Section 206 Program
Aquatic Ecosystem Restoration

Wiswall Dam Aquatic Ecosystem Restoration

Durham, New Hampshire

Draft Environmental Assessment

August 2005

U.S. Army Corps of Engineers
New England District

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Executive Summary

Finding of No Significant Impact

Environmental Assessment

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August 2005

U.S. Army Corps
of Engineers
New England District

Draft Executive Summary
Wiswall Dam Aquatic Ecosystem Restoration
Durham, New Hampshire

This report documents the formulation and evaluation of alternative actions to restore anadromous fish passage and riverine habitat in the Lamprey River in the vicinity of Wiswall Dam in Durham, New Hampshire. The report documents the selection of the recommended action and serves as an environmental assessment to disclose the environmental consequences of this action in accordance with the National Environmental Policy Act of 1969. This report also contains a Finding of No Significant Impact for the proposed project.

This project is authorized under Section 206 of the Water Resources Development Act of 1996 (WRDA) (P.L. 104-303) as amended. This authority allows the U. S. Army Corps of Engineers (Corps) and a local sponsor to carry out aquatic ecosystem restoration projects if the project would improve environmental quality, is in the public interest, and is cost effective. Under this Section 206 authority, the costs of this project are shared by the federal government and the sponsor on a 65% federal, 35% non-federal basis. The local sponsor for this project is the New Hampshire Department of Fish and Game. New Hampshire initiated the study in March of 2000 with a formal request for federal assistance in restoring anadromous fish passage around Wiswall Dam, pursuant to the Aquatic Ecosystem Restoration Program.

The Wiswall Dam is an 11-foot high and 200-foot long concrete structure with a 160-foot spillway. This concrete dam, along with previous dams at the same site since 1835, blocks native anadromous fish migration to 43 miles of riverine spawning ground upstream of the dam. Native anadromous fish species potentially affected by the dam include American shad, river herring, and Atlantic salmon.

The objectives of the project are:

- Providing effective anadromous fish passage upstream of Wiswall Dam for a full range of native fish over a project period of at least 50 years
- Providing additional riverine habitat restoration benefits, such as resident fish passage and benthic and riparian habitat connectivity, water quality improvements, and restoring river morphology and function
- Providing a cost-effective project with low maintenance costs

Four alternatives were analyzed in detail, including the no-action alternative, removal of Wiswall Dam, construction of a Denil-type fish ladder, and construction of a nature-like bypass channel around the dam. The selected proposed alternative is construction of the nature-like bypass channel. This constructed fishway provides anadromous fish passage for a variety of species to 43 miles of riverine habitat upstream of the dam. The channel also reconnects riverine habitat upstream and downstream of the dam by providing continuous riverine habitat with the constructed channel.

The recommended alternative is selected because it is a cost-effective plan that best meets the objectives of anadromous fish passage and provides additional riverine habitat restoration in the Lamprey River system. The total cost of the project is estimated to be approximately $950,000. This cost includes study and design costs of $350,000, real estate contributions by the sponsor valued at $150,000, and construction costs of $450,000.

The bypass channel will be approximately 1,100 feet long and 15 to 30 feet wide. Approximately 800 feet of channel will be excavated 5 to 10 feet into a bench on the east side of the river and 300 feet will be constructed using a dike along the east bank of the river immediately downstream of the dam. The channel gradient is approximately 1% dropping a total of approximately 11 feet, the height of Wiswall Dam. Flows down the constructed channel are expected to average approximately 100 cubic feet per second (cfs), with extremes ranging from 2 cfs during drought conditions to 1,000 cfs during major flood events. The channel substrate will be sand and gravel with a variety of boulders and outcrops to mimic the geomorphology of the natural river.

Approximately 3,900 cubic yards of soil and rock will be excavated to construct the channel, and this material will be used to construct the dike and channel substrate. Channel banks and side slopes will be revegetated with a variety of native vegetation, including wetland and riparian species. An area of approximately 1 acre will be cleared of young pine plantation and mixed deciduous forest. Approximately 0.1 acre of shrub wetland will be deepened and replaced with perennial riverine habitat and additional shrub wetland along the channel banks and side slopes. Work is expected to occur on or after 2006, at a time that would have the least affect on existing fisheries and wildlife resources. It is anticipated that the project will be completed in one season. Monitoring of the project will occur over the next 5 years, and small-scale modifications may be needed to optimize the channel function at passing anadromous fish. No significant long term or short-term adverse impacts to the environment are anticipated.

Draft
Finding of No Significant Impact

Wiswall Dam Aquatic Ecosystem Restoration Project
Durham, New Hampshire

The proposed Federal action involves the construction of a nature-like bypass channel around Wiswall Dam on the Lamprey River in Durham, New Hampshire to restore anadromous fish passage around the 11-foot high, 200-foot wide concrete dam. The bypass channel will allow anadromous fish access to an additional 43 miles of river habitat on the Lamprey River watershed upstream of Wiswall Dam. The bypass channel also is intended to reconnect riverine habitat upstream and downstream of the dam by providing continuous riverine habitat with the constructed channel. The work is authorized under Section 206 of the Water Resources Development Act of 1996 (WRDA).

The bypass channel will be approximately 1,100 feet long and 15 to 30 feet wide. Approximately 800 feet of channel will be excavated 5 to 10 feet into a bench on the east side of the river and 300 feet will be constructed using a dike along the east bank of the river immediately downstream of the dam. The channel gradient is approximately 1% dropping a total of approximately 11 feet, the height of Wiswall Dam. Flows down the constructed channel are expected to average approximately 100 cubic feet per second (cfs), with extremes ranging from 2 cfs during drought conditions to 1,000 cfs during major flood events. The channel substrate will be sand and gravel with a variety of boulders and outcrops to mimic the geomorphology of the natural river.

Approximately 3,900 cubic yards of soil and rock will be excavated to construct the channel, and this material will be used to construct the dike and channel substrate. Channel banks and side slopes will be revegetated with a variety of native vegetation, including wetland and riparian species. An area of approximately 1 acre will be cleared of young pine plantation and mixed deciduous forest. Approximately 0.1 acre of shrub wetland will be deepened and replaced with perennial riverine habitat and additional shrub wetland along the channel banks and side slopes. Work is expected to occur on or after 2006, at a time that would have the least affect on existing fisheries and wildlife resources. It is anticipated that the project will be completed in one season. Monitoring of the project will occur over the next 5 years, and small-scale modifications may be needed to optimize the channel function at passing anadromous fish. No significant long term or short-term adverse impacts to the environment are anticipated.

My determination of a Finding of No significant Impact is based on the Environmental Assessment and the following considerations:

a. The project will restore anadromous fish habitat in 43 miles of the Lamprey River, as well as reconnecting riverine habitat above and below the Wiswall Dam.

b. The project will have no known negative impacts on any State or Federal rare or endangered species.

c. Impacts to the National Register-listed Wiswall Falls Historic Site and to as yet unidentified pre-Contact and/or historic archaeological resources, if unavoidable, will be properly minimized and/or mitigated in coordination with the New Hampshire State Historic Preservation Officer (NH SHPO) and interested parties in accordance with the National Historic Preservation Act of 1966, as amended, and 36 CFR 800. This will include the preparation of a Memorandum of Agreement (MOA) in consultation with NH SHPO with specific stipulations to be completed as mitigation for any adverse impacts. These stipulations may include additional historic documentation, archaeological investigations, and other measures to be determined during further coordination with the NH SHPO. These measures will be completed prior to construction. A draft MOA, when complete, will be included as an appendix in the EA. This FONSI is conditional upon approval of said MOA.

d. Sediment loading would be minimized by employing erosion control plans and by scheduling in-river construction during the seasonal low flow/low water periods. Detailed erosion control measures will be in place prior to construction activities, including those in the water to minimize turbidity.

e. The 0.1-acre of shrub wetland that will be deepened by the construction will be replaced by at least 0.1 acre of shrub wetland and perennial riverine habitat.

f. The project will not adversely affect the existing fisheries, waterfowl, and adjacent wetland habitat.

g. This project will have no long-term impacts on air quality and conforms to the Federal requirements for activities under the Clean Air Act within the New Hampshire State Implementation Plan.

Based on my review and evaluation of the environmental effects as presented in the Environmental Assessment, I have determined that the Wiswall Dam Aquatic Ecosystem Restoration Project is not a major Federal action significantly affecting the quality of the human environment. Therefore, I have determined that this project is exempt from requirements to prepare an Environmental Impact Statement.

____________________ __________________________

Date

Curtis L. Thalken
Colonel, Corps of Engineers
District Engineer

Wiswall Dam Aquatic Ecosystem Restoration Project
Lamprey River, Durham, New Hampshire

Draft
Environmental Assessment

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1.0 Introduction

The following Environmental Assessment (EA) provides documentation of an environmental restoration study that examines alternative actions to restore anadromous fish runs on the Lamprey River at Wiswall Dam in Durham, New Hampshire. The EA documents the formulation and evaluation of alternative actions to restore anadromous fish runs through the dam site. The EA then documents the selection of the proposed action and discloses the environmental consequences of this action in accordance with the National Environmental Policy Act of 1969. This report also documents a Finding of No Significant Impact (FONSI) for the proposed project. Alternative actions considered in detail include the no-action alternative, dam removal, construction of a fish ladder on Wiswall Dam, and construction of a bypass channel around the dam. The proposed alternative is to construct a 1,100-foot long nature-like bypass channel around the northern side of the dam.

1.1 Study Authority

This project is authorized under Section 206 of the Water Resources Development Act of 1996 (WRDA) (P.L. 104-303) as amended. This authority allows the U. S. Army Corps of Engineers (Corps) and a local sponsor to carry out aquatic ecosystem restoration projects that are found to improve environmental quality, are in the public interest, and are cost effective. The sponsor for this project is the State of New Hampshire, Department of Fish and Game. The costs of this project are cost-shared by the federal government and the sponsor on a 65% federal, 35% non-federal basis. The Fish and Game Department initiated the study in March of 2000 with a formal request for federal assistance in providing fish passage beyond the Wiswall Dam, pursuant to Section 206 of WRDA.

1.2 Study Purpose

The purpose of this Environmental Restoration Study is to:

1) Assess the feasibility of restoring aquatic habitat at Wiswall Dam on the Lamprey River in Durham, New Hampshire, including providing anadromous fish passage around the dam,
2) Formulate and evaluate alternatives with the objective of selecting a proposed action, and
3) Provide an EA for the proposed restoration project in compliance with the National Environmental Policy Act of 1969 (NEPA) and all appropriate Federal and State environmental regulations, laws, and Executive Orders.

This report serves as a Corps decision document as to project feasibility and as an EA to document the proposed action and alternatives, environmental resources in the affected area, and the environmental effects of the proposed project. The report also provides the Corps District Engineer with information for determining whether a Finding of No Significant Impact (FONSI) or an Environmental Impact Statement (EIS) should be prepared for the proposed action. The report also provides reporting requirements under the Clean Water Act - Section 404 (b) (1).

1.3 Project Location

Wiswall Dam is located on the Lamprey River in Durham, New Hampshire in the southeastern corner of the State, near the Atlantic coast (see Figures 1 and 2). It is the second upstream dam on the Lamprey River, which flows approximately 48 miles from the Saddleback Mountains in Northwood to the southwest corner of Great Bay in Newmarket. In November of 1996, the Lamprey River was designated as a Wild and Scenic River by the National Park Service under the National Wild and Scenic Rivers Act. This designation was due primarily to the river's valued wildlife resources and importance as a tributary to the Great Bay National Estuarine Reserve. The Wiswall Dam is a concrete structure that is 11 feet high and 200 feet wide, with a 160-foot concrete spillway (Figure 3). The existing concrete dam structure, which has been used to power various mill operations, was constructed in 1912; however, there has been a dam in this location since 1835 (or earlier). The remains of a stone block sluiceway and sluice gate are located on the left abutment bank. The Wiswall Dam is currently owned by the town of Durham, and the approximately 26-acre pool behind the dam serves as supplemental public water storage and supply for Durham and the University of New Hampshire (UNH) campus in Durham.

Wiswall Dam has been maintained and repaired periodically by the town of Durham, and the dam will continue to require maintenance until removed. Recently, the New Hampshire Department of Dam Safety conducted an inspection of the dam, and concluded that the dam may not meet stability requirements to safely pass a 100-year flood event or greater. The department directed the town to conduct a stability analysis to determine what will be required for the dam to be considered stable under flood conditions. The town plans to conduct the stability analysis in 2005.

Wiswall Dam Ecosystem Restoration Project

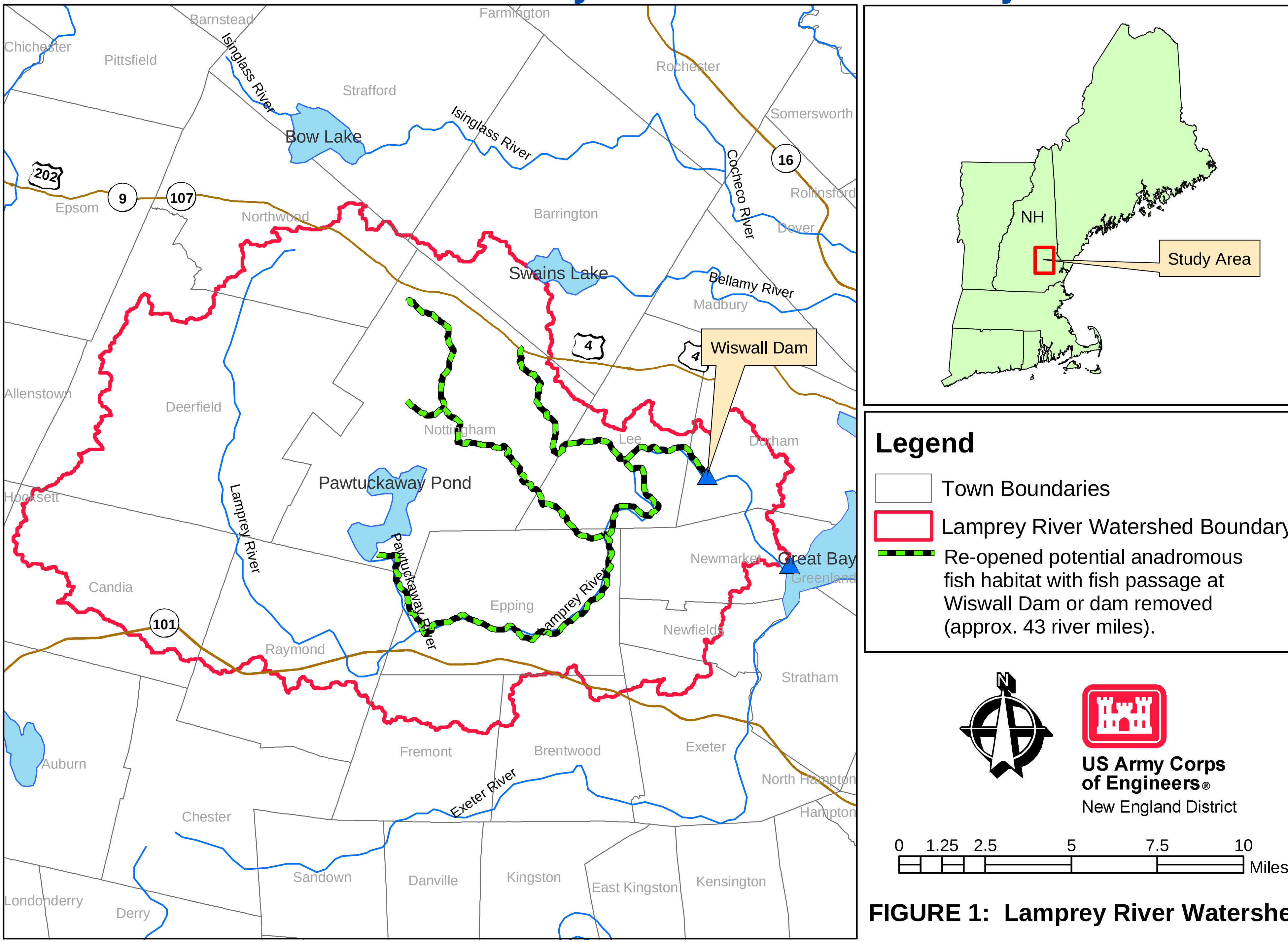
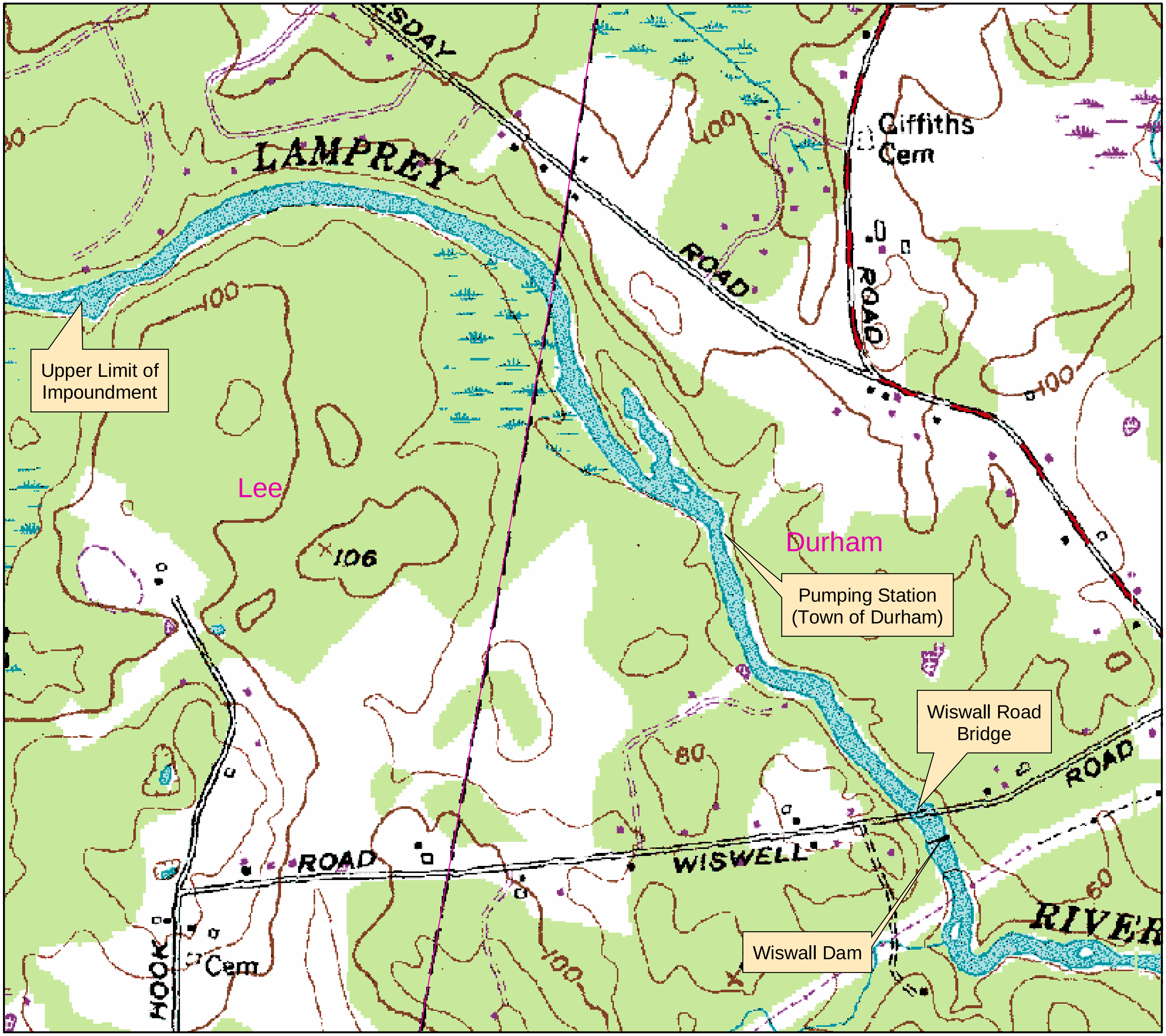
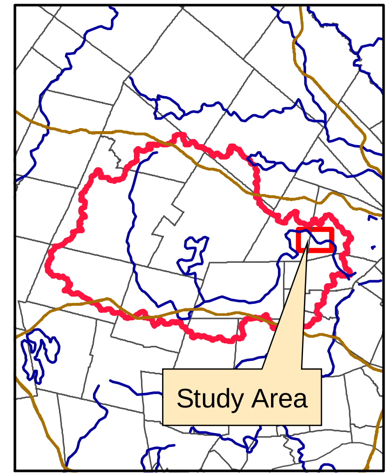


FIGURE 1: Lamprey River Watershed

Wiswall Dam Ecosystem Restoration Project





Legend

Town Boundaries

US Army Corps of Engineers®
New England District

N

0 500 1,000
Feet

FIGURE 2: Study Area

Figure 3. Wiswall Dam on Lamprey River
The spillway is approximately 11 feet high and 140 feet wide.

1.4 Project Purpose and Need for Action

The purpose of the proposed project is to restore the aquatic ecosystems that are impacted by the Wiswall Dam and associated impoundment on the Lamprey River, with a primary goal of restoring the migration of anadromous fish to habitat upstream of the dam. Approximately 43 additional miles of riverine habitat would become accessible to native anadromous fish, including river herring, American shad, American eel, sea lamprey, and Atlantic salmon if fish passage were provided beyond Wiswall Dam. Since anadromous fish are a federally significant resource (ER 1105-2-2100), and fish passage around Wiswall Dam would improve the habitat of anadromous fish, the project purpose has national significance.

Historically, the Lamprey River supported populations of alewives and blueback herring (collectively known as river herring), American eel, sea lamprey, American shad, and Atlantic salmon. However, in past decades, dams built for industrial and residential development have obstructed fish migrations on the river. Currently, efforts are underway to restore these anadromous fish to their historic spawning habitat in the Lamprey River and other New Hampshire coastal rivers. These efforts began in the late 1960s and early 1970s with the construction of fishways at dams on the Lamprey, Exeter, Cocheco, Winnicut, Taylor, and Oyster Rivers in order to re-open freshwater spawning and nursery habitat for river herring and other anadromous species. On the Lamprey River, a fish ladder was constructed at Macallen Dam in Newmarket, which is the first barrier to upstream migration on the river. This fishway has been successfully passing river herring to upstream areas between Newmarket and Wiswall Dam since it was placed into operation (in approximately 1972). Currently, some of these fish are trapped at the fish ladder, and transported to Pawtuckaway Lake, which flows into the Lamprey River upstream from the Wiswall Dam in Epping via the Pawtuckaway River. These river herring migrate downstream to mature at sea, and return to the Lamprey River to spawn. However, once they pass the fishway at the Macallen Dam, the Wiswall Dam blocks them from further upstream spawning migration. Therefore, the need for the project is to allow anadromous fish to migrate further upstream into their native spawning habitat.

The New Hampshire Department of Fish and Game estimated that approximately 50,000-60,000 river herring pass through the fishway at the Macallen Dam annually, including those that are retained for transport. The fish migrate upstream as far as Wiswall Dam, spawning in the section of the river between Macallen Dam and Wiswall Dam. However, there are approximately 43 river miles containing anadromous fish spawning and nursery habitat upstream from Wiswall Dam that are inaccessible to these fish due to the lack of fish passage at Wiswall Dam (see figure 1). In order to re-open this additional upstream habitat, it is necessary to provide fish passage around Wiswall Dam.

2.0 Project History

In approximately1835, the original dam was constructed at Wiswall Falls, a natural drop in elevation along the Lamprey River, in order to provide waterpower for several mills. These included a sawmill, gristmill, and flourmill. During the next 40 years, improvements were made, including a discharge canal used to provide power for paper mill operations. Mill operations ceased after a fire destroyed most of the buildings in 1883, and, in 1896, the dam was breached by a freshet (Lamprey River Resource Assessment, 1994). The existing dam was built in 1912 by Newmarket Electric Light, Heat, and Power Company in order to generate hydroelectric power, and later it was acquired by the New Hampshire Electric Company, which retained the land until 1955. The hydroelectric generation facility has since been dismantled. The Town of Durham currently owns the property, and the impoundment behind the dam is used as the town's supplemental public water supply, as well as that of UNH. The former mill site is listed on the National Historic Register, as the Wiswall Mills Historic Site, and Wiswall Dam itself may be eligible for listing.

2.1 Historic and Current Restoration Efforts

Prior to the construction of the first dams, the Lamprey River provided spawning and nursery habitat for anadromous Atlantic salmon, American shad, river herring, sea lamprey, and the catadromous American eel. With the construction of the dams on the Lamprey River, particularly the Macallen Dam in Newmarket (the first barrier to upstream migration), returning pre-spawning adults of these anadromous fish were no longer able to migrate upstream to spawn in the Lamprey River. Consequently, their populations on the Lamprey River were eliminated. In the late 1960s and early 1970s, efforts began to restore these anadromous fish to many of the coastal rivers in New Hampshire, including the Lamprey. In approximately 1970, a fishway was constructed at Macallen Dam in Newmarket, and it has been passing river herring (initially stocked upstream of the dam) since it was placed into operation. In addition to the efforts to restore river herring, American shad were stocked upstream from the Macallen Dam, initially (during the 1970s) as eggs, and then later as spawning adults.

Since 1972, the New Hampshire Fish and Game Department has monitored fish passage at the Macallen Dam in order to determine the success of the restoration efforts. Returns of river herring from 1972 to 1999 ranged from 1,380 fish in 1973 to a peak of 66,189 fish in 1982. In the late 1980's to the mid 1990's the numbers declined to a low of 11,200 fish in 1996, but have since recovered to 20,067 fish in 1999 (Progress Report, State of New Hampshire, Project I: Anadromous Fish Investigations, Job 2: River Herring Restoration and Evaluation, January 1, 1999 – December 31, 1999). American shad returns were not as successful, with initially less than 12 fish per year returning to the New Hampshire Coastal Rivers, including the Lamprey River, from the egg stocking technique. Beginning in 1980, the stocking of spawning adults (rather than eggs) resulted in better shad returns; however, the stocking of shad on the Lamprey was temporarily discontinued in order to concentrate on one river at a time, beginning with the Exeter River (Final Report; New Hampshire Anadromous Fish Investigation and Marine Recreational Fishery Evaluation, Project 1: Coastal American Shad Restoration and Evaluation, January 1, 1994 to December 31, 1998).

In the spring of 1994, the State of New Hampshire Department of Fish and Game began to trap some of the returning river herring at the Macallen Dam fishway for in-river transfer. The species returning consisted predominately of alewives, which were transported upstream to Pawtuckaway Lake. Between 1994 and 1998, a total of 9,625 alewives were stocked in Pawtuckaway Lake from the Macallen Dam fishway. This in-river stocking enabled Lamprey River alewives to utilize additional spawning habitat upstream from the Wiswall Dam previously inaccessible to these fish because of the lack of fish passage. In 1997, returns of alewives to the Lamprey River (counted at the Macallen Dam) increased to 13,788 fish from the low of 11,200 fish that returned in 1996. The number of alewives returning to the Macallen Dam fishway continued to increase, to 20,067 fish in 1999. The fish collected in 1999 had a large number of four- and five-year-old fish (which would have hatched in 1995 and 1994 respectively), and are therefore attributed to the in-river stocking program that began in 1994. The dramatic increase in returns of these fish, which began in 1997, may be attributed to this stocking program (Progress Report, State of New Hampshire, Project I: Anadromous Fish Investigations, Job 2: River Herring Restoration and Evaluation, January 1, 1999 – December 31, 1999). These data suggest that the carrying capacity (for alewives) of the habitat between the Macallen Dam and the Wiswall Dam has been attained, and that in order to increase the numbers of alewives returning to the Lamprey River watershed, it is necessary to utilize additional habitat upstream from the Wiswall Dam. Historical levels of anadromous fish populations, when based on the potential carrying capacity of a free flowing river system, would have been greater than the recent levels of returning fish. If fish passage were provided, then anadromous fish could utilize approximately 43 additional miles of spawning habitat upstream from Wiswall Dam, increasing the overall productivity of alewives and blueback herring (river herring) closer to historical levels, as well as reopening historical spawning habitat to other anadromous fish species.

2.2 Ecological Importance of Anadromous Fisheries Restoration

With the designation of the Lamprey River as a National Wild and Scenic River in 1996, restoration of its anadromous fish resources has become institutionally more important. Rivers with this classification must contain attributes that are considered to have “outstandingly remarkable” natural, cultural, or recreational resource values (Wild and Scenic Rivers Act, P.L. 90-542, as amended, 16 U.S.C. 1271-1287). Included in the aggregate of “outstandingly remarkable” resource values attributable to the Lamprey River is its contribution of anadromous fish species to the Great Bay Watershed. Currently the Lamprey is the largest contributor of anadromous fish to the Great Bay Watershed (Lamprey Wild and Scenic River Study, Draft Report, June 1995). Therefore, the continued restoration and survival of anadromous species to this river is significant not only for the overall ecology of the river itself, but also for the ecology of the Great Bay National Estuary. Providing fish passage beyond the Wiswall Dam would further contribute to this resource by reopening necessary anadromous fish spawning habitat along the additional 43 river miles.

Providing fish passage at the Wiswall Dam will not only benefit river herring and shad, but also anadromous Atlantic salmon. This species has been the focus of extensive restoration efforts in New England rivers for the last thirty to forty years. Anadromous salmon stocking in New Hampshire's coastal rivers began in the 1960's and included attempts to establish various species, including Pacific salmon, and met with varying degrees of success. The most significant restoration efforts on the Lamprey River started approximately 13 years ago with the annual stocking of Atlantic salmon as fry, parr, or smolts in the Cocheco and Lamprey River systems. In 1989, the New Hampshire Fish and Game Department scatter-stocked Atlantic salmon fry at densities ranging between 30-60 fish/100 square-yards in selected locations within these rivers and their tributaries.

The Atlantic salmon stocking has recently been discontinued, primarily due to their inability to access suitable spawning habitat upstream from the Wiswall Dam (due to the lack of fish passage there). However, it had continued through approximately 1999, and resulted in juvenile survival rates (in the Lamprey River) in some years comparable to those attained in the Merrimack and Connecticut rivers (Progress Report, New Hampshire's Fisheries Investigations, Project 1: Anadromous Fish Investigations, Job 4: Coastal Atlantic Salmon Restoration Program, January 1, 2000 – March 31, 2000). Return rates of these stocked fish ranged from two to six fish counted at the fish ladders at both the Cocheco and Lamprey Rivers (in 2000), with the four of these fish counted at the Lamprey River (between the spring and fall migrations). Although these numbers may appear low, they are in the general order of the percentages of Atlantic salmon returns to other New England rivers where restoration efforts have been more extensive. The goal of New Hampshire's Coastal Atlantic Salmon Restoration Program (for the Lamprey River) was to attain a minimum return of 22 spawning female Atlantic salmon to the fish ladder at the Macallen Dam by 2003. However, this return rate was not met. Recent Atlantic salmon returns throughout New England have been much lower than in past years, including those in the Lamprey River. Therefore, the focus of anadromous fisheries restoration has shifted to river herring and shad. It should be noted, that although the recent returns of Atlantic salmon to the Lamprey River have been low, when interpreted relative to the original goal, they are comparable to returns of this species in other New England rivers, which have also decreased in recent years.

Providing fish passage at the Wiswall Dam would enable alewives and American shad, and potentially Atlantic salmon, (which were previously stocked), to access approximately 43 additional river miles containing spawning and nursery habitat. This increased habitat would have a positive effect on the restoration of these populations to the Lamprey River by increasing spawning success and juvenile survival.

Additional benefits to the ecosystem that could be incurred by the provision of fish passage at the Wiswall Dam would be the passage of other anadromous (sea lamprey) and catadromous (American eel) species currently living in the Lamprey River, as well as the passage of resident species and a connectivity of their habitat. Fish ladders that have been constructed in other New England rivers (i.e. the Deerfield River in Massachusetts) have passed, in addition to anadromous species, white sucker, largemouth bass, smallmouth bass, brook trout, brown trout, rainbow trout, carp and striped bass (Slater, 2001). It is presumed that these species would pass at Wiswall Dam as well.

Other ecological benefits include the increase in productivity associated with the re-establishment of anadromous fishes to their historical habitat. If shad and river herring become re-established in this river, the out-migrating juveniles could provide forage for resident lacustrine fish in the Lamprey River, and the returning adults could provide forage for larger fishes in the lower areas of the Great Bay National Estuary. These include striped bass, which move into the areas around the same time as many of the returning alosid (i.e. shad, alewives, blueback herring) species.

3.0 Formulation of Alternatives

A wide range of alternatives was formulated to address the goal of aquatic ecosystem restoration associated with Wiswall Dam. These alternatives were based on site visits, literature reviews, and consultations with various experts, government staff, and members of the public knowledgeable of the Lamprey River. Three construction alternatives appeared feasible and were evaluated in detail to determine their costs and environmental benefits in order to select a preferred alternative to be the proposed action. In addition, the no-action alternative is required to be analyzed under NEPA and is used as a benchmark to compare the effectiveness of other alternatives.

The Wiswall Dam Fish Passage Working Group (Working Group) was formed in 2001 to define project objectives, collect data and public input, and investigate alternatives. This group is made up of representatives of local, state, and federal organizations, as well as local interest groups. The Working Group has met regularly over the last three years. Two public meetings were held in Durham, New Hampshire in 2002 and a meeting with the Durham Board of Selectmen in 2004 to determine interests and issues and collect additional information. The Working Group developed the project objectives, issues, and constraints based on input from the many cooperating organizations and the public.

The objectives of the study for plan formulation are:

- Providing effective anadromous fish passage upstream of Wiswall Dam for a full range of native fish over a project period of at least 50 years (The constraints placed on the system by Macallen Dam were not considered limitations because, during the 50-year project life, it is anticipated that anadromous fish passage at Macallen Dam will improve.)
- Providing additional riverine habitat restoration benefits, such as resident fish passage and benthic and riparian habitat connectivity, water quality improvements, and restoring river morphology and function
- Providing a cost-effective project with low maintenance costs

Project issues and constraints that were considered in plan formulation include:

- Public input indicated a strong local interest in protecting recreational opportunities that the river corridor provides, including boating, fishing, swimming, and nature viewing.
- The Wiswall Dam Site is recognized by the state and locally as an important historic site, and there is interest in protecting historic attributes of the site.
- The Wiswall Dam and impoundment provide public water storage and supply considered vital to the town of Durham and UNH. The town of Durham requested that the project consider protecting the water supply and storage or mitigate for any losses.
- The State of New Hampshire requires run-of-river conditions when the river flows are less than 12 cfs and that drawdown in the impoundment be no more than six inches below the spillway, except for emergency situations.

Lamprey River flows have been less than ten cfs during the late summer months.
- The state requires additional flood discharge around the dam during the 100-year event, requiring the use of the existing millrace, or other structure for passage of up to approximately 1,000 cfs.
- Nine acres of wetlands habitat are dependent on the impounded water behind Wiswall Dam, and drainage of the impoundment would drain the wetlands.
- Real estate requirements for the project include the dam, water flowage rights, and land owned by the town of Durham, and additional privately owned lands. Real estate rights for the project would need to be secured by the State of New Hampshire.

When this study was initiated in 2001 under the Federal Aquatic Habitat Restoration Program, two alternatives were proposed: construction of a Denil-type fish ladder or complete dam removal. For the first year of study, data collection and analysis focused on these two alternatives. Due to issues regarding public water supply and recreation opportunities related to the Wiswall Dam impoundment, the Working Group expanded the study to include additional alternatives that could preserve the dam, and yet provide some of the restoration objectives that the dam removal could meet. These alternatives include fish ramps and bypass channels.

3.1 Alternatives Considered in Detail

The following are four alternatives, including the No-Action Alternative, that were considered in detail, are numbered and described as follows.

3.1.1 Alternative 1. No Action

The No Action Alternative, as defined under NEPA, serves as a benchmark against which the proposed action and alternatives can be compared. It can also be expressed as the future without project condition. The future without project condition is the assumption that the existing Wiswall Dam will continue to block the upstream migration of anadromous fish. This blockage would preclude the restoration of self-sustaining runs of Atlantic salmon as well as shad, and river herring to the Lamprey River upstream from Wiswall Dam. Any future Atlantic salmon stocking efforts designed to restore Atlantic salmon to the river would serve only to provide downstream migrants, and these migrants would not be able to return to their natal spawning areas. . In addition, the returning alewives from the upstream stocking in Pawtuckaway Lake (as mentioned in Section 1.4 of this Environmental Assessment), would be unable to migrate upstream beyond the Wiswall Dam, and the additional upstream spawning habitat for this species would remain inaccessible. In addition, the additional ecological benefits (described in section I) resulting from the provision of upstream fish passage beyond the dam would not be realized.

For the no-action alternative, and all alternatives in which Wiswall Dam remains in place, the dam would need to be maintained by the town of Durham and repaired or upgraded, as necessary, to meet dam safety requirements.

3.1.2 Alternative 2. Dam Removal

In this alternative, the floodgates at the Wiswall Dam would be opened at a controlled rate allowing the impoundment to drain, and the concrete dam with its associated structures would be dismantled and removed from the site (see Figure A-1, Appendix A). This would restore Wiswall Falls to its historic condition and open up an additional 1.6 miles of riverine habitat while providing unimpeded upstream and downstream passage for anadromous and/or catadromous species currently using the fishway at the Macallen Dam in Newmarket. The former 1.6-mile impoundment behind the dam would be replaced by 1.6 miles of historical river channel and its associated habitat of riffle, pool, and run combinations. The bathymetric survey conducted for the study indicates that the river morphology would include a series of long pools separated by short sets of riffles (see Figure 4). The pools would range in depth from two to ten feet deep, on the average. The river width would narrow in the currently impounded reach, re-exposing riverbanks (see Figure 5). Some of the silty sediments deposited behind the dam would scour, leaving coarser sand and gravel more suitable for riverine/anadromous fish spawning and migration. Accumulated substrates behind the dam would redistribute to downstream depositional areas, allowing the river channel to revert to its historical condition.

The aquatic habitat would change from a lacustrine environment supporting a typical assemblage of lacustrine fish and emergent wetlands, to one supporting riverine fish species. Anadromous fish on the Lamprey River after passing through the fishway on the Macallen Dam, would have unobstructed access to approximately 43 river miles upstream from the Wiswall Dam, including tributaries, containing habitat suitable for spawning and nursery. The anadromous species that are expected to spawn in the upstream habitat include river herring, American shad, and sea lamprey as well as potentially restored Atlantic salmon.

A bathymetric survey and sediment mapping and analysis in the impounded area behind the dam indicate that a very small quantity of sediment has accumulated behind the dam. All the sediment tested had very low levels of contaminants. A maximum of one to two feet of accumulated sediment was found along the slow-water margins of the impoundment. No dredging would be needed if the dam was removed, and sediments on the margins would dewater in place and quickly stabilize with native vegetation. A total of 14 acres that are now under water would be drained. The drained land consists of nine acres of wetlands and five acres of open water. These drained lands would continue to be part of the land parcels along the river, most of which are privately owned. The exposed areas would revert to river terraces and riverbanks. Natural seeding could revegetate most of the exposed areas. Disturbed areas around the dam would be restored and revegetated using mulch and seed.

Long-term maintenance requirements at the dam site and along the banks of the river would probably be minimal. However, flow velocities under Wiswall Road bridge would increase compared to current conditions, and further analysis would be needed to determine whether additional protection measures would be needed for the bridge.

Dam removal would cause the loss of the impoundment and the associated lacustrine habitat, as well as approximately nine acres of wetlands supported by the impoundment along the riverbanks of the Lamprey River (see figure 6). With the loss of the impoundment, the water levels would recede and no longer support some of the aquatic bed wetlands that border the river on the adjacent banks. Some of these wetlands are connected by small channels and/or inlets, and they provide nursery and spawning habitat for numerous lacustrine fish species. The bathymetry indicates that the river with the dam removed would contain generally steep soil banks with small floodplain terraces. Some fringe wetland would develop along the margins of the restored river.

Dam removal would cause the loss of the town of Durham’s and UNH’s supplemental water storage capability behind the dam. However, the town’s pump station, approximately one-half mile upstream from the dam, could be modified to continue to be able to pump water from the river during most flows, subject to legal requirements and restrictions. The intake pipe is located in a deep hole in the river that would remain as a relatively deep pool after dam removal. Various alternatives for replacing the lost water storage were examined in a study conducted in 2003, and these alternatives are discussed in more detail in Section 4.2.2.

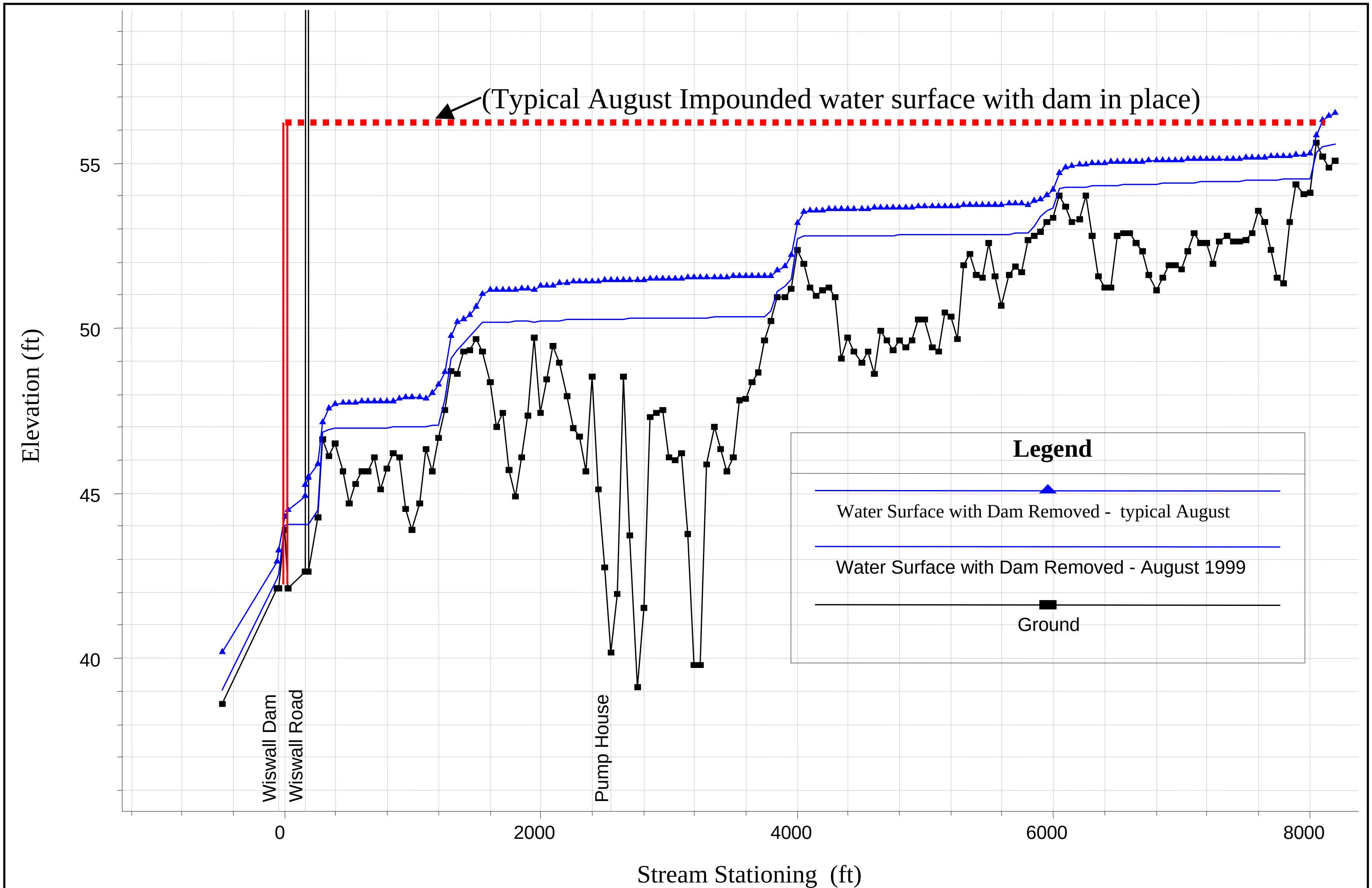
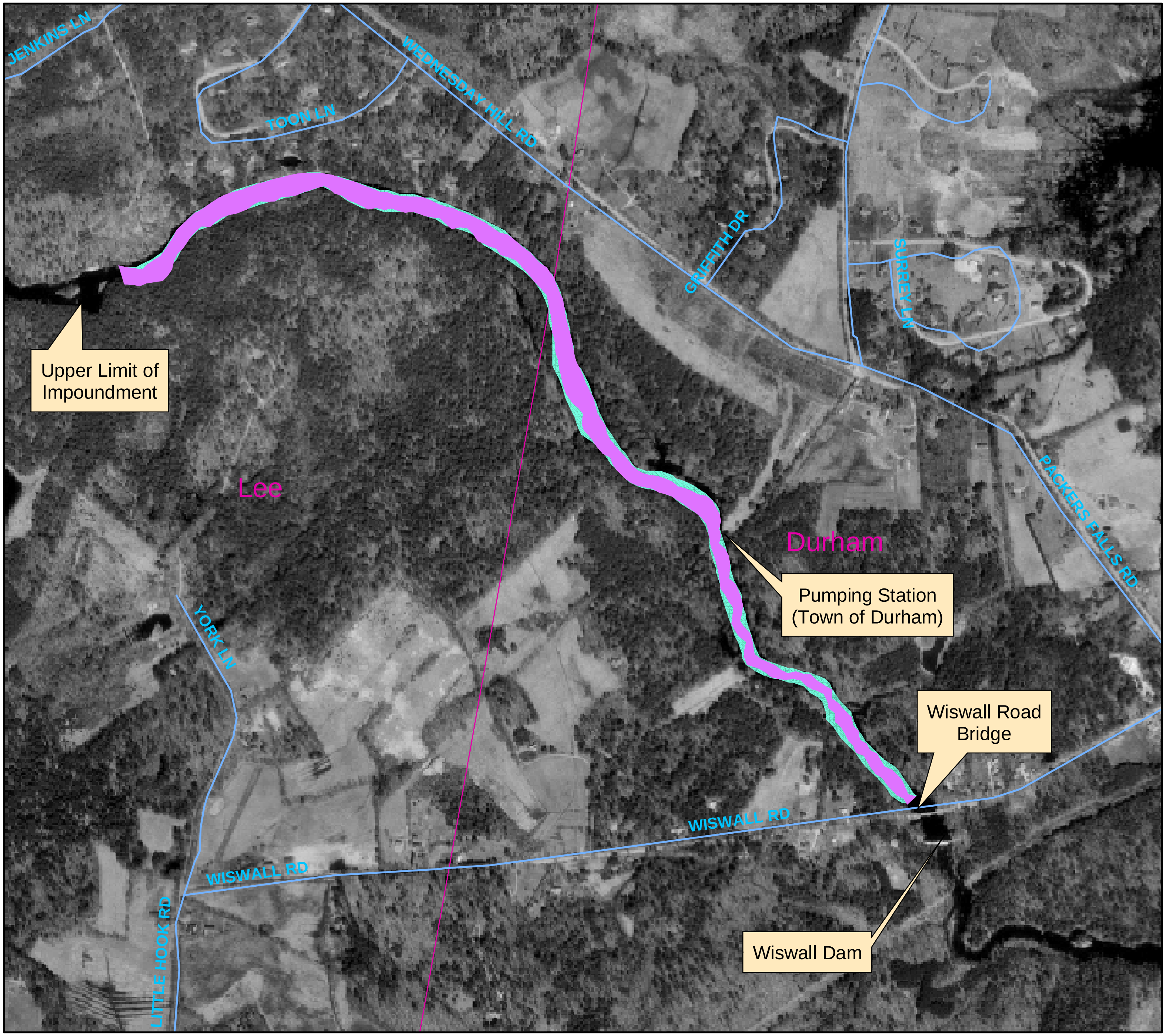
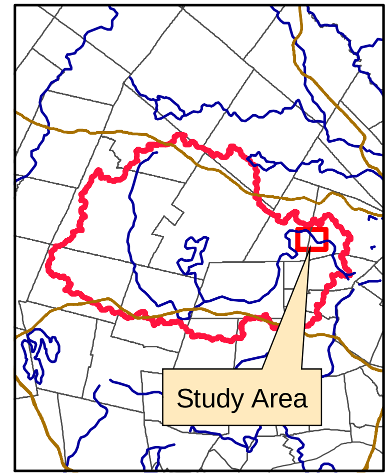


Figure 4. Water Profile upstream of Wiswall Dam with dam removed.

Wiswall Dam Ecosystem Restoration Project





Legend

- Mean Annual Flow Without Dam (18.9 acres)
- Mean Annual Flow With Dam (25.5 acres)
- Town Boundaries

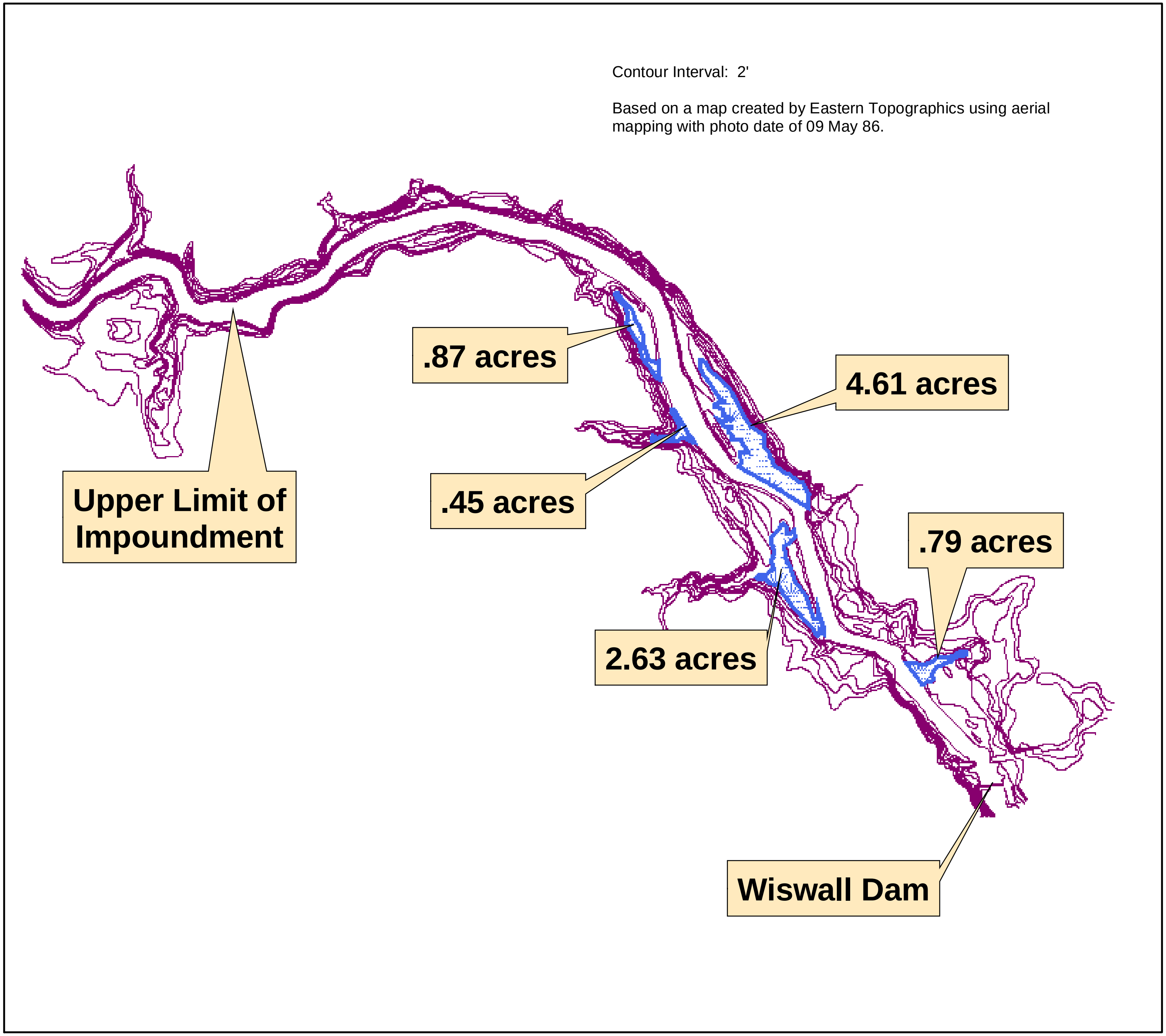
US Army Corps of Engineers®
New England District

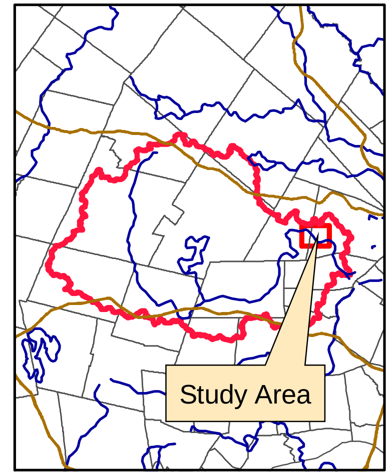
N

0 500 1,000
Feet

FIGURE 5: Lamprey River Water Surface Area In Impoundment Reach Behind Wiswall Dam

Wiswall Dam Ecosystem Restoration Project





Legend

Wetlands (total = 9.35 acres)

Contours 2 ft.

US Army Corps of Engineers®
New England District

N

0 500 1,000
Feet

FIGURE 6: Wetlands Established Behind Wiswall Dam Impoundment

3.1.3 Alternative 3. Construction of Fish Ladder

In this alternative, a concrete Denil Fish Ladder would be constructed on the east embankment of the Wiswall Dam (see Figure A-2, Appendix A). The exit pool channel would be notched into the existing concrete spillway, and the ladder would descend along the embankment for a distance of approximately 130 linear feet to a 180-degree turning pool, and continue its descent parallel to the streambank for 55 feet to a second 150-degree turning pool. It would then continue for another 5 feet to a second 150-degree turning pool. It would then continue for another 5 feet to the entrance channel downstream from the dam. A backup stop log structure at the upstream end of the ladder would also be incorporated. The fish ladder would be faced with stone or other material as needed to mitigate visual impacts to the Wiswall Mill Historic Site.

In this alternative, up-migrating fish would be allowed access to areas upstream of Wiswall Dam. During periods of upstream and/or downstream migration, the water would be allowed to flow through the fish ladder (by opening the stop log control structure) enabling fish to migrate through the fish ladder. Alternatively, for downstream migration, a notch could be placed in the spillway to direct fish over the spillway into a plunge pool below the dam, or the fish ladder could provide downstream access by putting a notch in the stop logs at the upstream end of the fish ladder.

Limitations to this alternative include the fact that fish ladders are generally 70%-90% efficient at passing shad and river herring (compared to having no dam in place) and even less effective in passing some other species, such as striped bass. Therefore, construction of a fish ladder would not be as effective as complete dam removal in allowing free upstream and downstream fish migration in that section of the Lamprey River. In addition, benefits that would be associated with dam removal, such as restoration of the historic riverine habitat (consisting of riffles, runs, and pools), would not be realized. However, the existing lacustrine habitat and its associated lacustrine fishery would be maintained, as well as the extensive upstream wetlands habitat that has been created by the impoundment.

3.1.4 Alternative 4. Construction of Low-Gradient Nature-Like Bypass Channel

The nature-like bypass channel would be a constructed low-gradient channel that connects the river at the top of the dam to the river at the base of the dam (see Figures A-3 and A-4, Appendix A). The bypass channel would be designed to function much like a natural channel, replicating the shape, function, and habitats of the natural river channel. This design is referred to as a “nature-like” bypass channel (Parasiewitcz 2002).

The bypass channel would be located on a 2-acre area adjacent to and downstream of Wiswall Dam and on the east side of the Lamprey River (the left bank looking downstream). The channel would cross over two parcels of land, one owned by the town of Durham and the other privately owned. The channel would also cross approximately 300 feet of a public utility easement carrying low-voltage electric lines. The design would provide for utility easement access, operations, and maintenance, and avoidance of impacts to utility poles and lines. The proposed construction of a natural stream bypass channel would require excavating and clearing an approximate 24,000-square-foot area (approximately 0.5 acres) of vegetated (i.e. forested) upland as well as a small section of emergent wetland, 0.1 acre in size, located in the proposed path of the channel.

The channel would be approximately 1,100 feet in length with a channel gradient of approximately 1%, and have a total cut or fill width of between 30 and 70 feet. The channel would divert water around the dam, ranging from all the water in the river (up to 45 cfs) during low flows to several hundred cfs during high river flows. The channel would follow a broad circular path, starting, at its upstream end, at an inlet, 50-foot long by 20 feet wide, that was once the constructed entrance to the millrace around the dam. The upper 800 feet of channel would follow through a gently rolling terrace and then turn back to the river's edge. The final 300 feet of channel would follow along the left bank of the river back to the base of the dam. The entire channel bottom would be covered with gravel, cobbles, and boulders to create a continuous benthic habitat and to control channel flows.

A limited-use access road would be constructed along the channel for operations and maintenance purposes. The road would connect to Wiswall Road at the vicinity of the existing Wiswall Dam parking area. The road would be approximately 500 feet long and 14 feet wide, and follow the eastern bank of the channel. Vegetation and fencing would be used, if necessary, to manage access and use around the channel for safety and operations purposes. Fencing, if needed, would be designed to complement the setting, and would provide for operations and maintenance access. A single-lane bridge would be needed at the upper end of the channel to provide pedestrian and motorized access across the channel to the town-owned property and dam. An additional single-lane bridge may be needed further down the channel for maintenance access.

The opening under the bridge at the upper end of the channel would be designed to control or limit flood discharge down the bypass channel during major flood events. Hydraulic modeling (see Appendix B, Hydrology and Hydraulics Analysis) indicates that the channel would be able to accommodate at least 600 cfs of the river flow during major flood events with negligible damage to the bypass channel.

The upper 800 feet of channel would be excavated into the ground approximately six to eight feet for most of the cut length. A geotechnical analysis determined the location of bedrock using ground-penetrating radar. Approximately one-half of the depth of the channel would be cut into bedrock (See Figure 7). A section approximately 100 feet long would have a cut depth of approximately 12 feet. The excavated reach would have a low water channel approximately 6 feet wide with irregular banks 2 feet high cut into bedrock. Above the low-water channel, the channel banks would slope outward through bedrock and soil at between 20% and 50% slope to the ground surface. The area of the deep cut would have a series of vertical bedrock banks separated by narrow benches. The vertical banks would be necessary to minimize the width of the overall cut. All exposed soil surfaces that are above the normal low flow of the channel would be re-vegetated with riparian plant species. Some portions of the channel banks would contain seeps that may accommodate wetlands species.

The lower 300-foot section of the channel would be mostly on fill material composed of soil and rock and separated from the main river by an earthen berm on the left bank of the river (facing downstream). Soil and rock materials from the excavated portions of the channel would be used to construct the earthen berm. This berm, approximately 300 feet long, would function as a dike to hold the bypass channel at a higher elevation than that of the river. The berm would be approximately 3½ feet higher than the bypass channel bottom, and range between 3½ feet and 8 feet above the main river bottom. Portions of the berm and channel may need to be lined with clay or other material to reduce seepage. The slopes of the berm would be rock lined to prevent erosion from river and bypass channel flood flows. The stone and vegetation used would be matched to be similar to existing material at the historic mill site, helping to soften the appearance of this new feature. The top of the berm would be approximately eight feet wide. During major flood events, river water would flood over the lower 300 feet of bypass channel, and bury it by as much as six to ten feet during 100-year recurrence interval floods. The channel and berm would be designed to withstand such flood events. Riparian vegetation would be planted or allowed to naturally establish on parts of the filled area where it would not interfere with the channel lining. The construction would require excavation of approximately 3,100 cubic yards of soil and excavation, with potential blasting, of approximately 800 cubic yards of bedrock in order to achieve the 1% to 1.3% channel gradient (See Appendix C, Geotechnical Investigations).

The lower 300-foot section of the bypass channel would cross over the lower opening of the historic millrace, filling the base of the millrace by three to five feet. The bypass channel would be designed to withstand flood release flows that could be released down the millrace during major flood events. Additionally, due to the high flood levels at the base of the mill race as shown in hydraulic modeling of flood flows, the fill from the bypass channel would have a negligible effect on the discharge capacity to the millrace during major flood events.

The channel would be designed to provide optimal upstream and downstream migration of a range of anadromous fish as well as providing year-round access for resident species. The channel would function optimally over the range of river flows from approximately 45 cfs to 1,500 cfs when anadromous fish are expected to be moving up the river (April 1 to June 30) (See Table 1). At flows lower than 45 cfs, the channel would maintain a low water channel.

The design would also control the rate of flow down the channel to provide for minimum flows and control the flood levels in the channel to minimize flood damage (See Appendix B, Hydrology and Hydraulics Analysis). A detailed hydrologic and hydraulic analysis was conducted to ensure that flows met the depth, width, and velocity requirements for effective migratory fish passage and that flood flows were controlled. The channel gradient would average approximately 1%, with a maximum grade of 1.4%. The channel would contain a low-water thalweg, approximately 6 feet wide. During very low flows, the impoundment level would be reduced a few inches as flow levels drop into the low-water thalweg of the bypass channel. This water drop could be controlled during periods of very low flows with the use of small stop logs at the upper end of the channel. During the period of fish migration (April 1 to July 1), the flows in the channel would provide for optimal conditions for fish passage, i.e. be at least 1.5 feet deep, at least 3 feet wide, and have an average velocity of no greater than 4.5 feet per second (Haro (2003), Wildman (2003), and Parasiewicz (2002).

The flow velocity would vary considerably vertically and horizontally in the channel. This variability would allow for a variety of fish passage conditions over a wide range of flows. Larger and stronger fish species could seek the most direct routes with higher velocities, and the smaller or weaker fish species could seek the lower velocity pathways such as in the inside of the meander bends and along the channel bottom or in between boulders. To accomplish this flow variability and to provide for slower zones within the water column, the channel would contain a high density of large boulders and cobbles, uneven exposed bedrock on the channel bottom, variations in depth and width, and outcropping rocks and boulders along the channel margins. With these kinds of channel characteristics, the roughness coefficient would be high over a wide range of flows. Boulders and rock outcrops would be as large as 4 feet high in the channel, allowing for high roughness even at high flows.

The channel would connect to the main river at the base of the dam on the north side of the river. The entrance (downstream end) of the bypass channel would turn toward the downstream direction of the river (approximately 15 degree angle downstream) to accommodate upstream migrating fish. A rock berm or other structure would deflect turbulent water from the spillway and prevent the spillway water from interfering with fish passage into the bypass channel. The attraction flow for migrating fish would be accomplished by a substantial flow rate of the bypass channel, along with an entrance width of 13 to 17 feet wide and an attraction flow velocity ranging from 2.8 to 3.8 feet per second. The flow rate of the channel during migration periods would range from 45 cfs (100% of river flow) at low flows to 190 cfs (16% of the river flow) at the higher end of the operation range.

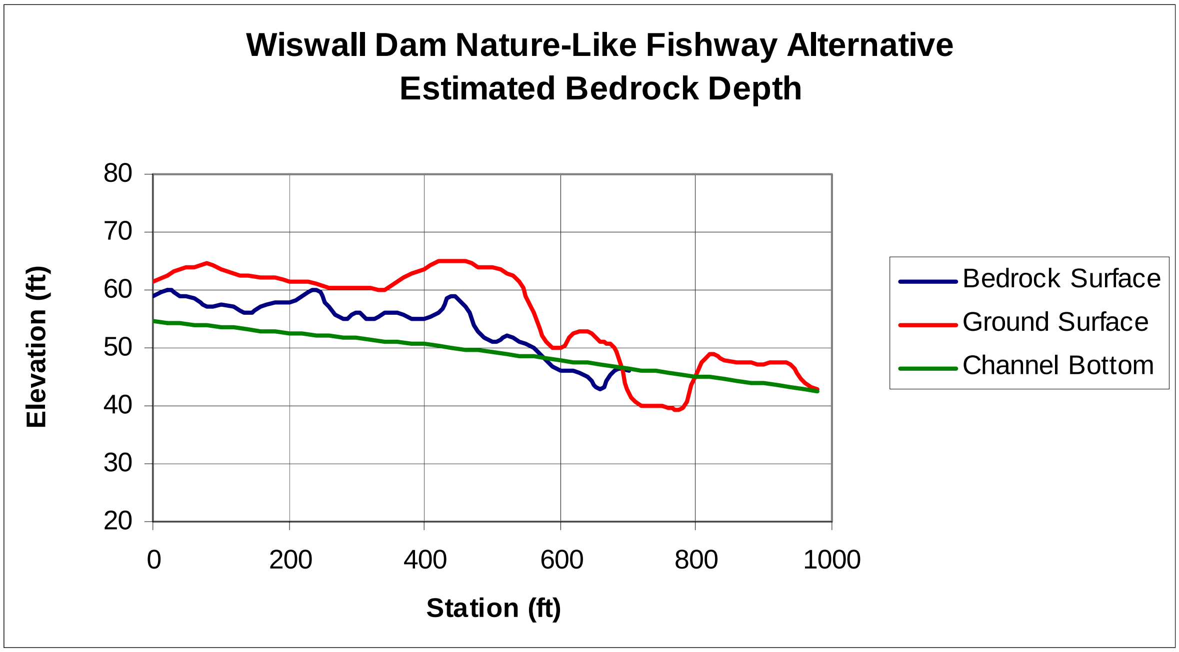


Figure 7. Ground and Bedrock Profile along the Nature-Like Fishway Length. Data collected from Ground Penetrating Radar.

Table 1. Hydraulic Parameters of Nature-like Bypass Channel as Initially Configured

	Headpond Elevation (ft, NGVD)	Channel Depth (ft)	Channel Velocity (ft/sec)	Spillway Flow (cfs)	Flow in Channel (cfs)	Total Flow in River (cfs)	Flow in Channel (%)
Severe Drought	55.2	0.6	1.5	0	7	7	100
	55.4	0.8	1.8	0	12	12	100
	55.6	1	2.0	0	18	18	100
	55.8	1.2	2.2	0	26	26	100
	56	1.4	2.4	0	35	35	100
Spillway Crest	**56.1**	1.5	2.5	0	40	40	100
	56.2	1.6	2.6	14	45	59	76
Normal Range of Operation	56.4	1.8	2.8	72	57	129	44
	56.6	2	2.9	156	71	226	31
	56.8	2.2	3.1	258	86	343	25
	57	2.4	3.2	376	103	478	22
	57.2	2.6	3.4	508	122	629	19
	57.4	2.8	3.5	652	143	795	18
	57.6	3	3.7	808	165	974	17
	57.8	3.2	3.8	975	190	1165	16
	58	3.4	3.9	1152	217	1369	16
10-Yr Flood*	60.1	5.5	5.2	3606	644	4250	15
100-Yr Flood*	62.3	7.7	6.4	6785	1425	8210	17

*Assumes that trapezoidal channel opening is unconstrained by the opening of the access bridge crossing it near its upstream end

3.2 Alternatives Considered but Eliminated from Detailed Analysis

3.2.1 Construction of Fish Lift

In this alternative, a fish lift with a trapping channel would be installed on the left dam abutment. This would allow upstream migration of anadromous fishes beyond the dam, but would require a power supply as well as lift operators during the time of active upstream migration. It would also require periodic maintenance in order to ensure its operability during the upstream fish migration periods, as well as construction of an associated area of attraction water, either built into the entrance of the trap, or directed to a nearby location, with higher flow rates designed to attract up-migrating anadromous fish. However, there would be less construction impacts to the riverbank compared to those of a Denil fish ladder, due to the smaller total area required for its installation. For some species, trapping and lifting them over an existing dam is ineffective in that not enough adults can be passed in order to establish a viable population.

Generally, with a fish lift, although there may be lower initial construction costs, there would be greater long-term operation and maintenance costs. Disadvantages of a fish lift would include the inability to allow passive migration of up-migrating fish, in that it would require an operator to be present on site to mechanically lift the fish at specified intervals. Due to the requirement of costly operations and maintenance and other disadvantages, compared to the Denil fish ladder, this alternative was eliminated from further study.

3.2.2 Construction of Rock Ramp Type Fishway at the Former Sluiceway

In this alternative, a rock ramp fishway would be constructed at the former sluiceway located on the left side of the Wiswall Dam. The former channel would be re-opened in order to provide an exit area approximately 100 feet upstream from the spillway on the right bank. The channel would be excavated to provide a gradual (5:1) slope for a distance of approximately 200 feet continuing along the right bank bypassing the spillway, and then be constructed to angle back upstream and rejoin the Lamprey River near the base of the spillway to form the downstream entrance pool. The channel would be approximately 300 feet long, and approximately 12 feet wide, and would be constructed of rock cobbles, boulders and gravel placed and/or anchored on a concrete base in concrete (which would form the sides of the channel). The rocks and cobbles would be configured to provide a series of ascending resting pools, as well as riffles between the pools, which would enable fish to move upstream around the dam. During the upstream and downstream migration periods, gates in the channel would be opened to allow water from the Lamprey River to be diverted through the channel for fish passage.

The major disadvantage of this alternative is that the channel gradient is steep and the channel is confined to 12 feet wide. Flow velocities would be very difficult to maintain at low enough levels to function for fish passage. During high flows, the channel flow would need to be controlled to reduce damage to the channel. The town of Durham, NH may need to rely on this channel for flood release during major floods, and if this were to occur, major damage could occur to the channel. The channel would need extensive maintenance due to high flow velocities disrupting the channel morphology. Since the channel would contain loose gravel and or cobbles, these would be subject to being moved and /or altered by significant flow events. Therefore, it may be necessary to redistribute and/or replace this material on an annual basis, depending upon the amount of flow that might occur in the channel. Due to the uncertainty of fish passage and the need for extensive maintenance, this alternative was eliminated from further analysis.

3.2.3 Modification of the Dam Gates to Provide Fish Passage

An alternative was considered to modify the current gate structures on Wiswall Dam to allow the gates to be opened in such a way to provide upstream passage of anadromous fish during migration in the spring months. A preliminary analysis revealed that the gates would need to be increased in size substantially to allow spring flows to pass while keeping flow velocities at low enough levels to allow fish passage (at or below 5 feet per second). In addition, the impoundment would need to be drained during the spring months to allow unrestricted flow through the gates. Draining and filling the impoundment several times during the year would cause instability and habitat degradation in the ecosystems associated with the impoundment and wetlands connected to the impoundment. In addition, during drained conditions, the exposed banks would be unvegetated and be subject to substantial erosion. The erosion would cause degraded water quality, increased suspended load, and increased sedimentation downstream of Wiswall Dam. Due to the habitat degradation and detrimental impacts to the river, this alternative was not considered further and eliminated from detailed analysis.

4.0 Comparison of Alternatives

The Wiswall Dam Fish Passage working group examined the four alternatives in detail to evaluate environmental effects as well as environmental benefits and costs. The process used to determine a proposed action was to examine the environmental effects and economic costs of the four alternatives to determine what alternatives were feasible within available resources and what alternatives provide environmental benefits in a cost-effective manner. First, the group examined the range of effects to determine feasibility. Table 2 summarizes the alternative effects of the four alternatives, including the no-action alternative. Then an analysis comparing environmental benefits to costs was conducted to determine the most cost-effective alternatives, and to aid in selection of the preferred alternative.

Table 2. Comparison of Various Fish Passage Alternatives for Wiswall Dam				
Alternative	**No Action**	**Dam Removal**	**Denil Fish Ladder**	**Nature-Like Bypass Channel**
Effects to Fisheries	No upstream access at Wiswall Dam for anadromous and resident fish. Downstream access	Will restore riverine habitat from below the dam to the upper extent of the impoundment, thereby increasing populations of riverine species. Will allow passage of all anadromous and catadromous fish including river herring, shad, and salmon, to access 43 miles of river. Will also allow passage of all resident fish in river. Will increase forage in river with increased numbers of anadromous fish. Will reduce the acreage of lacustrine habitat, thereby reducing the populations of lacustrine species.	Will allow passage of anadromous and catadromous fish species, including river herring, shad, and salmon, to access 43 miles of river. Will allow limited passage of some resident fish species. Will increase forage in river with increased numbers of anadromous fish.	Will allow passage of anadromous and catadromous fish species, including river herring, shad, and salmon, to access 43 miles of river. Will allow passage of most or all resident fish species. Will increase forage in river with increased numbers of anadromous fish. Will provide downstream access without fish having to go over spillway. Will add 1,100 feet of riverine habitat.
Effects to benthic and riparian habitats	No connection between upstream and downstream areas of river.	Restores riverine benthic and riparian habitats in reach that includes dam and impoundment. Connects benthic and riparian habitats above and below dam.	No change from no-action alternative.	Creates 1,100 feet of riverine benthic habitat, as well as riparian habitat along portions of the bypass channel. Provides connectivity of benthic habitat above and below dam.
Effects to River Morphology	Impoundment will remain with approx. 1.5 miles of impounded water. No restored riffle/pool/ runs.	Restoration of original river morphology in the reach starting from below the dam to the upper extent of the impoundment. Restoration of original riffles and pools, floodplain, channel banks, and channel bars.	No change from no-action alternative.	No change to impounded reach other than a slight drop in water level during very low flows. Addition of 1,100-foot reach of channel, 30-70 feet wide, with riffles and pools around dam that accommodates up to 100% of the river flow during low flows, and 10% or more of the flow during higher river flows.
Effects to Water Quality	Impoundment may provide potential for thermal and dissolved oxygen stratification	Will reduce river temperature during summer months and increase dissolved oxygen levels in currently impounded reach.	No change from no-action alternative	No change from no-action alternative.

Table 2. Cont.				
Alternative	**No Action**	**Dam Removal**	**Denil Fish Ladder**	**Nature-Like Bypass Channel**
Effects to Wetlands	Will maintain approximately 9 acres of wetlands behind dam with associated habitat.	Dam removal will cause a drop in water level and drain 9 acres of wetlands associated with impoundment behind the dam. Portions of drained areas will revert to upland. Will restore fringe wetlands that existed along the channel before damming.	No Change. Will allow wetlands associated with impoundment behind dam to remain intact (i.e. without any drainage and loss).	Bypass channel will alter 0.1-acre shrub wetland and replace it with open channel and approximately 0.1 acre of fringe wetland along the bypass channel. Will allow wetlands associated with impoundment behind dam to remain intact (i.e. without any drainage and loss).
Effects to Public Water Supply	Will allow town of Durham and UNH continued use of stored water and pumping station behind the dam for water supply purposes.	Will remove storage capacity of river that is currently provided by impoundment behind Wiswall Dam. Pumping of water for water supply may continue during most river flows with modifications to pumping station. Pumping may be limited or not allowed during river flows that are below run-of-river minimum requirements.	Will maintain existing impoundment pool and associated water storage currently maintained and operated by the town of Durham. No change to pumping station requirements. Requires modifications to dam.	Will maintain existing impoundment pool and associated water storage currently maintained and operated by the town of Durham. No change to pumping station requirements. Will release a portion of the floodwaters during major flood events, which could increase dam safety.
Effects to Recreational Opportunities	Recreational opportunities in impounded reach include calm-water boating with carry-in access from town land, fishing from boat and dam, ice fishing and access to ice surface during winter	Loss of impoundment pool that provides calm-water recreational opportunities for the public, accessed at dam and bridge, and for adjoining landowners. Most of the formerly impounded area would be accessed through private land, limiting public access. During moderate to high flows, the river would provide white-water recreational opportunities through the reach, providing a continuous white-water run from Lee to New Market.	No effect to recreational opportunities in impounded reach. May require restrictions to access and fishing in the immediate vicinity of the dam.	No effect to recreational opportunities in impounded reach. May require restrictions to access and fishing in the immediate vicinity of the bypass channel.
Effects to Cultural Resources	Historic mill site remains in present condition, unless town constructs floodwater discharge channel through site. Crib dam remains are left submerged under impoundment	Removal of historic dam and impoundment; however, dam is not part of the registered historic site.	Some visual obstruction to historical walls of millrace, part of the Wiswall Mills Historic site. Although dam is not on the National Register, it may yet be eligible. Fish ladder would constitute a visible modification.	Some modifications to the abandoned inlet and outlet of the millrace, part of the Wiswall Mill Historic Site. Portion of land corridor that would revert from private to public ownership (town or state) would contain a portion of the Wiswall Mill Historic Site and thereby provide additional protection to that currently privately-owned portion of the historic site.

4.1 Comparison of Alternatives through a Cost and Habitat Output Analysis

To assist the Corps and sponsor (NH Hampshire Fish and Game Department) in selecting a proposed action, the feasibility-level costs of the alternative restoration plans are compared with the environmental benefits within the framework of an incremental analysis to display the most cost-effective alternatives. The incremental cost analysis entails a cost-effectiveness analysis and an incremental-cost analysis, the guidance for which is found in the Corps Environmental Regulations ER 1105-2-100, Planning Guidance Notebook, Section 3-5, Ecosystem Restoration, April 2000.

Four alternative plans were analyzed in detail for restoring fish passage and aquatic habitat at Wiswall Dam in which feasibility-level costs and environmental benefits were estimated. The four alternatives are 1) no-action, in which the dam remains in place and, 2) complete dam removal, 3) construction of a Denil-type fish ladder around the dam, and 4) construction of a nature-like bypass channel.

4.2 Project Costs

Feasibility-level project cost estimates were developed for the alternatives in order to conduct the cost effectiveness and incremental cost analyses and to provide a preliminary estimate for project construction. For the purposes of cost-effectiveness analysis, the project costs compared for each alternative include project construction cost, real estate investment value, and operations and maintenance costs. The estimated project costs, including study costs, are summarized in Table 3.

Table 3. Project Investment Costs for four alternatives for Wiswall Dam Restoration
Construction cost includes a 20 percent contingency, escalation costs, engineering, and design during construction, and construction management costs.

Costs	Alternatives			
	No Action (Without Project) Alt. 1	**Dam Removal Alt. 2**	**Denil Fish Ladder Alt. 3**	**Nature-Like Bypass Alt. 4**
Planning and Design	0*1	$320,000.00	$320,000.00	$320,000.00
Construction Financial Cost	0	$418,000.00	$574,000.00	$449,000.00
Real Estate Value*2	0	$3,475,000.00	$75,000.00	$150,000.00
Operations And Maintenance	0	0	$2,000 per year	$2,000 per year
Monitoring	0	$35,000.00 over 5 years	$35,000.00 over 5 years	$35,000.00 over 5 years

*1 Planning and Design considered zero cost for the Without Project Alternative for purposes of economic cost analysis.
*2 Real Estate value includes value of needed land, easements, rights-of-way, utility relocations, and disposal sites (LERRDS).

4.2.1 Construction Costs

Detailed construction cost estimates were conducted using construction-cost software (MCASES). Summaries of construction cost estimates for the three construction alternatives are listed in Tables 4, 5, and 6 below. The No-Action Alternative has no construction costs. Estimated construction costs as shown include a 20 percent contingency of basic construction cost, engineering and design costs estimated at 8 percent of basic construction cost, and construction management costs estimated at 6 percent of basic construction cost. For this draft report, costs are not annualized. Any revisions of this report may include revised cost estimates, as well as adjustments to costs. For revised cost estimating and adjusting, the project economic life is considered to be 50 years.

Table 4. Dam Removal (Alternative 2), Wiswall Dam – Estimated Construction Quantities and Costs
This cost estimate does not include any protection of Wiswall Road Bridge.

Construction Item	**Quantity**	**Cost (rounded)**
Mobilization/Demobilization	Each	$27,000
Excavation – Earth	3,100 CY	$15,000
Access Road and Parking Gravel Fill	200 CY	$8,000
Clearing and Grubbing	3,000 SY	$6,000
Cofferdam	100 LF	$10,000
Erosion Control	1,000 LF silt fence, 500 LF hay bale	$4,000
Stone Protection	400 CY	$18,000
Excavation of Concrete Dam	1,000 CY	$152,000
Remove Crib Dam material	200 CY	$7,000
Disposal	1,700 CY	$28,000
River Bed Restoration	LS	$28,000
Top Soil and Seed	3,000 SY	$6,000
Subtotal Cost		$309,000
Contingency (20%)		$62,000
Escalation (inflation)		$9,000
Engineering and Design During Constr.		$8,000
Supervision and Administration		$30,000
Total Construction Cost		$418,000

Table 5. Denil-type fish ladder (Alternative 3), Wiswall Dam – Estimated Construction Quantities and Costs		
Construction Item	**Quantity**	**Cost (rounded)**
Mobilization/Demobilization	Each	$27,000
Excavation – Earth	100 CY	$2,000
Clearing and Grubbing	165 SY	$1,000
Access Road and Parking	300 SY	$5,000
Gravel Fill	230 CY	$9,000
Cofferdam	240 LF	$20,000
Erosion Control	300 LF	$3,000
Fencing, grating, and Access Control	LS	$12,000
Stone Protection	100 CY	$5,000
Excavation – Rock	50 CY	$2,000
Dam alterations	LS	$18,000
Concrete Fish Ladder	200 CY	$271,000
Stone Facing	1,400 SF	$50,000
Baffles	50 Each	$5,000
Subtotal Cost		$430,000
Contingency (20%)		$86,000
Escalation (inflation)		$6,000
Engineering and Design During Constr.		$10,000
Supervision and Administration		$42,000
Total Construction Cost		$574,000

Table 6. Nature-Like Bypass Channel (Alternative 4), Wiswall Dam – Estimated Construction Quantities and Costs		
Construction Item	**Quantity**	**Cost (rounded)**
Mobilization/Demobilization	Each	$27,000
Excavation – Earth	3,100 CY	$45,000
Access Road and Parking Gravel Fill	200 CY	$8,000
Clearing and Grubbing	3,000 SY	$6,000
Cofferdam	100 LF	$10,000
Erosion Control	1,000 LF silt fence, 500 LF hay bale	$4,000
Fence	1,000 LF chain link or similar cost	$19,000
Stone Protection	400 CY	$19,000
Excavation – Rock	800 CY	$36,000
Two Bridges	60 CY	$43,000
Channel Bed construction	LS	$28,000
Dike Construction – Fill Placement	2,800 CY	$57,000
Dike Construction – Fabric placement	3,000 SY	$10,000
Dike Construction – Rock placement	800 CY	$5,000
Topsoil and Seed	3,000 SY	$16,000
Subtotal Cost		$333,000
Contingency (20%)		$66,000
Escalation (inflation)		$9,000
Engineering and Design During Constr.		$8,000
Supervision and Administration		$33,000
Total Construction Cost		$449,000

4.2.2 Real Estate Investment requirements

Real estate requirements for each alternative were assessed, and a preliminary value estimate was determined for obtaining the necessary lands, easements, rights-of-way, utility relocation, and disposal sites (LERRDS). The Corps produced a real estate report that estimates the LERRDS requirements and values based on a market analysis and various cost estimates (See Appendix D, Real Estate Report). More information on Corps regulations pertaining to LERRDS requirements for Section 206 studies is found in the Corps of Engineers Real Estate Handbook ER-405-1-12. A summary of LERRDS requirements and economic values for the three construction alternatives is as follows.

The dam removal alternative involves the loss of public water storage capacity associated with the dam and impoundment behind the dam. This public water supply is owned and operated by the town of Durham, NH. This public water storage loss would potentially require public utility relocation in the form of another public water storage system. Federal regulations, under Public Law 91-646, require that the value to relocate or replace the public utility be included in the project costs, so the $3,475,000 value estimate shown as the LERRDS value includes a cost estimate of replacing the lost water storage capacity. The estimate was derived from a report entitled "Wiswall Dam Removal Study, Water Supply Impacts, prepared in February 2003 by Dufrene-Henry for the Association of United States Delegates to the Gulf of Maine Council. In this report, several alternative water storage systems were examined, including installation of water tanks, construction of a lined earthen reservoir, restoration of a drained reservoir, and conceptual development of a pumping system to inject water into the Spruce Hole Aquifer in Durham. Probable costs for construction of the water storage systems ranged from $3,310,000 to $13,500,000. In 2004, an additional water storage alternative was examined, that of pumping and piping water from the Macallen Reservoir, on the Lamprey River downstream from Wiswall Dam. Use of Macallen Reservoir for Durham's supplemental water supply was estimated to cost $4,292,000 to construct. Therefore, the $3,475,000-value assigned for the LERRDS value is the minimum amount possible for this alternative, and could be substantially higher.

For the Denil fish ladder alternative, the LERRDS value of $75,000 includes a temporary construction easement for one year, a permanent access easement, and a permanent land easement for the placement of the fish ladder.

For the nature-like fish byway channel, the LERRDS value of $150,000 includes a temporary construction easement for one year, an access road right-of-way along the east side of the channel, a permanent access easement, and the value of fee-simple land acquisition along the channel corridor.

4.2.3 Operations and Maintenance

Operations and maintenance (O&M) requirements and costs for this project are considered those that are directly related to the project. Any O&M that would need to occur whether the project were constructed or not are not considered project-related costs and are not included in the O&M costs for the project alternatives. All O&M costs in this draft are subject to review and change.

For the dam removal alternative, O&M would be minimal, so it is considered as zero cost for the purposes of determining project costs. The river channel and banks would be constructed to withstand flood events with minimal damage. As discussed in the Hydrology and Hydraulics Report, the Wiswall Road Bridge would receive increased flow velocities with dam removal and this effect may increase O&M costs of the bridge. Any O&M needed on the Wiswall Road Bridge is not being considered as part of the project costs in this draft report.

For the Denil Fish ladder, the O&M is estimated at $2,000 per year (2003 dollars) to perform general O&M requirements such as cleaning, inspection, adjusting, and operating stop logs, and occasional minor repairs. Over a fifty-year project life, the total O&M discounted to 2003 dollars is $32,000. This estimate is supplied by the New Hampshire Fish and Game Department. Replacement of baffles and stop logs that may get damaged from floods, animal damage, vandalism, or ice flows could increase the maintenance costs, but for purposes of cost estimating, these potential additional costs are not included in this draft. Also, significant reconstruction of the Denil fish ladder may be necessary over a 50-year period, and these costs are not included either.

For the nature-like bypass alternative, the O&M costs are estimated at $2,000 per year, or a total of $32,000 over 50 years. O&M would include inspection and occasional cleaning of major debris. The channel would be designed for a minimum of a 50-year life. It would be designed to accommodate flood flows with minimal damage to the channel bed and banks, stone protection, and other structures. The bridges that would cross the bypass channel would require periodic inspection and possible periodic repair. Fencing would require periodic maintenance and repair, and replacement of parts.

4.2.4 Monitoring Costs

For all three construction-alternatives, monitoring will be essential to ensure that the objective of anadromous fish passage is met, and vegetation and erosion-control measures are satisfactory. An estimated $35,000 total cost is estimated for monitoring over the first five years after project construction is completed and finalized. During the construction period, monitoring and adjustments will be conducted as necessary, and the costs of these activities are considered construction costs. Federal cost sharing of the monitoring costs is limited under Corps Regulation ER-1105-2-100, Appendix F.

4.3 Environmental Benefit Outputs

The Corps performed a detailed analysis to identify and quantify environmental outputs relating to the no-action and project alternatives. A report documenting this analysis is included as Appendix E. This section provides a summary of environmental outputs. For each alternative, environmental benefits were measured as habitat units of aquatic habitat affected by the alternatives. The habitat units are measured in acres. The habitat units were derived from the available (or affected) habitat acres that are multiplied by habitat indices measured as a percentage of the maximum habitat obtainable. Three aquatic habitat types were identified as follows:

1) Riverine habitat, which includes the 43 miles of river corridor at and upstream of Wiswall Dam that could be opened up to anadromous fish with fish passage around Wiswall Dam
2) Lacustrine habitat that occurs in the 8,000 feet of river upstream of Wiswall Dam
3) Wetlands habitat associated with the Wiswall dam impoundment

Habitat Units calculated for each alternative are shown in Table 7.

Table 7. Habitat Unit Outputs in Acres for Four Alternatives addressed for the Wiswall Dam Restoration Project					
Habitat		**Alternatives**			
		1 No Action	**2 Dam Removal**	**3 Denil Fish Ladder**	**4 Nature-Like Bypass**
Riverine Habitat (Including Anadromous Fish Passage)	Habitat Index (% effective)	39%	93%	65%	75%
	Affected Habitat Area (Acres)	233	217	233	234
	Habitat Units (Acres)	**91**	**202**	**152**	**176**
Lacustrine Habitat	Habitat Index (% effective)	86%	45%	90%	91%
	Affected Habitat Area (Acres)	25.5	19	25.5	25.5
	Habitat Units (acres)	**22**	**9**	**23**	**23**
Waterfowl and Wetlands Habitat	Habitat Index (% effective)	100%	33%	100%	100%
	Affected Habitat Area (Acres)	35	19	35	35
	Habitat Units (Acres)	**35**	**6**	**35**	**35**

The habitat unit outputs are draft values that are subject to change in any subsequent draft reports. Further review and input may alter habitat index values (i.e. the percentage of habitat effectiveness of each of the alternative). Any conclusions are preliminary, and are subject to review.

As shown in Table 7, the riverine habitat unit output is greatest for the dam removal alternative (202 acres), followed by the bypass channel (176 acres), and then the Denil fish ladder (152 acres). The lowest riverine habitat unit output is from the no-action alternative at 91 acres. Lacustrine and waterfowl habitat unit outputs are maximized almost equally by three alternatives: the no-action alternative, the Denil fish ladder, and the bypass channel alternative. For these alternatives, the lacustrine habitat unit outputs are 23 or 24 acres and the waterfowl habitat unit outputs are 35 acres. The dam-removal alternative substantially reduces both the lacustrine and waterfowl habitat unit outputs to 9 acres for the lacustrine habitat and 6 acres for the waterfowl habitat. A summary of habitat outputs is as follows. More detailed information is found in an incremental analysis report for this study prepared by the Corps (Appendix E).

4.3.1 No-Action

Under the no-action alternative, the entire riverine habitat available is 233 acres. This acreage includes the 8,000-foot reach of impounded area behind the dam, containing 26 acres, and wetlands associated with the impoundment, containing 9 acres of habitat. It also includes 41.5 miles of river (198 acres) above the impoundment that could be available for anadromous fish. The 233 acres of river would continue to provide habitat for non-anadromous fish and residential riverine and benthic species. However, the riverine habitat contains several limiting factors so was given a habitat index of 39%. The riverine habitat would remain fragmented due to lack of movement of residential species between upstream and downstream reaches. The no-action alternative would not provide for upstream migration of anadromous fish, so anadromous fish habitat upstream of the dam would remain minimal, limited that used by the fish transported to specific locations. The no-action plan would provide for limited downstream migration of herring that are stocked upstream, along with their offspring. The impounded reach has a reduced value as riverine habitat compared to that of a free-flowing river.

The lacustrine habitat includes the 26 acres of impounded water in the 8,000-foot reach of pool behind the dam, and it is estimated to have a habitat index of 86%. The waterfowl habitat encompasses both the open water and the wetlands for a total of 35 acres, with a habitat index of 100%, reflecting high quality habitat.

4.3.2 Dam Removal

Under the dam removal alternative, the total acreage of riverine habitat would be 217 acres, slightly smaller than that of the no-action alternative due to reduced acreage of habitat behind the dam. The riverine habitat index would increase to 93% due to several factors. Dam removal would provide full passage for anadromous fish to and from the 43 miles of river available to anadromous fish upstream of Wiswall Dam. This alternative would also provide full upstream and downstream access to residential aquatic species and provide habitat connectivity of river reaches presently downstream and upstream of Wiswall Dam.

Dam removal would reduce the size and quality of lacustrine-type habitat existing in the 8,000-foot reach upstream of Wiswall Dam, with a resulting habitat area of 19 acres and habitat index of 45%. The alternative would also drain approximately nine acres of wetlands associated with the impoundment behind Wiswall Dam. This loss of wetlands along with reduction in open water habitat would cause waterfowl habitat to have a reduced habitat index of 33%.

4.3.3 Denil Fish Ladder

With the Denil fish ladder, the total acreage of riverine habitat would be 233 acres, the same as that of the no-action alternative. The Denil-type fish ladder alternative would provide for upstream and downstream passage for anadromous fish to and from the 43 river miles available to anadromous fish upstream of Wiswall Dam. The upstream passage is estimated to be approximately 80% efficient for the full range of anadromous fish, due to the somewhat limiting size and conditions provided by the ladder. Downstream access for anadromous fish is estimated at 65% efficient, because access is limited to fish finding and traveling over the dam spillway, through a notch in the spillway, or down the fish ladder. The impoundment would provide additional restrictions to passage, so the overall habitat index of the riverine habitat is estimated to be 65%.

The lacustrine and wetlands habitats associated with the Wiswall Dam impoundment are expected to remain relatively unchanged, except for the added benefit of forage associated with an increased population of anadromous fish.

4.3.4 Nature-Like Bypass Channel

With the nature-like bypass channel, the total acreage of riverine habitat would be 234 acres, similar to that of the no-action alternative with the addition of one acre of riverine habitat in the bypass channel. As designed, the nature-like bypass channel is estimated to be 80% effective at upstream passage of anadromous fish and 90% effective at downstream passage through the Wiswall Dam reach. The passage effectiveness is based on design considerations that provide for recommended riverine and hydraulic conditions that allow passage of anadromous species over a broad range of flows during the migration period. Details of the hydraulics analysis and design recommendations along with references are contained in the Hydrology and Hydraulics Report prepared for this study (Appendix B). The bypass channel is also designed to flow all year so it would provide downstream access of anadromous fish and their offspring, and provide general riverine habitat for the acre of constructed channel. The channel would also create connectivity of riverine and benthic habitat for residential species upstream and downstream of Wiswall Dam. The impoundment would provide some restrictions to passage, so the overall habitat index of the riverine habitat is estimated to be 75%.

The lacustrine and wetlands habitats associated with the Wiswall Dam impoundment are expected to remain relatively unchanged, except for the added benefit of forage associated with an increased population of anadromous fish.

4.4 Incremental Analysis

An incremental analysis is a two-step process conducted by the Corps for environmental restoration projects to evaluate alternative plans where the plan benefits are in the form of habitat outputs rather than economic outputs. A more complete documentation is included in Appendix E (Incremental Analysis). This process involves two discreet analyses: a cost-effective analysis followed by an incremental cost analysis. First, through a cost-effectiveness analysis, the costs of the alternative restoration plans are compared with the environmental benefits to display the most cost-effective alternatives. An alternative is considered cost effective if no other plans provide the same or greater number of habitat units for less cost. Secondly, an incremental cost analysis of the most cost-effective alternatives (or “best-buy plans”) is performed to arrive at the "best" level of output within the limits of both the sponsor's and the Corps capabilities. The incremental cost analysis examines how the costs of additional units of environmental output increase as the level of environmental output increases. The incremental analysis by itself does not point to the selection of any single plan and is used with other decision-making criteria to select and recommend a particular plan. The incremental analysis is conducted in accordance with IWR Report 95-R-1, Evaluation of Environmental Investments Procedures Manual-Interim: Cost Effectiveness and Incremental Cost Analyses, May 1995; and ER 1105-2-100, Planning Guidance Notebook, Section 3-5, Ecosystem Restoration, April 2000. More complete documentation of the incremental analysis conducted for this project is documented in Appendix E.

In conducting the evaluation, the first step was to compare the costs and habitat unit (HU) outputs of the alternatives to identify cost-effective plans and identify any plans that are not cost effective. The costs and habitat units of each alternative plan are summarized in Table 8.

Table 8. Project Cost (total economic cost) compared to Habitat Unit outputs for four alternatives, ranked by riverine HU outputs
For each alternative, three different habitat outputs are shown and then combined by adding the total value of Riverine output with 25% of the Lacustrine output value and 25% of the Waterfowl value.

Alternative	Habitat Unit Outputs (Effective Acres)				Total Economic Cost ($)*
	Riverine (R)	Lacustrine (L)	Waterfowl (W)	Combined (R+0.25L+0.25W)	
No Action	91	22	35	105	$0
Dam Removal	202	9	6	205	$3,426,700.00
Denil Fish Ladder	152	23	35	167	$982,200
Nature-Like Bypass	176	23	35	190	$890,800

* Total Economic Cost of Project is considered the economic cost of the project over 50 years. This cost removes escalation and adds interest lost during construction. Costs are discounted to present dollars for purposes of economic analysis.

For purposes of selecting a proposed plan to meet the objectives of this study, the riverine habitat outputs were considered the most important of the three habitat types. The riverine habitat is critical to meet the primary objective of the study, to provide anadromous fish habitat. Therefore, to formulate a total HU output for each alternative, the riverine HU output was weighted four times greater than the outputs of lacustrine and waterfowl. The formula used to calculate the total HU was: Total HU = Riverine HU + (0.25) Lacustrine HU + (0.25) Waterfowl HU. This formulation is subjective and is simply to illustrate the relative significance of the three habitat types to meet the study objectives. The incremental analysis conducted for this study used the Total (combined) HU outputs as the environmental benefits of the alternatives.

When comparing total (combined) HU to costs, the cost-effective plans are no action, nature-like bypass, and dam removal. Comparing the three alternatives, there is no alternative that provides the same or more output for less cost. Based on the habitat units presented, the Denil fish ladder is not cost effective because the nature-like bypass provides more output for less cost. The three cost-effective alternatives are also "best buy plans." Table 9 shows the best-buy plans for optimizing riverine HU output. The table depicts the increased costs and increased outputs compared to the no-action alternative.

Table 9. Cost-Effective Plans and Best-Buy Plans when comparing Weighted Combined HU Outputs

Alternative	Weighted Combined Habitat Unit Outputs (Effective Acres)	Project Costs	Change in Output of HU from No Action	Increased Cost per Increased HU compared to the No Action
No Action	105	$0.00	0	N/A
Nature-Like Bypass	190	$890,200	85	$10,500
Dam Removal	205	$3,426,700	100	$34,300

To determine what plans are best buys, the cost and output of each alternative are compared to those of the no-action alternative, and the increased cost per increased HU is determined. A plan is considered a best-buy plan if there are no other plans that will give the same level of output at a lower increased cost per increased HU compared to the no-action alternative (Table 9).

Using the best buy plans determined for combined HU outputs, an incremental cost analysis was performed as shown in Table 10.

Table 10. Incremental Costs when comparing Best Buy Plans for Riverine HU Outputs					
Alternative	Weighted Combined HU Outputs (Effective Acres)	Project Costs	Incremental Output of Weighted Combined HU	Incremental Output of Project Costs	Incremental Cost per Incremental Output for Riverine Outputs
No Action	105	$0.00	0	0	N/A
Nature-Like Bypass	190	$890,800	85	$890,800	$10,500
Dam Removal	205	$3,426,700	15	$2,535,900	$167,700

The incremental cost curve is the relationship between the HU outputs (column 2) and the incremental cost per incremental output (column 6) as displayed in Table 10.

Development of the incremental cost curve facilitates the selection of the proposed alternative. The question that is asked at each increment of HU output is whether the additional gain in environmental benefit is worth the additional cost. As shown in Table 10, the nature-like bypass provides an additional 85 habitat units compared to the no action alternative, with an incremental cost of $10,500 per HU. The dam removal plan provides an additional 15 HU compared to the nature-like bypass for an incremental cost of $167,700 per HU, or a total of $2.54 million for the additional 15 HU.

4.5 Selection of the Proposed Alternative

Since this project is federally funded through the Section 206 program, a plan that best meets national interests must be identified under Corps of Engineers regulations (ER 1105-2-100). This national plan, called the National Environmental Restoration (NER) Plan, is a cost effective and best buy plan that provides aquatic habitat restoration benefits that are in the national interest. The NER plan must meet planning objectives and constraints and reasonably maximize environmental benefits while passing tests of cost effectiveness and incremental cost analyses, significance of outputs, acceptability, completeness, cost efficiency, and effectiveness. The plan must also have a reasonable cost in context with other similar projects (Corps Regulations ER 1105-2-100, Appendix E). Corps regulations allow federal funding to be contributed to support the project to the maximum allowed when the NER plan is chosen as the proposed plan. Locally preferred plans can also be funded (partially or in whole) if they are determined to be best buy plans through incremental analysis and meet other planning criteria.

When comparing weighted combined habitat outputs, as presented, of the four alternatives in relationship to their respective costs through an incremental cost analysis, the no-action plan, nature-like bypass alternative, and the dam removal alternative are all cost-effective as well as best-buy plans. Based on the presented figures, the Denil fish ladder alternative is not cost effective because another alternative (the bypass channel) results in a greater benefit for less cost. When comparing weighted combined HU outputs to costs through an incremental cost analysis, the bypass channel alternative has an incremental cost of $10,500 per combined HU, whereas the dam removal alternative has a greater incremental cost ($167,700 per HU) for a relatively small gain in riverine HU. Due to the substantial increase in incremental cost per HU for the additional HU output from dam removal, the nature-like bypass appears to provide the best value at a reasonable cost. The bypass alternative also appears to be technically effective at meeting planning objectives, as shown in the feasibility analysis and technical reports. Therefore, the nature-like bypass channel alternative is tentatively considered in this draft report as the draft NER plan, and carried forward in this report as the draft "Proposed Plan." The selection of the Proposed Plan is subject to modification based on review and revised information.

The nature-like bypass channel alternative appears to meet selection factors of cost efficiency and effectiveness. For this alternative to be brought forward into a final EA, the plan must also meet factors of acceptability and completeness. To meet the acceptability factor, the plan should be acceptable to state and federal resource agencies and local governments, and this draft is subject to final review by the Wiswall Dam Fish Passage Working Group. For the plan to meet the completeness factor, a plan for acquisition of the real estate requirements needs to be implementable.

5.0 Affected Environment

The Wiswall Dam is located immediately downstream of Wiswall Road, in the town of Durham, New Hampshire. The Lamprey River flows an approximate distance of five miles through Durham, with approximately 1.6 miles of it impounded behind Wiswall Dam. The Dam is approximately 11 feet high, with a spillway elevation of approximately 57 feet. A map of the New Hampshire Coastal Zone Management Area indicates that the dam is outside of the coastal zone. Access to the dam is via Wiswall Road, approximately one mile from its intersection with Packers Falls Road. The Lamprey River in the vicinity of Wiswall Dam is bounded by residential property and privately owned land, which is a mixture of forested upland and, in areas immediately adjacent to the river, forested, scrub-shrub, and emergent wetland. The 26-acre impoundment created by the dam is currently set up as a supplemental water storage area and supply for the town of Durham and UNH. The water intake structure, owned by the town of Durham, is located approximately 0.5 miles upstream on the north bank of the river. Durham has pumped water from the impoundment during summer and fall months since 1971. Currently, Durham must comply with New Hampshire's requirements for run-of-river conditions when river flows are less than 12 cfs. The low flows occur regularly during summer and fall months. During run-of-river conditions, the town is allowed to draw down the reservoir 6 inches, and maintain that level until the river flow into the impoundment increases to over 12 cfs, at which time the town may re-fill the reservoir. During the last two years, the town has used a siphon to release water over the dam while pumping during run-of-river conditions.

The entire 26-acre impoundment is accessible by small boat and/or canoe due to the relatively slow moving current, and is used by recreational paddlers and anglers. Public access to the impoundment is from town of Durham's land at Wiswall Dam and at the Wiswall Road Bridge, crossing the river. Additional boat and/or canoe access is via private property that borders the river. Depths of the impoundment range from approximately 16 feet in the vicinity of Durham's water intake structure, ½-mile upstream from the dam, to approximately 4 feet at the upper limits of the impoundment, approximately 1.6 miles upstream.

5.1 Terrestrial Environment

5.1.1 Topography

The Lamprey River descends a total of 600 feet from its headwaters in Northwood, New Hampshire, to tidewater at Newmarket. Generally, the topography in this area is the result of glacial activity, which carved the valley into its existing form. It is characterized by moderately to steeply sloping hills and valleys, with fringing wetlands along the margins of the river, particularly in areas where the river has been impounded by dams, including Wiswall Dam. Larger, more extensive wetlands occur near the headwaters of the river in Northwood and Nottingham.

Several areas of abrupt change in elevation are located along the Lamprey River. These include Packers Falls in Durham, and Wadley Falls upstream in Lee. Elevation changes between these areas range from approximately sea level at the base of the Macallen Dam, to 55 feet at the spillway crest of the Wiswall Dam, to approximately 100 feet at Wadley Falls, where there is a bedrock outcropping.

5.1.2 Geology and Soils

The Lamprey River valley is underlain by a grouping of bedrock known as the Avalonian Composite Terrain, which constitutes the oldest dated rocks in the state of New Hampshire, being formed between 650 and 410 million years ago (Dr. Eugene Boudette, NH State Geologist; from Lamprey River Resource Assessment, 1994). Generally, these are metamorphic rocks, however areas of granite and feldspar (i.e. Exeter epidiorite) intrusion exist in several areas (Lamprey River Resource Assessment, 1994). The Lamprey River channel in the vicinity of the Wiswall Dam is underlain by bedrock exposed from scouring in many sections, which defines the bottom of the impoundment. The dam itself is constructed on bedrock outcropping previously known as Wiswall Falls, where the elevation normally dropped approximately 12 feet. This rock remains close to the ground surface along the left side of the dam, with several additional outcroppings adjacent to the former millrace. Adjacent to the millrace, the bedrock is generally between two and six feet below the surface.

The surficial geology of the study area is of glacial origin and consists of two kinds of glacial drift in the Lamprey River corridor. These are stratified deposits, formed by materials from melting glacial ice sorted by running water, and till, which consists of unsorted clay, sand, gravel and rocks deposited directly by the ice sheet with little or no modification by the melting water.

Soils in the Lamprey River corridor near the Wiswall Dam and impoundment sites are mainly stratified deposits from glacial drift or reworked alluvial sediments. The soils in the study area are characterized as excessively drained to well drained and dominated by rocky, fine sandy loam and include silt loam suitable for agriculture and forestry (Hinckley-Windsor-Saugatuck), and are formed in sand and gravel deposits on outwash plains and terraces. The river terraces along the sides of the Wiswall Dam impoundment may have formed by ancestral river outwash. Portions of these terraces are now flooded by the impounded water, forming nine acres of shallow wetlands connected to the river. Draining the impoundment would cause most of the flooded terraces to drain, since the soils are characterized as well drained. Further information on the surficial geology is found in the Lamprey River Resource Assessment (1994) prepared by Margaret Watkins, (NH DES) for the Lamprey River Advisory Committee and the Towns of Durham Epping, Lee, and Newmarket.

Generally, the significance of the soils in the Lamprey River corridor to the Wiswall Dam impoundment is the degree to which they affect the aquatic habitat of the river. Soils suitable for forestry provide forested riparian buffer that helps protect water quality and shades the riverbank, limiting the amount of solar warming of the river, while areas of sand

and gravel provide necessary substrate which provide habitat for invertebrates and are utilized by riverine fish for spawning and forage. Fine sand and silt are easily eroded, and although necessary to allow rooted vegetation in slower moving areas, can affect riverine fish spawning and nursery habitat by suffocating eggs, larval fish and aquatic invertebrates necessary as food items. Soils used for agriculture within the corridor could have a negative effect on the river, due to runoff from fertilizers, pesticides, and animal wastes.

Within the Wiswall Dam impoundment, most of the soil supports the growth of riparian forest upland, as well as scrub-shrub fringing wetland. The upland soils appear to be moderately fine sandy loam. The river channel itself contains areas of scoured bedrock, with minimal areas of sandy substrate. Bathymetric mapping and sediment probing in the Wiswall Dam impoundment revealed that very little sediment had accumulated behind the dam. This lack of deposition may be due to low sediment loads in the river. Most of the banks appear to be relatively stable with little or no streambank erosion, and resulting sand and soil input into the river.

5.1.3. Prime Farmland

The Federal Farmland Protection Policy Act (FPPA) of 1981 was enacted to minimize the extent to which federal programs contribute to the irreversible conversion of farmland to nonagricultural uses. The Act applies to farmland with soil types classified as prime, unique, or of statewide or local importance, but not to farmland already in or committed to urban development or water storage. Soil survey mapping indicates that the proposed site for the natural stream bypass channel contains three soil types considered as locally important farmland soils. These are Hollis-Charlton fine sandy loam, 3 to 8% slopes; Swanton fine sandy loam, 0 to 3% slopes; and Windsor loamy sand, 3 to 8% slopes. In addition, there is a small area of Prime Farmland soil (Elmwood fine sandy loam, 3 to 8% slopes) adjacent to the footprint of the proposed project.

5.1.4 Vegetation

Vegetation in the Lamprey River Corridor in the vicinity of the Wiswall Dam includes upland forest along the riparian corridor on the left bank, as well as emergent, scrub-shrub and forested wetland. In the vicinity of the impoundment, the forested upland areas are located primarily along the right bank, with species that include hemlock, white pine, black cherry, red maple, white birch, and red oak.

Generally, the section of the river near the dam is residential property, some of which is forested upland downstream from the dam, and scrub-shrub wetland upstream of the dam. Species in the forested and scrub-shrub wetlands include, red maple and white oak, as well as shrub species including buttonbush, sweet pepperbush, silky dogwood, high-bush blueberry, arrowood, and maleberry. Residential property abuts the northern section of the impoundment along the left bank, and includes cleared lots with mowed grass, with stands of hemlock, white pine as well as other upland hardwood species. Vegetation in the area of the proposed bypass channel includes white pine, red maple, and emergent wetland species (sedges) in the wetter areas adjacent to the river.

5.1.5. Wildlife

The Lamprey River corridor provides habitat for numerous avian and mammalian wildlife species that utilize the forested riparian areas as well as the associated wetlands that fringe the river. These include water based furbearers such as beaver, mink, muskrat and river otter, which are all common to the area, as well as the land based furbearers which include black bear, coyote, fisher, gray fox, opossum raccoon, red fox, bobcat, skunk, shorttail weasel, and longtail weasel. All of these species are common to abundant in the area, with the exception of black bear, bobcat and opossum, which are only occasionally found in the corridor. Other mammalian species common to the area include whitetail deer, moose, porcupine, woodchuck, flying squirrels, eastern chipmunk, and red and eastern gray squirrels. In addition, eastern cottontail and snowshoe hare may occur in the area.

Within the area of the Wiswall Dam impoundment, the semi-residential nature of the abutting land limits the types of mammalian wildlife species to those more suited to inhabiting areas closer to human populations. These include many of the smaller mammals, such as red and eastern gray squirrel as well the larger ones such as white tailed dear, and raccoon.

Avian species found in the area are extremely diverse and include over 159 different species that were observed during a survey of the riparian zones and wetland conducted during the spring and fall of 1993 by Maggie Wittner, Ornithologist, for the Lamprey River Advisory Committee (Lamprey River Resource Assessment, 1994). A listing of these species is presented in Appendix F of the EA. Among those documented, there were four state listed endangered species. These are the pied-billed grebe, bald eagle, sedge wren, and peregrine falcon; as well as three state-threatened species, which include the northern harrier, osprey, and common nighthawk. Other species noted included the red-shouldered hawk and the whip-poor-will which are listed as species of concern, as well as black duck (which is declining), black crowned night heron, bobolink, and meadowlark which are species that have been declining recently. Common loons have also been observed in the Lamprey River during the spring (April). Many of the New Hampshire species known to prefer riparian habitat have been documented in the Lamprey River corridor. These wildlife sightings generally indicate the presence of a large diversity of habitat types along the river.

5.1.6 Reptiles and Amphibians

A listing of the reptiles and amphibians observed in the Lamprey River corridor is presented in Appendix F of the EA (from Lamprey River Resource Assessment, 1994). Detailed field studies of the Lamprey River corridor have been conducted on turtles, and it was found that all six of the turtles known to occur in New Hampshire have been documented in the river corridor. These include Blanding's turtle, snapping turtle, wood turtle, painted turtle, musk turtle, and spotted turtle. Both the Blanding's turtle (*Emydoidea* *blandingii*) and wood turtle (*Clemmys insculpta*) are found in the vicinity of the Wiswall Dam impoundment, and are considered to be rare in the state. Both of these species were observed in wetland habitat associated with the riparian areas of the Lamprey River, within several miles of the Wiswall Dam. In addition, it is likely that these species use the river as a travel corridor within their specific ranges. These species are discussed further in Section 5.3.3 of this Environmental Assessment.

5.2 Aquatic Environment

5.2.1 Hydrology

Estimated mean annual flow discharge from the Lamprey River as measured at the USGS Gage at Newmarket (# 01073500), collected over a period of 66 years between 1935 and 2000) ranged from 128 cubic feet per second (cfs) in 1965 to 456 cfs in 1954. Mean annual stream-flow for this 66-year period was 283 cfs. Extreme instantaneous flow rates have ranged up to 7,570 cfs on April 7, 1987, to lows of 1 cfs on October 21, 1935. These flows reflect a drainage area of 183 square miles, which comprises approximately 87% of the entire watershed of the river. Mean monthly flows for the period from 1961 to 1975 measured from the above gage in cubic feet per second per square mile of drainage (cfsm), ranged from 0.23 cfsm for August, to 4.13m cfsm in April. The next-to-lowest mean annual flows were measured in September (0.27 cfsm) indicating that the low flow season continues into the fall. Highest flows are generally in April, with the next to highest flows occurring in March. More information is found in the Hydrology and Hydraulics Appendix (Appendix B).

The Lamprey River itself originates at the base of the Saddleback Mountains in Northwood, and much of the flow originates from runoff from these hills, as well from the inflows from several major tributaries that drain the areas of Lee, Nottingham, Epping, Deerfield, and Raymond. Along its course from Northwood, the Lamprey is joined by the North Branch River in Raymond, the Pawtuckaway River in Epping, and the North River in Epping near the border of Lee. The last major tributary is the Little River, which also joins the Lamprey River in Lee. Groundwater sources provide much of the water during low flow periods (i.e. periods of low precipitation), and the fact that significant drops in flow occur during drier months reflects the relatively low occurrences of sand and gravel aquifers in the Lamprey River watershed (Lamprey River Resource Assessment, 1994). Actual flows from the tributaries into the Lamprey River are not available due to the absence of gauging stations on those rivers. The Little River is the tributary that is closest to the Wiswall Dam, joining the river approximately four miles upstream from the impoundment.

At least three dams on the Lamprey River are classified as “Active” by the New Hampshire DES, including Wiswall Dam. These include the Macallen Dam, located approximately five miles downstream from the Wiswall Dam in Newmarket and the Bunker Dam approximately 20 miles upstream in Epping. Wadleigh Falls Dam, approximately 8 miles upstream in Lee, is now breached. In addition, several inactive dams still exist along the Lamprey River, including a partially breached dam between Tuttle Road and Route 155 in Lee. Historically there has been a minimum of 15 dams along the mainstem of the

Lamprey River, although many of them have been breached and/or otherwise destroyed. In addition, there are several dams along the major tributaries, including three on the Little River, one on the Pawtuckaway River, and two on the North River. Although these dams exist on the Lamprey River, none of them are used to significantly regulate flow, although fall drawdowns occur on the Pawtuckaway Dam, Bunker Pond, Mendums Pond, and North River Pond which help to augment low flows during the early fall.

The Wiswall Dam operates as a run-of-the-river dam, with the 11-foot spillway maintaining the surface elevation of the impoundment behind the dam, at approximately 57 feet NGVD during low flows. The impoundment serves as supplemental public water storage and supply for the Town of Durham and the UNH. This water supply is critical during periods of high water demand, such as when UNH is in full session in the months of September and October. When in use, water is pumped from the impoundment behind Wiswall Dam either directly to the Town of Durham's water plant or to the Oyster River Reservoir, Durham's primary water supply.

In 1993, a test was conducted by the town of Durham on the the Wiswall Dam impoundment water supply system to determine its capacity for large prolonged water withdrawal, and the 24-hour withdrawal use was calculated to be 6.2 cfs. This is approximately 26% more than the calculated 7Q10 for the Lamprey River. Therefore, it is likely that additional water supplies may be needed in the future to sustain the Town of Durham, particularly during low flow periods on the Lamprey River (Lamprey River Resource Assessment, 1994).

A flood analysis was conducted as part of this study, and this analysis is documented in the Hydrology and Hydraulics Appendix (Appendix B). In the impounded area upstream of Wiswall Dam, most of the former floodplain is now submerged. Current flooding increases water levels behind the impoundment from approximately two feet during one-year events to approximately six feet for a 100-year event. Immediately downstream of the dam, the river has relatively steep banks with a narrow floodplain. Flooding raises the water levels downstream of the dam from approximately two feet during one-year events to ten feet during the 100-year event.

5.2.2 Water Quality

5.2.2 (a) Classification

The Lamprey River is classified as Class B by the State of New Hampshire Department of Environmental Services. Class B waters are generally suitable for fishing and contact recreation (swimming, boating), and are good wildlife habitat. In addition, they are suitable for public water supply with adequate treatment. It should be noted that these water quality classifications are designations, which have been made by the New Hampshire DES for which a specific water body should be used; and therefore a goal to which the water quality should legally attain. Therefore, this classification of a water body designates its purpose, and does not necessarily indicate that the particular classification is being met. New Hampshire currently has two water quality classifications, Class A and Class B. Class

A waters are generally of the highest quality and considered potentially usable for water supply after adequate treatment. Discharge of sewage or wastes is prohibited into waters of this classification. Prior to 1991, a third classification, Class C existed, and included waters that were considered to be adequate for fishing, boating, and certain industrial uses. However, in 1991 the state upgraded all Class C waters to Class B in order to achieve the Federal Clean Water Act goal of having all waters in the State being fishable and swimmable. Therefore, all waters in the state have water quality classifications of either Class A or Class B, with the majority being Class B (New Hampshire, 2000 305b Water Quality Report).

Within these water quality designations, streams and/or rivers are classified as either supporting, partially supporting or not supporting Class A or B uses, based upon compliance or noncompliance (violations) with water quality criteria specific to these classes. The determination of support, partial support, or non-support depends upon the type, frequency and duration of a noncompliance with a water quality criterion in a given body of water. The State of New Hampshire Department of Environmental Services has conducted water quality monitoring on the Lamprey River since 1988, (or earlier). Generally, most of the Lamprey River supports the Class B Water Quality designation. Specific water quality criteria that have been violated (although infrequently) on the Lamprey River include E. coli bacteria and Dissolved Oxygen concentration (these are some of the most common indicators of water quality). The New Hampshire water quality standard for E. coli in Class B waters is a maximum of 406 cts/100 ml of water for any single sample, or a maximum of 126 cts/100 ml based on a geometric mean of at least 3 samples over a 60-day period unless naturally occurring. Exceedences of these Class B standards in the Lamprey River have occurred primarily upstream from the Wiswall Dam in Epping, at locations near and/or downstream from the downtown area or wastewater treatment plant. In addition, some violations of the Dissolved Oxygen standard of 5 mg/l for Class B waters has also been reported from this location, as well as violations of the Ammonia standard. In 1995, a Total Maximum Daily Load (TMDL) study was conducted on the Lamprey River by the NH DES Surface Water Quality Bureau, which concluded that advanced treatment is needed at the Epping Wastewater Treatment Facility (WWTF) to avoid dissolved oxygen and ammonia violations in the river. In 1999, Epping's National Pollutant Discharge Elimination System (NPDES) permit was reissued with advanced limits. As a result, the Town is currently designing an advanced wastewater treatment facility using innovative technology, which is expected to alleviate further exceedences of the Class B Water quality criteria (Page II-2-18 of the State of New Hampshire 2000 Section 305(b) Water Quality Report, New Hampshire DES).

5.2.2 (b) Specific Water Quality Data

Water Quality data collected by the New Hampshire Department of Environmental Services between 1998 and 2000 from the Lamprey River downstream from the Epping Wastewater Treatment Plant at the Route 87 bridge indicated that the Lamprey River water quality generally met Class B standards for the period with relatively few violations of specific criteria. Dissolved Oxygen concentrations during that period fell below the 5-mg/L Class B criterion on only 2 occasions (out of a total of 40 measurements) with the lowest concentration being 4.33 mg/L, which occurred on July 24, 1999. Most of the dissolved oxygen concentrations measured during that time were well above the 5 mg/l criterion, with a maximum level of 9.96 mg/L occurring on October 30, 1999, and mean dissolved concentration of 8.93 mg/l. This mean level for the period is actually above the Class A Water Quality Criterion of 6.0 mg/L for dissolved oxygen.

Levels of E. coli bacteria measured during that same period from the Route 87 bridge in Epping, also met the Class B single sample criterion (i.e., maximum of 406 cts/100ml) with the exception of one sample collected on June 23, 1998, which had 480 cts/100ml. Out of the 25 times that this station was sampled during the two-year period, that was the only single sample violation of the Class B water quality criterion for E. coli. It should be noted that most of the E. coli bacteria levels from the other samples were significantly lower than this single violation; with the lowest level being 10 cts/ml, and the mean level for the two-year period being 121.45 cts/ml.

Water quality in the Wiswall Dam impoundment (collected from Wiswall Road) during the same two-year period generally met or exceeded the minimum dissolved oxygen criterion for Class B waters (of 5mg/l) on almost all of the 31 sampling occasions with the exception of the single sampling date of August 7, 1999 with a measurement of 4.89 mg/l. The mean dissolved oxygen concentration from the two-year sampling period was 7.87 mg/L, which not only exceeds the Class B Criterion of 5 mg/L, but also the New Hampshire Class A water quality criterion of 6 mg/L. Levels of E. coli bacteria measured at that same location for the same two-year period also met Class B Water Quality Criteria, ranging from 10 cts/100 ml on several occasions to a maximum single sample level of 360 cts/100 ml collected on July 10, 2001. Generally, the levels were well below the single sample Class B criterion of 406 cts/100 ml, with the mean level for the entire period being 51 cts/100 ml (on a total of 20 samples for the period).

Other water quality parameters that were measured in the Lamprey River in the vicinity of the impoundment include temperature, pH, conductivity and turbidity. These parameters generally appeared to be suitable for the survival, reproduction, and growth of most lacustrine fish species. Temperatures recorded at Wiswall Road during the two-year period from the months of June through October ranged from a 7.1^{o} C (44.8^{o} F) on October 30, 1999, to a maximum of 26^{o} C (78.8^{o} F) in on June 23, and August 8, 1999, with interim readings in July of that year being 25.7^{o} C (78.3^{o} F). Typically, most salmonid fish (particularly brook and rainbow trout) prefer water temperatures that are less than 20^{o} C (68^{o} F) but can tolerate temperatures as high 24^{o} C (75.2^{o} F) for short durations, although it is generally considered to be their upper lethal temperature limit (Raleigh, 1982). The temperature data above indicate that the water temperatures in the Wiswall Dam impoundment during the summer of that year (and most likely all of the years sampled) are generally too warm to support salmon and trout, although they are suitable for lacustrine fish species (e.g. largemouth bass, yellow perch). Therefore, any resident salmonid species would generally move out of the impoundment to areas of cooler water, such as locations upstream in the river, smaller feeder tributaries, or areas of groundwater inflow, such as bank undercuts close to the water table, or deeper areas of the impoundment itself with adequate dissolved oxygen concentrations. It should be noted that the impounding of a river by a dam could generally cause an overall increase in summer water temperatures by slowing the water and providing longer exposure to solar and atmospheric warming. Therefore, if the Wiswall Dam were removed, it is likely that this would have an overall cooling effect on the water in the Lamprey River in the former impoundment.

Measurements of pH in the Wiswall Dam impoundment collected by the NH DES during the approximate two-year period between 1998 and 2001 were also within the Class B Water Quality Criteria, which ranges from 6.5 to 8 (unless due to natural causes), with the exception of 5 dates where the pH was less than 6.5. The lowest level recorded from the impoundment was 5.88, which, although below the specific Class B criterion, was still within the suitability range for many lacustrine (largemouth bass) as well as riverine (trout) fish species. Largemouth bass can reproduce in waters where the pH ranges between 5 and 10, with an optimum pH of 6.5 –8.5 (Stuber, Gebhart and Maughan, 1982) and brook trout can tolerate pH levels between 4 and 9.5 with their optimal range being 6.5- 8 (Raleigh, 1982). It should be noted that only three of the lower pH readings (out of a total of 32) were below 6.24 with the mean pH for the period being 6.88. Natural causes of low pH in the watershed can include bog wetlands, where the biological activity can produce organic acids, which drain into the river. Other causes of lower pH can include point sources of industrial discharges as well as non point sources including atmospheric deposition. Based upon the above data however, it appears that the pH of the Lamprey River is suitable for the reproduction and survival of native (and non-native) riverine and lacustrine fish.

5.2.3 Riverine Processes and Sediment Chemistry

Bathymetric and sediment depth sampling of the Wiswall Dam impoundment was conducted by the U.S. Army Corps of Engineers during the spring of 2002. A series of 12 transects were surveyed for bathymetry and probed for sediment depth (transects 1-5a, b, c; and 6-10) (Appendix C, Geotechnical Investigations). Generally, the probe data indicated relatively little sediment present in the impoundment, with much of the main channel being scoured bedrock. Most of the sediment in the impoundment was found along the margins of the impoundment (i.e. the banks), as well as in areas further upstream from the dam. Within approximately 100 feet upstream of the dam, the center of the channel had insufficient sediment to allow penetration by the sampling device. Generally, flow velocities are fast enough in this section of the river to suspend most of the material that would normally be deposited in the channel. The exception was transect 6 located approximately 2,800 feet upstream from the dam. Sediment depths in this location ranged from a small section of scoured rock in the center of the channel, to 4 feet of soft sediment along the margins. Other transects showed much greater scour areas, with relatively narrower strips of soft sediment along the edges, ranging from only 1 to 2 feet deep along the edges. Those transects furthest upstream had the least amount of sediment, with transects 8, 9, and 10 indicating a streambed that was scoured. Grain size analysis indicated that most of the material was in the category of silty fine sand to medium sand.

In addition, during the winter of 2002, sediment core samples were collected (also by the U.S. Army Corps of Engineers) from three locations in the Wiswall Dam impoundment, composited, and analyzed for bulk chemistry and grain size. Analyses included, Volatile Organic Compounds VOC's), Semi Volatile Organic Compounds (SVOC's), Pesticides, Polychlorinated Biphenyls (PCB's), Total Petroleum Hydrocarbons (TPH), Total metals, Inorganic compounds, and Total Organic Carbon (TOC). Generally, very few contaminants were detected in the sediments, with the few detected being at low concentration levels. Small amounts of acetone and methylene chloride were detected in all of the VOC samples, however it appears that these may be laboratory contaminants, and not necessarily representative of the sediments (i.e. methylene chloride was detected in the blank). Station 1(See Appendix C, Geotechnical Analysis) had an estimated concentration (below quantitation limit) of 2-Butanone, another laboratory artifact. No pesticides or PCB's were detected in any of the sediment samples, and concentrations of total arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, silver and zinc, all were below established biological effects levels (i.e. Long and Morgan, 1990). The metals in the highest concentrations were zinc and chromium, which ranged from 18 to 23 mg/Kg and 8 mg/K to 16 mg/Kg respectively, however, as noted these concentrations are below the levels where biological effects to sensitive forms of aquatic life are expected to occur.

5.3 Biological Resources

5.3.1 Aquatic Vegetation/Wetlands

As noted previously, fringing scrub-shrub, emergent, and aquatic-bed wetlands associated with the Wiswall Dam impoundment extend along both the north and south sides of the Lamprey River for approximately 2 miles upstream of the dam (See Figure 6). These wetlands appear to be supported primarily by the water level in the impoundment. Along the southern side, a fringe of wetland runs parallel to the river, which is separated from the pool by a natural berm. This creates an extensive area of emergent, aquatic-bed, scrub-shrub, and forested wetland that is relatively isolated from the main body of the pond (Figure 3). This area is dominated by tussock sedge (*Carrex stricta*) with forested areas of red maple (*Acer rubrum*) along the margins and extending into the more upland areas, which are dominated by white pine. The primary characteristic of these wetlands (on the southern shore) of the river is forested cover (i.e. red maple over the wetter areas, and white pine along the higher berms), which shades most of the area. The habitat contains stands of shallow open water within the shaded areas, connected to the main surface of the pond through several narrow inlets.

The wetlands that exist on the southern side extend over a wider area than those on the north and are primarily emergent and scrub-shrub, with less forested cover. In addition, there are larger areas of deeper open water connected to the main body of the Lamprey River (Figure 3). Generally, this complex includes a more varied ecosystem, with the open water providing fisheries as well as waterfowl habitat. This area is locally known as Thompson's Marsh. During a site visit in December of 2001, numerous small bass (not positively identified) were observed in the inlet area, apparently utilizing what appeared to be productive fish/aquatic habitat, consisting of extensive shallows. These could potentially provide spawning and nursery habitat for this species, and their connection to the deeper open water areas of the impoundment can allow adults access to these areas for forage and refuge. In addition to providing fish habitat, the open shallow water in these back wetlands can provide habitat for waterfowl.

Similar to the wetlands on the southern shore, these wetlands are also primarily supported by the water level of the impoundment, although a small stream flowing from the north contributes to the hydrology of this area. It should be noted that during an experimental drawdown of the Wiswall Dam impoundment in 1994, most of these wetlands were left dry, temporarily stranding many resident fish and invertebrate species inhabiting the area (Lamprey River Advisory Committee Report, 1994).

Major emergent/aquatic bed plant species in this area include tussock sedge (*Carex stricta*), common cattail (*Typha latifolia*), pondweed (*Potamogeton epihydrus and P. spirillus*), pickerel weed (*Pontedareia cordata*), common arrowhead (*Sagittaria latifolia*), which are found near the fringes of the open water. Scrub-shrub vegetation includes willow, buttonbush (*Cephalanthus occidentalis*), sweet pepperbush (*Clethra alnifolia*), silky dogwood (*Cornus amomum*), highbush blueberry (*Vaccinium corymbosum*), arrowood (*Viburnum recognitum*), willow, alder and small red maple (*Acer rubrum*) (Lamprey River Resource Assessment 1994).

Within the Lamprey River corridor, there are 172 documented wetland and aquatic plant species with several good examples of floodplain, riverine and wetland communities (Lamprey River Management Plan, New Hampshire Department of Environmental Services http://www.des.state.nh.us/Rivers/plans/lampln13.htm).

5.3.2. Fisheries

A list of the fish species known to occur in the Lamprey River upstream from the Wiswall Dam is presented in Table 11. These include several lacustrine species (i.e. largemouth bass, chain pickerel, brown bullhead, bluegill and black crappie) as well as many riverine species including blacknose and longnose dace, creek chub, brook trout, brown trout, and rainbow trout. The Lamprey River upstream of the Wiswall Dam (in the vicinity of the impoundment) supports a typical lacustrine fish assemblage, which includes largemouth and smallmouth bass, chain pickerel, as well as bullhead species (Doug Grout, Personal Communication, 2002; Judith Spang, Personal Communication, 2001). Natural reproduction of brook and brown trout occurs in the upper regions of the Lamprey River, but this has not been reported in the area of the Wiswall Dam impoundment. Shallow inlets with emergent and floating aquatic vegetation, with forested canopy located along both the north and southern shores of the Wiswall Dam impoundment (described in the previous section) have the potential to provide excellent spawning and nursery habitat for many lacustrine fish species (centrarchids) including largemouth bass. However, the area has not been sampled due to inaccessibility.

Table 11. Fish Species Able To Move Through Wiswall Dam Area (From New Hampshire Fish and Game Department, 2003)

With Fish Ladder [1]	With Dam Removed [2]	
***Alewife*[3]**	***Alewife***	***White sucker***
Blueback herring[3]	*Blueback herring*	Longnose sucker
American shad[3]	*American shad*	*Blacknose dace*
Atlantic salmon[3]	*Atlantic salmon*	*Longnose dace*
Sea lamprey[3]	*Sea lamprey*	*Creek chubsucker*
American eels[3]	*American eels*	*Chain pickerel*
Brown trout[3]	*Brown trout*	*Redfin pickerel*
Brook trout[3]	*Brook trout*	*Northern pike*
Rainbow trout[3]	*Rainbow trout*	*Yellow perch*
Smallmouth bass[3]	*Smallmouth bass*	*Bluegill*
	Largemouth bass	*Redbreasted sunfish*
	Fallfish	*Black crappie*
	Bridle shiner	*Brown bullhead*
	Common shiner	*Yellow bullhead*
	Golden shiner	*Swamp darter*
	Spottail shiner	*Creek chub*
	Pumpkinseed	*Rock bass*

[1] = Fish species observed using Newmarket fish ladder on Lamprey River.
[2] = Fish species known to occur in Lamprey River based on samples collected in 1998, 1985, 1984, and 1983.
[3] = adult fish only (Doug Grout, New Hampshire Dept. of Fish and Game).

As noted in the previous sections of this report, anadromous fish restoration efforts are currently in progress and include the stocking of alewives in Pawtuckaway Lake upstream from the Wiswall Dam. Additional anadromous species that have been stocked in the Lamprey include Atlantic salmon and shad. All of these species have been observed using the fish ladder at the Macallen Dam in Newmarket. In addition, other migratory species (anadromous, catadromous and potamodromous) have been reported using the fish ladder including sea lamprey, American eel, brown trout, rainbow trout, brook trout, and largemouth bass. These can be found in the Lamprey River downstream from Wiswall Dam (in the Macallen Dam impoundment and upstream) and are expected to be able to move through the Wiswall Dam impoundment if fish passage (or dam removal) is provided.

In addition to the stocking of anadromous fish (i.e. river herring and Atlantic salmon), brook, brown, and rainbow trout have all been stocked in various locations of the Lamprey River. Although summer water temperatures in the Wiswall Dam impoundment have exceeded the ranges suitable for holding trout species, there are areas of colder water in many of the smaller tributaries as well as along the banks in areas of groundwater seepage.

5.3.3 Threatened and Endangered Species

Coordination with the U.S. Fish and Wildlife Service has indicated that there are no federally listed threatened or endangered species, with the exception of transient bald eagles *Haliaeetus leucocephalus*, inhabiting the Lamprey River corridor in the vicinity of the Wiswall Dam (See letter dated April 21, 2003, Appendix G). However, coordination with the State of New Hampshire Division of Fish and Game, Natural Heritage Inventory has indicated that two rare turtle species and one rare plant species have been observed in the Lamprey River Corridor, within an approximate 5-mile radius of the Wiswall Dam impoundment (See letter dated January 23, 2002, Appendix G). These include Blanding's Turtle (*Emydoidea blandingii*), wood turtle, (*Clemmys insculpta*), and knotty pondweed (*Potomageton nodusus*). New Hampshire Natural Heritage Inventory records indicate that several Blanding's Turtles have been observed in a small field approximately 2 miles upstream from the Wiswall Dam. This species' preferred habitat generally includes densely vegetated shallow ponds, marshes, or small streams. It nests in unvegetated sites composed of hard soil, such as plowed fields, railroad embankments, and dirt roads. In addition to nesting on land, this turtle has also been known to feed there, where it eats vegetation, slugs, insect larvae and earthworms (in addition to its fresh water feeding diet of plants, fish, aquatic invertebrates). This species was observed on Lee Hook Road in Lee, approximately 2.5 miles upstream from the Wiswall Dam, in various habitats containing riparian cover, a vernal pool, and a dry farm pond, located along the uncut edge of a mown hayfield, less than 20 meters (approximately 66 feet) from the edge of a river bank. Although there are no recorded sightings of this species in the wetlands adjoining the Wiswall Dam impoundment, it is possible that habitat for this species occurs in these areas. In addition, this species can travel widely and most likely use the river as a travel corridor.

The wood turtle inhabits riparian areas, and is considered the most terrestrial of the North American turtles utilizing both aquatic and terrestrial habitats during its lifetime (Commonwealth of Massachusetts, 1994). It can feed in both of these habitats, and is considered semi-aquatic, although the terrestrial habitat occupied by this species is generally within a few hundred meters (approximately 1,000 feet) from a stream or river system (Commonwealth of Massachusetts, 1994). It utilizes aquatic habitat for over wintering, where it burrows into either a muddy stream bottom, or muddy bank for hibernation. In southern Coastal Massachusetts, it can become active in March (and presumed at approximately the same time in southern New Hampshire) when it leaves its burrow and begins its terrestrial activity, moving up onto the riverbank to bask in the sun, and eventually during the spring and summer occupying meadows and upland forests. By late summer it returns to the streams and/or rivers to mate and over-winter. It is omnivorous and in the terrestrial environment can feed on insects, carrion, worms, blackberries, dandelions, grasses sedges, mushrooms (Wisconsin Department of Natural Resources, 2003), and in the aquatic environment on fish, tadpoles, mollusks and filamentous algae. Their range is generally limited to within a few hundred meters (approximately 1,000 feet) of the river, and moving linearly along the riparian corridor a distance of approximately a mile, although some individuals have been known to move greater distances using the riparian corridors for dispersal (Harding, 2002).

This species was observed in the vicinity of the confluence of the Lamprey and Little Rivers, in Lee, approximately 3.5 miles upstream from the Wiswall Dam impoundment in or around a vernal pool, surrounded by red-maple swamp (mesic woods) and buttonbush. Based upon most of the information stated above, it would appear that the Wiswall Dam impoundment is outside of the range of these particular individual turtles. However, this does not rule out the presence of similar habitat closer to Wiswall Dam, which may be occupied by this species, although they were not recorded as being observed there by the NH Natural Heritage Inventory.

Observations of the rare aquatic macrophyte species, knotty pondweed (*Potamogeton nodosus*) were made approximately 2 miles upstream of the impoundment and one half mile downstream of the impoundment (at Packers Falls) both in areas of fast flowing water. Generally, this species inhabits these areas, and, therefore, is unlikely to be found in the slower moving water associated with the Wiswall Dam impoundment in the vicinity of the Wiswall Dam.

Several state listed threatened and endangered avian species have been documented to occur in the Lamprey River corridor, however they have not been sited in the vicinity of the project area. These include the state endangered pied-billed grebe, bald eagle, sedge wren and peregrine falcon, and the state threatened northern harrier, osprey, and common nighthawk. As noted, coordination with the New Hampshire Natural Heritage Inventory has not documented the presence of these species in close proximity to the proposed project.

5.3.4 Essential Fish Habitat

The 1996 amendments to the Magnuson-Stevens Fishery Conservation Management Act strengthen the ability of the National Marine Fisheries Service and the New England Fishery Management Council to protect and conserve the habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. This habitat is termed "essential fish habitat", and is broadly defined to include "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The Great Bay Estuary, which includes the mixing zones for the Lamprey and Cocheco Rivers been has been designated as essential fish habitat (EFH) for at least one or more life stage(s) of several marine, estuarine, and anadromous finfish species. For the 10' x 10' square of latitude and longitude which includes the Great Bay and the mixing zones of the Lamprey and Cocheco Rivers, the managed EFH species listed are: Atlantic salmon, Atlantic cod, pollock, red hake, white hake, winter flounder, yellowtail flounder, windowpane flounder, Atlantic halibut, Atlantic sea scallop, Atlantic sea herring, bluefish, and Atlantic mackerel. A listing of these species and their affected life stages is located in Appendix G.

On the Lamprey River itself the EFH designation extends only as far as the Macallen Dam in Newmarket (head of tide) for all designated species except Atlantic salmon. The New England Fisheries Management Council Essential Fisheries Habitat Amendment (October 7, 1998) identifies the Lamprey River upstream from the Macallen

Dam as EFH, using the criteria for designation as; all rivers where Atlantic salmon are currently present, for any of the life stages of eggs and larvae, juveniles, and adults. As noted previously, past Atlantic salmon stocking efforts on the Lamprey River have resulted in returns of pre-spawning adults to areas upstream from the Macallen Dam via the fish ladder in Newmarket.

In addition to the EFH designation of the Lamprey River and Great Bay Estuary for Atlantic salmon and other species listed above, the River supports an existing river herring run (alewives and blueback herring) originally from the stocking program noted previously, with pre-spawning adults returning to areas upstream of Newmarket via the fish ladder at the Macallen Dam. With the proposed fishway, an additional 43 miles of river is expected to become accessible to these fish with its potential spawning habitat. Although river herring are not designated as EFH species, they are prey for many EFH and/or federally managed species (i.e. bluefish, Atlantic salmon), which occur in both the Great Bay Estuary, as well as the Gulf of Maine. Therefore, by restoring anadromous fish passage to areas of the Lamprey River upstream from the Wiswall Dam, EFH for both Atlantic salmon as well as forage for some of the estuarine and marine species inhabiting the Great Bay Estuary may be affected. Further discussion of these effects can be found in the EFH assessment in the Environmental Consequences section of this EA (Section 6.3.4).

5.4 Historical and Archaeological Resources

The Lamprey River is considered one of New Hampshire's most historic streams. At Wadleigh Falls in Lee, archaeological remains have been found that date back approximately 8,000 years, making this site one of the ten most significant in the state (Lamprey Wild and Scenic River Study, Draft Report, 1995). Generally, mill sites existed and/or still exist at almost all of the rapids in the river, including Wiswall Dam. The dam is located within an area of intensive industrial activity, having begun as a sawmill, followed by a grist and flour mill, and then used to manufacture textiles, shoes, knives, hoes, shovels, pitchforks, nuts and bolts, bobbins carriages, sleighs, chairs, matches, and wallpaper.

5.4.1 Historic Period

The Wiswall Falls Mill Site was approved for nomination to the National Register of Historic Places in 1988. The Wiswall Dam itself was not a part of this 1988 nomination. For much of the 19th century, the site was the location of the town's most successful manufacturing industry. The following description is taken from the National Register Nomination Form:

The Wiswall Falls Mill Site is a 3-acre historic archaeological site located on the east shore of the Lamprey River in the southwest corner of the town of Durham, New Hampshire. It includes the physical evidence of nine separate structures, all related to the industrial use of the site between 1835 and 1883, initially by saw and grist mills, and later by a paper mill manufacturing wallpaper. The most prominent feature is the stone-lined power canal, 12 feet wide, 8-10 feet deep, and 250 feet long. Since the early 20th century, it has remained virtually undisturbed. The property remained in private ownership until it was sold to the town in 1965. The site has been the subject of Phase I and Phase II archaeological investigations in 1985 and 1986, indicating that significant portions of the site remain intact and that relevant archaeological information still exists, which could provide insight into the history of the site and aspects of the economic growth of the town of Durham. A brief overlying period of use as a hydroelectric site has not obscured the interpretive value of the complex. Documentary, as well as physical evidence indicates that the site is significant and possesses the necessary integrity to be nominated to the National Register of Historic Places (January 1988).

Three separate archaeological investigations of the site were conducted in 1985 and 1986 in association with two license applications to the Federal Energy Regulatory Commission: two by Charles E. Bolian and Jeffrey P. Maymon in 1985 and 1986, and one by Victoria Kenyon in 1986. Based on a walkover survey and subsequent testing, Bolian and Maymon identified the aboveground remains of nine separate structures, listed below, and described in further detail in the Wiswall Falls Mill Site Nomination Form. As part of their Phase II work in 1986, Bolian and Maymon conducted further subsurface investigations on structures 3 and 7, those structures anticipated to be impacted by the proposed hydroelectric development.

STRUCTURES AT WISWALL FALLS MILL SITE:

Structure 1 – Power Canal
Structure 2 – Sawmill
Structure 3 – Paper Mill, east foundation; Hydroelectric Plant
Structure 4 – Boiler Room
Structure 5 – Shingle Shed (unconfirmed)
Structure 6 – Unknown Building
Structure 7 – Shed
Structure 8 – Stockhouse
Structure 9 – Unknown Building

5.4.2 Prehistoric Period

The earliest archaeological activity at the site was the 1977 report of site NH40-10 in the New Hampshire state archaeological site files. This site consisting of a single tan flint flake, is located approximately 75 meters downstream from the National Register listed Wiswall Falls Mill Site. Archaeological surface surveys along the waterline by both Bolian (1983) and Kenyon (1985) showed large amounts of lithic flaking. Kenyon reported the discovery of lithic cores in a shovel test pit, while Bolian recovered twenty-four flakes in a single shovel test pit. However, no diagnostic material was recovered to permit a chronological assessment. Kenyon noted that prehistoric sites had been recorded at many areas along the Lamprey River dating from both the Archaic and Woodland periods (Kenyon 1985; Bolian and Maymon 1985). Although the mill site was located in an area considered to have a high potential for the recovery of prehistoric archaeological resources, testing by Bolian and Maymon (1986) in areas of relatively little disturbance uncovered no evidence of prehistoric activity.

5.5 Cultural and Economic Resources

The town of Durham is located in New Hampshire's Seacoast Region, and considered a waterfront community, directly abutting the Great and Little Bay estuaries, and the Piscataqua River, with its access to the Atlantic Ocean. In addition to the Lamprey River, the Oyster River runs through the town, which also provides water for recreational use and wildlife habitat. Durham comprises an area of approximately 25.5 square miles, of which 2.2 miles is water surface. The population (based on a 2000 census) is approximately 12,664 people. The main campus of the University of New Hampshire (founded in 1866) is also located in Durham (within ten miles of Wiswall Dam), which has an undergraduate student population of over 10,000.

With the water resources noted above, water-based recreation is a primary resource for the local residents of the towns surrounding the Lamprey River. Recreational activities in and around both the Lamprey and Oyster Rivers include, boating, canoeing, hiking, fishing, hunting, swimming, wildlife viewing and picnicking. Primary industries in the town are service based, providing services for the student population as well as the surrounding communities. Input from public meetings and use surveys indicate that recreational opportunities on the Lamprey River, including the Wiswall Dam impoundment, are very important to the local residents. Written public input and from two public meetings is found in Appendix H.

Recreational paddlers use the Lamprey River in the vicinity of the dam and the impoundment heavily, and the unusual topography of the flooded banks with inlets leading to large adjacent wetlands provides a unique opportunity for wildlife viewing and fishing. Swimming, wading, and water play also occur during summer months in the vicinity of Wiswall Road Bridge. Property owners abutting the river in the vicinity of the impoundment use the river recreationally, and several private docks have been built for boat/canoe access and swimming. In addition, the river's proximity to the University of New Hampshire allows its use by students as well as the non-student population. Numerous ponds and parks are also located in the town, which provide additional recreational opportunities. Public access to the river and impoundment, including the ability to launch small watercraft is available from the Town of Durham's land at the dam and the Wiswall Road right-of-way. Once boaters access the impoundment, they have public access to the entire length of the impoundment by traveling on the water's surface upstream from the dam. The recent Wild and Scenic designation for the section of the Lamprey River near the Wiswall Dam impoundment also improves the river's economic and cultural value.

In addition to being a recreational resource, the impoundment behind the Wiswall Dam serves as a supplemental water supply for the Town of Durham. It has been utilized for this purpose during the late summer/early fall low flow season to augment the Town's existing water supply (i.e. the Oyster River), when reduced flows concurrent with the increased population from returning UNH students have placed additional demands upon the existing water supply.

5.6 Environmental Justice

Executive Order 12898 "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" requires federal agencies to examine proposed actions to determine whether they will have disproportionately high and adverse human health or environmental effects on minority or low income populations. The Wiswall Dam and land immediately adjacent to the dam are owned by the Town of Durham, and the abutting property downstream on the left bank of the river, is privately owned. The potentially affected land also includes a low-voltage electricity transmission line corridor. Property within the vicinity of the dam, upstream and downstream, as well as on the right bank, is also privately owned residential property, with the exception of Wiswall Road and the upstream pumping station, which are owned by the Town of Durham. Within this area, there are no known specific low-income populations that could be disproportionately adversely affected by the construction of a fish ladder or bypass channel, either temporarily during construction, or long-term. The impoundment behind the dam and the river adjacent to the publicly owned land are currently accessible to fishing. The area receives regular use by anglers, and the opportunity currently exists for anglers who depend upon fishing for supplemental food supply to use the site.

5.7 Protection of Children

Executive Order 13045 "Protection of Children from Environmental Health Risks and Safety Risks" sees to protect children from disproportionately incurring environmental health risks or safety risks that might arise as a result of Army policies, programs, activities, and standards. Environmental health risks and safety risks include risks to health and safety attributable to products or substances that a child is likely to come in contact with or ingest.

The proposed project involves construction of a fish bypass channel to provide fish passage around a previously existing dam. There will not be any alteration of the existing safety fences, which limit access to the potential fall areas of the dam. Currently fencing is in place on the left dam abutment. This will remain in place during and after construction activities. In addition, potential areas of the fish bypass channel that could present a safety hazard will be fenced to prevent their direct access by all unauthorized personnel, including children.

5.8 Air Quality

Ambient air quality is protected by Federal and State regulations. The U.S. EPA has developed National Ambient Air Quality Standards (NAAQS) for certain air pollutants, with the NAAQS setting concentration limits that determine the attainment status for each criteria pollutant. The six criteria air pollutants include ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, and lead.

New Hampshire currently has non-attainment areas for carbon monoxide and ozone, with the cities of Manchester and Nashua considered non-attainment for carbon monoxide. In 1997, the EPA established a new 8-hour ozone standard and in April 2004 designated a portion of southern New Hampshire to be non-attainment for the 8-hour standard. This includes portions of Strafford County, including the cities and towns of Dover, Durham, Rochester, Rollinsford, and Somersworth (U.S. Environmental Protection Agency, 2004b).

The Wiswall Dam is in Strafford County, town of Durham. Durham, New Hampshire is considered non-attainment for ozone, receiving a “moderate” classification under the new 8-hour ozone air quality classification. The General Conformity thresholds for ozone in a moderate non-attainment area have an emission rate threshold of 100 tons per year (tons/year) of VOC (volatile organic compounds) or NO_x (nitrogen oxides) (U.S. Army Environmental Center, 2002). The total direct and indirect emissions associated with the project must be compared to the General Conformity Rule trigger levels for the State of New Hampshire.

6.0 Environmental Consequences of Proposed Action

The proposed construction of an approximately 1,100-foot long nature-like bypass channel on the left (north) side of the Lamprey River, bypassing Wiswall Dam, will not have long-term adverse effects on the environment of the Lamprey River in the vicinity of the Wiswall Dam and its associated impoundment. The bypass channel will provide passage for anadromous (and catadromous) fish to spawning habitat (and rearing habitat for eels) in sections of the Lamprey River upstream from the Wiswall Dam. The construction of a fish bypass channel will have a positive effect on the overall ecosystem of the Lamprey River. The passage of anadromous fish beyond the dam will also provide a recreational benefit to the town of Durham, (i.e. observation of fish migration) which already has several large parks and recreational areas, as well as improve the existing warm water fisheries of the impoundment behind the Wiswall Dam by the recruitment of anadromous fish into the ecosystem.

6.1 Terrestrial Environment

6.1.1 Topography

Construction of a natural stream bypass channel on the left (north) side of the Wiswall Dam will create a permanent channel through a terrace on the northern side of Lamprey River and an approximately 300-foot long earthen berm serving as a dike along the northeast bank of the Lamprey River immediately downstream of Wiswall Dam. The cut channel will have a depth of between 6 and 12 feet and a width of between 30 and 70 feet with gently sloping vegetated banks underlain by soil. The channel will have a gradient of between 1% and 1.3 % and contain permanent river flow. The existing topography is relatively flat in the upstream area, with more abrupt changes near the downstream area, so in order to create the necessary gradients, it will be necessary to excavate the higher areas and fill in the lower sections. The channel bottom will contain gravel and boulders with rock outcrops. The resulting landscape will include additional riverine habitat with a restored riparian zone along the margins of the channel throughout most of its length. The small, localized changes in topography will be restricted to the area immediately adjacent to the constructed channel along its length.

6.1.2 Geology and Soils

The construction of the proposed nature-like bypass channel is not expected to have any significant adverse effects on the existing geology and soils of the site. The construction will require excavation of approximately 3,100 yd^3 of soil and excavation, with potential blasting, of approximately 800 cubic yards of bedrock in order to achieve the 1% to 1.3% channel gradient. All exposed soil will be stabilized with slopes ranging from 20% to 50% and revegetated. The bedrock blasting will primarily be superficial and controlled. Light and shallow line charges will be used, extending to a maximum depth of 8 feet, and, therefore, will not be expected to significantly impact the integrity of the dam foundations, as well as other structures in the immediate vicinity. However, monitoring of the dam during the blasting process will be a requirement of the contractor. In addition, the nearest bedrock wells are a sufficient distance from the blasting zone such that any shockwaves will have little to no effect on the wells.

The construction of the bypass channel is not expected to have any long-term negative effects on the soils in the immediate vicinity. Short-term effects will be potential erosion and runoff of loosened excavated material into the Lamprey River; however, this impact will be minimized by the placement of silt curtains and the use of other erosion control features. Upon completion of construction activities, all excavated areas, including the riparian edges of the newly constructed channel, will be stabilized and re-vegetated. The excavated material (both the soil and the rock) will be used to create the berm and will be placed into the streambed to create the riffle-pool and run complexes. In addition, the material will be used to raise the lower areas of the streambed to the appropriate gradient.

6.1.3 Prime Farmland Soils

The FPPA applies to farmland with soil types as prime, unique, or of statewide or local importance, but not to farmland already in or committed to urban development or water storage. As noted, soils of local farmland importance exist on the site, and a "Farmland Conversion Impact Rating Form" has been completed in coordination with the Strafford County Conservation District and the Durham Office of the U.S. Department of Agriculture (USDA). Generally, the amount of impact is considered not significant, but will be documented in compliance with the FPPA (Steve Hundley, USDA, Durham NH, Personal communication). A copy of the completed form is included in Appendix G.

6.1.4 Vegetation

The proposed construction of a nature-like bypass channel will require excavating and clearing an approximate 24,000-square-foot area (approximately 0.5 acres) of vegetated (i.e. forested) upland as well as a small section of emergent wetland, 0.1 acre in size, located in the proposed path of the channel. Approximately half of this area will be temporarily used for construction access, and then restored once the channel has been completed. Primary tree species along the section are white pine and red maple. The construction of the channel will create approximately 0.5 acres of additional riparian area within the previously forested area. Although the constructed channel will divide the small emergent wetland, the result will be an increase in riverine habitat capable of supporting aquatic life. The channel will expose seeps that will probably create additional wetlands along the channel banks in the vicinity of the existing wetlands. In addition, the plan proposes construction of additional shallow areas planted with emergent wetland species in some areas of the channel to provide emergent wetland habitat (approximately 0.25 acres). Tree canopy is expected to become re-established through natural succession once the banks have been stabilized and initially revegetated.

6.1.5 Wildlife

The proposed project is not expected to have any long-term negative effect upon the existing wildlife in the Lamprey River in the vicinity of the Wiswall Dam, but is expected to have an overall positive effect. Initial construction will involve the clearing of approximately 0.50 acres of forested habitat, which includes the area to construct a temporary access road, as well as the excavated channel itself; however upon completion of the project, the adjacent artificially created riparian area will be re-planted with native vegetation and flow will be diverted into the channel. This will allow it to function as an artificially created stream and riparian area. It is anticipated that most terrestrial wildlife species will avoid the area of active construction, and with the restoration of the habitat, return. In addition, sections of the proposed construction area have been previously disturbed, including an upper gravel parking area, as well as a power line right of way in the lower section where the tree canopy has been removed. Most of the associated negative effects are expected to be temporary, and upon the completion of the project will result in the restoration of an anadromous fish migration corridor to this section of the Lamprey River.

Positive effects of the construction of the natural fish bypass channel include the restoration of riparian migratory habitat, as well as increased forage for terrestrial wildlife species upstream in the watershed. Currently the existing dam not only blocks the passage of migratory fish to upstream areas of the river, but also blocks the movements of terrestrial wildlife species. Many avian, mammalian, and herptile (reptile and amphibian) species migrate through riparian corridors using the edges as cover and forage habitat. The construction of the natural bypass channel is not only expected to provide fish passage, but may also provide additional riparian habitat potentially useable by other terrestrial wildlife. In addition, both the upstream migration of pre-spawning adult alewives and shad, as well as the downstream migration of the juveniles, will provide beneficial forage to resident wildlife species, including birds and other predatory terrestrial species. Native animals that are piscivorous (fish eating) will particularly benefit from the anticipated increase in fish biomass in the river. Such animals include avian species such as herons, loons, and raptors, as well as mammals, such as river otter and to a lesser extent raccoons, and black bear, all of which have been found in areas of the Lamprey River Watershed.

6.1.6 Reptiles and Amphibians

The proposed project is not expected to have any long-term adverse effects on reptile and amphibian species in the vicinity of the Wiswall Dam. As noted, most motile species are expected to avoid the areas of active construction, and the small area of existing wetland that will be excavated generally does not contain standing water that would be used as amphibian spawning and nursery habitat. The completed channel is expected to provide additional aquatic habitat, which could potentially be used by reptiles and amphibians, either as a migration corridor, or as aquatic forage (i.e. turtles). In 2003, an adult snapping turtle was observed attempting to pass beyond the base of Wiswall Dam upstream. The opening up of a riparian corridor around the dam is expected to allow improved passage of turtles beyond the Wiswall Dam.

6.2 Aquatic Environment

6.2.1 Hydrology

The construction of a naturalized bypass channel on the left bank of the Lamprey River is not expected to have any adverse effect upon the overall hydrology of the river in the project area, but is expected to have a positive effect by providing additional flood flow conveyance around the dam to downstream areas. Construction of the bypass channel will allow a percentage of the flood flows to be diverted around the existing structure, thereby potentially reducing flood levels over the dam.

The bypass channel will involve construction of the inlet to the channel with specifications that control flows down the channel and control the amount of drawdown that the channel will produce in the impoundment. Flows will generally be maintained in the channel all year long. At low flows, most or all the water flowing in the river will flow down the channel. At higher flows, the percentage of water flowing down the channel will be reduced to 10% or less. At low flows, the impoundment will drawdown slightly, and this drawdown can be controlled by stop logs if necessary. During high flows (as would be expected during the upstream migration season), attraction flows for the fish will be provided by the downstream configuration of the entrance channel, which will discharge just below the dam. Because the natural bypass channel will not significantly lower the normal level of the pool behind Wiswall dam, it will not affect its use as a supplemental water supply for the Town of Durham.

6.2.2 Water Quality

The construction of a natural bypass channel around Wiswall Dam is not expected to have any significant long-term adverse effects on the water quality of the Lamprey River downstream or upstream. Most of the riverbed behind the Wiswall Dam impoundment is scoured bedrock with minimal sediment. In addition, the existing sediments have been tested and found to have contaminant levels below those criteria where there would be any significant effects to sensitive aquatic life (see Section 5.2.3). Erosion control structures will be installed around the project footprint to prevent the mobilization of silt and other excavated material into the river. In addition, a coffer dam will be constructed around the areas of the bank that are planned to be excavated, both upstream and downstream in order to isolate them from the main river channel. When the project is completed (including the re-stabilization of the banks), the cofferdams and erosion control structures will be removed. The flow in the constructed channel is not expected to cause any erosion that would affect water quality, since a large section of the channel will be carved into bedrock, and all of the constructed soft unconsolidated banks will be stabilized with aquatic/riparian vegetation. The operation of the channel itself may locally improve dissolved oxygen through additional aeration as it flows through the constructed riffle-pool sequence. Prior to construction, a water quality certificate will be obtained from the state of New Hampshire, pursuant to Section 401 of the clean Water Act.

6.2.3 Riverine Processes and Sediment Chemistry

The proposed project will create an additional area of riverine habitat, including riffles and pools. The channel will be designed to allow normal sedimentation of cobbles, gravels, and finer sediments into riffles, pools, and backwaters respectively, creating a naturalized stream environment. As noted previously, chemical analysis conducted on the sediments from areas of the impoundment upstream from the dam did not indicate elevated levels of contaminants. Therefore, the opening of a bypass channel is not expected to disperse any contaminated sediments to downstream areas of the Lamprey River.

6.3 Biological Resources

6.3.1 Aquatic Vegetation/Wetlands

As noted earlier, the proposed channel will traverse approximately 0.1 acres of emergent wetland. This area is unavoidable given the configuration of the topography and constraints on the channel design. The associated excavation and construction operations have been evaluated, and the construction complies with the guidelines established in Section 404 (b)(1) of the Clean Water Act. This evaluation is presented at the end of this EA. The channel will convert the traversed wetland into riverine wetland. Exposed seeps on the gently sloping banks of the constructed channel will probably support wetland vegetation and result in an area of emergent wetlands similar to the amount that would be removed. In addition, shoaling will probably occur on the sides of the constructed channel as a result of normal sedimentation, creating areas where additional wetland vegetation can become established. Overall, there will be a gain in riverine aquatic habitat suitable for passing migratory fish. The excavation of the small wetland will be compensated as noted above with a beneficial effect on the existing ecosystem of the Lamprey River. Since the impoundment behind the dam will be maintained at or near its existing level, the bypass channel will not have any negative affects on the upstream wetlands bordering the impoundment.

6.3.2 Fisheries

The proposed project will have an overall positive effect upon the fisheries of the Lamprey River. The construction of a nature-like fishway will allow the upstream passage of anadromous (and catadromous) fish to their historic habitat upstream from the dam in the Lamprey River watershed, opening up approximately 43 miles of riverine habitat. This will benefit the existing fishery as well as the ecosystem by not only restoring historic species, but also by the influx of additional forage for the existing fish populations. Generally, in freshwater areas where river herring (i.e. alewives and blueback herring) have been restored, studies show that resident fish populations have been enhanced. The juvenile herring produced in the spawning run serve as food supply for bass and other resident and/or migratory species. All life stages of anadromous herrings are important forage for many freshwater and marine fish (i.e. striped bass) that may occur in the estuary. In addition, the mortality of anadromous alewives provides an important source of nutrients for headwater ponds (Loesch, 1987).

Approximately 43 river miles of migratory and spawning habitat will become available to anadromous alewives, blueback herring, and shad with the proposed bypass channel. In addition, the bypass channel will make available potential spawning habitat for Atlantic salmon upstream of Wiswall Dam. If an Atlantic salmon population is re-introduced to the Lamprey River watershed, the salmon would be able to continue their upstream migration to historic upstream spawning areas.

Restoration of Atlantic salmon to this section of the river will not only enhance the quality of the fishery by restoration of an historic native species, but also have an economic and/or recreational benefit to the downstream areas of the Great Bay and Little Bay estuaries. Restoration efforts for this species have been ongoing throughout New England since the since the 1960's, and represent efforts by the Federal and State governments, as well as numerous local non-profit river associations. In order for these fish to be restored to the Lamprey River, as well as their ocean rearing habitat, access to their spawning habitat needs to be provided. The Lamprey River with its tributaries represents historic spawning habitat, and the success and survival and return of the stocked juveniles indicates the presence of sufficient habitat and water quality for these fish to survive and reproduce. Therefore, the provision of fish passage will allow these fish to access this historic habitat and allow for the continued progress of their restoration to the Lamprey River.

The construction of a nature-like bypass channel is expected to create additional riverine habitat used by resident fish in the Lamprey River. Trout, largemouth and smallmouth bass, white sucker as well as smaller species (i.e. dace) will be able to move through the channel unimpeded, both upstream and downstream. This fishway will allow these fish to utilize habitat both upstream and downstream from the dam for feeding, spawning, or riverine refuge (i.e. trout). In addition, the deposition of cobbles, gravel, and sand in the constructed riffle, pool, and run areas, will provide suitable substrate for colonization by benthic invertebrates which could provide a food supply for fish inhabiting that section of the river. The bypass channel will also enable these benthic invertebrates to migrate around the Wiswall Dam to areas upstream of the impoundment. In Europe, caddis fly larvae have been observed in bypass channels (FAO, 2002), and it is assumed that any channel with suitable substrate will provide passage for migrating benthic organisms, as well as fish. With the eventual re-growth of the riparian canopy, leaf litter can also be expected to contribute to the overall productivity of the constructed channel by providing additional nutrients/detritus to the substrate, used as food by benthic invertebrates.

6.3.3 Threatened and Endangered Species

Coordination with the U.S. Fish and Wildlife Service indicated that no Federally listed threatened or endangered species under the jurisdiction of the U.S. Fish and Wildlife Service occur in the vicinity of the Wiswall Dam with the exception of occasional transient bald eagles (*Haliaeetus leucocephalus*) (See letter dated April 21, 2003, Appendix G). Recent coordination with the New Hampshire Division of Fish and Game Natural Heritage and Endangered Species Inventory has indicated the presence of several rare turtle and plant species in the Lamprey River Corridor in the vicinity of the Wiswall Dam. These include

Blanding's turtle (*Emydoidea blandingii*), wood turtle, (*Clemmys insculpta*), and knotty pondweed (*Potomageton nodusus*) (see letter dated January 11, 2002, Appendix G). However, based on the previous discussion in section 5.3.3 of this Environmental Assessment, it is unlikely that suitable habitat for the Blanding's turtle is present in the footprint of the proposed project, since its preferred habitat generally vegetated shallow ponds and marshes or small streams. The area within the project footprint consists is primarily forested, with minimal areas of standing water. Although there is the potential for wood turtle to be present, this species is highly mobile and would avoid the area of active construction. Generally, both species, if present, would be expected to move out of the construction area. The knotty pondweed, being strictly an aquatic species, should not be affected by land-based construction activities. In addition, there have been no observations of any of these species in the immediate vicinity of the project footprint. When the project is completed, it is anticipated that there will be an overall positive effect on the habitat of both of these turtles by re-opening a riverine migratory corridor, which these species have been known to use.

6.3.4 Essential Fish Habitat Assessment

The proposed construction of a nature-like bypass channel around Wiswall Dam is not expected to have any significant long-term negative impacts on EFH for the designated life stages of Atlantic salmon (noted previously), as well as the noted life stages of the species listed in section 5.3.4 of this EA, which occur in the Great Bay Estuary. During construction, erosion control measures will be in place to minimize negative effects to water quality resulting from silt/sediment runoff. Cofferdams will also be employed in order to isolate the actual areas of in-river work both upstream and downstream of the dam (i.e. the entrance and exit channels). Work will be timed in order to avoid interference with either up-migrating or down-migrating anadromous river herring, as well as any Atlantic salmon that may be in the area.

The proposed project is expected to have an overall positive effect on EFH for the designated life stages of Atlantic salmon in the Lamprey River. The proposed natural stream bypass channel will enable anadromous Atlantic salmon as well as river herring to access an additional 43 miles of river with potential spawning and nursery habitat upstream from the Wiswall dam. Although recent returns of Atlantic salmon to the Lamprey River have been low, the potential spawning habitat exists in the Lamprey River and its tributaries for restoration of this species to the river. The natural bypass channel will provide both upstream and downstream passage for pre/post spawning adults as well as down-migrating smolts.

The proposed project is also expected to have a positive effect on many of the EFH species that inhabit the Great Bay Estuary as well as the Gulf of Maine. The bypass channel will open up additional spawning habitat for anadromous alewives and blueback herring, which are preyed upon by several of the listed EFH species such as bluefish and Atlantic salmon (Scott and Crossman, 1979). In addition, many other larger marine predator species prey on Alewives, including striped bass. The additional alewife and blueback herring spawning habitat that will become available to these fish from the bypass channel is expected to increase their numbers in the Great Bay Estuary as well as the Gulf of Maine, thereby having a positive effect on these ecosystems, including the EFH species inhabiting these areas.

6.4 Historical and Archeological Resources

In evaluating the project alternatives and their potential impacts upon a National Register listed historic site, the following determinations of effect can be assumed. (While the bypass channel is the proposed alternative, all alternatives are assessed in this section.):

Dam removal: Although Wiswall Dam is not included within the National Register nominated historic site, the dam represents a contributing element to the historic site, and its removal would constitute an adverse effect upon significant resources. In addition, removal of the dam would also require the removal of an older timber crib dam located in the impoundment beneath the current structure. If this alternative were ultimately selected, additional coordination with the New Hampshire State Historic Preservation Officer (NH SHPO) would be required and proper mitigation methods developed in a Memorandum of Agreement (MOA) prior to implementation.

Construction of fish lift: This alternative would require extensive alterations to the dam and to the historic viewshed, resulting in an adverse effect upon the Wiswall Falls Mill Site. This alternative would require a power supply and the use of lift operators as well as periodic maintenance during operation. Further details on the implementation of this alternative would be needed for a proper evaluation. At this time, this alternative was eliminated from detailed analysis due to the high maintenance required.

Construction of fish ladder: The construction of a Denil type fish ladder would result in an adverse effect upon the Wiswall Falls Mill Site due to the extensive ground disturbance and modifications required for implementation. In addition, this alternative would create an obtrusive visual impact to the setting of the dam and surrounding elements of the historic landscape. These modifications would result in a “change [in] the character of the property’s use or of [the] physical features within the property’s setting that contribute to its historic significance (36 CFR 800.5(a)(2)(iv)).” This would result in further coordination and development of an MOA with specific stipulations for the mitigation of this impact. It is expected that comparable stone facing of the wall of the ladder would help to mitigate some of the impact. Stone facing would be made comparable to that existing at the historic site.

Construction of rock ramp-type fishway at former sluiceway: This alternative would incorporate a rock ramp fishway within the former sluiceway on the left side of the Wiswall Dam. This alternative would alter the original design characteristics of the sluiceway, resulting in an adverse effect to the historic site (see above), even though none of the stonewalls are expected to be removed. Possible impacts to the paper mill site (#3) are anticipated as the fishway turns to the north and along the river, ultimately connecting just below the dam. This alternative would result in the preparation of an MOA that would stipulate mitigation measures that may include historic documentation of the existing sluiceway and further Phase II and/or Phase III archaeological investigations. We conclude that this alternative would result in an adverse effect upon significant cultural resources.

Construction of low gradient nature-like bypass channel: This alternative would entail construction of a new channel that would bypass most of the Wiswall Falls Mill Site's nine structures and connect just below the dam. This alternative is expected to avoid the majority of the sites within the historic landscape. In addition, it would incorporate portions of private property that are included within the nomination boundary within the area of potential effect, extending resource protection beyond town-owned property. However, due to the substantial subsurface modifications required for construction of this channel, including the need for both an inlet and outlet located within portions of the historic site, as well as the potential for additional impacts to include filling of the sluiceway and alterations to portions of the paper mill site, this alternative would constitute an adverse effect upon the Wiswall Falls Mill Site. In this case, further coordination would be needed and preparation of an MOA would be required with specific mitigation measures. Documentation of the existing site conditions and additional Phase II/III archaeological studies of impacted areas are possible mitigation measures that would be adopted as part of this scenario.

Lastly, the regrading of an existing parking area along Wiswall Road and construction of a 14-foot wide gravel access road have the potential to impact significant or as yet unidentified resources. Structure #9 is located adjacent to the parking area as presently configured. The access road would run parallel to the bypass channel from Wiswall Road south and then west to the dike to be constructed adjacent to the Lamprey River as part of this alternative. It appears that portions of the access road would be located on private property and outside of the Wiswall site nomination boundary. Alignment of the parking area and access road may need to be redesigned to avoid sensitive areas of the site.

In summary, each of the above alternatives (with the possible exception of the fish lift) would constitute an adverse impact upon the Wiswall Falls Mill Site. We expect the NH SHPO to concur with these determinations. At the meeting with the New Hampshire Division of Fish and Game on January 26, 2004, a representative from the NH SHPO's office (Ms. Edna Feighner) was present and concurred verbally with these conclusions. Further evaluation and coordination, including development of an MOA, would then be required during Plans and Specifications phase of the study.

6.5 Cultural and Economic Resources

The construction of a naturalize bypass channel on the left bank of the Lamprey River around the Wiswall Dam is expected to have an overall benefit to the cultural and economic resources of the town of Durham. As noted, recreation is a major activity/resource for the town, and the restoration of anadromous fish to the Lamprey River will enhance recreational activities in several ways. These include fish viewing, since the up migrating fish will be visible in the channel, as well as improved recreational fishing, since the influx of river herring into the system can improve the overall productivity of the existing fisheries in the river. Additional value will be added to the Lamprey River ecosystem and its Wild and Scenic Status, as well as to the productivity of the Great Bay National Estuary, by the restoration (i.e. return) of river herring to the ecosystem.

6.6 Environmental Justice

The proposed project is not expected to pose impacts upon any minority or low-income populations adjacent to or in the vicinity of the project pursuant to Executive Order No. 12898. The proposed will provide benefits to the recreational fishing community in general, since public access to the river and impoundment is maintained by this alternative. Therefore, there are not expected to be any disproportionate impacts on any Environmental Justice populations resulting from the proposed project.

6.7 Protection of Children

EO 13045 requires federal agencies to examine proposed actions to determine whether they will have disproportionately high human health or safety risks on children. During the construction phase of the proposed project, heavy construction equipment and vehicles will be transported to the site. However, the actual site will be fenced off to prevent unauthorized personnel from entering the work area (including children). In addition, there will be a temporary increase in truck traffic transporting materials to and from the site. These trucks will be limited to the public roadways, and the existing project access road (right of way), and are therefore not expected to cause any disproportionate direct, indirect or cumulative impact to children associated with environmental health or safety risks. Construction itself is expected to last for approximately 4 months. Therefore, this increased traffic will be for a short duration and temporary.

A fence is currently in place at one of the hazardous fall areas of the dam. The proposed bypass channel will also include fences over potentially hazardous fall areas to prevent access by unauthorized personnel to these areas. Public access to the project is not expected to disproportionately impact children, since any hazardous areas will be fenced to prevent access. There are no schools or playgrounds in the immediate vicinity of the footprint of the proposed project.

6.8 Air Quality Statement of Conformity

Section 176 (c) of the Clean Air Act (CAA), specifically with EPA’s General Conformity Rule, requires all Federal agencies, including Department of the Army, to review new actions and decide whether the actions would worsen an existing NAAQS violation, cause a new NAAQS violation, delay the State Implementation Plan (SIP) attainment schedule of the NAAQS, or otherwise contradict the State’s SIP. Corps of Engineers guidance on air quality compliance is summarized in Appendix C of the Corps Planning Guidance Notebook (ER1105-2-100, Appendix C, Section C-7, pg. C-47).

New Hampshire is authorized by the EPA to administer its own air emissions permit program, which is shaped by its SIP. The SIP sets basic strategies for implementation, maintenance, and enforcement of the National Ambient Air Quality Standards (NAAQS). In New Hampshire, federal actions must conform to the New Hampshire state implementation plan or federal implementation plan. The State's Implementation Plan (SIP) is the federally enforceable plan that identifies how that State will attain and/or maintain the primary and secondary National Ambient Air Quality Standards (NAAQS) established by the EPA (U.S. Environmental Protection Agency, 2004b). When the total direct and indirect emissions caused by the operation of the federal action/facility are less than threshold levels for emission established in the General Conformity Rule (40 CFR 93.153) a Record of Non-applicability (RONA) is prepared and signed by the facilities environmental coordinator. Table 12 displays General Conformity Trigger Levels established for VOC's and NOx within the study area.

Table 12. General Conformity Trigger Levels Established for Durham, NH

Pollutant	General Conformity Trigger Levels (tons per year)
VOCs	50
NOx	100

To conduct a general conformity review and emission inventory for the Wiswall Dam Section 206 Project, a list of construction equipment was identified using the project construction cost estimate. A first column of the emissions calculations table (Appendix I) provides a summary equipment list. The New England District of the Corps prepared calculations of the worst-case project-specific emissions of NOx and VOCs to determine whether project emissions would be under the General Conformity Trigger Levels. Because of the small scale of the project, several simplifying assumptions were applied in performing the calculations to prepare a worst-case analysis. The actual emissions would most likely be much lower, but in no case above the calculated values. The horsepower for all equipment is the highest horsepower rating for any of the equipment of that type to be used in the project construction. For instance, if two different dozers were required, the Corps used the horsepower rating for the larger dozer for each of the two dozers. A load factor is the average percentage of rated horsepower used during a source's operational profile. To simplify the calculations, the Corps used a worst-case estimate of 1.0, or 100 percent for all equipment. The Corps used 10 hours per day as worst-case hours of operation for most equipment, except pumps for which the Corps used 24 hours per day of operation. The Corps used the total construction duration to estimate days of operation, rather the specific days of operation for each piece of equipment. Based on these calculations, the worst-case NOx emissions were no greater than 41.63 tons and the worst-case VOC emissions were no greater than 5.91 tons. In both cases, the total construction emissions were below the General Conformity Trigger Levels (Table 12).

Detailed calculations (i.e. not worst case) for several projects of similar scale in the Corps of Engineers, Philadelphia District (small navigations, emergency streambank stabilization, and ecosystem restoration projects in New Jersey, and a road maintenance project in Delaware) had calculated emissions well below the threshold levels (Table 12). Table 13 summarizes the emissions estimates for these four projects. Detailed calculations for the Wiswall Dam Project would be likely to have values closer to this range. Appendix I contains the equipment list for the Wiswall Dam Section 206 Project, and the calculations and listing of equipment for and the four projects in the Philadelphia District.

Table 13. Estimated Project Emissions for Ozone at Four Corps of Engineers Projects Located in Severe Non-Attainment Areas

Project	Location	Type	Maximum Pollutant (tons)	
			NOx	VOCs
Wills Hole Thorofare	New Jersey	Small Navigation-Dredging	9.80	0.25
Barnegat Bay Dredged Hole #6	New Jersey	Ecosystem Restoration	19.90	0.36
Manasquan River at Bergerville Rd	New Jersey	Streambank Stabilization	0.69	0.10
Summit Bridge Road Maintenance	Delaware	Road Maintenance	5.01	0.71
Combined Totals			35.40	1.42
Multiple of 2 combined totals (tons):			**70.80**	**2.84**

The total estimated direct and indirect emissions that would result from construction of the Wiswall Dam are below the General Conformity trigger levels of 100 tons per year of NOx and VOCs. General Conformity under the Clean Air Act, Section 176 has been evaluated for the project according to the requirements of 40 CFR 93, Subpart B. The requirements of this rule are not applicable to this project because the total direct and indirect emissions from the project are below the conformity threshold values established at 40 CFR 93.153 (b) for ozone (NOx and VOCs) in a moderate attainment area. Therefore, the Wiswall Dam project is not considered regionally significant under 40 CFR 93.153 (i).

New Hampshire requires new and modified sources of air pollution to obtain a permit to operate. In New Hampshire, for construction, a temporary construction permit has to be obtained before the modification of an existing source or the installation of a new source begins. The proposed project does not have any new or will not modify any stationary air pollution sources. An air quality permit is not required.

6.9 Cumulative Effects

Cumulative impacts are those resulting from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions. The past and current activities in the Lamprey River in the vicinity of Wiswall Dam include maintenance and repair of the spillway and floodgates at the dam itself, as well as repair of the bridge abutments and re-surfacing of the pavement on Wiswall Road, approximately 0.25 miles upstream from the dam. The bridge and dam may require maintenance within the next 10 years. However, it is expected that any construction activities would be accomplished during construction windows established to minimize negative effects to the existing aquatic and/or wetland habitat. These events are generally infrequent, and therefore the effects of these and previous activities would not be expected to significantly affect water quality, air quality, hydrology, and other biological resources.

This project is expected to benefit the overall ecological health the Lamprey River by restoring anadromous fisheries and connectivity of the riverine habitat. The direct effects of this project are not anticipated to add to any adverse impacts from other actions in the area (i.e. those noted above). Therefore, no adverse cumulative impacts are projected as a result of this project.

Beneficial cumulative effects include those which when added to this project will further improve the Lamprey River ecosystem. The provision of fish passage beyond the Wiswall Dam cumulatively increases the overall available anadromous fish habitat in the Lamprey River. Without this project, these fish are only able to pass from tidewater over the Macallen Dam, to the base of the Wiswall Dam. With this project in place, approximately 43 additional river miles are available for spawning and migratory habitat. If other dams on either the Lamprey River or its tributaries are removed, then additional anadromous fish habitat will become available with further improvements to the ecosystem resulting from the restoration of historic anadromous fisheries. Further improvements to the fish passage facility at Macallen Dam could increase the numbers and species of migrating fish reaching Wiswall Dam. The proposed fishway at Wiswall Dam would allow this increased number of fish to continue migrating upstream of Wiswall Dam, providing cumulatively positive benefits to any fish-passage improvements to the Macallen Dam.

6.10 Actions Taken to Minimize Impacts

Construction of the natural bypass channel at the Wiswall Dam is proposed to occur during the summer low flow season outside of the times of any existing anadromous fisheries downstream migration. A Water Quality Certificate will be obtained prior to construction pursuant to section 401 of the Clean Water Act, and any construction windows and/or time restrictions that may be noted in it would be followed in order to minimize potential impacts to existing or migrating fish species. During construction, flows will be diverted around the upstream and downstream connections to the river, and proper erosion control measures will be utilized. Temporary cofferdams will be used to divert the water around the area of active construction, and silt fences will be installed around the excavation area. These measures will minimize any potential water quality impacts to the river from silt runoff. Access of construction equipment to the area will be accomplished by the construction of the access road (noted previously) along the proposed channel, which will also provide public viewing access once the project is completed.

The completed channel will involve diverting flow from the spillway through the bypass channel, which will discharge at the base of the spillway. Therefore, flows downstream from the spillway area will not be altered by the operation of the channel. In addition, parts of the lower channel will be enlarged, to create shallow areas, which will be planted (or allowed to re-vegetate) with native wetland vegetation. Upon completion, the construction footprint will be re-stabilized and replanted with native vegetation including the areas along and adjacent to the constructed access road.

7.0 Coordination

7.1 Personal Communication

- The following persons were coordinated with in the preparation of this report.
- Mr. Doug Grout, New Hampshire Department of Fish and Game, Region 3, Durham, New Hampshire.
- Mr. Joseph McKeon. U.S. Fish and Wildlife Service, Central New England Fishery Resources Complex, Nashua, New Hampshire.
- Mr. Vernon Lang, U.S. Fish and Wildlife Service, Concord, New Hampshire.
- Mr. Richard Quinn, U.S. Fish and Wildlife Service, Newton Corner, Massachusetts.
- Ms. Cheri Patterson, New Hampshire Department of Fish and Game, Region 3, Durham, New Hampshire.
- Dr. Alex Haro, U.S. Geological Service, Contes Anadromous Fisheries Research Laboratory, Turners Falls, Massachusetts.
- Ms. Stephanie Lindloff, New Hampshire Department of Environmental Protection, Concord, New Hampshire.

7.2 Site Visit

A coordinated site visit was conducted by Corps of Engineers Personnel on February 12, 2002. The following people attended:

- Mr. Adam Burnett, USACE, New England District, Planning Branch
- Mr. Ken Levitt, USACE, New England District, Evaluation Branch
- Mr. Bob Levesque, Town of Durham, New Hampshire
- Mr. Dave Price, New Hampshire Department of Environmental Services, Wetlands
- Mr. Vernon Lang, U.S. Fish and Wildlife Service, Concord, New Hampshire
- Mr. Joseph McKeon, U.S. Fish and Wildlife Service, Nashua, New Hampshire

7.3 Correspondence

Project coordination Letters were mailed to the following people prior to the preparation of this report pursuant to the Federal Fish and Wildlife Coordination Act, Federal Endangered Species Act, and the National Historic Preservation Act (See Appendix G).

Mr. Michael Bartlett
U.S. Fish and Wildlife Service
70 Commercial Street
Suite 300
Concord N.H. 03301-5087

Mr. Jack Terrill
Asst. Regional Admin. for Habitat Conservation
National Marine Fisheries Service
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Mr. David Webster
Director, Massachusetts Office of Ecosystem Protection
EPA – New England, Region 1
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Mr. Harry T. Stewart, P. E.
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Department of Environmental Services
6 Hazen Drive, PO Box 95
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Mr. Douglas Grout, Marine Biologist
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Mr. Joseph F. McKeon
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U.S. Fish and Wildlife Service
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Wayne E. Vetter, Executive Director
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Mr. Ken Kettenring
State of New Hampshire
Department of Environmental Services (DES)
Wetlands Bureau
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Mr. George D. Bisbee
Assistant Commissioner
State of New Hampshire
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Mr. David More
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Mr. John Kanter
Nongame and Endangered Wildlife Program
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2 Hazen Drive
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Mr. James McConaha, Director and SHPO
New Hampshire Division of Historical Resources
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Mr. Vernon Lang
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Mr. Jamie Fosburgh
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Mr. Harry T. Stewart, P. E. Director, Water Division
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Mr. David More
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Concord NH 03302

Mr. David Webster
Director, Massachusetts Office of Ecosystem Protection
EPA – New England, Region 1
One Congress Street, Suite 1100 (CMA)
Boston, Massachusetts 02114-2023

7.4 Wiswall Dam Fish Passage Working Group

The Wiswall Dam fish Passage Working Group, with participants from federal, state and local natural resource agencies and interests, was formed in 2001 in order to address the various effects of fish passage alternatives on the ecological, economic, aesthetic, and recreational environments of the project area, and to assist with developing an appropriate alternative. The agencies include:

- Lamprey River Advisory Committee (includes representatives from the towns of Durham, Epping, Lee and Newmarket)
- U.S. National Park Service
- New Hampshire Department of Environmental Services
- New Hampshire Fish and Game Department
- Town of Durham
- University of New Hampshire
- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service

Individual participants are listed below:

- Bob Levesque, Town of Durham,
- Brad Larrabee, University of New Hampshire
- Cheri Patterson, NH Fish and Game
- Doug Grout, NH Fish and Game
- Grace Levergood, NH DES - Dam Bureau
- Jamie Fosburgh, National Park Service
- Joe McKeon, U.S. Fish and Wildlife Service
- Judith Spang, Lamprey River Advisory Committee
- Laura Wildman, American Rivers
- Margaret Watkins, National Park Service
- Ralph Abele, U.S. EPA
- Scott Decker, NH Fish and Game
- Stephanie Lindloff, NH DES
- Vernon Lang, U.S. Fish and Wildlife Service
- Adam Burnett, U.S. Army Corps of Engineers

This committee met monthly during the course of the study to discuss the various aspects of the proposed project. Minutes of these meetings are available upon request by contacting Mr. Adam Burnett, U.S. Army Corps of Engineers, New England District, 696 Virginia Road, Concord, MA 01742, (978) 318-8547 (adam.w.burnett@usace.army.mil).

7.5 Public Meetings

Public Meetings concerning the proposed fish passage project were conducted by the U.S. Army Corps of Engineers and the Wiswall Dam Fish Passage Working Group on February 12, 2002, and November 13, 2002.

The purpose of the meeting on February 12, 2002, was to inform the public of the proposed fish passage alternatives and to elicit comments. Comments included concern over the dam removal and resulting loss of the impoundment and its associated ecological, recreational, and economic functions. In addition, there was concern by the Town of Durham with the loss of their back-up water supply. Many of the participants either owned land that abutted the Wiswall Dam impoundment, or regularly used it for recreation and wanted the dam to remain in place. Other comments were from abutters concerned with the effect of the loss of the impoundment on property values.

The meeting on November 13, 2002 was conducted by the Wiswall Dam Fish Passage Working Group as a forum on recreational activity at the Wiswall Dam impoundment. Questionnaires were distributed to the participants. Copies of these questionnaires and results of the survey can be found in Appendix H (Public Input).

Generally, major public comments that were raised during both meetings concerned: 1) recreational use of the impoundment, 2) nature viewing and aesthetics, 3) public access by boaters, due to loss of the impoundment, 4) loss of the public water supply, and 5) protection of historic attributes of the area.

8.0 Compliance With Environmental Statutes and Executive Orders

8.1 Federal Statutes

1. Archaeological Resources Protection Act of 1979, as amended, 16 USC 470 et seq.

Compliance: Not Applicable as issuance of a permit from the Federal land manager to excavate or remove archaeological resources located on public or Indian is not required.

2. Preservation of Historic and Archeological Data Act of 1974, as amended, 16 U.S.C. 469 et seq.

Compliance: Project is being coordinated with the State Historic Preservation officer. Impacts to archaeological resources, if applicable, will be properly mitigated. Additional coordination with the SHPO will include preparation of an MOA with specific mitigation measures. Documentation of the existing site conditions and additional Phase II/III archaeological studies of the impacted areas are possible mitigation measures that would be adopted as part of this project.

3. American Indian Religious Freedom Act of 1978, 42 U.S.C. 1996.

Compliance: Must ensure access by Native Americans to sacred sites, possession of sacred objects, and the freedom to worship through ceremonials and traditional rites. Coordination with the NH SHPO and interested American Indians will continue during the Plans and Specifications preparation as archaeological surveys are planned and the preparation of a Memorandum of Agreement completed as partial mitigation for use of the bypass channel at the Wiswall Falls National Historic Site. Properties of traditional religious and cultural importance, if any, will be identified at that time.

4. Clean Air Act, as amended, 42 U.S.C. 7401 et seq.

Compliance: Public notice of the availability of this report to the Environmental Protection Agency is required for compliance pursuant to Sections 176c and 309 of the Clean Air Act.

5. Clean Water Act of 1977 (Federal Water Pollution Control Act Amendments of 1972) 33 U.S.C. 1251 et seq.

Compliance: A Section 404(b)(1) Evaluation and Compliance Review is incorporated into the project report. An application shall be filed for State Water Quality Certification pursuant to Section 401 of the Clean Water Act.

6. Coastal Zone Management Act of 1972, as amended, 16 U.S.C. 1451 et seq.

Compliance: A CZM consistency determination shall be provided to the State for review and concurrence that the proposed project is consistent with the approved State CZM program. Not Applicable. Project is not within the Coastal Zone.

7. Endangered Species Act of 1973, as amended, 16 U.S.C. 1531 et seq.

Compliance: Coordination with the U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) has determined no formal consultation requirements are necessary pursuant to Section 7 of the Endangered Species Act.

8. Estuarine Areas Act, 16 U.S.C. 1221 et seq.

Compliance: Applicable only if report is being submitted to Congress. Report is not being submitted to Congress, therefore, Not Applicable.

9. Federal Farmland Protection Policy Act (FPPA) of 1981 7 U.S.C. 4201 et seq.

Compliance: Coordination with District Soils Conservation Office has occurred. Completed Farmland Conversion Impact Rating Form is included with this EA.

10. Federal Water Project Recreation Act, as amended, 16 U.S.C. 4601-12 et seq.

Compliance: Public notice of availability of the project report to the National Park Service (NPS) and Office of Statewide Planning relative to the Federal and State comprehensive outdoor recreation plans signifies compliance with this Act.

11. Fish and Wildlife Coordination Act, as amended, 16 U.S.C. 661 et seq.

Compliance: Coordination with the FWS, NMFS, and State fish and wildlife agencies signifies compliance with the Fish and Wildlife Coordination Act.

12. Land and Water Conservation Fund Act of 1965, as amended, 16 U.S.C. 4601-4 et seq.

Compliance: Public notice of the availability of this report to the National Park Service (NPS) and the Office of Statewide Planning relative to the Federal and State comprehensive outdoor recreation plans signifies compliance with this Act.

13. Marine Protection, Research, and Sanctuaries Act of 1971, as amended, 33 U.S.C. 1401 et seq.

Compliance: Not applicable, the project does not involve the transportation or disposal of dredged material in ocean waters pursuant to Sections 102 and 103 of the Act, respectively.

14. National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470 et seq.

Compliance: Coordination with the State Historic Preservation Office signifies compliance.

15. Native American Graves Protection and Repatriation Act (NAGPRA), 25 U.S.C. 3000-3013, 18 U.S.C. 1170

Compliance: Regulations implementing NAGPRA will be followed if discovery of human remains and/or funerary items occur during implementation of this project.

16. National Environmental Policy Act of 1969, as amended, 42 U.S.C 4321 et seq.

Compliance: Preparation of an Environmental Assessment signifies partial compliance with NEPA. Full compliance shall be noted at the time the Finding of No Significant Impact is signed.

17. Rivers and Harbors Act of 1899, as amended, 33 U.S.C. 401 et seq.

Compliance: Not Applicable. No requirements for projects or programs authorized by Congress. The proposed aquatic ecosystem restoration project is being conducted pursuant to the Congressionally-approved authority.

18. Watershed Protection and Flood Prevention Act as amended, 16 U.S.C 1001 et seq.

Compliance: Floodplain impacts were considered in project planning.

19. Wild and Scenic Rivers Act, as amended, 16 U.S.C 1271 et seq.

Compliance: The Lamprey River in the study area is designated as a Recreational River under the Wild and Scenic Rivers Act. Coordination with the Department of the Interior to determine project impacts on designated Wild and Scenic River has occurred. Project will not negatively impact the Wild and Scenic River designation.

20. Magnuson-Stevens Act, as amended, 16 U.S.C. 1801 et seq.

Compliance: Coordination with the National Marine Fisheries Service and preparation of an Essential Fish Habitat (EFH) Assessment signify compliance with the EFH provisions of the Magnuson-Stevens Act.

8.2 Executive Orders

1. Executive Order 11593, Protection and Enhancement of the Cultural Environment, 13 May 1971.

Compliance: Coordination with the State Historic Preservation Officer signifies compliance.

2. Executive Order 11988, Floodplain Management, 24 May 1977 amended by Executive Order 12148, 20 July 1979.

Compliance: Public notice of the availability of this report or public review fulfills the requirements of Executive Order 11988, Section 2(a) (2).

3. Executive Order 11990, Protection of Wetlands, 24 May 1977.

Compliance: Public notice of the availability of this report for public review fulfills the requirements of Executive Order 11990, Section 2 (b).

4. Executive Order 12114, Environmental Effects Abroad of Major Federal Actions, 4 January 1979.

Compliance: Not applicable to projects located within the United States.

5. Executive Order 12898, Environmental Justice, 11 February 1994.

Compliance: The project is not expected to have a significant impact on minority or low-income population, or any other population in the project area.

6. Executive Order 13007, Accommodation of Sacred Sites, 24 May 1996.

Compliance: Not applicable. Project is not located on Federal Lands.

7. Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks. 21 April 1997.

Compliance: The project would not create a disproportionate environmental health or safety risk for children.

8. Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, 6 November 2000.

Compliance: Not applicable, since there are no Federally recognized tribes in New Hampshire.

8.3 Executive Memorandum

Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing NEPA, 11 August 1980.

Compliance: Coordination with local NRCS and USDA has occurred. Farmland Conversion Impact Rating Form is included with EA

White House Memorandum, Government-to-Government Relations with Indian Tribes, 29 April 1994.

Compliance: Consultation with Federally Recognized Indian Tribes, where appropriate, signifies compliance Not Applicable. No Federaly recognized Indian Tribes in New Hampshire.

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