

Bronx Zoo and Stone Mill Diadromous Fish Passage Final Designs
Final Report

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Table of Contents

Executive Summary.....	page 4
Introduction.....	page 6
Objectives and Background.....	page 10
Design Process.....	page 12
Permitting	page 14
Next Steps	page 16

Executive Summary

The Bronx River, New York City's only freshwater river, runs from the Kensico Reservoir in Westchester County to where it meets the East River and Long Island Sound in the Hunt's Point and Soundview neighborhoods of the South Bronx, NY. Though much of the area surrounding the eight mile stretch of the Bronx River within the borough of the Bronx is highly urbanized, the river acts as a corridor for important native plant and wildlife populations. However, three dams on the Bronx River currently prevent upstream migration of alewife and blueback herring (collectively referred to as river herring).

River herring are anadromous fish, living most of their lives in the ocean and returning to their natal rivers to spawn, from March to June of each year. River herring play an important role in nutrient and energy transport between freshwater and marine waters. River herring are key prey for birds and mammals in streams, ponds and rivers including osprey, river otter, and great blue heron, and for large fish and mammals in estuaries and the ocean including bottlenose dolphin, tuna, striped bass and white perch.

Dams have blocked river herring movement on the Bronx River since the 1600's when European settlers first came to the area. Dams were originally built to run mills for tobacco factories, bleacheries, tanneries and other industries. Regionally, today's populations of river herring have been drastically reduced from historic levels and continue to decline in many locations in the Northeast, in part, due to such migration barriers.

For the past decade, the New York City Department of Parks and Recreation (NYC Parks) Natural Resources Group (NRG) has worked to address fish passage and river herring habitat enhancement on the Bronx River. NRG has worked with regional and national experts on anadromous fish passage to study the feasibility of establishing a sustainable river herring population in the Bronx River, consider alternatives for creating passage on the river, raise funds and develop designs, and construct a fish passage at the first impediment to fish migration on the Bronx River at the East 182nd Street Dam. The first fish passage on the Bronx River will open in spring of 2015 at the southernmost dam.

The goal of this HEP - NEIWPC funded project was to produce final designs, plans, specifications, cost estimates and to secure permits for the installation of fish passage at the northern two barriers to river herring migration within New York City on the Bronx River: the Bronx Zoo Dam within Wildlife Conservation Society's (WCS) Bronx Zoo and

the Stone Mill Dam within the New York Botanical Garden (NYBG). The construction of these fish passages will make 7.3 additional miles of spawning habitat available for river herring, and address the Harbor Estuary Program's Target Ecosystem Characteristic (TEC) of establishing Tributary Connections by reconnecting freshwater river reaches to the region's estuary and marine systems. NRG worked with the engineering and design firm of Milone and MacBroom, Inc. (MMI) to complete the final designs and construction documents for these two remaining fish passages on the Bronx River in the Bronx.

Introduction

Three dams on the Bronx River in the borough of the Bronx, NY currently prevent upstream migration of anadromous alewife and blueback herring, collectively referred to as river herring. River herring play an important role in nutrient and energy transport between freshwater and marine waters; they live most of their lives in the ocean and each year from March to June migrate to freshwater streams, rivers and lakes to spawn. Currently, alewife are known to swim up to the base of the first downstream dam at East 182nd Street, but are not able to migrate upstream to suitable spawning habitat, as they cannot navigate around the dam. The fish passage at the East 182nd Street Dam, supported by a \$430,000 grant from Wildlife Conservation Society and the National Oceanic and Atmospheric Administration (WCS/NOAA) and a \$446,800 grant from New York State Department of State Environmental Protection Fund (NYS DOS-EPF), will open for the first migration season in spring of 2015 and will make about 10 acres of previously inaccessible upstream spawning and rearing habitat available to river herring.

Providing fish passage upstream from the East 182nd Street Dam to the Bronx Zoo Dam and then to the Stone Mill Dam on the Bronx River will provide access to approximately 7.3 miles of additional upstream spawning and rearing habitat to the next upstream dam in Westchester County. This increased habitat availability for river herring will contribute to regional efforts to protect and restore habitat for these species that serve as important prey for native fish and wildlife in our rivers, estuaries and the ocean.

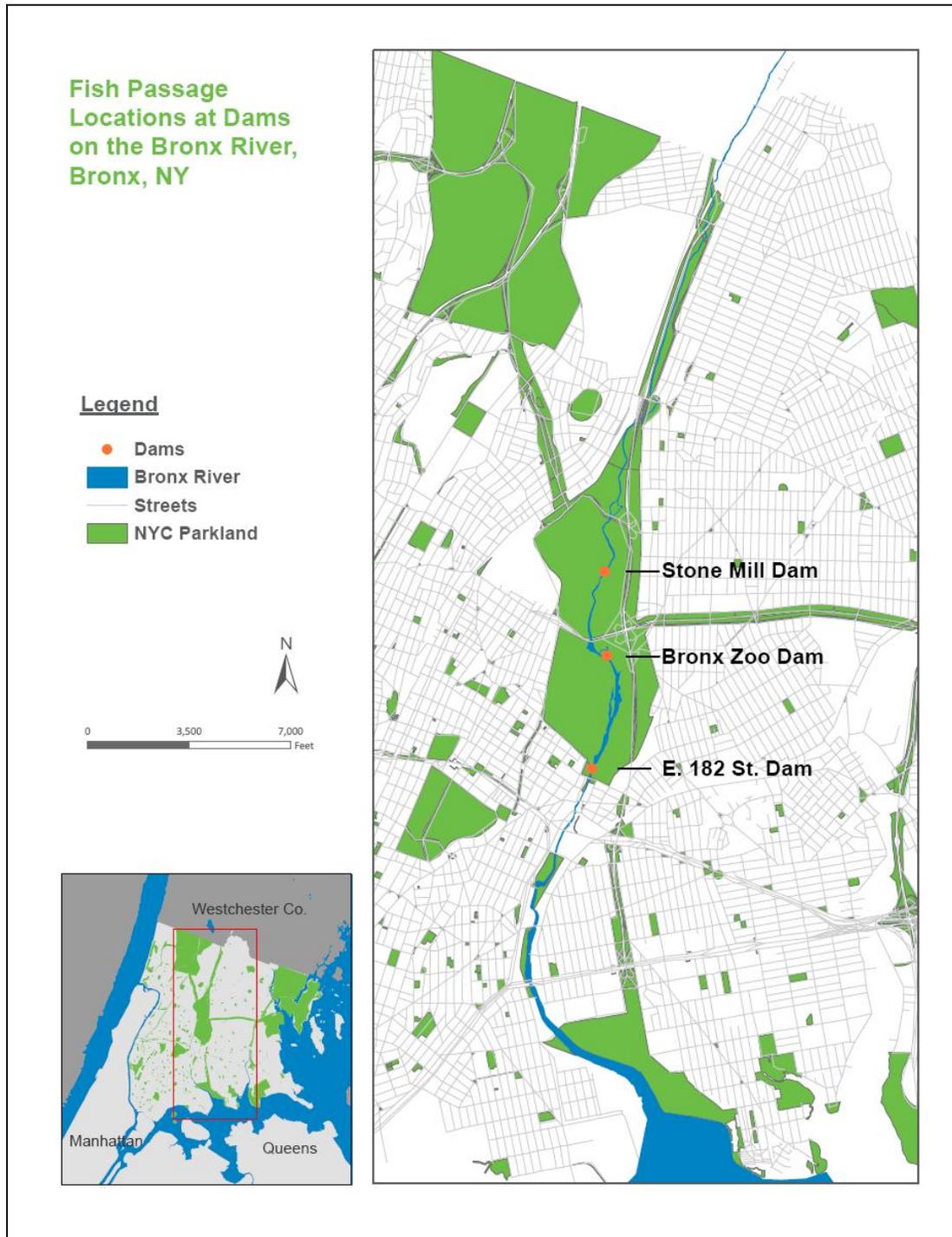
Today's populations of river herring have been drastically reduced from historic levels and continue to decline in many locations in the Northeast due, in part, to migration barriers. Construction of fish passages around these barriers will help reverse this trend by expanding habitat available to river herring. The establishment of passageway will also help increase regional population size and sustainability of river herring that support recreational and commercial fisheries. Educators, recreational fishermen, boaters and naturalists along the Bronx River will also benefit from this increased biodiversity. The fish passage locations, within the Bronx Zoo and the New York Botanical Garden (NYBG), will offer a unique opportunity to show the visitors the connection between the river, watershed, estuary and ocean.

Site Locations

The Bronx Zoo Dam is located within the WCS Bronx Zoo (40°51'13" N, 73°52'30" W). The Stone Mill Dam is located within NYBG (40°51'42" N, 73°52'29" W). Both sites are within the Long Island Sound/Bronx Park New York-New Jersey Harbor Estuary Program (HEP) Priority Site (LI4C), which was selected by the HEP Habitat Workgroup

as the Highest Priority Site. The Bronx Zoo and NYBG are both located within Bronx Park. The primary landowners for this project are NYC Parks, WCS and NYBG. NYC Parks assumed jurisdiction over the dams for the purposes of this project.

Fish Passage Locations at Dams on the Bronx River.



Bronx Zoo Dam facing west. The fishway will be installed on the west side of the spillway (on left of photo).



Western spillway of the Bronx Zoo Dam where the exit of the fishway will be installed.



Stone Mill Dam from the east bank. The fishway will circumvent the dam and exit to the right of the bedrock at the bottom of the photo.



Stone Mill Dam from the southeast bank. The fishway will be visible from a publically accessible walking path.



Objectives and Background

The project goal was to develop final design plans and construction documents for fish passages at the Bronx Zoo Dam and Stone Mill Dam on the Bronx River, and included the following objectives:

- Produce final designs for functional anadromous fish passage while meeting partner goals for aesthetics and constructability.
- Produce technical specifications and cost estimates.
- Obtain permits from the appropriate regulatory agencies including the U.S. Army Corps of Engineers (USACE), New York State Department of Environmental Conservation (NYSDEC), and New York State Historic Preservation Office (SHPO).

Advancement of Target Ecosystem Characteristics (TECs)

The construction of these fish passages will make available additional feeding, spawning, and rearing habitats for river herring, and address the Harbor Estuary Program's Target Ecosystem Characteristic (TEC) of establishing Tributary Connections by reconnecting freshwater river reaches to the region's estuary and marine systems. Since the recent installation of the fish ladder at the East 182nd Street Dam, the Bronx Zoo Dam and the Stone Mill Dam are the only remaining man-made obstacles in New York City on the Bronx River that river herring will encounter on their upstream migration. The presence of adult and juvenile river herring in freshwater and estuarine systems may result in an increase in prey available for larger fishes (e.g., striped bass, bluefish, and summer flounder) and wildlife. Predators of river herring already present in the Bronx River system include striped bass, American eel, brown trout, sunfish, shiners, snapping turtles, herons and osprey. Another ecological benefit of river herring in the Bronx River is the potential increased transport of nutrients and energy between the river, estuarine and ocean systems and may increase the abundance and health of predator populations throughout the freshwater and marine systems.

Prior Restoration Efforts

From 2003-2004, NRG and Lehman College conducted a study of the feasibility of restoring anadromous fish to the Bronx River¹. The goal of the study was to identify and evaluate the relative importance of factors that could limit river herring's access,

¹http://www.nycgovparks.org/sub_about/parks_divisions/nrg/bronx_river_epa/aquatic_life/aquatic_life_pages/Anadromous_fish/Anadromous_Fish_reintroduction/anadromous_fish_reintroduction.html

spawning, and survival in the river and that could explain their absence. The study included review of historical river and fisheries information, extensive interviews with technical fisheries experts, collection of data on fish currently in the river system, and investigation of environmental variables that impact river herring and their habitat at various life stages. Critical environmental variables examined included water quality (temperature, dissolved oxygen, suspended sediment and contaminants), flow conditions (return frequency, velocity, and depth), and physical habitat conditions (substrate and channel bed morphology). The investigation focused on the most significant habitat in the lower two-thirds of the river (approximately 13 miles in length), where flow and channel conditions were thought to be most favorable for anadromous fish. The study concluded that water quality, geomorphic, and hydrologic conditions were suitable for river herring survival, reproduction, and recruitment. The investigation also concluded that the removal of obstacles to upstream migration would allow access to spawning habitat for the fish, as well as help increase faunal diversity in the river. Water quality and hydrologic conditions have not changed significantly since the feasibility study was released in 2004, according to on-going water quality sampling by the Bronx River Alliance, and hydrologic monitoring by the U.S. Geological Survey (USGS).

Based on the recommendations from the Feasibility Study that fish passage should be established along the Bronx River, NRG began working with partners to assess alternatives for removing fish passage obstacles in 2005. Topographic, hydrologic, hydraulic and geotechnical data were collected at all three dams in the Bronx to develop conceptual design alternatives and, after consultation with local land stewards (WCS and NYBG), to develop 50% complete designs for the chosen alternatives². Funding was secured to complete the designs and construct the fish passage at the furthest most downstream dam on the river, at East 182nd Street.

Over the last decade, NRG has also partnered with many local organizations and secured funding from state and federal agencies to improve in-stream habitat and riparian conditions along the Bronx River. As part of this continuous effort, we have implemented bank stabilization, re-vegetation, and floodplain forest restoration projects in freshwater reaches in the Bronx Park. NRG has also installed boulder vanes and large woody debris to restore some of the aquatic cover, in-stream structure, and pool habitat that was lost through channelization, channel clearing, and invasive species proliferation. Under NRG's guidance, the Bronx River Alliance, a local non-profit partner, modified their routine management of fallen trees so that limbs are cleared to allow canoe and kayak passage, while still allowing large woody debris to be retained in

² The land managers at the dams, WCS and NYBG, rejected dam removal as a viable option, early in the process, so it was not fully explored as an alternative.

the river to provide aquatic habitat benefits. These restoration and management efforts are incrementally helping to reduce sediment and nutrient loads and increase the quantity and diversity of habitats available to fish, invertebrates, and other riverine species.

The successful spawning of alewives, which were transplanted to the river in 2006 and 2007, and the reappearance of two beavers in the river in 2010 are evidence of the improved health of the urbanized Bronx River system.

Design Process

50% Design Review and Data Collection

With funding for this project from NEIWPC beginning in 2012, more detailed topographic, flow, sediment and substrate, vegetation, and site constraints datasets were collected to advance the existing 50% designs to final design plans, technical specifications, and contract documents for the Bronx Zoo and Stone Mill sites. During this process, NRG worked very closely with the technical advisory team that has provided advice on the river herring restoration project in the Bronx since 2003. The advisory team includes:

- Jim Turek, Restoration Ecologist, Assistant Northeast Team Leader, Restoration Center, National Oceanic and Atmospheric Administration.
- Steve Gephard, Supervisor, Diadromous Fish Program and Habitat and Conservation Enhancement Program, Inland Fisheries Division, Connecticut Department of Energy and Environmental Protection.
- Curt Orvis, Fish Passage and Water Resource Supervisor, Fish Passage Engineering, Northeast Region Fisheries, U.S. Fish and Wildlife Service.
- Jim MacBroom, Engineer and Senior Vice President, Milone and MacBroom, Inc. (MMI).
- Alex Haro, Fisheries Ecologist and Section Leader, S.O. Conte Anadromous Fish Research Center, Biological Resources Division, USGS.

Project Kickoff Meetings

For the Bronx Zoo Dam, a project kickoff meeting was held on February 7, 2012 at the WCS Bronx Zoo. At the meeting, Jim MacBroom of Milone and MacBroom, Inc. (MMI) and NRG provided a review of the 50% fish passage design for the Bronx Zoo Dam that MMI completed in 2007 with funding from a 2004 WCS-NOAA Community Restoration grant. It was determined that MMI needed to conduct a Dam Hazard Assessment at the Bronx Zoo Dam for NYSDEC's Dam Safety Unit. This work by MMI was funded by WCS.

NRG coordinated with WCS to include dam hazard assessment work in WCS Bronx Zoo's contract with MMI, which provided the analysis necessary for permitting of the fish passage construction.

For the Stone Mill Dam, a project kickoff meeting was held with New York Botanical Garden (NYBG) staff on May 2, 2012 to review the 50% fish passage design with the new NYBG Capital Projects Manager and discuss the next steps for advancement of the final designs. During the contract period, NYBG officially renamed the Snuff Mill Dam to the Stone Mill Dam.

Field Surveys

MMI conducted pre-survey site visits to the Bronx Zoo and Stone Mill Dams on October 1, 2012. During the site visits, MMI and NRG reviewed the project scope with WCS and NYBG staff. We discussed concerns about construction access, timing of construction, aesthetics, and expected maintenance issues once the fishway is in place. One particular concern discussed at NYBG was the crushed stone path in which the fishway will be installed. Another field survey of the dam sites was conducted by MMI on November 19, 2012.

90% Design Work and Review

A design review meeting for the Stone Mill Dam Fish Passage was held with NYBG staff on June 6, 2013. NYBG determined that additional review time was necessary for a design modification in the path layout adjacent to the proposed fish passage. NYBG provided comments on the 90% designs in spring of 2014 and recommendations on the crushed stone path layout adjacent to the proposed fish passage.

A review meeting for the 90% design plans for the Bronx Zoo Dam Fish Passage was held with WCS staff on June 21, 2013. WCS provided initial comments in summer of 2013 and in spring 2014, WCS provided additional comments on and recommendations concerning site access, staging, and information to the existing USGS informational kiosk.

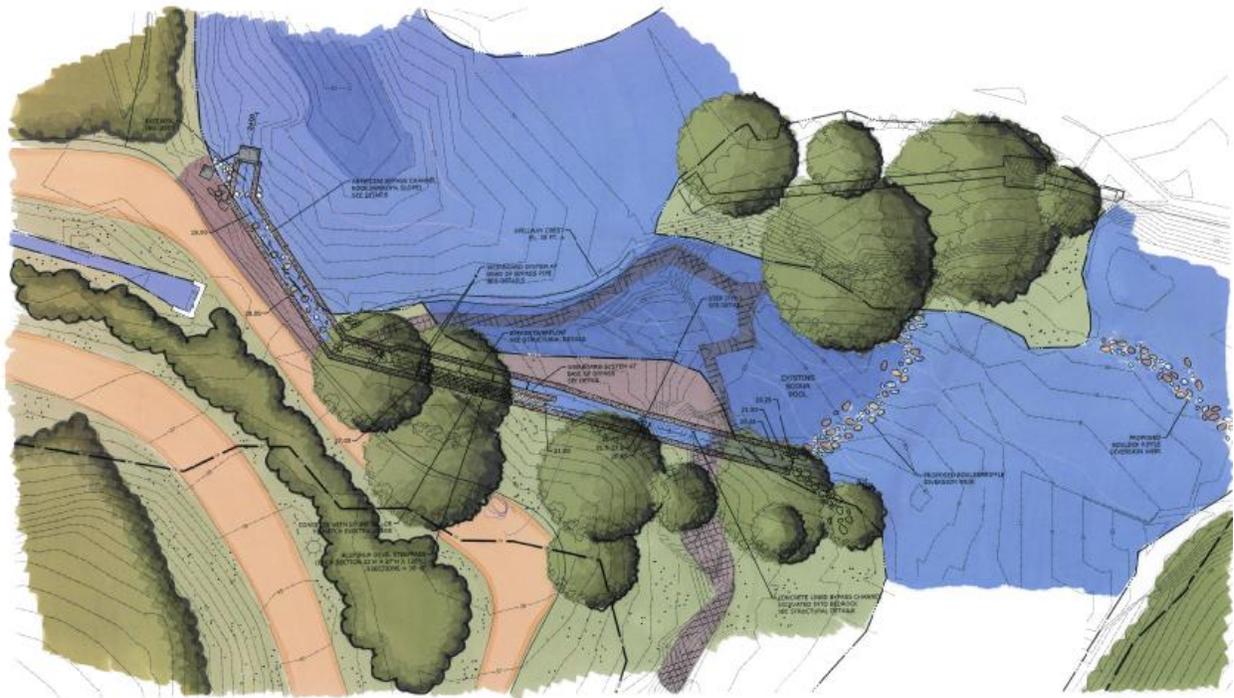
Both sets of plans were also reviewed by Curt Orvis of the U.S. Fish and Wildlife Service, and Steve Gephard of the Connecticut Department of Energy and Environmental Protection.

Final Review

Final designs and technical specifications for the Bronx Zoo Dam fish passage were reviewed at a meeting with WCS on August 13, 2014. The contractor staging area was

confirmed at the meeting. Final designs and technical specifications for the Stone Mill Dam Fish Passage were reviewed at a meeting with NYBG on August 14, 2014.

Design layout of Bronx Zoo Dam Fish Passage by Milone and MacBroom, Inc.



Permitting

Several permits are required for the construction of the Stone Mill and Bronx Zoo Dam Fish Passages. In December 2013, all permitting applications were submitted for both the Bronx Zoo and Stone Mill Dam Fish Passages. MMI provided additional support for permitting documents.

NYSDEC-USACE Joint Permit

NRG applied for a New York State Department of Environmental Conservation (NYSDEC) / U.S. Army Corps of Engineers (USACE) Joint Permit for both fish passages. This permit is required because the projects could disturb a stream, affect water quality and involve excavation. NRG worked with MMI to provide estimates of the amount of rock to be added below the mean high water line for boulder weir installations for the USACE for both the Stone Mill and Bronx Zoo Dam Fish Passages. NRG received the

USACE permits for both the Stone Mill Dam and Bronx Zoo Dam Fish Passages on May 20, 2014 and June 2, 2014, respectively.

NYSDEC Dam Safety

Due to the location of the fish passages on the dams, these projects also required review and approval by NYSDEC's Dam Safety Section. NRG held a conference call with NYSDEC's Dam Safety Section in spring of 2013 and discussed requirements for dam safety permitting at the Bronx Zoo and Stone Mill Dams. It was determined that only the Bronx Zoo Dam required further investigation for a dam safety permit. NRG formulated a scope of work with Tectonics Engineering and Surveying Consultants, P.C. (Tectonic) in order to assist with dam safety permitting for the Bronx Zoo Dam. Upon further consideration, however, NYSDEC Dam Safety determined that the Bronx Zoo Dam Fish Passage does not require a Dam Safety Permit since the fishway will not affect the hydrology of the dam's spillway. NYSDEC required only a narrative explanation of why a Dam Safety Permit is not required, which was drafted by Tectonics Engineering and Surveying Consultants, P.C. and submitted as a supplement to the NYSDEC-USACE Joint Permit application. NRG staff met with the NYSDEC Region 2 and Dam Safety offices on January 6, 2014. NYSDEC advised NRG that they would issue the permit upon completion of the final designs.

New York State Historic Preservation Office (SHPO)

A permit for both fish passages was submitted to the New York State Historic Preservation Office (SHPO) to determine if any significant historical resources would be affected by either project. Since the proposed fish passage location at the Stone Mill Dam overlaps with historical resources that date back to the 1700's and 1800's and includes the old mill race, SHPO determined that a Phase 1 Archaeological Assessment is required. Funding of the archeological assessment is outside of the scope of the NEIWPC grant and NRG is actively searching for new funding to cover the costs of this SHPO requirement.

New York City Environmental Quality Review (CEQR)

Agencies within the City of New York are required to review proposed projects, identify the effects that the projects may have on the environment, and prepare an environmental assessment statement to reveal any potential impacts that could be avoided by altering the project design. The environmental assessment statement results in either a positive or negative declaration. A positive declaration means that the project may have a significant effect on the environment and an environmental impact statement must be made. A negative declaration means that the project will not have a significant impact on the environment and the CEQR process is complete. The NYC

Parks Director of Parklands determined a CEQR “negative declaration” for both fish passages because neither project poses a significant adverse impact on the environment.

New York City Public Design Commission

New York City Public Design Commission (PDC) reviews all permanent landscape architecture proposed on city owned land, and the PDC reviewed and approved both the Bronx Zoo and Stone Mill Dam Fish Passages.

Local Waterfront Revitalization Plan

The installation of fish passages on the Bronx River was determined to be in line with New York City’s Waterfront Revitalization Program.

Tree Restitution

NRG worked with NYC Parks’ Bronx Borough Forestry Division on tree protection and restitution plans for both fish passages, as required by NYC Local Law 3. These plans were incorporated into both final design plans.

Next Steps

Secure Funding

The design engineers estimated that construction of fish passage will cost \$1,381,821.30 at the Bronx Zoo Dam and \$1,225,102.42 at the Stone Mill Dam. NRG’s strategy has been to complete designs and secure funding for fish passage on the three barriers on the Bronx River from downstream to upstream to coincide with river herring migration from the ocean to the northern freshwater reaches of the river. NRG will work to facilitate the construction of the Bronx Zoo Dam first, since it is the next upstream barrier to river herring migration after the East 182nd Street Dam.

The Bronx River Alliance, a local non-profit partner for this project, has already secured \$250,000 for construction funds for the Bronx Zoo Dam fish passage from the Bronx Borough President, Rubin Diaz. These funds are very important because they will provide match for potential grant funds that we apply for. NRG is exploring potential funding options, and will continue to apply for funding and work with partners to do the same in order to implement construction of the final design plans.

One potential source of funding would be a partnership with the U.S. Army Corps of Engineers (USACE) through one of their cost-sharing programs. The USACE is currently conducting a Bronx River Ecosystem Feasibility Study through a cost-sharing partnership with Westchester County and the NYC Department of Environmental

Protection. Two of the recommended ecosystem restoration projects in this study are the installation of fish passage at the Bronx Zoo and Stone Mill Dams. Once the Feasibility Study is complete, the USACE may decide to recommend these projects for construction if the City can raise local matching funds. The cost sharing arrangement is typically 25% from the local sponsor, and 75% from USACE. If USACE receives authorization to fund the project, they will need to conduct their own alternatives analysis to verify that a suitable ecological design was chosen. However, we are confident that the designs developed under this grant would be adopted for implementation, in part because the designs have been developed in such close collaboration with project partners and stakeholders. Under this successful scenario, the USACE would issue the construction contracts for the project and oversee construction for both fish passages.

Monitoring Plan for the East 182nd Street Dam

A monitoring program will be put in place for the constructed fish passage at the East 182nd Street Dam. This program will be implemented during the next river herring migration season – March to June 2015. NRG, in collaboration with local partners, will monitor the number of fish that swim upstream through the fish ladder at the East 182nd Street Dam. This will provide an indication of how many fish would benefit from additional fish passage at the next two upstream dams. Once the fish passage at the East 182nd Street Dam is proven to be successful, we will have a stronger case in soliciting funds for the Bronx Zoo Dam and Stone Mill Dam Fish Passages.

Continue Securing Permits

NRG applied with the New York State Historic Preservation Office (SHPO) for anadromous fish passage at both the Stone Mill and Bronx Zoo Dam. The Bronx Zoo Dam does not require permitting from SHPO. The Stone Mill Dam Fish Passage requires SHPO permitting and an archaeological assessment of the proposed construction area due to the site's archaeological sensitivity. The Stone Mill Dam was built in 1840 to power a tobacco factory and is a National Historic Site. NYSDEC required the final contract documents before approving a permit. We expect to get the NYS DEC permit in September 2014. NYS DEC also requested a written endorsement from Curt Orvis, Fish Passage and Water Resource Supervisor at USFWS. Mr. Orvis was not able to provide written endorsement of these fish passage designs due to his role in reviewing projects funded through the USFWS National Fish Passage Program, but he did provide a detailed technical review, and his comments were incorporated into the design plans.

Memoranda of Understanding

Once funding is secured for fish passage construction at the dams, NYC Parks will need to generate a memorandum of understanding with both WCS and NYBG. This will be done in advance of putting each contract out to bid. During this time, the legal teams at NYC Parks, WCS, and NYBG will scrutinize the final plans and determine any conditions or clarifications of the design plans that need to be set forth.

Future Revisions

Once funding for construction of the Bronx Zoo Dam and Stone Mill Dam has been secured, the final design plans and technical specifications will be reviewed and updated for accuracy.

Several elements of the final design plans will be reviewed. Names of NYC Parks staff listed on the plans will be updated. The trees in the project area will be resurveyed for changes in size or condition. Any changes in construction timing and access at the Bronx Zoo or NYBG will be incorporated into the final designs. Cost estimates for each fish passage will also need to be reassessed based on current engineer estimates at the time of construction. Additionally, any lessons that were learned after implementation of the East 182nd Street Dam will be incorporated into the revised design plans and technical specifications.

Design of the installation of monitoring equipment was not included in the scope of this grant. NRG will work with experts from USGS and CTDEEP to include monitoring equipment design for each fish passage location. These designs will be adjusted based on the experience that NRG and partners gain from the monitoring design with at the East 182nd Street Dam which will be implemented in spring 2015.

Construction

The constraints to construction at the Bronx Zoo and the NYBG will be much more limiting than at the East 182nd Street Dam due to the different nature of operations at these facilities. Although acceptable construction access and construction hours were identified in the plans, notes, and specification of the design documents, these conditions will have to be reviewed again in detail once funding for construction has been secured, because conditions and policies at each of these institutions may have changed. These construction projects will also not be issued to the lowest bidders, as is the case for typical NYC Parks construction projects. Consequently, once funding for construction is secured, an appropriate mechanism has to be identified for assuring that the most qualified contractor for the work is selected. At this time, it has not been determined whether NYC Parks would lead the contract or not. For example, if a

funding partnership with USACE is established, then USACE would lead the construction.

Future Considerations

Dam removal was not considered as a viable alternative for fish passage restoration at either the Bronx Zoo or Stone Mill Dams due to aesthetic and historical considerations valued by WCS and NYBG. However, it should be noted that dam removal has been increasingly implemented around the country, including extensively in Pennsylvania, as well as in Ohio, Maine, Oregon and Washington, for the long term ecological and safety benefits. The ecological benefits of dam removal often outweigh building fish passage for one species. These benefits include non-migratory fish movement within the river and sediment transport to the estuary. In the future, review of fish passage design alternatives on the Bronx River should include a thorough review of the dam removal alternative.