grading would involve the stripping of existing vegetation and topsoil removal, excavation, and placement of fill. These activities would result in disturbance of surficial soils and subsoils within the footprints of any of the Build Alternatives. Exposure of previously vegetated soils could lead to erosion and water quality impacts, if not properly controlled.

To mitigate potential sedimentation impacts during construction, the Project commitments (see Section 11.0) include the development and implementation of a sedimentation and erosion control program. This sedimentation and erosion control plan (as part of the Stormwater Pollution Prevention Plan) would also be consistent with the National Pollutant Discharge Elimination System and the NHDES’ AoT permitting requirements and the 2017 Construction General Permit (see Section 4.11). Proper maintenance of erosion control devices such as hay bales and silt fences would be an integral part of the Project so as to ensure their adequate installation and use. Erosion control measures and construction schedules would require that areas stripped of vegetation be stabilized as soon as practicable after exposure to prevent soil loss by wind and water. Where appropriate, upslope drainage would be diverted around work areas, and temporary erosion and sediment controls would be installed as necessary during construction. BMPs for fertilizer application during construction would also be followed. In addition, mechanisms to avoid and control chemical leaks and spills from the construction equipment would be instituted. With proper implementation and maintenance of a well-planned erosion and sedimentation control plan, impacts during construction should be temporary.

Minor road adjustments to limit stream and wetland crossings would continue to be evaluated for the Proposed Project to further minimize impacts. Where practical, efforts would be made to maintain a buffer strip of vegetation near streams. In those areas where vegetation removal is required, revegetation with appropriate seed mixes or plantings would be completed as soon as possible.

6.2.3 Noise

Construction noise differs from traffic noise in length, type, and duration of noise events. Construction noise is of a fixed duration and ceases at the completion of the construction phase. Construction noise, usually limited to daylight hours, differs from normal vehicular traffic noise, which continues throughout the day- and night-time hours. Additionally, construction-related noise is responsible for a variety of impulsive, discontinuous noise sources, such as jack-hammer and/or vibratory rollers. Traffic noise, although varying in level, is more continuous as a noise source. Temporary increase in noise levels would occur during the time period that construction takes place. Noise levels from construction, although temporary, can impact areas adjacent to the Proposed Project.

Impacts from construction noise depend upon the following criteria:

- Time and duration of construction activities;
- Equipment types; and
- Equipment usage cycle.

Typical construction phases for the Proposed Project may involve the following construction activities:

- **Demolition**: Removal of structures within the ROW.
- **Clearing and Grubbing**: Existing landscaping, along with unwanted earth and rock.
- **General Earthwork**: Alteration of site topography to prepare the area for the roadway design. Earth-moving operations would be required to prepare the roadbed. Trenches would be excavated for drainage materials.
- **Foundations**: Preparation for, and construction of, foundation support systems for both bridge and other primary foundation structures.
- **Paving Operations**: Preparation of the base layer, such as roadbed compaction and the laying of substrata material as well as surface paving operations.
- **Finishing**: Cleanup and landscaping.

Equipment such as bulldozers, scrapers, pavers, backhoe, graders, loaders, cranes, trucks, compressors, vibratory compactors, generators, and pile driving operations are typically used during construction.

Mitigation measures will be incorporated into the contract documents to lessen potential construction noise impacts. The following mitigation strategies will be employed to the extent practicable to limit the potential impact of noise:

- Source Control
  - All exhaust systems in good working order, also using properly designed engine enclosures, and intake silencers.
  - Regular equipment maintenance.
- Site Control
  - Placement of stationary equipment as far away from sensitive receptors as possible (e.g., pumps, compressors, aggregate crushers, AC plants, operators).
  - Choice of disposal sites and haul routes thereto.
  - Employing shielding where possible.
- Time and Activity Constraints
  - Schedule of operations to coincide with periods when people would least likely be affected.
  - Limiting working hours and work days to least noise-sensitive times.
- Community Awareness
  - Public notification of construction operations.
  - Methods to handle complaints.

6.2.4 Visual Resources

Some short-term visual impacts would occur during construction as a result of land clearing and earth-moving. Additionally, some views would be disrupted by the presence of temporary construction or access roads. Construction equipment and materials would be aesthetically incompatible with the existing natural, built, and aesthetic environments because of their contrast in material, form, and color. Because the duration of the presence of equipment and materials is temporary, construction-related visual impacts are anticipated to be minor; therefore, no mitigation has been proposed.

6.2.5 Traffic

Construction would create increase truck traffic on secondary roads, and unavoidable temporary delays would be experienced on I-93 during construction of the new ramps as the overpass bridge is constructed, traffic is shifted temporarily from one side to the other, equipment is moved around, and materials are delivered. Coordination would occur between local and state emergency response personnel to develop efficient incident management procedures and protocols. Intelligent Transportation System (ITS) technologies would 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, would be instituted to reduce traffic-related, short-term impacts and minimize construction zone delays. Additional temporary delays would be experienced along secondary roads in the Town of Derry during widening activities. Businesses and their customers may experience some inconvenience due primarily to construction activities along their frontage.

Construction activities would be coordinated with property owners to ensure that reasonable access to properties is maintained. Temporary signing and other issues related to temporary relocation of access points, caused by construction activities, would be appropriately addressed on an individual basis.

6.3 Relationship between Short-term Use of the Environment and the Maintenance and Enhancement of Long-term Productivity

Improving traffic flow between I-93 and the Derry-Londonderry area is perceived as a solution to current and forecasted traffic delays and safety issues. It is also viewed as an important factor in facilitating future economic growth in the communities. The proposed roadway improvements address these needs as identified by the communities, and are based on comprehensive planning studies that go back more than 20 years, and were undertaken in cooperation with NHDOT and FHWA. These planning studies have taken into consideration the need for transportation improvements using predicted regional future area growth and land use patterns, and information derived from traffic modeling. In more general terms, transportation improvements in NH are subject to a comprehensive planning process by the state. Approval of a highway project is contingent upon the fact that local short-term impacts and use of resources by the Proposed Project are determined to be consistent with the maintenance and enhancement of long-term productivity for the state.

Each Build Alternative would have similar short-term impacts upon environmental resources in the study area. Short-term impacts associated with construction within the study area would include increased noise, temporary reduction in air quality, potential water quality impacts resulting from soil erosion, removal of vegetation, traffic delays/increases, disturbance of wildlife habitat, and visual impacts. Most of these short-term impacts would be mitigated and would stop after completion of the Project. Short-term benefits would include additional employment opportunities and revenues for the local economy realized during the construction period.

Socioeconomic impacts associated with the Build Alternatives would include loss of residences, businesses, and/or open space or agricultural land; changes to the character of neighborhoods; possible devaluation of properties near any proposed roadway; and loss of associated tax revenue for the communities. Some businesses could also experience a decrease in revenue due to loss of parking and diminished customer accessibility while construction is underway. The Build Alternative alignments could also impact planned future development, both residential and commercial in some areas. However, these economic impacts would be compensated for in the long-term by improving access to other developable parcels. The total annual property tax losses to the Towns would be small, particularly in relation to the potential additional tax revenues from future development. In addition, loss of residences and businesses would have a minimal impact on the community due to an adequate supply of available properties for sale or lease within the study area as a whole. Therefore, the financial impacts on the Towns and the economic impacts caused by direct displacements are expected to be minor.

Natural resource impacts associated with roadway projects can include impacted surface water quality, increased stormwater runoff, and changes in noise levels and traffic patterns. The degradation, loss, and fragmentation of wetlands and wildlife habitat could result in long-term impacts on animal populations within the study area. These negative impacts would likely be partially offset by the permanent habitat protection and enhancement provided in the wetland mitigation areas. Impacts on archaeological resources are not anticipated.

6.4 Irreversible and Irretrievable Commitment of Resources

Implementation of the Proposed Project would 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 interchange and connector road. 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; however, 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 would be expended. Additionally, labor and natural resources would 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 would not have an adverse effect upon continued availability of these resources. Any construction would also require a substantial one-time expenditure of local, state, and federal funds which are not retrievable.

The commitment of these resources is based on the concept that residents in Derry and Londonderry would benefit by the improved quality of transportation services which are anticipated to outweigh the commitment of these resources.

7.0 SECTION 4(f) RESOURCES

7.1 Introduction

Potential impacts of USDOT 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 Department of Transportation Act as amended by the Federal-Aid Highway Act of 1966 (Public Law 90-495, 49 USC 1653) (which has been later revised and recodified but still referred to as Section 4(f)). Under Section 4(f), the Secretary of Transportation shall not approve any program or project that "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."

Parks and recreational lands include all properties that are publicly owned and open to the public that are expressly reserved for recreational purposes, such as neighborhood parks, golf courses, school playgrounds and ball fields, and similar facilities.

7.2 Description of the Proposed Action

The Proposed Project is located in the Towns of Derry and Londonderry and includes construction of a new interchange with I-93 (known as Exit 4A) and other transportation improvements to reduce congestion and improve safety along State Route 102 (NH 102), from I-93 easterly through downtown Derry, and to promote economic vitality in the Derry/Londonderry area. Detailed discussions of the purpose and need and the alternatives under consideration are provided in Chapters 2 and 3, *Purpose and Need* and *Alternatives Analysis*, respectively.

7.3 Description of Section 4(f) Evaluation

7.3.1 Section 4(f) Historic Resources

As discussed in Section 4.18, *Cultural Resources*, the following individual properties and historic districts were found eligible for the NRHP (Table 7.3-1) (see Table 4.18-2 for detailed descriptions), and as such, are subject to Section 4(f). There are no known archaeological sites listed or eligible for the NRHP affected by the alternatives.

Table 7.3-1. Historic Resources Subject to Section 4(f)

Name (ID)	Town	Historic District
Benson/Warren House (DER0029)	Derry	Broadway Historic District (Area B)
Veterans Memorial Building (DER0044)	Derry	
Central Fire Station (DER0047)	Derry	
Adams Memorial Building (DER0048)	Derry	
First National Bank (DER0062)	Derry	
First Baptist Church (DER0070)	Derry	
Masonic Temple (DER0078)	Derry	
St. Luke's Methodist Episcopal Church (DER0080)	Derry	
Greenough House (DER0085)	Derry	
Abbott/Cutlip House (DER0090)	Derry	
Arthur Greenough House (DER0099)	Derry	
Proctor House (DER0100)	Derry	
Birch Street Residential Historic District (Area BI)	Derry	NA
Gilbert and Helen Hood House (DER0102)	Derry	
Derry Village Historic District (Area DV)	Derry	
J&F Farms (DER0132)	Derry	
Palmer Homestead (DER0134)	Derry	
E.F. Adams House (DER0135)	Derry	
Amedee Cote House (DER0141)	Derry	
3 Manchester Road (DER0196)	Derry	
Manchester and Lawrence Railroad	Derry and Londonderry	NA
The Gearty House (LON0105)	Londonderry	
Reed Paige Clark Homestead (LON0114)	Londonderry	
The Robert J. Prowse Memorial Bridge (LON0116)	Londonderry	
The Moody House (LON0117)	Londonderry	

7.3.2 Section 4(f) Recreational Resources

As discussed in Section 4.19, *Parks, Recreation, and Conservation Lands*, 35 of the 49 properties identified within the study area are potentially subject to the provisions of Section 4(f) of the USDOT Act of 1966 (see Table 7.3-1 and Figure 4.19-1).

Conservation Lands

The Town of Londonderry has one conservation area potentially subject to Section 4(f) within the study area: the Dumont Conservation area (#10), which is bisected by the Old Trolley Line Trail. The Old Trolley Line Trail and Londonderry Rail Trail traverse the study area.

No wildlife or waterfowl refuges subject to Section 4(f) have been identified in the study area.

Recreational Resources

In the Town of Derry, the study area contains a variety of parks, recreational areas, and trails, most of which would be considered Section 4(f) resources. Examples of public recreational resources include Rider Fields (#8) and Trail, which includes baseball, recreational areas, a small playground, and open space, and Hoodkroft Country Club (#1), a golf course partially owned by the Town of Derry that is open to the public and abuts a large wetland area associated with Beaver Brook. Trails within the study area include the Rider Fields Trail, as well as the Derry Bicycle Path, the Rail Trail Path, and the Derry Rail Trail. The Derry Bicycle Path encircles the downtown Derry area and overlaps with the Rail Trail Path, which connects the Londonderry and Derry Rail Trails. Note that the planned segment of The Derry Rail Trail in the vicinity of the crossing of Alternative A (see Figure 4.19-1) is under private ownership; therefore, Section 4(f) does not apply.

The Londonderry Rail Trail is a cooperative effort between the Town of Londonderry and the Londonderry Trailways organization to complete about 6 miles of trail on an abandoned rail corridor (Londonderry Trailways, 2016). This will link the Derry and Manchester Rail Trails and be part of the 20-mile Granite State Rail Trail that runs from Salem to Manchester. Currently, the Rail Trail is paved from Rockingham Road (NH 28) near North School west of I-93 to the intersection of Rockingham Road near Seasons Lane on the east side of I-93. The North Village, Little Cohas, and Airport segments are currently planned to pave the existing western terminus of the trail to the Manchester town line (2.3 miles). In addition, the Southeastern Border segment is planned to connect the existing eastern terminus of the trail to the Derry town line (0.6 mile). From the Derry town line to a point north of Hood Park, there is a gap in the Rail Trail (Figure 7.2-1). This planned segment will be completed in future years as Londonderry completes the Southeastern Border segment. Although this gap in the Rail Trail is passable on foot or mountain bike, the trail ROW north of North High Street is private property; therefore, it is not currently part of the trail network.

The Old Trolley Line Trail currently exists as a well-used trail by hikers and mountain bikers along an old trolley line, and the Londonderry Conservation Commission has identified the trail as a long-term opportunity to help complete an extensive loop trail originating at the town center (Londonderry Conservation Commission, 2014).

Table 7.3-2. Parks, Recreation, and Conservation Lands Subject to Section 4(f)

Parcel ID[a]	Name	Location	City	Ownership	Type of Use
1	Hoodkroft Golf Course	NH 102 (Chester Road)	Derry	Semi-Private	Golf course. Partially owned by Town of Derry, open members, and the general public
2	Veteran's & O'Hara Ball Fields	Wilson Avenue	Derry	Town of Derry	Baseball, soccer, playground, tennis, various recreational leagues
3	MacGregor Park	Birch Street	Derry	Town of Derry	Small park downtown, picnic area, benches, veterans memorial
4	Buckley Field	Hood Road	Derry	Town of Derry	Baseball, recreational areas, small playground
5	Pinkerton Academy Athletic Field	Crescent Street	Derry	Town of Derry	Recreational field
6	Pinkerton Academy Fields	Pinkerton Street	Derry	Pinkerton Academy	Baseball field, tennis courts
7	Pinkerton Academy Fields East	Pinkerton Street	Derry	Pinkerton Academy	Baseball field, football field, track
8	Rider Fields	Tsienneto Road	Derry	Town of Derry	Baseball, recreational areas, small playground, open space
10	Dumont	North and east of Trolley Car Lane, bisected by Old Trolley Line Trail	Londonderry	Private and Town of Londonderry	Hiking, cross-country skiing, nature observation
-	Old Trolley Line Trail	Various west of I-93	Londonderry	Town of Londonderry	Public recreational trail
-	Londonderry Rail Trail	Various east of I-93	Londonderry	Town of Londonderry	Public recreational trail
-	Rail Trail Path	Various east of I-93	Derry	Town of Derry	Public recreational trail
-	Derry Rail Trail	Various east of I-93	Derry	Town of Derry	Public recreational trail
-	Derry Bicycle Path	Downtown Derry	Derry	Town of Derry	Public recreational trail circles the downtown area
-	Rider Fields Trail	Near Rider Fields	Derry	Town of Derry	Public recreational trail

Sources: Town of Derry (2016b; 2017a; 2017b; 2017c); Derry Rail Trail Alliance (2017); NHFGD (2016c); Londonderry Conservation Commission (2014)

[a.] Parcel ID for reference on Figure 4.19-1

7.4 Potential for Use and Impacts on Section 4(f) Resources

As described above, publicly owned recreation land is protected by regulations that include Section 4(f) of the USDOT Act of 1966. The identification of potential impacts on Section 4(f) resources are based on an evaluation of use. Use in the Section 4(f) context is defined in 23 CFR 774.17 as follows:

Except as set forth in §§ 774.11 and 774.13, a "use" of Section 4(f) property occurs:

(1) When land is permanently incorporated into a transportation facility;

(2) When there is a temporary occupancy of land that is adverse in terms of the statute's preservation purpose as determined by the criteria in § 774.13(d); or

(3) When there is a constructive use of a Section 4(f) property as determined by the criteria in § 774.15.

Incorporation into a transportation facility occurs when land from a Section 4(f) property is either purchased as transportation ROW or when an interest in the property is acquired that allows permanent access (e.g., permanent easement).

Temporary occupancy results when a Section 4(f) property, in whole or in part, is required for project construction-related activities. While the property is not permanently incorporated into a transportation facility, the construction-related activity is considered to be adverse in terms of the preservation purpose of Section 4(f). Section 23 CFR 774.13(d) provides the conditions under which "temporary occupancies of land…are so minimal as to not constitute a use within the meaning of Section 4(f)." If all of the conditions in Section 774.13(d) are met, the temporary occupancy does not constitute a use. If one or more of the conditions for the exception cannot be met, then the Section 4(f) property is considered used by the project even though the duration of onsite activities is temporary.

Constructive use involves no actual physical use of the Section 4(f) property via permanent incorporation of land or a temporary occupancy of land into a transportation facility. Rather, constructive use occurs when the proximity impacts of a proposed project adjacent to, or nearby, a Section 4(f) property result in substantial impairment to the property's activities, features, or attributes that qualify the property for protection under Section 4(f). A project's proximity to a Section 4(f) property is not in itself an impact that results in constructive use. The assessment for constructive use should be based upon the impact that is directly attributable to the proposed project (e.g., increased noise levels, visual effects), not the overall combined impacts to a Section 4(f) property from multiple sources over time.

If FHWA determines that a transportation use of Section 4(f) properties results in a *de minimis* impact on that property, an analysis of avoidance alternatives is not required, and the Section 4(f) evaluation process is complete. *De minimis* impacts on publicly owned parks, recreation areas, and wildlife and waterfowl refuges are defined as those that do not "adversely affect the activities, features and attributes" of the Section 4(f) resource. The finding of a *de minimis* impact on recreational and wildlife resources can be made when:

1. The transportation use of the Section 4(f) resource, together with any impact avoidance, minimization, and mitigation or enhancement measures incorporated into the project, does not adversely affect the activities, features, and attributes that qualify the resource for protection under Section 4(f);

2. The public has been afforded an opportunity to review and comment on the effects of the project on the protected activities, features, and attributes of the Section 4(f) resource; and
3. The official(s) with jurisdiction over the property are informed of FHWA's intent to make the *de minimis* impact finding based on their written concurrence that the project will not adversely affect the activities, features, and attributes that qualify the property for protection under Section 4(f).

7.4.1 Section 4(f) Historic Resources

No Build Alternative

The No Build Alternative would not result in the use of Section 4(f) historic resources.

Build Alternatives

Alternative A

Alternative A (the preferred alternative) is not anticipated to result in adverse effects to historic properties. Based on the effects tables provided to SHPO on September 4, 2018 (Appendix N), the effects to the Palmer Homestead, E.F. Adams House, and Knapp Brothers Shoe Manufacturing properties and the grade-separated crossing of the M&L Railroad are not considered to be adverse effects and would constitute a *de minimis* use under Section 4(f). Therefore, further analysis of avoidance alternatives and measures to minimize harm is not required.

Alternative B

Effects would be similar to those described under Alternative A, and Alternative B is not anticipated to result in an adverse effect. Based on the other known historic resources in the study area, Alternative B would have no effect on any other historic resources. Therefore, Alternative B would result in a *de minimis* use of historic resources under Section 4(f).

Alternative C

As discussed in the 2007 DEIS, it was determined that the west side of the Alternative C interchange would have an adverse effect to the Reed Paige Clark Homestead properties (LON0114) located immediately west of the I-93 corridor and south of Stonehenge Road) (see Figure 4.18-4). The adverse effect on the property would be for both the need to acquire land to build the Northern Interchange [specifically the associated former potato field (Londonderry Map 13/Lot 20)] and also the visual impact a major raised interchange would have on the Reed Paige Clark Homestead (Londonderry Tax Map 13/Lot 21) located on the north side of Stonehenge Road. The total estimated property taking on Lot 20 required for the ROW for the Alternative C interchange would be approximately 2.4 acres. Of this, approximately 1.4 acres would be located within the roadway footprint. Other than the Reed Paige Clark Homestead properties, no other known historic resources would be affected by Alternative C.

If Alternative C was selected as the preferred alternative, additional analysis of potential avoidance alternatives and measures to minimize harm would be required to comply with Section 4(f).

Alternative D

Similar to Alternative C, construction of the new Alternative D Interchange would require identical impacts on the same two Reed Paige Clark Homestead properties (Lots 20 and 21), resulting in an adverse effect. The adverse effect on these properties would be for both the need to acquire land to build the Northern Interchange and the visual impact a major raised interchange would have on the Reed Paige Clark farmstead located on the north side of Stonehenge Road. No other historic resources would be affected by Alternative D.

If Alternative D was selected as the preferred alternative, additional analysis of potential avoidance alternatives and measures to minimize harm would be required to comply with Section 4(f).

Alternative F

As discussed in the 2007 DEIS, it was determined that Alternative F would have an adverse effect upon historic resources through the Broadway Historic District (Area B) located along NH Route 102. Alternative F would extend alongside the Derry Village Historic District and near the Birch Street Historic District but would have no adverse effect on these resources. The Alternative would also traverse adjacent to one NRHP individually eligible property along NH Route 102 (Gilbert and Helen Hood House, DER0102), with no effect to the property.

If Alternative F were selected as the preferred alternative, additional analysis of potential avoidance alternatives and measures to minimize harm would be required to comply with Section 4(f).

7.4.2 Section 4(f) Parkland and Recreational Resources

No Build Alternative

The No Build Alternative would not result in the use of Section 4(f) recreational resources.

Build Alternatives

Alternative A

As outlined in Section 4.19, Alternative A would permanently impact 0.02 acre of the Rider Fields property (Site #8 on Figure 4.19-1), a 21-acre Section 4(f) resource owned by the Town of Derry that includes athletic fields, parking facilities, and undeveloped land. Within the 0.02 acre, the improvements to Tsienneto Road would result in the need to move the mailbox and sign for the Upper Room Family Resource Center. None of the recreational facilities within Rider Fields would be impacted. The Project would result in slope and driveway impacts beyond the proposed ROW that would require additional, temporary easements of 2,500 square feet (0.06 acre) on the Rider Fields property. The impacts associated with the temporary easement are limited to the vegetation between the Upper Room driveway and the Rider Fields driveway. This vegetated area near Tsienneto Road is not typically used for recreational purposes by the public and is approximately 346 feet from the sports fields to the north that constitute the primary recreational area of the park.

NHDOT would coordinate with the Town of Derry to move the mailbox and sign for the Upper Room Family Resource Center and to replace the stone walls and vegetation that would be impacted by the Project. The temporary easement would not impact the usability of park, and access to the park would be maintained throughout the construction period. Neither the Upper Room Family Resource Center nor the activities, features, and attributes of the Rider Fields would be adversely impacted on a permanent or temporary basis. As a result, NHDOT considers the impact of Alternative A on Rider Fields to be *de minimis*.

Alternative B

Alternative B would impact 0.96 acre of an undeveloped portion of Rider Fields (Site #8). The Alternative B alignment would cross this resource near its northern undeveloped edge, avoiding direct impacts to the athletic fields and parking facilities. This Alternative would require impacts to1 acre to provide needed ROW for the proposed roadway. An additional 0.35 acre of the property would be left as a remnant that would be separated from the athletic fields by the roadway and would be left inaccessible. An informal path used by locals traverses north-south across the northwest corner of the property. The path is used to access the site from residential properties and the power line corridor located to the north. Along with the direct impacts to the park, there would be increased noise levels and a decrease in scenic value. If Alternative B were selected for the Project, further analysis of avoidance alternatives and measures to minimize harm would be required.

Alternative C

Alternative C would result in impacts to two conservation lands—it would impact 0.05 acre of the Dumont conservation area (Site #10) and 0.04 acre of the Rockingham Road conservation area (Site #11). The impacts to the Dumont conservation area are related to the I-93 southbound entrance ramp, and the impacts to the Rockingham Road conservation area are limited to the small conservation lot along 28 near Seasons Lane. Further assessment and coordination would be needed to determine whether this use would be considered *de minimis*.

Alternative C would also impact Rider Fields near its northern property line. Impacts to Rider Fields would be identical to those already described for Alternative B. If Alternative C is selected for the Project, further analysis of avoidance alternatives and measures to minimize harm would be required.

Alternative D

Alternative D would impact the Dumont and Rockingham Road conservation areas. Impacts are identical to those already described for Alternative C. Alternative D would also impact 0.2 acre of Rider Fields. Impacts to Rider Fields would be identical to those already described for Alternative A.

Alternative F

Alternative F would impact two recreational areas. The Derry Bike Path, a Section 4(f) resource, crosses NH 102 in downtown Derry. Because Alternative F would involve improvements to NH

102, it would require construction activities within the existing road crossing for the Derry Bike Path. It is expected that any impacts on this existing crossing would occur during construction, and they would be temporary; further analysis would be required if this alternative were selected to determine whether the temporary impacts would meet the temporary occupancy exemption requirements. Acquisition of property in the area of the existing crossing of the Derry Bike Path would not be required. In addition, the existing crossing and access to the Bike Path at this location would be maintained, including during the construction phase where practicable. Farther to the east on NH 102, and on the south side of the road, is Hoodkroft Country Club, a semi-private golf course. Alternative F would impact 0.18 acre of the golf course property but would not affect any of the facilities at the golf course.

7.5 Coordination

A letter was sent to the Town of Derry Parks and Recreation Department on September 4, 2018, (see Appendix K) to inform the agency that impacts on Rider Fields from Alternative A are anticipated to be *de minimis*.

[Preparer's note to FHWA: Assuming SHPO concurs with the no adverse effect findings under Section 106, a letter to SHPO will be sent informing the agency about the intent to make a de minimis *determination under Section 4(f).]*

8.0 PUBLIC INVOLVEMENT AND AGENCY COORDINATION

Throughout the environmental process, a number of meetings were held with federal and state resource agencies. Regular attendees included representatives from USACE, EPA, USFWS, FHWA, NHDOT, NHDES, NHFGD, and NHDHR. In addition to the meetings with the resource agencies, meetings were held with several Project-related groups, including a Local Advisory Oversight Committee, the TAC, and the CATF. Chapter 8 of the 2007 DEIS provides a detailed account of public involvement and agency coordination from Project inception through publication of the DEIS.

In support of the evaluation for this SDEIS, NHDOT and FHWA held eight resource agency coordination meetings and three public information meetings.

8.1 Resource Agency Coordination Meetings

8.1.1 Cooperating and Participating Agencies

The initial agency coordination and the agency and public scoping process for this Project occurred during the preparation of the 2007 DEIS. NHDOT prepared an Agency Coordination Plan with the intent of the coordination process to allow federal and state agencies to provide input on the issues that will be examined as part of the EIS process. Invitations were sent to federal agencies, tribes, state agencies, and local agencies in October and November 2016. Table 10.1-1 includes the cooperating and participating agencies that accepted the invitation.

Table 8.1-1. Cooperating and Participating Agencies

Agency	Agency Type	Role
U.S. Army Corps of Engineers	Federal	Cooperating and Participating
U.S. Environmental Protection Agency	Federal	Cooperating and Participating
New Hampshire Department of Environmental Services	State	Cooperating and Participating
New Hampshire Division of Historical Resources	State	Cooperating and Participating
U.S. Department of Agriculture, Natural Resources Conservation Service	Federal	Participating
Southern New Hampshire Planning Commission	Regional	Participating
New Hampshire Office of Strategic Initiatives	State	Participating
New Hampshire Department of Business and Economic Affairs	State	Participating
Town of Chester	Local	Participating

8.1.2 Agency Meetings

The Project team provided updates to the natural resources and cultural resources agencies on the development of the SDEIS on the following dates:

- Cultural Resources Agency Coordination Meetings
  - February 11, 2016
  - October 13, 2016
- Natural Resources Agency Coordination Meetings
  - February 17, 2016
  - October 19, 2016

Meeting notes from the cultural resources agency coordination meetings and the natural resources agency coordination meetings are published on NHDOT's website.[24]

A kickoff meeting for the participating agencies was held on March 6, 2017, at which time consensus was reached on the finalizing the Coordination Plan. Two technical working group meetings were held in spring 2017: one focused on wetland impacts and mitigation/Section 404 permitting issues, and one focused on water resources (including chloride/TMDL issues). A meeting was held with USACE and USEPA on August 30, 2017, which focused on indirect effects and cumulative impacts and water quality (i.e., chloride).

In addition to the participating agency meetings listed above, the agencies were provided opportunities to review and comment on technical reports supporting the SDEIS and preliminary administrative drafts of the chapters of the SDEIS.

8.2 Public Meetings

Three public meetings were held on September 27, 2016; May 24, 2018; and July 25, 2018. All public meeting materials are provided on the project website (see Section 8.3)

8.2.1 Public Information Meeting 1

Public information meeting 1 was held on September 27, 2016, at the Derry Municipal Center. The purpose of the meeting was to update the public on the status of the Exit 4A Project and receive feedback. The Project website was introduced. In addition to the Project schedule, the purpose and need for the Proposed Project, alternatives under consideration, and a summary of some of the environmental issues that would be evaluated and updated in the SDEIS were presented.

Public input during the open comment session included questions and concerns about increased traffic on Tsienneto Road, accidents on Tsienneto Road near Scenic Drive, accommodation of the rail trail, impacts to residences and businesses, Project costs, alternatives under consideration, water quality and chloride issues, the northern long-eared bat, and cumulative impacts.

[24] Dates for all meetings are published on NHDOT's website (cultural resources meetings: https://www.nh.gov/dot/org/projectdevelopment/environment/units/program-management/crmeetings.htm; natural resources meetings: https://www.nh.gov/dot/org/projectdevelopment/environment/units/project-management/nracrmeetings.htm).

8.2.2 Public Information Meeting 2

Public information meeting 2 was conducted on May 24, 2018, at the Derry West Running Brook Elementary School. The meeting included open-house style presentation of the plans for the Build Alternative alignments A, B, C, D, and F and evaluation matrix, and the public was invited to discuss their questions with members of the Project team. In addition, there was a PowerPoint presentation that consisted of an overview of the Project's origins through to the current timeline and presentation of the re-evaluation of the 2007 DEIS reasonable range of alternatives, which indicates no new information or circumstances that would warrant reconsideration of Alternative A being the preferred alternative. It was noted that the Project would have no westerly access to the local street network. This was a condition of the original approval from USDOT to allow a new interchange. After the presentation, the public was welcomed to ask questions and express their concerns. Questions and concerns voiced during the public meeting included the following topics: Project schedule and cost, truck traffic on NH 102, delays at signalized intersections evaluation of alternatives, water quality and flooding, accommodation of the planned rail trail, benefits (or lack thereof) to Derry, compliance with environmental commitments, meeting notifications and review of the SDEIS, and issues outside of the scope of the Project (e.g., NH 102 rotary and blasting during construction of I-93).

Hand-written comments and questions were received after the meeting. In addition to the concerns noted above, written comments included water and sewer on Tsienneto Road, opposition to the Project, the importance of the Granite State Rail Trail, impacts to specific properties, and requests for additional improvements (e.g., signalization) beyond the limits of the Project.

8.2.3 Public Information Meeting 3/Public Hearing

A combined public officials/public information meeting and public hearing for use of design-build procurement was held on July 25, 2018, at West Running Brook Middle School in Derry. The purpose of the meeting was to present the additional detailed information on the preferred alternative (Alternative A) and to hold a public hearing on the potential use of design-build procurement for the Project.

The format was similar to the May 24, 2018, public information meeting in that there was an opportunity to informally review plans for Alternative A and to ask questions of the Project team. The presentation focused on (1) the update of the Exit 4A alternative selection process with a more detailed explanation of Alternative A, and (2) the public hearing on the NHDOT design-build process. Additionally, information was provided on the underpass to accommodate the planned trail, the proposed reconstruction of the original gap sections along Tsienneto Road, which would include sidewalks, and I-93 sound walls.

An opportunity for public comments was provided during the meeting. Questions and concerns expressed by the public included the following: design-build process, schedule, advantages, liability, and quality; Project funding; increased traffic along Tsienneto Road and at Ross' Corner (NH 28/Folsom Road/Tsienneto Road intersection); acquisition of properties, including partial takes, easements, and eminent domain; negative economic impacts to downtown Derry; public review of studies in support of the SDEIS; the need for the Project; preferences for alternatives under consideration; changes in access to Tsienneto Road, Folsom Road, and Madden Road; and water quality.

8.3 Project Website

The project website (http://www.i93exit4a.com/) was established to provide the public with information throughout the development of the SDEIS. In addition to providing notice of upcoming public involvement events, the website also provides background information on the proposed project and the SDEIS process. The website serves as a repository for project documents, including summaries of public meetings. The SDEIS will be published on the website.

9.0 SDEIS DISTRIBUTION LIST

9.1 Federal Agencies

Executive Director
Advisory Council on Historic Preservation
Office of Planning and Review
Old P.O. Building, Suite 809
1100 Pennsylvania Avenue, NW
Washington, DC 20004

Office of NEPA Policy & Compliance (GC-20)
Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Kenneth L. Horak
Acting Regional Director
Federal Emergency Management Agency
99 High Street, 6th Floor
Boston, MA 02110

Federal Energy Regulatory Commission
Environmental Evaluation Branch
888 First Street, NE
Washington, DC 20426

Jacqueline Davis-Slay, Acting State Conservationist
Natural Resource Conservation Service
Federal Building
2 Madbury Road
Durham, NH 03824-2043

Michael Hicks
U.S. Army Corps of Engineers
New England District Regulatory Branch
696 Virginia Road
Concord, MA 01742-2751

Peter Whitcomb
Assistant State Soil Scientist, Cultural Resources Coordinator
Natural Resources Conservation Service
U.S. Department of Agriculture
The Concord Center
10 Ferry St., Suite 211
Concord, NH 03301

Office of the Secretary
U.S. Department of Agriculture
Room 200A
1400 Independence Avenue, SW
Washington, DC 20250

Regional Administrator, Region I
U.S. Department of Housing & Urban Development
Thomas P. O'Neill, Jr. Federal Building
10 Causeway Street, 3rd Floor
Boston, MA 02222

Michaela E. Noble, Director
Office of Environmental Policy and Compliance
U.S. Department of Interior
Main Interior Building, MS 2340
1849 C Street, NW
Washington, DC 20240

U.S. Department of Interior
Geological Survey
NH/VT District
361 Commerce Way
Pembroke, NH 03275

U.S. Environmental Protection Agency
Office of Federal Activities
NEPA Compliance Division, EIS Filing Section
Ariel Rios Building (South Oval Lobby)
Mail Code 2252-A
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Timothy L. Timmermann
Associate Director
Office of Environmental Review
U.S. EPA New England-Region 1
5 Post Office Square, Suite 100
Mail Code ORA 17-1
Boston, MA 02109-3912

Michael Bartlett
U.S. Fish and Wildlife Service
70 Commercial Street, Suite 300
Concord, NH 03301-5087

9.2 Native American Tribes

Paul W. Pouliot
Cowasuck Band of the Pennacook-Abenaki People
840 Suncook Valley Road
PO Box 52
Alton, NH 03809

Randy Bear Monteiro
Wampanoag Tribe of Gay Head-Aquinnah
20 Black Brook Road
Aquinnah, MA 02535

9.3 State Agencies

Timothy Drew, Administrator
Public Information and Permitting Use
New Hampshire Department of Environmental Services
29 Hazen Drive
Concord, NH 03302

Chris Way, Deputy Director
New Hampshire Division of Economic Development
Department of Business and Economic Affairs
172 Pembroke Road
Concord, NH 03301

Laura Black, Special Projects and Compliance Specialist
New Hampshire Division of Historical Resources
Department of Cultural Affairs
19 Pillsbury Street, P.O. Box 2043
Concord, NH 03301-2043

Glenn Normandeau, Executive Director
New Hampshire Fish and Game Department
11 Hazen Drive
Concord, NH 03301

New Hampshire Natural Heritage Bureau
172 Pembroke Road
Concord, NH 03301

Jennifer Gilbert, CFM ANFI
Floodplain Management Program Coordinator
New Hampshire Office of Strategic Initiatives-Division of Planning
107 Pleasant Street
Johnson Hall, 3rd Floor
Concord, NH 03301

9.4 State and Federal Elected Officials

Councilor Joseph D. Kennedy
New Hampshire Executive Council
PO Box 201
Union, New Hampshire 03887

Councilor Andru Volinsky
New Hampshire Executive Council
488 Shaker Road
Concord, New Hampshire 03301

Councilor Russell E. Prescott
New Hampshire Executive Council
50 Little River Road
Kingston, New Hampshire 03848

Councilor Christopher C. Pappas
New Hampshire Executive Council
629 Kearney Circle
Manchester, NH 03104

Councilor David K. Wheeler
New Hampshire Executive Council
523 Mason Road
Milford, NH 03055

N.H. Senator Sharon Carson
New Hampshire Senate
Statehouse
107 N. Main St., Room 120
Concord, N.H. 03301

Honorable Chris Sununu, Governor
State of New Hampshire
107 North Main St.
Concord, NH 03301

U.S. Representative Carol Shea-Porter
United States House of Representatives
660 Central Ave.
Unit 101
Dover, NH 03820

U.S. Senator Maggie Hassan
United States Senate
1589 Elm Street, Third Floor
Manchester, NH 03101

U.S. Senator Jeanne Shaheen
United States Senate
2 Wall Street, Suite 220
Manchester, NH 03101

9.5 Towns

Derry Municipal Center
14 Manning Street, 2nd floor (DPW office)
Derry, NH 03038

Cara Barlow
Library Director
Derry Public Library
64 East Broadway
Derry, NH 03038

Griffin Free Public Library
22 Hooksett Road
P.O. Box 308
Auburn, NH 03032

Leach Library
276 Mammoth Road
Londonderry, NH 03053

Londonderry Town Hall
268 B Mammoth Road
Londonderry, NH 03053

Sandown Public Library
305 Main Street
Sandown, NH 03873

William G. Herman, CPM
Town of Auburn
47 Chester Road
Auburn, NH 03032

Stephen O. Landau, Selectman
Town of Chester
84 Chester Street
Chester, NH 03036

David Caron, Administrator
Town of Derry
14 Manning Street
Derry, NH 03038

Kevin Smith, Manager
Town of Londonderry
268 Mammoth Road
Londonderry, NH 03053

Lynne Blaisdell
Town Administrator
Town of Sandown
320 Main Street
P.O. Box 1756
Sandown, NH 03873

9.6 Other Organizations and Individuals

Tom Irwin
Conservation Law Foundation
Concord Advocacy Center
27 North Main Street
Concord, NH 03301-4930

Phil Wilson, Chairman
Rockingham Planning Commission
156 Water Street
Exeter, NH 03833

Sierra Club – NH Chapter
3 Bicentennial Square
Concord, NH 03301

Society for the Protection of New Hampshire Forests
54 Portsmouth Street Hard Copy
Concord, NH 03301

Sylvia von Aulock, Executive Director
Southern New Hampshire Planning Commission
438 Dubuque Street
Manchester, NH 03102-3546

9.7 Mailing List

All individuals who have requested to be added to the mailing list as well as all those that have signed into the three Public Information Meetings will be sent an email notifying them of the publication of the SDEIS. Included will be a link to the full document that can be found on-line as well as a listing of locations where a hard copy of the document can be reviewed.

10.0 LIST OF PREPARERS

Federal Highway Administration

Jamison Sikora
Environmental Programs Manager
A.S., Architectural and Building Engineering Technology, Vermont Technical College
B.S., Civil Engineering, Norwich University

New Hampshire Department of Transportation

Keith Cota
Chief Project Manager
B.S., Civil Engineering, Clarkson College

John Butler
Roadway Engineer, Geometrics
B.S., Civil Engineering, Clarkson College

Marc Laurin
Senior Environmental Manager, Bureau of Environment
B.A., Biology, Potsdam State University (NY)

Mark Hemmerlein
Water Quality Program Manager
B.S., Forestry, University of Vermont
M.S., Botany, University of Wyoming

Jill Edelmann
Cultural Resources Manager
B.A., Cultural & Historic Preservation, Salve Regina University

Fuss & O'Neill

Christopher R. Bean, PE
Project Manager
B.S., Civil Engineering, Norwich University
M.B.A., University of New Hampshire

Paul Konieczka, AICP
Task Lead Traffic
B.S., Urban Geography, Salem (MA) State College

Linda Greer, PE, PTOE
Asst. Traffic and Asst. Highway Task Lead
B.S., Civil Engineering, North Carolina State

Nicole C. Fox, PE
Task Lead Highway
B.S., Civil Engineering, University of Florida

Kristen A. Hayden, PE
Task Lead Stormwater
B.S., Civil Engineering, University of Vermont

Jaime French, PE
Task Lead Bridge
B.S., Civil Engineering, Michigan Technological University

Shannon Beaumont
Task Lead Hydraulics
B.S., Civil Engineering, Tufts University

Gregory S. Brown, LLS
Task Lead Survey
A.A.S., Civil Engineering Technology, Hudson Valley Community College

Heidi A. Quesada, LLS
Asst. Task Lead Survey and Task Lead ROW Research
B.A., Political Science, University of Massachusetts, at Amherst
A.E.T., Architectural Engineering Technology, New Hampshire Technical Institute

Louis Berger

Wendy Aviles, ENV SP
Traffic Analyst
B.S., Civil Engineering, Pedro Enriquez Ureña University (UNPHU)
M.E., Master in Engineering, Concentration: Transportation, City College University

Mark Berger, AICP
Task Lead for Transportation
B.A., Geography, Rutgers University
M.S., Transportation Planning, New Jersey Institute of Technology

Glenn David Fresch
Task Lead for GIS Analysis
B.A., Economics, Drew University
MRP, Urban and Regional Planning, University at Albany
CGS, GIS, University at Albany

Deborah Mandell
Senior Editor
B.A., Government, Wesleyan University
M.B.A., Finance and Marketing, Northwestern University

Lawrence Pesesky, AICP
Project Principal
B.S., Agricultural Economics, Cornell University
M.S., Geography, Rutgers University

G. Doug Pierson, ENV SP,
Noise Monitoring
B.A. Geography, University of New Mexico
M.A. Geography, City University of New York
Denise R. Short
Senior Editor
B.A., English, College of Wooster
M.S., Agricultural and Environmental Policy, Tufts University

Kerri Snyder, AICP
EIS Preparation, Task Lead for Indirect Effects and Cumulative Impacts, Land Use, Parks and Recreation, and Section 4(f) Evaluation
B.S., Science, Education, University of Oklahoma
M.S., Zoology, University of Oklahoma

Leo Tidd, AICP
EIS Manager, Task Lead for Noise and Air Quality
B.S., Environmental Studies, SUNY College of Environmental Science and Forestry
M.P.A., Environmental Science and Policy, Columbia University School of International and Public Affairs

Normandeau Associates, Inc.

Vicki Chase, NH Certified Wetland Scientist
Normandeau Associates, Inc. team lead
Principal Regulatory Specialist
B.A., Anthropology, Harvard University
M.S., Resource Management and Administration, Antioch University of New England

Joel Detty
Task Lead for Water Resources
B.S., Atmospheric Science, University at Albany, State University of New York
M.S., Environmental Science and Policy, Concentration in Hydrology, Plymouth State University

Mark Hutchins
Normandeau Associates, Inc. team lead, Chloride technical report author (retired June 2017)
M.S., Civil Engineering/Water Resources, University of Maine
B.A., Geological Sciences, University of Maine

Lisa Ferrisi
Hazardous Materials and Water Resources Technical Assistant
B.S., Environmental Science, Unity College
M.S., Environmental Studies, Sustainable Development & Climate Change, Antioch University New England

Steve Lee
Task Lead for Hazardous Materials
B.S., Physical Geography, Plymouth State College
M.A., Physical Geography-Fluvial Geomorphology, Arizona State University

Ben Griffith
Task Lead for GIS Analysis
B.A., Biology, University of Rochester

Sarah Barnum, PhD. Certified Wildlife Biologist
Task Lead for Plant Communities and Wildlife and Threatened and Endangered Species (Wildlife)
B.S., Wildlife Biology, University of Vermont
M.S., Wildlife Biology, Utah State University
Ph.D., Conservation Planning, University of Colorado

Erik Lema, New Hampshire Certified Wetland Scientist
Task Lead for Plant Communities and Wildlife and Threatened and Endangered Species (Plants)
B.A., Environmental Science, State University of New York at Buffalo
M.S., Natural Resource Management, State University of New York College of Environmental Science and Forestry

Jamie O’Brien
GIS Analyst, Wetlands Review
B.A., Biology, Saint Anselm College
M.S.E.S., Applied Ecology, Indiana University
M.P.A., Environmental Policy and Natural Resource Management, Indiana University

Jen Bryant
GIS Analyst
B.S., Environmental Science, Minor in Biology, University of Redlands, CA

Sean Hale
EIS Review
B.A., Environmental Studies/Philosophy, Bowdoin College
M.S., Wetlands Conservation and Management, University of Massachusetts
NH Certified Wetland Scientist

Dennis Pelletier, New Hampshire Certified Wetland Scientist
GIS Analyst
B.A., Geography, University of New Hampshire

Ian Broadwater
Technical Reviewer, Wetlands
B.S., Plant and Soil Sciences, University of Maine

Justin Sweitzer, Associate Wildlife Biologist
Technical Reviewer, Wetlands
B.S., GeoEnvironmental Studies, Shippensburg University
M.S., Biology, Shippensburg University

Curtis Thalken, PE
Quality Assurance, Chloride Technical Report
B.S., United States Military Academy
M.S., Engineering Science, Thayer School of Engineering, Dartmouth College
M.A., Strategic Studies and International Relations, U.S. Naval War College

Preservation Company

Lynne Emerson Monroe
Project Historian
Advanced Studies in Historic Preservation, Boston University
B.F.A., University of Pennsylvania

Reagan B. Ruedig,
Project Historian
B.A., Duke University
M.S., Historic Preservation, University of Pennsylvania
M.A., Art History and Archaeology, New York University

RKG Associates, Inc.

Lawrence Cranor
Senior Project Manager
Socioeconomic Analyst
B.A., Sociology, University of Cincinnati
M.B.A., Marketing/Management, University of Cincinnati

Craig Seymour
Senior Principal
Socioeconomic Analyst
A.B., Economics/Civil Engineering, Brown University
M.B.A., Finance, University of New Hampshire

Victoria Bunker, Inc.

Victoria Bunker, PhD
Project Archaeologist
PhD in Anthropology, Boston University

11.0 ACRONYMS

AADT	annual average daily traffic
AAWDT	annual average weekday traffic
AoT	Alteration of Terrain
APE	Area of Potential Effect
AR	Administrative Record
AU	Assessment Units
BMP	best management practice
BLWP	Beaver Lake Watershed Partnership
CAA	Clean Air Act
CATF	Citizens Advisory Technical Committee
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CLD	CLD Consulting Engineers, Inc. (In August 2017, CLD became Fuss & O'Neill)
CO	carbon monoxide
CO2e	carbon dioxide-equivalent
CWA	Clean Water Act
dBA	A-weighted decibels
DEIS	Draft Environmental Impact Statement
DO	dissolved oxygen
DOE	Determination of Eligibility
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FEIS	Final Environmental Impact Statement

F&O	Fuss & O’Neill. As of August 7, 2017, CLD Engineers was acquired by Fuss & O’Neill
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Maps
FPPA	Farmland Protection Policy Act of 1984
GIS	geographic information systems
gsf	gross square feet
LOS	Level of Service
M&L	Manchester & Lawrence
µg/m3	micrograms per cubic meter
M&L	Manchester & Lawrence
mg/L	milligrams per liter
mph	miles per hour
MS4	Municipal Separate Storm Sewer System
NAAQS	National Ambient Air Quality Standards
NAC	Noise Abatement Criteria
NEPA	National Environmental Policy Act
NH RSA	New Hampshire Revised Statutes Annotated
NHDES	New Hampshire Department of Environmental Services
NHDOT	New Hampshire Department of Transportation
NHDRED	New Hampshire Department of Resources and Economic Development
NHFGD	New Hampshire Fish and Game Department
NHNHB	New Hampshire Natural Heritage Bureau
NHRP	National Register of Historic Places
Normandeau	Normandeau Associates, Inc.
NPDES	National Pollutant Discharge Elimination System

NPS	National Park Service
NRCS	Natural Resources Conservation Service
NSA	noise sensitive areas
NWI	National Wetland Inventory
PCNA	pre-contact Native American
PEU	Pennichuck East Utility, Inc.
ppb	parts per billion
ppm	parts per million
PSI	Preliminary Site Investigation
PUD	Planned Unit Development
ROD	Record of Decision
ROW	right-of-way
SDEIS	Supplemental DEIS
SHPO	State Historic Preservation Officer
SGCN	Species of Greatest Conservation Need
SNHPC	Southern NH Regional Planning Commission
TAC	Technical Advisory Committee
TAZ	traffic analysis zone
TDM	Transportation Demand Management
The Towns	The Town of Derry and the Town of Londonderry
TMDL	Total Maximum Daily Load
TNq	total nitrogen
TNM	traffic noise model
TSM	Transportation Systems Management
TSS	total suspended solids

USACE	United States Army Corps of Engineers
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VMT	vehicle miles traveled
WAP	Wildlife Action Plan
WHPA	wellhead protection areas

12.0 REFERENCES

AECOM. 2012. Total Maximum Daily Load for Phosphorus in Hoods Pond, Derry, NH. Original draft prepared by AECOM, 171 Daniel Webster Highway, Suite 11, Belmont, NH 03220, July 2009, Document Number: 090-107-20, Final Revisions by New Hampshire Department of Environmental Services. May 2012.

BLWP (Beaver Lake Watershed Partnership). 2007. Beaver Lake Watershed Management Plan. Available at: https://www.des.nh.gov/organization/divisions/water/wmb/was/documents/beaver-lake.pdf. Accessed May 3, 2018.

Boston Express. 2016. Boston Express Schedules. Available at: http://www.bostonexpressbus.com/index.php/schedules. Accessed February 21, 2018.

Brady, N.C. and R.R. Weil. 2001. The Nature and Properties of Soils, 13th ed. Prentice Hall, Upper Saddle River, New Jersey.

Bunker, V. 2006. Time and Place: The Archeology of the Eddy Site. The New Hampshire Archeologist 46–47(1).

Bunker, V. and J. Potter. 1994. The Nashua Project: Archaeological Data Recovery at the Mine Falls Park I and II Site (27 HB 32 and 33) and the Dead Pine Tree Site (27 HB 34), Nashua, New Hampshire. Report prepared for the New Hampshire Department of Transportation, Project #11507.

CART (Cooperative Alliance for Transportation). n.d. Services. Available at: http://www.cart-rides.org/html/services.htm. Accessed August 24, 2017.

Chester Planning Board. 2015. Chester Master Plan 2015. Available at: http://www.chesternh.org/WP2012/wp-content/uploads/2012/08/2015-Chester-Master-Plan-Update.pdf.

CLD (CLD Consulting Engineers, Inc.). 2000. Rationale Report, EIS Study: NH Route 102 Improvements, Derry-Londonderry, NH. Prepared for Towns of Derry and Londonderry, New Hampshire. July 2000.

CLD. 2001. Scoping and Rationale Report, EIS Study: NH Route 102 Bypass Study, Derry-Londonderry, NH. Prepared for Towns of Derry and Londonderry, New Hampshire. March 2001.

Concord Coach Lines. 2017. Schedule. Available at: https://3b28o63pmly8yngc7351s3zs-wpengine.netdna-ssl.com/wp-content/uploads/2017/05/CCL_NH_MAY_2017_FINAL-forWeb.pdf. Accessed August 24, 2017.

Connor, J. and M. O'Loan 1993. Prepared for the New Hampshire Department of Environmental Services. Staff Report NHDES-WSPCD 92-15. Available at: https://www.des.nh.gov/organization/divisions/water/wmb/cleanlakes/documents/beaver.pdf.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 131pp.

DeGraaf, Richard M & Yamasaki, Mariko, 1952- (2001). New England wildlife: habitat, natural history, and distribution. University Press of New England, Hanover, NH; London.

Derry Historic Research Committee. 1977. From Turnpike to Interstate. Canaan, NH: Phoenix Publishing.

Derry Rail Trail Alliance. 2017. Derry Rail Trail. Available at: http://derryrailtrail.org/.

Economic Research Service/USDA. 1998. Wetlands and Agriculture: Private Interests and Public Benefits. Agricultural Economic Report No. 765. By R.E. Heimlich, K.D. Wiebe, R. Claassen, D. Gadsby, and R.M. House.

Environmental Data Resources, Inc. 2010. The EDR Radius Atlas™ with GeoCheck® - Inquiry Number: 02883911.1r." October 1, 2010.

Environmental Data Resources, Inc. 2016. The EDR Radius Atlas™ with GeoCheck® - Inquiry Number: 4747294.2s." October 7, 2016.

EPA (U.S. Environmental Protection Agency). 1990. Initial List of Hazardous Air Pollutants with modifications. Modified on December 19, 2005. Available at: https://www.epa.gov/haps/initial-list-hazardous-air-pollutants-modifications#mods.

EPA. 2015a. National Ambient Air Quality Standards. Adopted December 28, 2015. Available at: https://www.epa.gov/criteria-air-pollutants/naaqs-table.

EPA. 2015b. Summary of Results for the 2011 National Scale Assessment. Released December 17, 2015. Available at: https://www.epa.gov/sites/production/files/2015-12/documents/2011-nata-summary-results.pdf.

EPA. 2017a. Sources of Greenhouse Gas Emissions. February 14, 2017. Available at: https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions.

EPA. 2017b. General Permit for Discharges from Construction Activities. Available at: https://www.epa.gov/sites/production/files/2017-06/documents/2017_cgp_final_permit_508.pdf.

EPA. 2017c. General Permits for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems. Available at: https://www3.epa.gov/region1/npdes/stormwater/nh/2017-small-ms4-general-permit-nh.pdf.

EPA. 2018a. 2016 Design Value reports. Available at: https://www.epa.gov/air-trends/air-quality-design-values.

EPA. 2018b. 319 Grant Program for State and Territories website. Available at: https://www.epa.gov/nps/319-grant-program-states-and-territories. Accessed May 03, 2018.

Federal Register. 2007. Control of Hazardous Air Pollutants from Mobile Sources- Final Rule: Vol. 72, No. 37, pages 8427-8570. February 26, 2007. Available at: https://www.gpo.gov/fdsys/pkg/FR-2007-02-26/html/E7-2667.htm.

FHWA (Federal Highway Administration). 1987. Guidance for Preparing and Processing Environmental and Section 4(f) Documents. Technical Advisory T 6640.8A. October 30, 1987. Available at:

https://www.environment.fhwa.dot.gov/Legislation/NEPA/guidance_preparing_env_documents.aspx.

FHWA. 1996. Measurement of Highway-Related Noise: Final Report (FHWA-PD-96-046). Available at: https://www.fhwa.dot.gov/environment/noise/measurement/measure.pdf.

FHWA. 2003. Interim Guidance: Questions and Answers Regarding the Consideration of Indirect and Cumulative Impacts in the NEPA Process. Available at: https://www.environment.fhwa.dot.gov/guidebook/qaimpact.asp.

FHWA. 2004. Synthesis of Noise Effects on Wildlife Populations. Publication No. FHWA-HEP-06-016. September 2004. Available at: https://www.fhwa.dot.gov/Environment/noise/noise_effect_on_wildlife/effects/effects.pdf.

FHWA. 2005. Record of Decision FHWA-NH-EIS-02-01-F. I-93, Salem to Manchester IM-IR-93-1(174)0, 10418-C; Salem, Windham, Derry, Londonderry, Manchester Rockingham and Hillsborough Counties, New Hampshire. Concord, NH, June 2005.

FHWA. 2010. Interim Guidance on the Application of Travel and Land Use Forecasting in NEPA. Available at: https://www.environment.fhwa.dot.gov/nepa/Travel_LandUse/travel_landUse_rpt.pdf.

FHWA. 2016a. Memorandum regarding Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents. Issued October 18, 2016. Available at: https://www.fhwa.dot.gov/environMent/air_quality/air_toxics/policy_and_guidance/msat/2016msat.pdf.

FHWA. 2016b. Highway Statistics: Distribution Of Annual Vehicle Distance Traveled (2015). Percentage by Vehicle Type - Rural / Urban. Available at: https://www.fhwa.dot.gov/policyinformation/statistics/2015/vm4.cfm.

FHWA 2017a. Policy on Access to the Interstate System. May 22, 2017. Available at: https://www.fhwa.dot.gov/design/interstate/170522.pdf.

FHWA. 2017b. A Methodology for Evaluating Mobile Source Air Toxic Emissions among Transportation Project Alternatives. Available at: https://www.fhwa.dot.gov/environMent/air_quality/air_toxics/research_and_analysis/methodology/methodology00.cfm.

FTA (Federal Transit Administration). 2014. Planning for Transit-Supportive Development: A Practitioner's Guide. Section 4: Corridor Planning and Transit-Supportive Development. June 2014. FTA Report No. 0056. Available at: https://www.transit.dot.gov/sites/fta.dot.gov/files/FTA_Report_No._0056.pdf.

Goodby, R. 1988. The Seabrook Phase and Post Hopewellian Interaction Networks in the Northeast. Unpublished M.A. research paper, Department of Anthropology, Brown University, Providence, RI.

Goodby, R. 1999. Phase I-A Preliminary Archaeology Reconnaissance: Derry/Londonderry Exit 4A. Report prepared for CLD, Inc. November 1999.

Google Earth. 2016. Google Earth Pro ver. 7.1.4.1529. Aerial Imagery 4/27/2016, 9/26/2015, 5/7/2015, 10/11/2014. Derry and Londonderry, New Hampshire. LandSat/Copernicus. Accessed October-November, 2016.

HHS (U.S. Department of Health and Human Services). 2017. U.S. Federal Poverty Guidelines Used to Determine Financial Eligibility for Certain Federal Programs. Office of the Assistant Secretary for Planning and Evaluation. Available at: https://aspe.hhs.gov/poverty-guidelines.

Historical Booklet Committee. 1969. Glimpses of Derry, New Hampshire. Ed Hatch, printer.

Hurd, D.H. 1882. History of Rockingham and Strafford Counties, New Hampshire. Philadelphia: J.W. Lewis and Company. Available at: http://www.library.unh.edu/find/digital/object/digital:00107.

Hurd, D.H. 1892. Town and County Atlas of the State of New Hampshire. Boston: D.H. Hurd and Company. Available at: http://www.historicmapworks.com/Atlas.php?cat=Maps&c=US&a=743.

Jaschik, S. 2012. Chester College will close. Inside Higher Ed, May 21, 2012. Available at: https://www.insidehighered.com/news/2012/05/21/chester-college-will-shut-down. Accessed September 8, 2016.

Kelsea, R.J. and J.P. Gove. 1994. Soil Survey of Rockingham County, New Hampshire. U.S. Department of Agriculture. Available at: https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/new_hampshire/NH015/0/rockingham_part1.pdf and at: https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/new_hampshire/NH015/0/rockingham_part2.pdf.

Kenyon, V. and P. McDowell. 1983. Environmental Setting of Merrimack River Valley Prehistoric Sites. Man in the Northeast 25:7–23.

Londonderry Conservation Commission. 2014. Recreation Plan, Londonderry Conservation Land. Adopted December 2014. Available at: http://www.londonderrynh.org/Pages/LondonderryNH_BComm/Conservation/outdoorrecplan.pdf.

Londonderry Trailways. 2016. Granite State Rail Trail, Londonderry, New Hampshire. Updated March 2016. Prepared by Londonderry Planning and Economic Development Department. Available at: https://londonderrytrails.org/about-the-rail-trail/.

Monroe, L.E. and K.A. Federer. 1993. Technical Report Historical and Architectural Resources: Initial Constraints—Bedford-Manchester-Londonderry, F-042-1(1), 11512. Prepared for Normandeau Associates and Holden Engineering & Surveying.

Monroe, L.E. and K.A. Federer. 1995. Londonderry Townwide Area Form. On file at New Hampshire Division of Historical Resources, Concord, NH.

NEIWPCC (New England Interstate Water Pollution Control Commission). 2007. Northeast Regional Mercury Total Maximum Daily Load. New England Interstate Water Pollution Control Commission. Lowell, Mass. Available at:

https://www.des.nh.gov/organization/divisions/water/wmb/tmdl/documents/mercury_final.pdf.

New Hampshire Department of Revenue Administration Town of Londonderry. 2017. NH Assessor Office, 2017 MS-1 Report (contact: Adrienne Summers, via e-mail 4/25/2018.) Town of Londonderry, NH property cards as offered by Patriot Properties, Inc. NH Department of Revenue Administration (NHDRA).

NHDES (New Hampshire Department of Environmental Services). n.d.a. New Hampshire Code of Administrative Rules: Chapter Env-A 300 Ambient Air Quality Standards. Available at: https://www.des.nh.gov/organization/commissioner/legal/rules/documents/enva300.pdf.

NHDES. n.d. New Hampshire Code of Administrative Rules: Chapter Env-Wq 1500 Alteration of Terrain. Available at: https://www.des.nh.gov/organization/commissioner/legal/rulemaking/documents/env-wq1500-adpt-post.pdf. Accessed May 03, 2018.

NHDES. 1995. New Hampshire Department of Environmental Services Recommendations for Implementing Groundwater Protection Measures When Siting or Improving Roadways. NHDES, Concord, NH. 1995.

NHDES. 1997. Lake Trophic Data Summary Sheet for August 1, 1997, for Wheeler Pond, Rockingham County, Londonderry, NH. Obtained from NHDES Water Division, Watershed Management Bureau.

NHDES. 1998. Lake Trophic Data Summary Sheet for data collected on February 4, 1998, and August 19, 1997, from Hoods Pond, Rockingham County, Derry, NH. Obtained from NHDES Water Division, Watershed Management Bureau.

NHDES. 2000b. Stream Biomonitoring Report for Stations 00M-23 (Beaver Brook), 00M-26 (Shields Brook), and 00M-50 (Little Cohas Brook).

NHDES. 2006. Water Quality Certification in fulfillment of Section 401 of the United States Clean Water Act (33 U.S.C 1341) WQC #2002-007. NHDES, Water Division, Concord, NH, May 2, 2006.

NHDES. 2007. Data Report for the Total Maximum Daily Loads for Chloride for Waterbodies in the Vicinity of the I-93 Corridor from Massachusetts to Manchester, NH: Policy-Porcupine Brook, Beaver Brook, Dinsmore Brook, North Tributary to Canobie Lake. New Hampshire Department of Environmental services. Concord, NH. 69pp. Available at: https://www.des.nh.gov/organization/divisions/water/wmb/tmdl/documents/chloride_data_report.pdf.

NHDES. 2008a. Total Maximum Daily Load (TMDL) Study for Waterbodies in the Vicinity of the I-93 Corridor from Massachusetts to Manchester, NH: Beaver Brook in Derry and Londonderry, NH. NHDES, Watershed Management Bureau, Concord, NH, April, 2008.

NHDES. 2008b. NH Stormwater Manual Volume 2 Post-Construction Best Management Practices Selection & Design. NH Department of Environmental Services. December 2008. Available at: https://www.des.nh.gov/organization/divisions/water/stormwater/manual.htm.

NHDES. 2009. The New Hampshire Climate Change Action Plan. Adopted March 2009. Available at: https://www.des.nh.gov/organization/divisions/air/tsb/tps/climate/action_plan/documents/nhcap_final.pdf.

NHDES. 2010. Final Report New Hampshire Statewide Total Maximum Daily Load (TMDL) for Bacteria Impaired Waters. New Hampshire Department of Environmental Services. Available at: https://www.des.nh.gov/organization/divisions/water/wmb/tmdl/documents/final-bacteria-tmdl-report.pdf.

NHDES. 2011a. Chloride Reduction Implementation Plan for Beaver Brook. New Hampshire Department of Environmental Services Watershed Management Bureau. 101 pp.

NHDES. 2011b. Department of Transportation Terrain Alteration Permit Exemption. NHDES, Alteration of Terrain Bureau, Concord, NH. July, 2011.

NHDES. 2015a. Final 2012 List of all Impaired or Threatened Waters. Available at: https://www.des.nh.gov/organization/divisions/water/wmb/swqa/2012/documents/a06-all-impaired.pdf.

NHDES. 2015b. Simple Method Pollutant Loading Model. New Hampshire Department of Environmental Services (NHDES) Watershed Management Bureau. April 15, 2015.

NHDES. 2016a. The New Hampshire Ambient Air Monitoring Program: 2016/2017 Annual Network Review and Plan. Available at: https://www.des.nh.gov/organization/commissioner/pip/publications/documents/r-ard-16-02.pdf.

NHDES. 2016b. NH Department of Environmental Services Water Division, Dam Bureau. Official List of Public Waters. Concord, NH. June 29, 2016. Available at: http://www.des.nh.gov/organization/commissioner/pip/publications/wd/documents/olpw.pdf.

NHDES. 2016c. Best Management Practices and Salt-Use Minimization Efforts in Chloride-Impaired Watersheds of New Hampshire – A Guidance Document for Private Developers and Contractors. NHDES, Watershed Management Bureau, Concord, NH. December, 2016.

NHDES. 2016d. Weather Severity Index Calculation Model. Watershed Management Bureau, New Hampshire Department of Environmental Services. Concord, NH.

NHDES. 2016e. Best Management Practices and Salt-Use Minimization Efforts in Chloride-Impaired Watersheds of New Hampshire–A Guidance Document for Private Developers and Contractors. NHDES, Watershed Management Bureau, Concord, NH. December, 2016.

NHDES. 2016f. New Hampshire Department of Environmental Services Water Well Inventory Metadata. February, 2016. Available at: https://www.des.nh.gov/onestop/documents/water-well-inventory-metadata.pdf.

NHDES. 2017a. NH Department of Environmental Services Onestop Datamapper. Available at: http://nhdesonestop.sr.unh.edu/html5viewer/. Accessed July 17, 2017.

NHDES. 2017b. DRAFT—2016 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology. New Hampshire Department of Environmental Services. Available at: https://www.des.nh.gov/organization/divisions/water/wmb/swqa/2016/documents/r-wd-17-08.pdf.

NHDES. 2017c. NH Department of Environmental Services Survey Lake Data Summary. January 2017. Available at: https://www.des.nh.gov/organization/divisions/water/wmb/lakes/documents/summary_data.pdf.

NHDES. 2017d. Draft 2016 List of Threatened or Impaired Waters that Require a TMDL. New Hampshire Department of Environmental Services. Available at: https://www.des.nh.gov/organization/divisions/water/wmb/swqa/2016/documents/r-wd-17-09-app-a1.pdf.

NHDES. 2017e. Environmental Monitoring Data for Chloride Total Maximum Daily Load Studies in the vicinity of the I-93 Expansion in Southern New Hampshire. New Hampshire Department of Environmental Services, Watershed Management Bureau, Concord, NH. July 14, 2017.

NHDOT (New Hampshire Department of Transportation). 2000. New Hampshire Statewide Bicycle and Pedestrian Plan. Prepared by the New Hampshire Department of Transportation Bureau of Transportation Planning.

NHDOT. 2003. Interstate 93 Improvements, Salem to Manchester, IM-IR-93-1(174)0, 10418-C. Road Salt Constituent Monitoring Program Data Summary Report. Prepared for New Hampshire Department of Transportation and the Federal Highway Administration by Great Bay Environmental Consulting. July 2003.

NHDOT. 2004. Final Environmental Impact Statement, Interstate 93 Improvements, Salem to Manchester. IM-IR-93-1(174)0, 10418-C. Prepared by VHB/Vanasse Hangen Brustlin, Inc.

NHDOT. 2007. Highway Design Manual. Available at: https://www.nh.gov/dot/org/projectdevelopment/highwaydesign/designmanual/.

NHDOT. 2009. Implementation Plan to Increase the Efficiency and Effectiveness of Road Salt Use to Meet Total Maximum Daily Load for Chloride in Water Bodies along the I-93 Corridor from Salem to Manchester, NH: Beaver Brook; Dinsmore Brook; North Tributary to Canobie Lake; Porcupine-Policy Brook. NHDOT, Bureau of Environment, Concord, NH, September, 2009.

NHDOT. 2010–2014. New Hampshire Department of Transportation Crash Data. Available at: ftp://pubftp.nh.gov/DOT/Planning and Community Assistance/Road Data/Public/Crash/.

NHDOT. 2016a. Bureau of Traffic, Traffic Reports. Available at: https://www.nh.gov/dot/org/operations/traffic/tvr/routes/documents/i-93.pdf. Accessed August 24, 2017.

NHDOT. 2016b. Bureau of Traffic, Traffic Reports. Available at: https://www.nh.gov/dot/org/operations/traffic/tvr/routes/documents/nh-28.pdf. Accessed August 24, 2017.

NHDOT. 2016c. Bureau of Traffic, Traffic Reports. Available at: https://www.nh.gov/dot/org/operations/traffic/tvr/routes/documents/nh-102.pdf. Accessed August 24, 2017.

NHDOT. 2016d. New Hampshire Department of Transportation Policy and Procedural Guidelines for the Assessment and Abatement of Highway Traffic Noise for Type I and Type II Highway Projects. Available at: https://www.nh.gov/dot/org/projectdevelopment/environment/units/program-management/documents/2016NHDOTTypeIandIINoisePolicy.pdf.

NHDOT. 2017a. New Hampshire Functional Classification map. Available at: https://www.nh.gov/dot/org/projectdevelopment/planning/gis-data-catalog/documents/FunctionSystem.pdf. Accessed August 24, 2017.

NHDOT. 2017b. Rebuilding I-93 Salem to Manchester. Available at: http://www.rebuildingi93.com/documents/factsheets/June2017/14633B-June-2017.pdf. Accessed August 28, 2017.

NHDOT. 2017c. Marc Laurin, NH Department of Transportation, Bureau of Environment. Email communication July, 2017.

NHDOT. 2018. Letter from Keith A. Cota, Chief Project Manager NHDOT, to Christopher R. Bean, CLD/Fuss & O'Neill, Inc., Concord, NH, March 13, 2018.

NHES (New Hampshire Employment Security). 2015. New Hampshire Community Profiles (individual town pages). Available at: http://www.nhes.nh.gov/elmi/products/cp/index.htm. Accessed September 13, 2016.

NHFGD. 2005. New Hampshire Wildlife Action Plan.

NHFGD. 2015a. New Hampshire Wildlife Action Plan Revised Edition. New Hampshire Fish and Game Department Wildlife Division, Concord, New Hampshire. Submitted October 1, 2005. Available at: http://www.wildlife.state.nh.us/wildlife/wap.html.

NHFGD. 2015b. NH Wildlife Action Plan 2015: Wildlife Habitat Land Cover. Available at: http://www.granit.unh.edu/cgi-bin/nhsearch?dset=wap2015_habitat/n. Accessed March 1, 2017.

NHFGD. 2016a. New Hampshire Fish Stocking Annual Report for 2016. New Hampshire Fish and Game Department Fisheries Division, Concord, New Hampshire. Available at: http://www.wildlife.state.nh.us/fishing/documents/stocking-full-2016.pdf.

NHFGD. 2016b. 2015 New Hampshire Wildlife Harvest Summary. Concord, NH. 52pp.

NHFGD. 2016c. Recreational Trails in New Hampshire. Available at: http://www.granit.unh.edu/data/search?dset=nhtrails/nh.

NHFGD. 2017. Personal Communication with J. Magee, habitat biologist, NHFGD in March 2017.

NHGov. 2017a. Londonderry Exeter 4 Park and Ride. NH Rideshare Program. Available at: https://www.nh.gov/dot/programs/rideshare/lots/londonderry.htm. Accessed August 24, 2017.

NHGov. 2017b. North Londonderry Park and Ride. NH Rideshare Program. Available at: https://www.nh.gov/dot/programs/rideshare/lots/north-londonderry.htm. Accessed August 24, 2017.

NHNHB (New Hampshire Natural Heritage Bureau). 2016. Datacheck responses NHB16-0960 and NHB16-0961. NH Department of Resources and Economic Development, Division of Forests and Lands. Concord, NH.

NHNHB. 2018. Biodiversity Tracking and Conservation System (BIOTICS) database: data request for environmental review (NHB18-0872), location specified by NHB_exit4_Apr2018 shapefile. Concord, NH.

Normandeau (Normandeau Associates, Inc.). 2011. Hyrax Wetland Delineation Report. September 2011.

NRCS (Natural Resources Conservation Service). 1993. Soil Survey Division Staff, Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. Available at: https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/ref/?cid=nrcs142p2_054262%20. Accessed March 22, 2017.

NRCS. 2013. New Hampshire Soil Data Dictionary. Revised March 18, 2013. Available at: https://prod.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1083451.pdf.

NRCS. 2017. Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available at: https://websoilsurvey.sc.egov.usda.gov/. Accessed March 21, 2017.

OEP (New Hampshire Office of Energy and Planning). 2016a. New Hampshire Population Projections by Municipality: 2016 (projection numbers). Received via email from K. Gallager, OEP, to K. Snyder, Louis Berger, on September 9, 2016.

OEP. 2016b. County Population Projections, By Municipality: August 2016 (memo attached to projection numbers). Received via email from K. Gallager, OEP, to K. Snyder, Louis Berger, on September 9, 2016.

Pillsbury Realty Development, LLC. 2013. Woodmont Commons Planned Unit Development Master Plan. Approved October 2, 2013. Available at: http://www.londonderrynh.org/Pages/LondonderryNH_BComm/Planning/commons.

Pillsbury Realty Development, LLC. 2018. Memorandum of Understanding between Woodmont Commons Developer and Town of Londonderry, NH. Available at: http://www.londonderrynh.org/Pages/LondonderryNH_BComm/Planning/commondocs/DevelopmentAgreement82813-FINAL%20DRAFT.pdf.

Potter, J. 1994. New Hampshire’s Landscape and Environment. The New Hampshire Archeologist 33/34:9–19.

Potter, J., and V. Bunker. 1991. Intensive Archaeological Survey: I-93 Manchester-Salem, New Hampshire. IR-93-1 (174), 10418-C. Report prepared for the New Hampshire Department of Transportation by Victoria Bunker, Inc., Alton, NH.

Potter, J., and A. Ohl. 1992. Draft Technical Report: Archaeological Resource Assessment, Bedford-Manchester-Londonderry Project, F-042-1 (1), 11512. Report prepared for Normandeau Associates, Inc. by Victoria Bunker, Inc., Alton, NH.

Proctor, M. 1938. The Indians of the Winnipesaukee and Pemigewasset Valleys. Franklin, New Hampshire. Towne and Robie Publishers.

Regional Economic Development Center of Southern New Hampshire. 2016. Comprehensive Economic Development Strategy. Available at: http://media.wix.com/ugd/69da16_9e03e77ffacc4e36b3b3e8607fa14491.pdf.

Rizzo Associates, Inc. 2003. Salem to Concord Bikeway Feasibility Study. Prepared for the New Hampshire Department of Transportation and the Citizen's Advisory Committee. April 30, 2003.

Rizzo Associates, Inc. 2005. New Hampshire State Trails Plan. Prepared for the New Hampshire Department of Transportation. May 20, 2005.

RKG Associates. 2016. Email to L. Hodgson, Urban/Transportation Planner, Louis Berger, from L. Cranor, Senior Project Manager, RKG Associates, regarding calculating employees per gross square feet of various development types. Received from RKG Associates on September 13, 2016, and September 20, 2016.

Rockingham County Conservation District. 1992. Stormwater Management and Erosion and Sediment Control Handbook. August 1992.

RPC (Rockingham Planning Commission). 2015. 2015 Regional Master Plan. Available at: http://www.rpc-nh.org/application/files/5414/6168/4994/Complete2015RegionalMasterPlan.pdf. Accessed September 1, 2016.

Sandown Master Plan Steering Committee, Planning Board, and Rockingham Planning Commission. 2013. 2013 Sandown, NH Master Plan. Available at: http://sandown.us/Pages/Sandownnh_Bcomm/PlanningBoard/masterplan/masterplanfinal2013.pdf.

Sasson, D.A. and S.K. Kahl. 2007. Salt Loading Due to Private Winter Maintenance Practices. A final report from Plymouth State University, Center for the Environment, Plymouth, NH to the NHDES. June 30, 2007.

Shaver, E., R. Horner, J. Skupien, C. May, and G. Ridley. 2007. Fundamentals of Urban Runoff Management. Technical and Institutional Issues. North American Lake Management Society. Madison, AWI 2007.

SNHPC (Southern New Hampshire Planning Commission). 2007. Town of Auburn, NH Master Plan. Prepared for the Auburn Planning Board. Available at: http://www.auburnnh.us/sites/auburnnh/files/file/file/masterplanfinalnomaps.pdf.

SNHPC. 2010. Regional Comprehensive Plan 2010 for the Southern New Hampshire Planning Commission Region. Available at: http://www.snhpc.org/pdf/Final_Full_RCP.pdf.

SNHPC. 2012a. Letter to G. Sirois, Director of Derry Planning Department, from D.J. Preece, Executive Director, SNHPC, regarding population and dwelling unit projections. Received from SNHPC during interview on July 25, 2016.

SNHPC. 2012b. Email to L. Tidd, Senior Planner, Louis Berger, from J. Chen, Senior Transportation Planner, SNHPC, regarding population, dwelling unit, and household projections for 2010-2050. Received from SNHPC on August 10, 2016.

SNHPC. 2012c. Email to L. Tidd, Senior Planner, Louis Berger, from J. Chen, Senior Transportation Planner, SNHPC, regarding employment projections for 2010-2050. Received from SNHPC on August 22, 2016.

SNHPC. 2014. Moving Southern New Hampshire Forward: 2015–2035. Adopted December 16, 2014. Available at: http://www.snhpc.org/pdf/SNHPCRegionCompPlan2015.pdf.

SNHPC. 2016a. Email to K. Snyder, Principal Environmental Planner, Louis Berger, from J. Chen, Senior Transportation Planner, SNHPC, regarding the allocation of OEP population projections to TAZ and calculation of households by TAZ. Received from SNHPC on October 21, 2016.

SNHPC. 2016b. Email to L. Tidd, Senior Planner, Louis Berger, from J. Chen, Senior Transportation Planner, SNHPC, regarding updated 2015 employment projections. Received from SNHPC on August 25, 2016.

SNHPC. 2016c. Email to K. Snyder, Principal Environmental Planner, Louis Berger, from J. Chen, Senior Transportation Planner, SNHPC, regarding the adjusted employment projections for 2020–2040. Received from SNHPC on November 7, 2016.

SNHPC. 2018. Personal communication (email) from Julie Chen (SNHPC) to Leo Tidd on January 29, 2018.

Stekl, P.J., and Flanagan, S.M. 1992. Geohydrology and Water Quality of Stratified-Drift Aquifers in the Lower Merrimack and Coastal River Basins, Southeastern New Hampshire: U.S. Geological Survey Water Resources Investigations Report 91-4025, 93 p., 6 pls. Available at: https://pubs.usgs.gov/wri/wrir_91-4025/html/pdf.html.

Town of Chester. 2015. Master Plan. Chester 2015 Master Plan. Available at: http://www.chesternh.org/wp-content/uploads/2012/08/2015-Chester-Master-Plan-Update.pdf.

Town of Derry. 2010. Master Plan. Adopted March 24, 2010. Available at: http://www.derry.nh.us/sites/derrynh/files/uploads/derrymasterplan2010_finaldraft_0.pdf.

Town of Derry. 2011. Salt Reduction Plan for Beaver Brook. Derry, New Hampshire. 22 pp.

Town of Derry. 2016a. Zoning Ordinance. Available at: http://www.derrynh.org/sites/derrynh/files/uploads/zo_07.07.2016.pdf.

Town of Derry. 2016b. Salt Reduction Plan for Beaver Brook, Revision 2. Derry, New Hampshire. 11pp.

Town of Derry. 2016c. Town Owned Conservation Properties. Available at: http://www.derrynh.org/conservation-commission/pages/town-owned-conservation-properties.

Town of Derry. 2017a. Derry Parks and Recreation Department, Parks and Playgrounds. Available at: http://www.derrynh.org/parks-recreation/pages/parks-playgrounds.

Town of Derry. 2017b. Conservation Land Use Map, Derry New Hampshire. Available at: http://www.derrynh.org/sites/derrynh/files/uploads/landusemap_public.pdf.

Town of Derry. 2017c. Derry Parks and Recreation Department, Field Directions. Available at: http://www.derrynh.org/sites/derrynh/files/uploads/field_directions.pdf.

Town of Derry. 2018. Assessor's Classification Report (LA4), Derry, NH, All Neighborhoods, Real Property. (Contact: Mark Jesionowski, via e-mail 4/25/2018) Town of Derry, NH property cards as offered by Vision Government Solutions, Inc.

Town of Londonderry. 2011. Salt Reduction Plan for: Beaver Brook Watershed within the Boundaries of Londonderry. Londonderry, New Hampshire. 38 pp.

Town of Londonderry. 2013. Comprehensive Master Plan. Adopted March 2013. Available at: http://www.londonderrynh.org/Pages/LondonderryNH_BComm/Planning/MPSCResources/LondonderryMasterPlan_FINAL_010413-ISSUU.pdf.

Town of Londonderry. 2015. Planning Board 2015 Annual Town Report. Available at: http://www.londonderrynh.org/Pages/LondonderryNH_BComm/SolidWaste/SOLID%20WASTE%20FINAL.pdf

Town of Londonderry. 2016. NH Zoning Ordinance. As amended through August 15, 2016. Available at: http://online.encodeplus.com/regs/londonderry-nh/doclibrary.aspx?id=ada5cd93-15cf-4aca-9273-2a8dc2a7503d.

Town of Londonderry. 2017b. The Town of Londonderry, New Hampshire. Property Assessment Data for Sleep Inn, 72 Perkins Road, Londonderry, NH 03053. Available at: http://londonderrynh.patriotproperties.com/.

Town of Londonderry. 2018a. Salt Reduction Best Management Practices for The Beaver Brook Watershed within the Boundaries of the Town of Londonderry. 3pp.

TRB (Transportation Research Board). 2000. Highway Capacity Manual, 2000.

TRB. 2010. Highway Capacity Manual, 2010.

USACE (U.S. Army Corps of Engineers). 1993. *The Highway Methodology Workbook: Integrating Corps Section 404 Permit Requirements with Highway Planning and Engineering and the NEPA EIS Process*.

USACE. 1999. The Highway Methodology Workbook Supplement. U.S. Army Corps of Engineers New England District. NAEEP-360-1-30a. 32pp.

USACE. 2015. Vernal Pool Best Management Practices. U.S. Army Corps of Engineers New England District Regulatory Division. 5 pp. Available at http://www.nae.usace.army.mil/Portals/74/docs/regulatory/VernalPools/VPBMPsJan2015.pdf.

USACE. 2016. New England District Compensatory Mitigation Guidance. U.S. Army Corps of Engineers New England District Regulatory Division. 138 pp.

USACE. 2017. General Permit No: General Permit No: NAE-2016-02415. Department of the Army Programmatic General Permit State of New Hampshire. USACE New England District, Concord, MA. 2017.

U.S. Census Bureau. 1909. A Century of Population Growth in the United States, 1790-1900. Available at: https://ia802607.us.archive.org/10/items/centuryofpopulat00unit/centuryofpopulat00unit.pdf.

U.S. Census Bureau. 1990. 1990 Census of Population and Housing, Population and Housing Unit Counts, United States. Available at: https://www.census.gov/prod/cen1990/cph2/cph-2-1-1.pdf.

U.S. Census Bureau. 2000. Decennial Census, Summary Files 1 and 3 using AmericanFactFinder. Available at: http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.

U.S. Census Bureau. 2010. Decennial Census, Summary File 1 using AmericanFactFinder. Available at: http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.

U.S. Census Bureau. 2015. American Community Survey. Available at: https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t.

USFWS (U.S. Fish and Wildlife Service) Upper Midwest Region. 2016. Range-Wide Indiana Bat Summer Survey Guidelines. U.S. Fish and Wildlife Service Ecological Services. Bloomington, MN 55437-1458. 48pp.

USFWS. 2018. Information for Planning and Conservation (IPaC) Species List 05E1NE00-2017-SLI-0288. USFWS New England Ecological Services Field Office, Concord, NH. June 20, 2018.

USGS (U.S. Geological Survey). 2002. USGS. 2002. Managing Habitat for Grassland Birds – A Guide for Wisconsin. Available at : http://www.npwrd.usgs.gov/resource/2002/wiscbird/guideline.htm.

USGS. 2003. Water Quality Trends in New England Rivers during the 20th Century. Prepared by Keith W. Robinson, Jean P. Campbell, and Norbert A. Jaworski. Water-Resources Investigations Report 03-4012. National Water-Quality Assessment Program. Available at: https://pubs.usgs.gov/wri/wrir03-4012/wrir03-4012report.pdf. 29 pp.

Weinstock, Lewis. 2012. Putting Multipollutant Monitoring Into Practice: EPA's NCore Network. May 24, 2012. Available at: http://pubs.awma.org/gsearch/em/2012/5/weinstock.pdf.

Williams, P. 2015. Chinese international school buys Chester College site. Tri-Town Times, September 30, 2015. Available at: http://tritowntimes.net/2015/09/chinese-international-school-buys-chester-college-site/. Accessed September 8, 2016.

Woodmont Planning Team. 2011. Woodmont Commons Master Plan. Available at: http://londonderrynh.org/Pages/LondonderryNH_BComm/Planning/commondocs/Master5 plan10.14.FINAL(1)10-14-11.pdf.