involve new alignment east of NH 28, the impacts in this area on undeveloped land and powerlines 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.

4.12.3 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WHPA for individual wells vary in radius from 1,300 feet to 4,000 feet, depending on the maximum daily amount of water withdrawn from the well.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 (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
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

[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)
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
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

Resource	A	B	C	D	F
WHPAs new impervious, acres[c]	0.22	1.16	1.16	0.22	0
Private wells (number)	0	2	2	0	0
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 0.22 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.

4.13.3 Mitigation

Mitigation measures for potential impacts related to groundwater resources would 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 WHPA 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 include lined treatment swales and non-structural BMPs include providing the water supplier, NHDES, and the Office of Emergency Management with 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).