SCHOOL STREET FISH PASSAGE COMPLIANCE COMPILATION

SCHOOL STREET PROJECT
FERC NO. 2539

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School Street Fish Passage Compliance
COMPILATION

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SCHOOL STREET FISH PASSAGE COMPLIANCE COMPILATION

INTRODUCTION

The School Street Hydroelectric Project (Project) (FERC No. 2539) is owned and operated by Brookfield Renewable (Brookfield). The Federal Energy Regulatory Commission (FERC) issued a new License to the Project on February 15, 2007, in which downstream fish passage for anadromous and catadromous fish, as well as resident fish, was required. In September 2007, a Final Plan was developed to investigate the Phase I fishway effectiveness and included requirements for testing downstream passage survival of resident fish, American Eels, juvenile and adult Blueback Herring; passage efficiency of juvenile and adult Blueback Herring; an inspection of the conveyance structures; and a hydraulic survey to document flow field and approach velocities in front of the angled bar rack and fishway entrances.

Brookfield completed their investigation of the Phase I Fishway Effectiveness as described in the Final Plan and Phase I Fishway Effectiveness Testing Study Plan and conducted a desktop evaluation to investigate juvenile Blueback Herring (JBBH) passage survival at the Project.

This document compiles all the study plans, final reports and any agency correspondence related to these studies between 2007 and 2019. Below is a list of each final report and a brief abstract of the overall objective, method, and conclusion.

FINAL REPORT ABSTRACTS

Phase 1 Fishway Effectiveness Testing and Hydraulic Survey, June 2011

Abstract: This report details the study methods and results of an inspection on the fishway conveyance structure, hydraulic survey and biological testing conducted in 2009 and 2010, along with a status update on American Eel and JBBH. The result of the inspection led to modifications to structures to reduce potential issues associated with fish passage. The water velocity analysis demonstrated that some velocities exceeded the threshold of 2 ft/sec during certain operations and areas within the water column. Using radio telemetry, it was shown that

81.8% of test blueback herring passed downstream via the fishway while the other 18.2% of fish were entrained via the penstocks or turbines. Passage survival was not calculated due to the potential to miss test fish passing the Route 32 bridge. 2010 juvenile herring evaluation was not completed due to high flow conditions and lack of fish. American eel downstream passage was also not completed due to lack of fish.

Phase 1 Fishway Effectiveness Testing Juvenile Blueback Herring and Adult American Eel Survival Evaluation Report, February 2012

Abstract: Downstream bypass survival evaluations of JBBH herring and adult American eel were planned to be conducted at the project during the summer and fall of 2011. Downstream bypass evaluations of 56 American eel showed 100% survival rates but did not meet the target sample size of 90 eels. Survival ratings of JBBH were low and two additional tests were planned for 2012. The downstream bypass efficiency study was not conducted in the 2011 migration season due to unsuitable environmental conditions caused by Tropical Storm Irene and was rescheduled for 2012.

Juvenile Blueback Herring Downstream Passage Efficiency Study, October 2012

Abstract: Downstream bypass survival and efficiency were studied in August and September 2012 using a Full Duplex PIT monitoring system. The monitoring system was deemed effective at detecting PIT tags at the downstream bypass. However, the evaluation of the downstream bypass feasibility was not conclusive due to the low survival rates of the JBBH. Poor survival was likely due to water temperatures, handling stress and the small size of the available test fish.

Juvenile Blueback Herring Downstream Passage Efficiency Study, March 2015

Abstract: Downstream bypass efficiency for JBBH was evaluated in 2014 using an acoustic camera and a split-beam sonar. The study was conducted in 2014 because it was not feasible in 2013 due to environmental conditions (high flows). The evaluation was effective at monitoring and most herring passed the Project through the intake turbines. Two attraction flow scenarios were tested, 230 cfs and 120 cfs. The higher flow of 230 cfs was most effective at bypassing juvenile herring. During the 230 cfs flow scenario, 64,142 herring were entrained, and 10,328 herring were bypassed, representing 13.87% of the total passage during a 7-day period. During the 120 cfs flow scenario, 372,246 herring were entrained, and 27,292 herring were bypassed,

representing 6.83% of the total passage during a 20 day. The inoperable status of Unit 1 may have contributed to a reduced use of fishway passage effectiveness by eliminating the guidance effect of a presumable key flow field.

Juvenile Blueback Herring Downstream Passage Efficiency Report. April 2016

Abstract: This study was developed to investigate the efficiency of downstream passage of JBBH by providing a quantitative estimate of the proportion of JBBH that use the fishway (bypassed) versus through the turbines (entrainment). The Project intake and fishway were monitored for 35 days each in August and September of 2015 using Acoustic Cameras and a split-beam sonar. No passage of herring through the downstream bypass was documented during the study period, and therefore a proportion could not be determined. Additional issues with water surface elevation, project operations and lack of fish also impacted the study results.

Desktop Evaluation of Entrainment and Downstream Passage Survival of Juvenile Blueback Herring, January 2018

Abstract: A desktop study was used to evaluate the most suitable route of passage for emigrating JBBH by assessing survival through multiple passage options available at the Project. An individual based model using Monte-Carlo simulation concluded the best overall route of passage based on survival rate estimates was through the units (entrainment). The New York State Department of Environmental Conservation and the United States Fish and Wildlife Service did not agree with the conclusions of this study and recommended the bypass reach as an alternative route of downstream passage.

FERC Final Determination Correspondence, March 2020

Abstract: On March 20, 2020, the FERC issued a letter determining that the requirements of Article 401 and the obligations set forth in the approved fish bypass effectiveness plan were met. Additional modifications to the downstream bypass were not recommended due to the potential cost and unknown benefits of the modifications.

FULL REPORT, STUDY PLANS AND CORRESPONDENCES

The section contains the final study reports, study plans and agency correspondence in chronological order starting from the first report submitted in 2011 and ending in 2019. Repeated appendices were removed from some reports in efforts to save space but are located within this document. Removed appendices and their locations are listed below:

Final Report: Juvenile Blueback Herring Downstream Passage Efficiency Study (October 2012)

- Permits removed in efforts to save space
- Phase 1 Fishway Effectiveness Testing Supplemental Plan can be found in the February 2012 Report

Final Report: Juvenile Blueback Herring Downstream Passage Efficiency Report (April 2016)

- Appendix A: Juvenile Blueback Herring Downstream Passage Efficiency Evaluation Study Plan was removed and can be found in the March 2015 report
- Agency correspondence for on this report is located directly after

PHASE 1 FISHWAY EFFECTIVENESS TESTING AND HYDRAULIC SURVEY

SCHOOL STREET PROJECT

FERC NO. 2539

PREPARED FOR:

BROOKFIELD RENEWABLE POWER
QUEENSBURY, NY

PREPARED BY:

Kleinschmidt
Energy & Water Resource Consultants

JUNE 2011

PHASE 1 FISHWAY EFFECTIVENESS TESTING AND HYDRAULIC SURVEY

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QUEENSBURY, NY

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PHASE I FISHWAY EFFECTIVENESS TESTING AND HYDRAULIC SURVEY

SCHOOL STREET PROJECT
FERC NO. 2539

BROOKFIELD RENEWABLE POWER
QUEENSBURY, NY

1.0 INTRODUCTION

The School Street Hydroelectric Project (Project) (FERC No. 2539) is owned and operated by Brookfield Renewable Power (Brookfield). The Project is located on the Mohawk River, 2.5 river miles upstream of its confluence with the Hudson River in Cohoes, New York (Figure 1). It is comprised of 1) a stone masonry gravity dam extending 1,280 ft across the Mohawk River, 16 ft in height, completed in 1865; 2) a reservoir with a surface area of approximately 100 acres at a normal maximum water surface elevation of 156.1 ft, and a gross storage capacity of 788 acre-feet; 3) a power canal extending approximately 4,400 ft from the dam to the powerhouse, 150 ft wide and 14 ft deep; 4) an upper gatehouse structure that currently includes nine slide gates and three steel tainter gates to control the diversion of flow into the canal; 5) a lower gatehouse with five steel headgates to control flow into the five penstocks; and 6) a powerhouse measuring 170 ft long by 78 ft wide, housing five generating units with vertical shaft Francis turbines rated at 92 ft of head, with a total maximum capacity of 38.8 megawatts.

The Project was issued a new FERC License on February 15, 2007. Downstream fish passage for anadromous and catadromous fish, as well as resident fish, was required as part of the new license. The fishway consists of an angled bar rack with one inch clear spacing and a fish conveyance system. The angled bar rack is located in the power canal just upstream of the lower gatehouse (Figures 2 and 3). The rack leads fish to the entrance of a fish conveyance system that transports fish around the powerhouse and discharges to the Project tailwater. The rack structure is angled approximately 45 degrees from the upstream face of the existing lower gatehouse. The lower portion of the rack includes a solid two-foot high concrete eel diversion berm to guide out-migrating American eel toward the bypass entrance at the downstream end of the rack.

The fishway conveyance structure is located near the downstream end of the angled bar rack. It has two intake portals and includes a multi-level gate with top and bottom entrances (Figures 4 and 5). Attraction flow to the fishway entrances can vary between two to five percent of the Project's total hydraulic capacity. Conveyance pipes from both entrances converge in a fish separation chamber part-way along the fish conveyance structure (Figure 6). The chamber reduces the volume of the bypass flow by guiding fish along a wire floor screen and directing them into a fish return weir pool. The excess attraction water flows through the screen and is discharged downstream of the Project. A gate valve at the downstream end of the fish separation chambers provides hydraulic control within the fish conveyance structure. An adjustable weir is located at the entrance to the fish return weir pool. The weir provides fine-tune adjustment to the depth of water cascading over the weir as well as the overall bypass flow (design flow 40 CFS). Once in the fish return weir pool, fish are guided to the entrance of the return pipe, and are deposited into the tailwater of the Project.

Fishway effectiveness testing is a license requirement and was conducted by Kleinschmidt Associates (Kleinschmidt). A fishway effectiveness testing plan was submitted and approved by the Federal and state agencies in September 2007. The plan included requirements for testing downstream passage survival for resident fish, American eels, and juvenile and adult blueback herring; passage efficiency of juvenile and adult blueback herring; an inspection of the conveyance structures; and a hydraulic survey to document flow field and approach velocities in front of the angled bar rack and fishway entrances.

On August 5, 2009, Brookfield and agencies conducted an inspection of the system, and subsequently performed a study to estimate survival of resident fish in early November, 2009. In 2010 Kleinschmidt conducted an evaluation of Project passage efficiency for adult and juvenile blueback herring, passage survival for adult blueback herring and a hydraulic survey. This report details the results of the inspection, hydraulic survey and biological testing conducted in 2009 and 2010 as well as a status update on American eel and juvenile blueback herring evaluations.

2.0 FISHWAY CONVEYANCE STRUCTURE INSPECTION

An inspection of the Phase I Downstream Fish Protection and Fishway Conveyance Structures was conducted on August 5, 2009, and was attended by representatives of the New York State Department of Environmental Conservation (NYSDEC), U.S. Fish and Wildlife Service (USFWS), Brookfield, and Kleinschmidt. The purpose of the inspection was to confirm conformance to design specifications and also to identify and adjust any potential unforeseen minor post-construction fish passage issues not previously addressed. A summary of the inspection is provided in Appendix A.

At the time of the inspection, the power canal was dewatered and the fish protection and fish conveyance structure was nearing completion. The inspection consisted of the major components of the facility and included the newly installed angled bar rack with 1 inch clear bar-spacing, fishway entrances, associated passage pipes, the collection/separation chamber, the outlet weir pool and the fish return pipe entrance.

The results of the inspection identified three engineering issues: including 1) the presence of sharp concrete edges on the leading top edge of the fishway intake structure and the enclosed conveyance pipes; 2) narrow gaps at the leading and trailing edge of the separation chamber screen; and 3) exposed bolt heads within the fish conveyance structures. At the time of the on-site inspection, the agency staff recommended that the identified sharp edges should be rounded or otherwise smoothed, the gaps should be filled and any exposed bolt heads within the fish conveyance structure should be capped. Brookfield addressed these issues and, as recommended, rounded and smoothed the identified sharp edges, filled the gaps at either end of the fish separator screen with semi-flexible foam material and installed rounded plastic caps over exposed bolt heads.

3.0 HYDRAULIC ASSESSMENT

3.1 INTRODUCTION

A hydraulic assessment was conducted at the School Street Project in October, 2010 as required by the Phase I Fishway Effectiveness Testing Plan Addressing Settlement Agreement Section 3.7, and 401 Water Quality Certification Condition 13, Final Plan (Final Plan). The Final Plan required the measurement of "approach velocities, as measured 1 ft upstream of, and normal to the bar rack" and that velocities "shall not exceed two feet per second". Furthermore, the Final Plan requires the documentation and measurement of hydraulics flow fields and velocities in front of the fishway entrances to demonstrate suitability over a range of 2-5% (120 CFS – 300 CFS) of Project capacity (6,000 CFS). It is important to note that the Final Plan does not define suitable entrance velocities or flow fields in front of the fishway intakes.

A suite of velocity measurements were collected along the angled bar rack structure as well as in front of the two fishway intakes at the School Street Project (Figure 7). The measurements were conducted at a fishway flow of 130 CFS or approximate 2.2% of Project maximum capacity flow. This report will describe the methods, results and conclusions of this hydraulic investigation and aims to satisfy the requirements as prescribed by the Final Plan.

3.2 METHODS

Velocity measurements were collected at the School Street Project on October 11 and 12, 2010. The trash racks and angled bar rack were cleaned immediately prior to measurement to ensure that debris did not dramatically impact velocity measurements within the study area. Water velocity was measured using a calibrated[1] Marsh McBirney flow meter (flow meter). During the course of this study water velocities were measured using differing methodologies for deploying the velocity meter depending on the location of the measurements and the site specific conditions.

[1] The Marsh McBirney flow meter is calibrated annually by the manufacturer and prior to every use in the field by the user.

3.2.1 VELOCITY MEASUREMENT ALONG THE ANGLED BAR RACK

Water velocity measurements were collected along the angled bar rack on October 11, 2010 by affixing the flow meter setting pole to the trash rake, suspending the flow probe approximately 3 ft below the rake. The rake was used to position the probe at various locations. The velocity measurements were collected at or near full Project operational capacity (5 units in operation, flow ranged from 4,693 to 5,620 CFS) (Figure 8) and represents a high flow scenario (Scenario 1). Additional, measurements were collected opportunistically on the afternoon of October 12, 2010 by affixing the flow meter to a handheld aluminum pole to collect surface measurements with fewer units in operation (Scenario 2, units 1-4 in operation, flow ranged from 2,659 to 2,874 CFS).

The water velocity was measured at 30 ft lateral increments along the 180ft long angled bar rack for a total of 5 stations. Station 1 was located 30 ft from the right end of the bar rack (looking downstream) and closest to the fishway entrances, Station 2 at 60 ft, Station 3 at 90 ft, Station 4 at 120 ft and Station 5 at 150 ft from the right end of the rack and closest to the left side canal wall (Figure 7). It is important to note that because the bar rack is oriented across the power canal at an angle of approximately 45º, the location of the velocity measurement in relation to the downstream position of the lower gate house increases in distance from Station 1 through Station 5 (Figure 7).

The depth of the water column was measured to the nearest tenth of a foot using a weighted tape measure at each of the five stations. Velocity measurements were collected at the top, mid and bottom of the water column. The top was defined as 3 ft below the surface of the water, the bottom as 3 ft above the water-sediment interface and mid defined as ½ of the difference between the top and bottom and varied within the water column depending on the overall water depth at each station. A tape measure was affixed to the probe so that the exact depth of the probe could be determined and the mid-point calculated. The flow meter was affixed to the upstream face of the trash rake so that the probe was oriented into the flow and located between 12-16 inches in front of the upstream face of the angled bar rack. These measurement were collected approximately 16 inches from the upstream face of the angled bar rack due to the challenges associated with mounting the velocity meter probe on the trash rake. The probe was mounted 3 ft below the bottom of the trash rake to minimize turbulence interference generated by the rake itself. The flow meter was programmed to calculate the mean instantaneous velocity over a period of 15 seconds. Multiple measurements (2-6) were collected at each depth and an average water velocity was calculated for each of the 15 locations measured.

Project inflow decreased on October 12, 2010, requiring the shutdown of Unit 5 (Scenario 2) (Figure 9). Additional velocity measurements were collected opportunistically to include surface velocity measurements at partial Project capacity (Figure 8). Measurements were collected at the immediate surface and 3 ft below the surface at each of the five stations. The probe was affixed to a 10 lb torpedo weight hung 3 ft blow the end of a 24 ft aluminum pole (Figure 10). The torpedo weight is designed to orient itself and subsequently the velocity probe into the flow. The apparatus was lowered into position by hand. Measurements were collected 1 ft upstream along the face of the angled bar rack at each of the five stations. Deeper measurements using this technique were not feasible due to the forces exerted on the suspended equipment by the flowing water.

3.2.2 VELOCITY MEASUREMENT AT FISHWAY INTAKES

Velocity measurements were collected in the vicinity of the outer wall fishway intake and the bar rack fishway intake entrances (Figure 7) on October 12, 2010 using a calibrated flow meter attached to a 10lb torpedo weight (Figure 10). The weight is designed to orient the flow meter probe into the flow. The weight and probe were tethered to a crane by a graduated line (Figure 11). The crane was used to position the probe at various locations and depths in front of each of the two fishway intakes. The graduated line determined the depth of the probe within the water column. Depth and water velocity measurements were collected at nine locations in front of the outer wall intake (Figure 12) and twelve locations in front of the bar rack intake (Figure 13). The measurements were spaced over a regular interval of approximately 3 ft and represent a cross sectional area of 36 ft^2 and 72 ft^2 at Stations 6 and 7, respectively (Figures 12 and 13). Velocity measurements included the top, mid and bottom at each location. The top is defined as 1 ft below the surface of the water, the bottom as 1 ft above the water-sediment interface, and mid[2] as defined as 3 ft below the water surface. Water velocity measurements were recorded at a fishway flow of 130CFS or 2.2% of the current Project hydraulic capacity (6000CFS). This fishway flow

[2] Mid water velocities were collected at a depth of only 3ft due to the configuration of the multi level gates installed at the fishway intakes.

volume was achieved through a combination of bypass flow (40CFS)[3] and attraction flow (90CFS).

Several gate operation variations were tested and flow field and turbulence observations, as well as spot velocity measurements were made concurrently for each scenario. Based on these field measurements and observations, it was determined that a gate configuration of full top gate opening and a 1-2 ft bottom gate opening provided maximum attraction flow velocities in front of the fishway intakes. This conclusion was evident by the combination of maximized flow velocities, as measured 3 ft upstream of the intakes at both, top and bottom locations, as well as relatively laminar flow field and minimal turbulence in the vicinity of the intakes as visually observed on the surface. A full suite of velocity measurements was collected under this gate operation scenario.

3.3 RESULTS AND DISCUSSION

3.3.1 VELOCITY MEASUREMENT ALONG THE ANGLED BAR RACK

The water depth was measured at each of the five stations and ranged from 11 ft at Station 5 to 21.3 ft at Stations 2 and 3 (Table 1). Water depths at Stations 1, 2 and 3 were generally similar, while depths at Stations 4 and 5 were notably shallower (Table 1). At the time of construction and the pre-watered inspection, the depth of the power canal was relatively uniform across the length of the angle bar rack. The relatively shallow depths along the left bank canal wall were likely due to the accumulation of sediments as a result of the low energy flow and eddy effects exhibited in this location. This conclusion is supported by the velocity data collected at Stations 4 and 5, as they generally exhibited the lowest velocities during scenario 1 testing. Surprisingly, this trend did not hold true during scenario 2 testing (partial Project capacity).

Water velocity measurements collected at top, mid and bottom at each station while operating under the conditions of Scenario 1 are presented in Table 2. These measurement were collected approximately 12 to 16 inches from the upstream face of the angled bar rack. It was deemed that the additional 4 inches of distance between the angled bar rack and the location of the velocity

[3] Measuring the depth of water in the final discharge pipe and applying it to the volumetric rule curve determined the bypass flow: the height of the outlet gate for the fish separation chamber determined the additional attraction flow.

measurements would likely not generate a significant deviation from the assessment result, though this cannot be substantiated. Measurements collected along the bar rack were generally consistent between multiple readings with the exception of the mid and bottom measurements at Station 1 where turbulence and eddies produced highly variable velocity measurements.

Water velocities were generally highest at Station 3 and lowest at Station 5 (Table 2). The two exceptions to this pattern were observed at the bottom and mid points of Station 4. These locations exhibited the highest mid velocity (1.72 ft/s) and conversely the lowest bottom velocity (0.73 ft/s) of any station measured.

The top of the water column consistently exhibited the highest velocities at all five stations and ranged from 2.32 ft/s at Station 5 to 3.27 ft/s at Station 3. Conversely, the bottom water velocity measurements exhibited the lowest velocities across all stations without exception. The water velocities measured at the bottom of the water column ranged from 0.73 ft/s at Station 4 to 1.09 ft/s at Station 3. The mid water velocity profile exhibited velocities between that of the top and bottom and ranged from 1.14 ft/s at Station 5 to 1.72 ft/s at Station 4.

Additional velocity measurements near the surface of the water column were recorded on October 12, 2010 during reduced Project operation (Scenario 2), and are presented in Table 3. All of the velocities measured were less than 2 ft/s and were lower than those measured in the same location at full Project capacity. Velocity ranged from a low of 0.82 ft/s on the surface at Station 1 to a high of 1.89 ft/s at a depth of three feet at Station 3. The velocities measured at a depth of three feet were consistently greater than those measured at the surface, with the exception of Station 5.

3.3.2 VELOCITY MEASUREMENT AT THE FISHWAY INTAKES

The depth of the water column was similar at both the outer-wall intake and the bar rack intake and ranged from 19 ft to 23 ft (Table 4). The flow in the area of the fishway intakes was observed to be relatively laminar at the surface with little turbulence or eddying.

The water velocities at the outer-wall fishway intake ranged from 0.06 ft/s at the bottom of Location 6 to 0.97 ft/s at the top of Location 1, immediately in front of the outer-wall intake entrance (Table 5). Water velocities were consistently the greatest when measured at the surface and the lowest when measured on the bottom of the water column. Further, those measurements recorded closer to the entrances of the fishway were generally greater than those measured farther way.

The water velocities at the bar rack fishway intake ranged from 0.17 ft/s at the bottom and a depth of 3 ft at Locations 3 and 3A to 0.85 ft/s at the surface of Location 1, immediately in front of the bar rack intake entrance (Table 6). Water velocity trends were very similar to those measured in front of the outer-wall fishway intake, however water velocities were generally greater in the vicinity of the bar rack intake in comparison. The bar rack fishway intake is located in close proximity to the angled guidance system. There were noticeable interactions between the surface flow field in front of the bar rack fishway intake and flow through the angled guidance system. On site observations suggests that the increase in water velocity at the Locations 3B through 4B may be related to this proximity and thus influenced by flow fields in front of the angled rack.

3.4 CONCLUSION

The assessment characterized the hydraulic conditions along the upstream face of the angled bar rack and in front of the two fishway intakes at the Project. The survey and subsequent analysis demonstrated that water velocities in front of the angled bar rack do exceed the threshold of 2 ft/s when the project is operating at or near maximum capacity. However, the 2 ft/s threshold is only exceeded at the top of the water column. Velocity measurements in the mid and bottom water column did not exceed the 2 ft/s threshold at any station. Station 3 exhibited the greatest water velocities. Water velocity measurements conducted under reduced Project operation (i.e. unit five not operating) were below the 2 ft/s threshold at all stations.

The water velocity measurements conducted within the vicinity of the two fishway intakes varied spatially. The highest velocities were recorded at the surface, especially those located immediately in front of the intakes. In general, the highest velocities were measured at locations closest to the intake however, there were exceptions to this pattern at the outer most locations at the bar rack fishway intake where water velocities are likely influenced by flow fields in front of the angled bar rack.

The velocity measurement in front of the angled bar rack was conducted at or near Project hydraulic capacity and likely represents a worst case scenario (i.e. high velocities). Thus, further hydraulic measurement is not warranted. Also, approach velocity at the surface was below the 2 ft/s threshold at all five stations during reduced operation flow (i.e. unit 5 not operating). The velocity and flow field survey conducted in the vicinity of the two fishway intakes was conducted at a total fishway flow of 130 CFS or 2.2% of Project capacity and have been documented herein. However, additional measurements in front of the fishway intakes at 5% or 300 CFS may be desirable to investigate the implications of greater fishway flow on flow fields and water velocities in the vicinity of the fishway intakes.

4.0 RESIDENT FISH PASSAGE ASSESSMENT

4.1 MATERIAL AND METHODS

The methods detailed in this section were guided by the scope of study defined in the Phase I Fishway Effectiveness Testing Plan (Erie Boulevard Hydropower, L.P., 2007), and were generated in consultation with the USFWS and NYSDEC. Furthermore, fish collection in support of these studies was conducted under the terms and condition of the New York Fish and Wildlife License Number 1536.

Based on observations from local 1993-1995 entrainment studies, most downstream movements of riverine, non-diadromous fish species in upstate New York rivers consistently occurred during the spring and late-summer through mid-fall period, when ambient river temperature falls between 10-20^{o}C (NMPC, 1996). As such, the resident fish survival studies for the School Street fish bypass facility were conducted in the fall of 2009 under these general conditions.

Test fish were selected representing various fish body types employed during the Niagara Mohawk Power Corporation (NMPC) entrainment survival studies, where body morphology and skeletal structure was observed to affect the vulnerability of some species to withstand physical injuries sustained during downstream passage through hydropower turbines. The species selected represented the range of warm water freshwater fishes and body types available in the Project vicinity. Historic sampling in the 1990's indicated that the School Street Project impoundment was dominated by centrarchids species, including smallmouth bass, largemouth bass, rock bass, and bluegill, as well as yellow perch and various cyprinids (NMPC, 1994).

Individuals were collected for this study using boat electrofishing. The sampling gear included a Smith-Root 5.0 Generator Powered Pulsator (GPP) unit, powered by an 11-hp Honda generator with a maximum output of 5 KW at 16 amps. The Smith-Root system was mounted on an 18 ft Lowe Roughneck boat powered by a 30-hp Evinrude E-Tec outboard engine.

Resident fish collection was conducted on October 31 and November 3, 2009 in the Crescent Project impoundment located immediately upstream of the School Street impoundment and below canal lock number two of the Erie Canal system in the Mohawk River (Figure 14).

Electrofishing *w*as conducted using the high range setting 120 v, Pulse DC at a range of 4-8 amps. Collected fish were placed in a 75 gallon aerated live-well where they were held during sample collection, and then transferred to a 150 gallon aerated temporary mobile live-well for transport. Test fish were held prior to testing in a holding tank located at the School Street Project (Figure 15). Water in the holding tank was continuously circulated at a rate of approximately 5 GPM, and water quality parameters similar to those measured in the power canal were maintained.

4.1.1 MARK AND RECAPTURE

A series of mark recapture tests were conducted at the School Street Project to estimate fish bypass passage survival of resident fish species. Test fish were held in a holding tank for a minimum of 24 hours prior to *marking* to minimize the effects of latent mortality associated with electrofishing capture. All fish used in this study appeared to be in good health and free from major blemishes.

Test fish were measured (total length) and marked using fin clips to distinguish between test groups, and sorted into “small” and “large” size categories for each available body type category. Further, the life stage (adult or juvenile) of those test fish that were measured were categorized for each species. The marked fish for each category and size group were enumerated and injected into the bar rack fishway entrance or fish return weir pool depending on the specific test trial, using a bucket and rope system. Those test fish exiting the fish passage system via the fish bypass return pipe were then recovered using a floating net pen positioned in the tailwater (Figure 16). The net pen was custom built for the School Street Project. The major components of the net pen include; 1) a collection/holding area (12 x 28 ft) enclosed with 3/8” heavy duty mesh netting to a depth of 6 ft; 2) a 2 ft high angled eel corral with 3/8” mesh netting; and 3) a floating work platform. The net was anchored in the outfall of the fishway flume and designed to capture all flow emanating from the flume outlet. Test fish were held in either the net pen or were transported back to the holding tank for a minimum holding period of 12 hours.

At the end of the recapture period, the fishway discharge was temporarily closed during the holding period. This prevented inducing net injury during the holding period resulting from test fish being continuously subjected to the turbulent hydraulics caused by the bypass discharge flow. After the minimum holding period of 12 hours, the condition of the test fish was assessed as alive, dead or stressed. The evaluation criteria for each category was as follows: alive fish were those that were intact, not exhibiting any external injuries, hemorrhaging or erratic swimming; stressed individuals were those still alive but exhibiting erratic swimming behavior and/or injury; and dead fish were those exhibiting no opercular motion, discolored or not physically intact. All test fish were released following the condition assessment.

A control group comprised of 64 individuals representing the local fish assemblage, as well as juvenile and adult size classes, was collected and handled in a similar manner as the test specimens. The control group was not subjected to fishway testing, but rather held in the tank for the same period of time as the test groups (minimum of 12 hours) and were evaluated for condition in the same manner.

4.1.2 FISHWAY OPERATION

The fishway was operated in a manner to provide guidance flows within the fishway conveyance structure, as well as maintain an appropriate water level within the system to facilitate passage over the movable weir and into the fish passage weir pool. A total of 6 gates were used to tune the fishway conveyance flows as described below:

- Gates 1 and 2 are surface and bottom gates respectively, and are located in the fishway entrance closest to the angled bar rack. These gates were opened approximately 1 to 1.5 ft to provide guidance flow in the fishway.
- Gates 3 and 4 are surface and bottom gates respectively, and are located in the fishway entrance along the bank right canal wall. Gate 3 was closed at the time of sampling to minimize debris passage into the fishway. Gate 4 was opened approximately 1 ft to provide additional flow through the fishway. No test releases were conducted in the entrance location.
- Gate 5 is a weir gate that provides flow over the outlet weir and into the fish return weir pool. This gate was adjusted to provide 4-6" of flow to facilitate passage over the weir. Leakage flow through the weir added to the total volume of water entering the fish return weir pool. This flow equated to an 8 to 12" water depth in the final return pipe (~40 cfs).
- Gate 6 is located on the downstream wall of the fish separation chamber and provides the main outflow of bypass attraction flow water. This gate was operated to maintain the water level within the fish separation chamber and was opened approximately 1 to 1.5 ft as necessary (Approximately 90 CFS).

4.2 DATA ANALYSIS

Sample data were entered into a Microsoft Access ® database. All calculations were performed within Access or Excel ® utilizing its suite of built-in functions and analysis capabilities. Basic sample population parameters, including species richness and descriptive statistics, of the top five species were calculated, including length frequencies. Passage survival, defined as the percentage of fish that are conveyed via the fishway and recovered "*alive*" after a minimum 12-hour holding period, was calculated using a simple proportion. That is, the number of recaptured fish evaluated to be "*Alive*" (A) divided by the total number of fish recaptured (R) (Alive, Stressed, and Dead) and multiplied by 100 (Equation 1).

Equation 1: Passage survival = (A/R) x 100

Survival was calculated for the overall test population, and also for each body type and size class category to demonstrate survival variation among morphologies. Individual species were sorted into the six body morphology groups; Centrarchid, Percid, Salmonid, Soft-Rayed, Clupeid or Anguilliform, as well as one of two size categories, large or small. Large fish were defined as individuals greater than or equal to 6 inches (or 152.4 mm) in total length and conversely small fish were those measuring less than 6" in total length.

4.2.1 RESULTS AND DISCUSSION

The resident fish survival assessment was conducted between November 5 and November 7, 2009. The tables and figures associated the assessment are located in Appendix B and C, respectively. A total of 284 fish were collected including a control group and five trial groups. The control group consisted of 64 individuals, which represented sub-sample of the test fish (Table 7). This group was held in tanks with water quality parameters similar to those measured in the power canal (Table 8). The test group consisted of 220 fish and the number of fish released in each trial varied between 20 and 78 fish (Table 9). The total length of 201 of the 220 test fish were measured and used to categorize test fish as either adult or juvenile by species (Table 10).

A total of 22 species was represented in the control and test groups (Table 11). The smallmouth bass, bluegill and rock bass were the most numerically dominant species and constituted over 57 percent of the test fish. These species are representatives of the Centrarchid family, which in whole represented over 72 percent of all the fish (Table 12). The percid and soft-rayed fish comprised 13.73 percent and 11.62 percent of the total, respectively. These three body type groups' composed 97.53 percent of the total group. Anguilliforms, Salmonids and Clupids were not well represented and constituted 1.06, 1.06 and 0.35 percent of the total fish respectively (Table 12).

The size variation by species of the most numerically dominant test trial fish is summarized in Table 1. Smallmouth bass was determined to be the largest species in the test trial group on average and rock bass was the smallest. Tests group sample sizes by body type and length category ranged from 3 (salmonid, anguilliform and soft-rayed- small) to 53 (centrarchid-small) (Table 14).

Fish releases were initially attempted immediately downstream of the bar rack fishway entrance, per request of the study team; however, recapture was very poor when fish were released at this location (0 % for most fish body types). This appeared to result from released fish having volitional access to the canal, fishway entrance area and separation chamber [4]. Recapture markedly improved when fish were released at the fish return weir pool and varied between 50 and 100 percent across all body types (Table 15). Subsequent survival tests therefore relied on releases made at this location to ensure that sufficient test fish could be recaptured for evaluation.

The control group was comprised of a range of body types and sizes and exhibited 100 percent survival over the course of testing. Test fish survival ranged between 66.67 percent (Salmonids) and 100 percent (Anguilliforms and Soft-Rayed Fish); however, salmonids and anguilliforms were represented by very small sample sizes (N=3 each). Within each body type group, survival of large (>6") versus small (<6") test fish were evaluated and summarized in Table 16. Survival among centrarchid body types and size categories ranged from 90.6 (small) to 100 percent (large); 88.9% for percids (both size categories) and 100 percent for soft-rayed fish (both size categories). Anguilliform and salmonid fish were only available in one size category and occurred in very small numbers.

[4] Recapture was 100 percent for salmonids, however this constitutes a single individual.

Centrarchids were well represented within the test groups and comprised 72.18 percent of the test group. Anguilliforms, clupeids and salmonids were not well represented in tests, as these species groups could not be abundantly collected at the time of the test. This was not totally unexpected as these groups include transient diadromous species, as well as cold water species, which are generally a small component of the year round fish assemblage in the mainstem of the Mohawk River. Furthermore, American eel and blueback herring survival will be addressed specifically in later studies to be conducted at the School Street Project. Survival rates recorded for salmonids and anguilliforms are based on the testing of only three individual test fish. The relatively small sample size of this test group makes it especially sensitive to mortalities in the calculation as two of the three individuals survived. Although a relatively small number of soft-rayed and percid fish were available for testing, sample sizes were larger and the trends in the available data appear consistent among size categories, suggesting that the results are reasonable.

Control group survival was 100%, indicating that survival rates recorded from test fish groups accurately reflects fish passage survival. There was no variation in survival between size classes (large vs. small) within each body type group of percid and soft-rayed fish types. The centrarchid group experienced slightly lower, but still good, survival within the small size class (survival 90.57%). The overall survival for all fish tested was 93.57 percent.

Releases made into the fish return weir pool improved collection efficiency over the fishway entrance and thus was an essential modification to the study design. Releases at the fishway entrance did not appear to induce resident fish to consistently move downstream. Though test fish were not subject to interactions with the fish separation chamber, this part of the fishway appears to have low velocities, large clearances and provides suitable fish holding areas. Passage through the most critical part of the fishway was readily evaluated, as it is anticipated that the greatest potential source of injury/mortality would be associated with the final descent into the bypass pipe and plunge into the Project tailwater due to turbulent flow and high velocity.

4.3 CONCLUSION

Bypass survival of resident fish was generally high across test groups, body types and size classes. The centrarchid group exhibited variation in survival between size classes; however survival in this category was still high at over 90 percent.

Fish body type and size have been demonstrated to be a source of variation of downstream passage survival in previously conducted studies of turbine passage (Cada, 1990; Franke, et al. 1997; Niagara Mohawk, 1996; ERPI, 1997). As a result, survival through the fishway was evaluated for each of the identified body types. These data indicate, however that the degree of variation in survival of resident fish species using this fishway does not vary significantly among body types and remains high.

The ability to fully evaluate the effects of the fish conveyance structure was somewhat limited by a lack of abundance of some fish body groups, particularly salmonids, clupids and anguillids. Salmonids were listed as a possible test target group as they were part of the original region wide study design reflected in studies conducted in New York during the 1990's, including study sites on Adirondack Rivers where trout species were common. However, salmonids are not locally abundant in the Mohawk River and thus the absence of data from this particular test group should not be significant to this study. Although a few anguillids and clupeids were opportunistically collected and tested during 2009, a full-scale test focused on these species will be planned for 2011, subject to test fish availability.

The fish release location likely had minimal effect on survival evaluation results because the predominant source of injury and/or mortality appears to be the final descent in the bypass pipe, as well as the plunge into the tailwater.

5.0 ADULT BLUEBACK HERRING

5.1 INTRODUCTION

An evaluation of adult blueback herring passage including, passage efficiency, survival and delay, was conducted from June 9 through July 13, 2010 using radio-telemetry methods. Prior to the study, Brookfield requested an amendment to the Final Plan (2007). In a letter dated March 30, 2010 to the NYDEC and the USFWS Brookfield proposed to modify the study design, based on site reconnaissance, and requested to use radio tags on five different frequencies instead of just one and to move the location of four antenna arrays to better detect fish movement at the Project. On April 9, 2010 the USFWS responded, in a letter, stating that; "*the rational for modifying these locations are acceptable to the Service*". The NYDEC deferred to USFWS and did not respond to the inquiry. The subsequent evaluation was conducted in accordance with the modified study plan (Appendix D).

5.2 INSTALLATION, CALIBRATION AND TESTING OF TELEMETRY SYSTEM

Eight automated multi-reader digital Grant System's Orion radio-telemetry receivers were installed to monitor radio tagged blueback herring within the study area during the 2010 emigration past the Project. Each receiver and subsequent antenna array was configured to maximize effectiveness, a process requiring site specific tuning including the use of various antenna configurations, signal amplification and attenuation.

i. **Antenna Array 1, Upper Gatehouse –** documented test fish occurrence upstream of the upper gate house and provided a record of those fish that have left the study area. This array consisted of a double yagi antenna mounted to an eight foot steal pole located immediately upstream of the upper gate house on the bank right side of the power canal looking downstream. The array was oriented perpendicular to the flow of the power canal and exhibited detection range that was effective across its entire width.

ii. **Antenna Array 2, Pedestrian Bridge –** documented test fish as they moved downstream within the power canal from the release location (downstream of the upper gate house) and was essential for documenting migration delay. The array consisted of a series of five dipole antenna. The antennas were hung vertically from 24 ft aluminum poles and fastened to the pedestrian bridge at equally spaced interval (Figure 17). The antennas were located within the water column at a depth of 3 ft and provided detection coverage across the entire width of the power canal to a depth of approximately 9 ft.

iii. **Antenna Array 3, Fish Separation Chamber Entrance –** documented test fish entering and holding within the separation chamber and was essential to the documentation of migratory delay associated with finding the entrances to the fishway. This array consisted of two dipole antennas wired in series and positioned in the center of the downstream terminus of the fishway entrances where they enter the separation chamber, one in each.

iv. **Antenna Array 4, Weir Pool –** documented test fish movement as they passed over the weir and entered the outlet weir pool before making the final decent into the tailrace. This array was essential for documenting Project and fishway passage and fishway delay. The array consisted of one dipole antenna mounted on the downstream side of the weir immediately adjacent to the upstream terminus of the final discharge pipe, below the water line.

v. **Antenna Array 5, Lower Gatehouse/Forebay –** documented test fish movement as they entered a point of no return (due to water velocity) before entering the penstocks and becoming entrained. This array consisted of five dipole antennas wired in series, one located in each of the five penstock entrances. The dipole antennas were mounted to 24 ft aluminum poles and positioned immediately upstream of the penstocks entrances at the head gates and below the water line.

vi. **Antenna Array 6, Tailrace –** served to substantiate and provide redundancy to Project passage via the fish bypass or entrainment. This array consisted of a double yagi antenna mounted on the downstream face of the powerhouse and oriented in a downstream direction.

vii. **Antenna Array 7, Route 32 Bridge Bank Right –** documented test fish movement downstream of the Project and provided information as to the likely condition (live) of the test fish. The array was located on the bank right side of the river looking downstream. And consisted of a double yagi antenna mounted on a ten foot steal pole. The antenna was oriented perpendicular the river alignment and provided detection coverage of approximate ¼ of the river's birth.

viii. **Antenna Array 8, Route 32 Bride Bank Left -** documented fish movement downstream of the Project and provided information as to the likely condition (live) of the test fish. The array consisted of three yagi antennas. Two were mounted to the downstream side of the Route 32 bride (DOT Permit No. 20100116640). They were located in the center of the bridge and oriented in opposite directions at an angle nearly perpendicular to the river alignment. These antennas provided coverage across the middle half of the river. The final yagi antenna was located on the back left side of the river and was mounted to an eight foot steel pole. The antenna was oriented nearly perpendicular to the river alignment and provided coverage of the final ¼ of the river.

The receivers were powered by a 12v battery system. With the exceptions of Antenna Arrays 7 and 8 all receiver stations were continuously recharged by trickle charges. Should AC power be interrupted the battery backup system yields approximately 48hrs of battery life. The remote receiver locations (Antenna Arrays 7 and 8) operated from battery power exclusively and were outfitted with a larger battery banks yielding a battery life of approximately 96hrs. Throughout the course of the study the batteries were changed every 48 to 72 hrs at the remote stations.

5.3 FISH COLLECTION, TAGGING AND RELEASE

Adult blueback herring were collected on the mornings of June 8, and 10 in accordance with the terms and conditions of the New York Fish and Wildlife License Number 1536. The test fish were collected from the fish separation chamber using long handled dip nets and immediately deposited into a 90 gallon aerated live well. The fish were then transported approximately 250 ft and placed into two of three 1000 gallon live tanks with pump through water from the Project power canal (pump rate ~2000 gallons/hr) (Figure 15). The third tank was reserved for the holding of tagged fish prior to release. The holding tanks were covered with fine mesh netting to prevent escape and predation as well as provide shading. Water quality measurements including: water temperature, conductivity, dissolved oxygen and pH were regularly recorded within each tank and the power canal.

Test fish were held for a minimum of 8 hours before tagging and a minimum of 2 hours after tagging to account for latent mortality. Fish tagging was conducted on June 8, 9 and 11. Test fish were selected at random for tagging, however those fish exhibiting torpid swimming, hemorrhaging, discoloration, fungus and significant descaling were rejected. Test herring were fitted with small radio-transmitters (8 x 18mm, weighing approximately 1.8g) via esophageal implantation. Five frequencies including; 149.340, 149.480, 149.740, 149.760 and 149.780 mhz with 20 transmitters per frequency were using for testing. These frequencies were chosen based on the results of a noise test conducted in the winter of 2010 and exhibited a relatively low volume of ambient radio noise at the Project. The use of five different frequency transmitters reduced the potential for signal collision which often confound the analysis of radio-telemetry data. Furthermore, the Orion receivers can simultaneously monitor multiple frequencies eliminating the need for frequency switching and subsequently temporal data gaps. The tag life of the radio-transmitters were estimated by the manufacturer to be 28 days at a 1.5s burst rate or 40 pulses per min.

Test fish were release in the upper portion of the power canal approximately 300 ft downstream of the upper gatehouse. This release point allowed test fish ample time to acclimate and resume normal swimming behavior before encountering the fish guidance structures. Fish were released in three cohorts of 14, 35 and 44 fish on June 9, 10 and 11 respectively. Based on agency recommendation, Brookfield proposed in the Final Plan to tag 100 adult blueback herring to test passage efficiency and survival. However, as is common for radio telemetry studies some tags malfunctioned resulted in a final sample size of 93 herring.

5.4 Control Group and Size Structure

Two control groups were established to provide information related to latent mortality as a result of handling and tagging stress. The control groups were subject to the same suite of stressors as the test herring. Each control group individual was tagged with a dummy tag. Control groups were tagged on June 8 and 11, 2010 and were held in a 1000 gallon tanks with a pump through systems for a minimum of 24hours and then evaluated as live, stressed, dead or tag regurgitated (live or dead).

A subset of 50 herring was selected at random to determine the size structure of the overall adult herring test group. The total length of each herring was measured and recorded.

5.5 Mobile Survey

A mobile survey was conducted on July 13, 2010. The survey consisted of radio frequency monitoring using a hand held yagi antenna and a Lotek SRX receiver at various locations throughout the power canal. The purpose of this survey was to account for any fish that may have still been in the study area. All five of the radio transmitters' frequencies were scanned at each location. The survey covered approximately 80% of the canal. Some areas could not be surveyed closely due to safety concerns.

5.6 Fishway Operation

Throughout the course of the study the fishway was operated in a normal manner to provide the desired guidance flows within the fishway conveyance structure, as well as maintain an appropriate water level within the system to facilitate passage over the movable weir and into the fish passage weir pool. Section 4.1.2 details the operational configuration of the fishway with the following exceptions; the bottom gates (2 and 4) were open 2ft and the top gates (1and 3) were at full gate. The total flow of the fishway was approximately130 CFS or 2.2% of the Project capacity.

5.7 DATA COLLECTION

The Orion receivers log data on removable scan disks. Data were downloaded nearly every other day throughout the course of the study. The data were downloaded from the scan disks to a dedicated field laptop. At the end of each day the data were backed up on Kleinschmidt's data archive network.

5.8 DATA ANALYSIS

Data processing included the use of a proprietary database program for raw radio-telemetry data processing. In general terms bypass efficiency (E) is defined as: the percentage of blue back herring that attempt to volitionally pass downstream and enter and use the fishway. The following equation was used to calculate bypass efficiency as a percentage of the fish that successfully used the fishway verse those that were either entrained, did not migrate, or were unaccounted for due to malfunction (i.e. tag loss/malfunction).

E = (100) (a/b), where;

a = the number of herring determined to have successfully passed via the fishway.

b = (the number of herring released) – (the number determined to have been entrained) – (the number of herring that were not accounted for either due to escapement, tag malfunction or lack of migration)

The Final Plan specified that blueback herring passage survival would be evaluated using radio telemetry methods. Thus, survival was defined as: the percentage of fish that passed the Project via the fishway and were detected downstream at the Route 32 bridge arrays. However, detection at the Route 32 Bridge was an inconclusive surrogate for Project passage survival due to site specific conditions and poor water quality (conductivity). Therefore, survival could not be evaluated using this approach. However, the proportion of fish that bypassed the Project and were detected downstream (D_{Bridge}) was calculated.

D_{Bridge} = (100) (a/b), where;

a = the number of herring that passed the Project via the fishway and were detected downstream of the Project at the Route 32 bridge arrays.
b = the number of fish known to have passed the project via the fishway.

Passage delay (D) is defined as: the duration of time required for an actively migrating herring to bypass the project via the fishway. It is also useful to know the duration of time for an actively migrating herring to find the fishway entrance (D_E) as well as the duration of time required for a herring to navigate the fishway itself (D_{FW}). Delay (D) was determined by calculating the amount of time that elapsed between detection at Antenna Array 2, located at the pedestrian bridge, and Project passage via the fishway. Delay (D_E) was determined by calculating the amount of time that elapsed between detection at Antenna Array 2 and detection at Antenna Array 3 located in the fishway entrance pipes. Delay (D_{FW}) was determined by calculating the amount of time that elapsed between detection at the fishway entrances, Antenna Array 3, and Project passage via the fishway.

For comparison purposes delay associated with entrainment (D_{ENT}) was determined by calculating the amount of time that elapsed between detection at the pedestrian bridge, Antenna Array 2, and entrainment, Antenna Array 5.

5.9 RESULTS

The results of this study were tabulated and organized in Appendix E and are represented on an individual test fish basis. Appendix E includes tag frequency and code, passage status, release date and time, passage date and time, entrainment data and time delay and survival.

Sixty six of the 93 herring (71%) that were tagged and released into the power canal were determined to have actively migrated and passed the Project, either through the fishway or via entrainment. Of the remaining 27 herring: 12 did not migrate, six were never detected, five were impinged on the angled bar rack, two were last documented at Antenna Array 1 located upstream of the upper gatehouse, one fish was documented as having passed the Project, however the route of passage is unknown, and one was detected only at Antenna Array 8 located along the Route 32 Bridge on the bank-left of the river, downstream of the Project (Appendix D).

Fifty four (81.8%) of the sixty six herring that actively migrated and passed the Project used the fishway. The remaining 12 (18.2%) herring were entrained.

The detected downstream occurrence (D_{Bridge}) was calculated for those test herring that were determined to have used the fish bypass. A connectivity malfunction occurred on the afternoon of June 10, 2010. The Route 32 Bridge, Antenna Arrays 7 and 8 malfunctioned and were repaired at 11:50 and 13:50, respectively, on June 11, 2010. The lapse in coverage reduced the sample size of herring available to calculate D_{Bridge} from 54 to 42 individuals, as those test fish that passed the Project during the downstream outage at the bridge were removed from the calculation. Of the 42 herring used in the calculation, 20 were detected downstream yielding a D_{Bridge} estimation of 47.6%.

Passage delay (D) ranged from 0.5 hrs to 73.3hrs with a mean delay of 10.6 hrs (SD 12.61) (Table 17). In addition to the overall Project passage delay, the range and mean delay associated with finding the fishway entrances (D_E) and the range and mean delay associated with navigating the fishway (D_{FW}) itself was calculated. D_E ranged from 0.3hrs to 26.4hrs with a mean of 6.1hrs (SD 6.37) and D_{FW} ranged from 0.2hrs to 46.9hrs with a mean of 4.4hrs (SD 8.78), respectively (Table 17). Project passage delay was calculated for those herring that were entrained through the Project. Delay (D_{ENT}) ranged from 0.3hrs to 93.1hrs with a mean delay of 23.8hrs (SD 30.03) (Table 18).

The timing of overall Project passage was determined daily. Fishway passage occurred between June 9 and 13, 2010 (Figure 18). The greatest number (n=22) of fishway passage occurred on June 12, 2010. Entrainment occurred between June 10 and June 14, 2010 with the greatest number (n=4) of herring entrained on June 12, 2010 (Figure 19).

The control group consisted of 40 herring. After a 24 hour holding period, 5 control herring were dead, 35 were alive, and none appeared stressed. These results yielded a survival of 87.5%. Two tags were regurgitated and found within the holding tanks. One herring that regurgitated the tag was dead, the other was alive.

The total length of the adult herring subset ranged from 211mm to 269mm. The mean length was 244mm (SD 10.4) (Figure 20).

Water quality measurements were recorded in the power canal and are presented in Table 19. The temperature ranged from 20.3°C on June 15 to 27.1°C on July 9, 2010. Conductivity was generally high when compared to other years of study on the Mohawk River and ranged from 248µs/cm on June 14, 2010 to 369µs/cm on June 8, 2010. Dissolved oxygen ranged from 5.5mg/L on June 7, 2010 and 8.2mg/L on June 15, 2010. pH was generally consistent and ranged from 6.9 on June 4, 2010 and 7.9 on July 2, 2010. Water quality monitored in the fish holding tanks is summarized in Table 20. With the exception of dissolved oxygen, water quality conditions mirror those of the power canal. Dissolved oxygen was generally lower in the holding tanks than in the power canal and ranged from 3.5 mg/L on June 10, 2010 to 7.0 mg/L on June 4, 2010.

The Mohawk River flow was variable and ranged from a low of 540 CFS on July 7, 2010 to a high of 12,600 CFS on June 13, 2010. The Project power output generally mirrored the availability of water (Figure 21). Fishway passage occurred between June 9 and 13, 2010 and generally occurred at river flows between 2,000 and 4,000CFS and corresponding power production (34-64% of max). Entrainment occurred slightly later in the migration season with 50% occurring prior to higher flows on June 13 and 14, 2010, and 50% occurring during the higher flow event.

5.10 Discussion

A total of 71% of available test herring (N=66) were detected as having migrated downstream via either the fishway or entrained. Our conclusions are based on the movement of these 66 test fish. A relatively large initial sample size was used in the study (N=93) as some anomalous results were expected.

The redundancy of the radio-telemetry system at the point of passage (*i.e.* two antenna arrays, one within the fish separation chamber as well as a backup receiver in the tail race) provided a passage record that correlated the last valid detection record upstream, either within the fish separation chamber (fishway passage) or within the penstocks (entrainment passage), with emergence in the tailrace. This pattern was documented in all 66 test herring used in the calculation of passage efficiency.

The remaining 27 tagged test fish did not provide conclusive information on fish passage, and thus were rejected from analysis. These fish did not migrate, were never detected, were impinged on the angled bar rack, were last documented upstream of the upper gatehouse and were presumed to have left the study area, or were documented as having passed the Project, however the route of passage is unknown or was detected only downstream of the Project. The 66 valid test herring movements yielded a passage efficiency for the fishway of 81.8%. A combination of mortality, predation, tag malfunction and small gaps within the telemetry system may account for the unknown test fish. Some mortality was expected as post-spawn mortality is high in blueback herring particularly in the southeast where some populations are considered semelparous (i.e., spawn once and die) (Klauda et al., undated publ.). Furthermore, the control group exhibited a mortality of 12.5%, suggesting that of the 93 tagged herring released at least 11-12 would likely not survive.

The impinged herring were detected during the mobile survey conducted on July 13, 2010, which was a considerable time following the test releases. These herring were not included in the Project passage calculation as there was no way to substantiate if impingement had occurred pre or post mortem and any test fish that exhibited mortality in the power canal is likely to be impinged on the angled bar rack due to water velocities and the laminar flow in the power canal allowing dead fish to drift into contact with the bar rack. The largest proportion of unknowns either did not migrate or were documented as having left the study area upstream through the upper gatehouse (51.9%). Studies conducted at the Crescent Project (FERC NO. 4678-NY) located immediately upstream in Cohoes, NY have demonstrated similar results. A study conducted in May and June, 2009 found that the majority of tagged adult blueback herring did not migrate downstream or were otherwise never detected in the study area after release (NYPA 2009).

In the Final Plan, survival was assumed to be reflective of the percentage of passed fish that successfully passed a downstream monitoring point (NY Route 32 Bridge). However, detection limitations at this location rendered this approach inconclusive. Range testing conducted at the bridge confirmed that coverage was complete across the entire width of the river within the upper water column. However, those fish migrating in the middle and lower water column would not have been detected. Furthermore, water conductivity affects the transmission range of radio tags and was generally high and variable during the study, resulting in unpredictable detection ranges. Further, a portion of bypassed test fish was rejected from the calculation because Antenna Arrays 7 and 8 were not operational during their passage at the Project. These factors likely resulted in missed detections and inconclusive results.

Passage delay was generally low with a few outliers that skewed the means (Table 17). In particular the standard deviation within the entrained group was very high (30.0) with half of the group exhibiting little delay and the other half exhibiting more extended delay (Table 18). For those fish that bypassed the Project via the fishway, the greatest delay was generally associated with finding the fishway entrance. However, the lengthiest record of delay (46.9 hrs) occurred within the fishway itself. The antenna arrays at the pedestrian bridge, within the fishway and penstocks provided a robust record of delay. Overall, 95.5% of the valid test herring were used to demonstrate delay at the project. Of the 66 herring three could not be included in the delay algorithm because they were not detected at the pedestrian bridge which was the starting place of the delay calculation. These three likely migrated within the lower water column, and out of range of the antenna array.

Project operation may have been a source of variation, although generation and canal flow were generally low and uniform during the majority of the passage period. On June 13, 2011 flow and Project generation increased. During this period eight test fish or 12.1% passed the Project during the rise in river flow and increased Project generation. Only two fish were bypassed during this period; however, six were entrained via the powerhouse (50% of the overall entrainment).

5.11 CONCLUSION

The data indicate that 81.8% of test herring conclusively exiting the power canal were passed via the fishway. The remaining valid test herring were entrained via the penstocks and turbines.

Project passage survival was not calculated due to the potential for missed test fish at the Route 32 Bridge, which failed to meet the study assumptions. The study did document that at least 48% of the fish that passed the project also subsequently arrived at the Route 32 Bridge. However, an equipment outage, combined with range testing that demonstrated that herring migrating in the mid and lower water column would not be detected by the Bridge antenna arrays, suggests that this estimate is low.

Delay was generally low for both bypassed and entrained herring. On average the greatest delay exhibited by those herring that bypassed the Project via the fishway was a result of time spent finding the fishway entrance. The delay exhibited by entrained herring was slightly longer than herring using the bypass. However, Project passage of test fish did not occur after June 14, 2010, only three days after the final cohort release.

The vast majority (89.4%) of passage occurred during generally stable river flow and operational conditions. However, a brief increase in turbine entrainment may have been induced by rising river flows coinciding with a sudden increase in generation related to a high flow event.

6.0 JUVENILE BLUEBACK HERRING ASSESSMENT

6.1 INTRODUCTION

The Final Plan calls for juvenile blueback herring passage efficiency and survival to also be evaluated at the Project.

Passage efficiency would be based on developing a ratio of juvenile herring passing via turbine entrainment vs. the fishway over a concurrent sampling period during the migration season. In June 2010 a pilot study was conducted to determine the feasibility of using hydroacoustics to evaluate passage efficiency. The results of the pilot study suggested that turbulence would not prohibit the analysis of data and a full scale study was planned for the seasonal migration in 2010 (Appendix D). Passage survival was to be assessed by collecting juvenile herring exiting the fishway using the same equipment and overall procedures developed for resident fish survival, i.e., use of the tailrace net pen (Section 3.5).

The team mobilized to conduct the study in early September, 2010. Based on the pilot study recommendations, Brookfield installed a split-beam hydroacoustic and DIDSON camera array to document the proportion of juvenile herring being entrained verses the proportion that were passing via the newly installed fishway.

Earlier observations documented schools of juvenile blueback herring in the fishway in August; however, large schools of out-migrating herring were not in evidence during the September-October study period. In late September, torrential rain in the watershed swelled the Mohawk River to flood stage (Figure 22). Inflow greatly exceeding project capacity spilled over the Project dam and may have resulted in few juvenile blueback herring (juvenile herring) entering the power canal study area. Due to a lack of juvenile herring entering the power canal, very little data were generated specific to juvenile herring downstream passage. As a result, no evaluation of juvenile herring passage efficiency or survival study could be conducted in 2010. Similar problems associated with juvenile herring occurrence and high flows were experienced upstream at the Crescent Project (FERC NO. 4678-NY) where juvenile herring studies were being conducted concurrent with the studies at School Street (Chris Tomichek, Kleinschmidt Associates, *personal communication*). Furthermore, hydroacoustic monitoring for juvenile blueback herring at State Dam, located immediately downstream of the School Street Project, also documented low numbers of herring in their forebay in the first half of September, prior to the high flow event (Green Island Power Authority, *Personal Communication*).

Although it was not possible to estimate fish passage efficiency or survival due to prevailing field conditions (i.e. a lack of juvenile herring), the following describes the hydroacoustic array design, data analysis methods and a summary of the observed hydroacoustic results.

6.2 HYDROACOUSTIC SAMPLING METHODS

6.2.1 EQUIPMENT INSTALLATION AND DATA COLLECTION

All equipment was installed September 7 through 9, 2010. Split-beam data were collected from September 7 through October 26, 2010. DIDSON data were collected from September 9 through October 26, 2010.

6.2.2 SPLIT-BEAM UNITS IN TURBINE INTAKES

Fish passage through the turbines was sampled with 3 split-beam transducers, one in each of the penstock intakes for units 1, 3 and 5. The transducers were mounted in a down-looking orientation on vertical 2-inch aluminum pipes attached to the front of the grated covering over each penstock intake immediately upstream of the headgate (Figure 23). Each transducer sampled approximately 10% of the penstock opening.

Simrad EK60 systems with 4x10° elliptical 120 kHz split-beam transducers were used in units 1 and 3. Data were collected at a ping rate of 15 pings per second and a pulse duration of 0.256 milliseconds. Simrad EK60 systems collect data without threshold. A BioSonics DTX system with a 4x8° 200kHz split-beam transducer was used at unit 5. Data were collected at a ping rate of 15 pings per second, a pulse duration of 0.200 milliseconds and an intensity threshold of -90dB.

6.2.3 DIDSON UNIT IN FISH BYPASS (SEPARATION CHAMBER)

A standard model DIDSON acoustic camera was installed on the eastern sidewall of the fish separation chamber, immediately upstream of the outlet weir (Figure 24). The DIDSON camera was oriented such that it provided a 29° field of view across the separation chamber immediately upstream of the weir; with the weir board clearly visible. Because of the shallow water above the bottom floor screen, the camera had to be fitted with an 8° concentrator lens to narrow the vertical extent of its view and thus reduce acoustic interference from the water surface. The tilt angle (-2°) of the camera was set such that the top of the submerged weir board was visible. A vertical extension was added to the weir board on both sides of the separation chamber. This prevented fish from passing within 3 ft of the transducer, where the field of view is too narrow, or too close to the opposite wall where the images collected during the feasibility study were masked by noise.

The DIDSON acoustic camera was connected through a 50 ft. transducer cable to a break-out box housed in a water-proof box. From there a 200 ft Ethernet cable connected the DIDSON system to a data collection computer in the gatehouse (Figure 25).

DIDSON data were collected in high frequency mode (1.8MHz), with a frame rate of 15 frames per second, start range of 0.4 m, and a window length of 5 m. Data were recorded continuously and generated a 650 MB file every 15-minutes.

6.2.4 REMOTE CONTROL AND DATA STORAGE

The sonar systems were controlled with laptop computers connected to a network and the internet to allow remote control (Figure 25). Data from all sonar systems was written to and automatically backed up on external RAID drives with a storage capacity of 2 and 4 TB.

6.3 DATA ANALYSIS

6.3.1 SPLIT-BEAM DATA

Split-beam data were processed in Myriax Echoview software. After applying an intensity threshold of -60dB, the data were analyzed with an α,β-tracking algorithm, which identifies the series of echoes that were returned by an individual fish over successive pings. The tracking results were reviewed on the echogram and exported as a database containing; time, target strength and 3-D positional information for each fish detected. This database was further filtered to remove all fish (or other targets) with a mean target strength of -52dB or less, which translates into fish approximately 1.5 inches in length or smaller (*Warner, Rudstam, and Klumb, 2002. In situ target strength of alewives in freshwater, TAFS 131:212–223*).

Fish counts were expanded for the non-sampled area of the intake cross-section. An expansion factor was calculated for each individual fish as a function of its effective beam width at the range it was observed. This effective beam width depends on the acoustic beam pattern and the size of the target. Thus, for a given transducer, at any given range, a large fish can be detected over a wider portion of the intake cross-section than a smaller fish. The expansion factor compensates for this differential detection probability. For each fish *i* the expansion factor x_i was calculated as:

$$x_i = \frac{w}{b_i}$$

where w is width (m) of the turbine intake, and b_i is the effective width (m) of the sonar beam for fish *i* at the range at which it is observed. For example, if for a given time period, one fish is observed at a range where its effective beam width is half the width of the intake, its expansion factor is 2. Thus, it is estimated that 2 fish passed (1 observed in the portion of the intake that was effectively covered by the sonar beam, 1 unobserved in the portion that was not). The expansion factors are summed over all fish observed in a given time period to estimate the total number of fish *F* that passed through the intake:

$$F = \sum_i x_i$$

6.3.2 DIDSON DATA

A sample of selected files, representing a total of 10 hours of data, was reviewed visually. Because of the highly dynamic noise introduced by the turbulent flow pattern, especially during periods when the water level within the separation chamber was fluctuating, it was not possible to analyze the data with any form of computer-driven processing or to generate any abundance estimates for juvenile herring. To illustrate the challenges of the collected dataset we created movie clips from selected periods when we saw fish of different sizes present upstream of the weir board and events when targets (some of which were possibly fish) crossed over the board.

6.4 RESULTS AND DISCUSSION

Three time periods were selected and reviewed based on on-site observations of fish presence and differences in flow conditions. In the first period, September 7 through September 11, 2010, fish were visually observed holding in the fish separation chamber. The second period, September 28 through September 30, 2010 and third period, October 1 – October 2, 2010, were chosen to look for events that occurred before, during and after flood conditions. In addition, a cursory review was conducted on some files collected after 10/20, when gizzard shad were found to be present in the fishway.

6.4.1 TURBINE INTAKES

Echogram examples of the split-beam data collected in the turbine intakes are shown in Figure 26 and Figure 27. Each echogram plots echoes over time (x-axis) and range (y-axis), with range increasing from top to bottom. The strong signal at the bottom of each echogram is the echo reflected by the intake floor. In Figure 26, the colors in the top two echograms relate to target strength, the warmer the color the stronger the echo. The strong echo of the intake floor is shown in red. The colors in the bottom two echograms relate to the angle at which the target was detected. Targets that move downstream (as do all targets shown in Figure 26) leave echo traces that change (over time) from cool to warm colors; whereas targets that move upstream generate traces that progress through the color spectrum in the opposite direction (example shown in Figure 27). Traces that show no change in angle color are echoes reflected by a stationary object such as the intake floor. Note that the echo traces in the echogram from Unit 1 (left) are short because the targets move quickly through the beam due to the current velocity. When a turbine is idle, as in the case of Unit 3 (right), the speed of the current is low and fish or other targets remain in the beam for a longer time and therefore generate longer echo traces. The diffuse clouds of echoes seen at the top of the echograms from Unit 1 are noise from entrained air. The short solid traces towards the bottom half of the Unit 1 echograms and most of the long solid traces in the Unit 3 echograms are fish.

Echogram examples of split-beam data collected in the intake of Unit 5, under high noise conditions, are shown in Figure 27. Shown are the target strength echogram (left), angle echogram (middle) and the so-called "single target" echogram, which displays the filtered data that is used by the fish tracking algorithm. Note that for Unit 5, the angles are reversed; here, a change in angle color from warm to cold indicates downstream movement. Four tracked fish are outlined in color on the "single target" echogram. The angle echogram indicates that the three fish near bottom are travelling downstream, while the fish that is closer to the surface is swimming upstream.

The results of the fish tracking analysis are presented as a time series of fish presence in the turbine intakes (Figure 28). Note that these estimates do not take into account whether a given turbine was operating (i.e. whether or not the current was fast enough to entrain fish) and are therefore not considered estimates of fish entrainment. Also, when the turbines were not operating, fish were observed swimming back and forth in the intake, *i.e.,* a single fish could pass multiple times. Therefore, these counts should also not be misinterpreted as estimates of absolute abundance. The sole purpose of these numbers is to document fish density over time as an indicator of relative fish presence. Higher counts of fish (estimated more than 500 targets per hour for a given intake) were observed in the afternoon of September 7, the early morning of September 9, and in the evening of October 1, 2010. High counts only occurred over a few hours in each period.

On-site observers reported juvenile blueback herring passing downstream in the fishway before the acoustic equipment was installed, and comparatively few after installation. This suggests that the fish recorded in the acoustic data may represent only a small fraction of the total run.

The histogram of the estimated size of tracked fish, observed between September 7 and September 11, 2010, shows one sharp peak with a mean length of 6.4 cm (Figure 29). Later on in the monitoring period, fish appeared to be larger. The size distribution of fish observed between September 28 and October 2, 2010 has a wider peak, with a mean length of 10 cm (Figure 30). The larger fish may have been early gizzard shad, which were first reported by on-site observers on October 20, 2010.

6.4.2 FISH BYPASS (SEPARATION CHAMBER)

The flow conditions encountered in the fish separation chamber made DIDSON data interpretation difficult. The feasibility study demonstrated that turbulence was relatively low in the separation chamber. However, the addition of the vertical extensions to the cross-board on both sides of the separation chamber generated a gyre and turbulence along the far wall of the chamber injecting noise into the data. Furthermore, it is critical to capture fish behavior such as active movement before they are passively swept downstream. The DIDSON image resolution is not high enough to recognize small fish solely by their shape. Additional clues, e.g., holding in the current or a sideways sliding motion, are necessary to distinguish small fish from similarly sized debris and entrained air.

During the feasibility study, adult herring were observed holding immediately upstream of the weir before going downstream. The hope was that juvenile fish would do the same and thus be distinguishable from debris and noise. However, some of the footage collected in fall indicates that juvenile fish are not always able to fight the current in any noticeable way, at least not within the DIDSON field of view. The problem of target identification was further exacerbated by the high amount of noise introduced by fluctuating water level within the separation chamber as determined by power canal water levels and the turbulent back currents generated by the extensions that we added to the cross-board to narrow the zone of passage. There was also a relatively large amount of debris present, including some plant material that was of similar size and shape as the juvenile fish (Figure 31). This adds further ambiguity to the image interpretation because the high frequency of the DIDSON is reflected by the surface of the fish and other targets. For the split-beam system this is less of an issue, because it operates at a lower frequency that is reflected mostly by the air in the swim bladder, which is typically a much stronger and more coherent reflector than plant material.

6.5 CONCLUSION

The circumstances encountered in the fall of 2010 made it impossible to use the collected DIDSON and split beam data for developing a ratio of juvenile blueback herring passing through the turbine intakes verse the fishway. Reports suggest that most juvenile herring entering the power canal may have passed before equipment installation, and or/during high flow events resulting in spillage. Thus, although the split beam system in the turbine intakes performed satisfactorily, few targets were available for detection.

Further approaches to estimate the proportion of fish passage in the fishway will require additional consultation to resolve issues of turbulence, debris, and the potential for false targets that potentially could preclude DIDSON data analysis. It is possible that under lower flow conditions and with less debris present, it may be possible to better identify juvenile blueback herring in the DIDSON images and thus derive a comparative count.

7.0 AMERICAN EEL ASSESSMENT

Adult American eel were targeted for evaluation in the fall of 2009 and 2010. Kleinschmidt contracted with Conroy's Bait to supply the test eels. The collection effort was conducted under the terms and condition of New York Fish and Wildlife License Number 1536 which states, "*The licensee and/or designated agents are further authorized to purchase, possess and release up to 90 (ninety) adult eel in the fish bypass which shall be obtained from Conroy's Bait in Watervliet, NY which shall be collected from the Hudson River between the lock in Stillwater and the I-90 bridge in Albany.*"

No adult American eel were collected by Conroy's Bait in 2009, and only three were collected in 2010. Low eel densities and high water conditions in the vicinity of the Project were among the primary reasons for the poor catch. Our fish collection efforts in the Mohawk River in 2009 also yielded very few American eel. Other alternatives will need to be considered to acquire 90 test fish, such as obtaining eels from a more readily available source or postponing of the evaluation until eels become more plentiful in the vicinity of the Project.

8.0 REFERENCES

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APPENDIX A

FISHWAY CONVEYANCE STRUCTURE INSPECTION AND MEETING SUMMARY

School Street Project
Phase I Downstream Fish Protection and Fishway Inspection
Meeting Summary

DATE: August 5, 2009
LOCATION: School Street Project, Cohoes, NY

Attendees:

Mark Woythal	NYS Dept. of Environmental Conservation (NYSDEC)
Colleen Kimble	NYS Dept. of Environmental Conservation
Stephen Patch	U.S. Fish and Wildlife Service (USFWS)
Curt Orvis	U.S. Fish and Wildlife Service
Tim Lukas	Brookfield Renewable Power (Brookfield)
Christine Tomichek	Kleinschmidt Associates (KA)
Keith Martin	Kleinschmidt Associates
Bryan Apell	Kleinschmidt Associates
Brandon Kulik	Kleinschmidt Associates

Introductions and Pre-inspection. Tim led the group through Brookfield's safety procedures, a Job Safety Plan for the day's inspection, and reviewed the overall project status. KA provided reference sets of current fishway engineering drawings so that each visitor could compare the fishway components to the design dimensions.

Tim noted that a recent flash flood event had resulted in damage to the turbine-generators such that normal full-station operation of all five units would not likely resume until late 2009. He indicated that Unit 1 was expected to be operational by mid- September, with additional Units to hopefully follow in one to two week intervals. Tim asked the attendees to think about how both the fish passage effectiveness study and fishway operation should commence given the near-term limitations on full-station operation.

At this time, the power canal was still dewatered and the fishway was nearing completion. The primary remaining fishway construction tasks were to finish installation of the separation screen in the collection chamber (which was on-site and could be examined), connecting the final segments of the downstream transport pipe (*i.e.*, the portions of pipe exiting the collection/separation chamber and leading to the tailrace), and installation of handrails, some gate operators, *etc*.

Since the canal is due to be re-watered on or about August 13, this inspection was an opportunity to view in-the-dry, the largely completed fish protection and bypass structures, and associated features that would ordinarily be submerged (*i.e.*, the lower portion of the angled bar rack, the fishway entrances and associated intake pipes, the adjacent/upstream canal topography and ice sluice entrance, *etc*.).

The group proceeded on-site to conduct an inspection of the following major components of the fish protection and downstream fish bypass facilities:

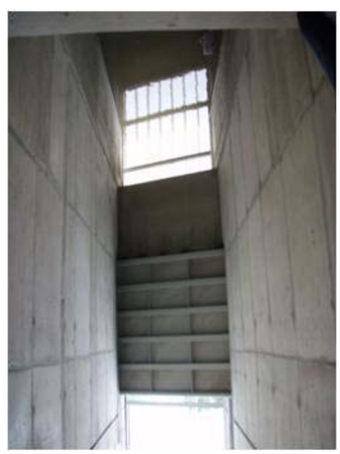
New angled bar rack with 1" clear bar-spacing.

The group viewed the bar rack superstructure (including the supporting beam structural members), concrete eel berm, and forebay from a variety of angles, both front and back by walking along the top of the overall structure. No concerns were noted regarding the bar rack structure or the concrete footer at the base (for purposes of eel diversion) visible beneath the shallow pool of water covering the bottom of the racks."

Fishway entrances, associated passage pipes, and collection/separation chamber. The group viewed the fishway entrances from both the front of the fishway structure and also by accessing the fishway via the collection/separation chamber (see photos below). Smooth piping and pipe joints and smoothness of the concrete surfaces were of specific interest.

Curt recommended that sharply-angled concrete edges at the top of the transition into the entrance pipes, downstream of the fishway entrances (at two separate entrance locations) be rounded or otherwise smoothed over. Tim indicated he would advise the site Contractor to address this.

Fishway entrance from upstream



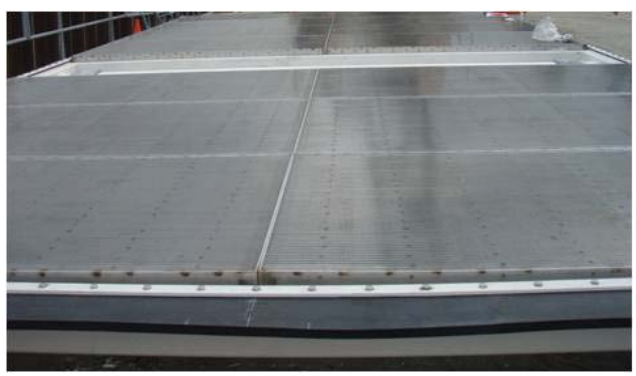
Top and bottom entrance from downstream

Fish passage pipe downstream of entrance (*left*) and at separation chamber (*right*)

Fish separation chamber looking downstream toward exit

Flow separation screen (*prior to installation in chamber*). The pivoting flow separation screen that will be placed within the flow separation/fish collection chamber was lying flat, on-site, allowing for close inspection prior to installation (which commenced immediately following, and was largely completed at the time the inspection was concluded).

Flow separation screen (*bottom edge*)



Flow separation screen (*side edge*)

Curt recommended that a narrow space between the outer screen support frame and screen panels, at both the leading and trailing ends of the separator, be covered to prevent smaller fish from entering this narrow trough, and also that exposed bolt heads along the sides of the frame be covered or rounded to reduce risk of fish injury. This was discussed with the Contractor and it was determined that the narrow space at the leading and trailing edges of the screen could be filled with a packing material and that rounded, snap-on caps would be applied to the exposed bolt heads.

Downstream Fish Transport Pipe – discharge to tailrace

The group examined the upstream entrance to the transport pipe where fish exit from the separation chamber. Vertical and horizontal rebar presently cross this opening. It was noted that this potentially may cause injury or delay to fish exiting the chamber. If biological study data indicates this to be an issue this can be further addressed. The discharge location to the tailrace appears to enter a suitable plunge pool, however tailrace hydraulics may change when the station is operational and/or river discharge volume is different.

Inspection Follow-up Items and Discussion. Following the inspection the group held a review and summary discussion to collectively capture and reiterate individual observations made throughout the inspection (*NOTE: Mark Woythal had to depart prior to the full discussion, but as noted below, several topics below were briefly discussed with him individually prior to his departure*).

- **Fishway engineering issues & resolutions**. It was agreed that the three issues identified above concerning
    - rounding/smoothing of the concrete leading edge at the top of the entrance pipes,
    - covering/filling of the narrow gap at the leading and trailing edges of the separation chamber screen, and
    - placing rounded caps over the exposed bolt heads were the only modifications to the fishway structure and components recommended at this time. Brookfield agreed to complete these modifications as final construction proceeds.

- It was also discussed that the grizzly racks at the fishway entrance (12-inch clear-spacing) and the rebar "cross-hair" in the entrance to the downstream fish passage pipe exiting from the fish separator chamber are a potential source of delay, or injury should fish collide with them. It was agreed to determine if any such effects or impacts were indicated as a result of the upcoming fishway effectiveness testing, and develop appropriate proposed modifications following those assessments.

- **Documentation of hydraulic assessment parameters**. Brandon summarized the hydraulic assessments that were called for in the fishway effectiveness study plan, and asked for additional input on the details for collecting the desired data.

  Curt recommended obtaining velocity measurements in front of the fishway entrances at proportional attraction flow increments from 2% up to 5% of total station inflow/discharge (i.e., the total flow passing through the power canal). He indicated that the objective is to identify fishway entrance velocities that creates an effective zone of influence such that detectable differences in flow velocities exist in a semi-circular field extending out to a distance of approximately 8-10 ft in front of each fishway entrance. Measurements should be obtained at both the top and bottom gates at each entrance.

  It was agreed that the desired flow measurements can be obtained during the course of the biological assessment of the fishway, and would require that all units be operational in order to assess flow conditions during full station operation. Curt indicated that the USFWS need not be present during measurements, however Brookfield should notify the agencies of the schedule for conducting the work and the exact locations of all flow measurements should be closely documented.

  Curt also requested that Brookfield document the flow dynamics along the face of the angled bar rack by taking measurements approximately 1-foot upstream from the face of the rack, and normal to the direction of flow, at full station operation. It was acknowledged that this would have to occur later in 2009 or in early 2010 after flood-damage repairs to all five units were completed and the station resumes normal operation.

- **Fishway operation**. Tim asked the agency representatives for guidance and recommendations on commencing fishway operation. Curt and Steve advised that there was no reason that fishway operation couldn't begin as soon as the final installation activities were completed and that it could continue throughout the required period for fishway operation (April 15 through November 30) while the ongoing fishway effectiveness studies are being conducted. *Note: Mark had recommended the same course of action prior to departing*.

- **Biological testing.** Brandon identified several items related to the biological evaluation portions of the fishway effectiveness study that required resource agency input and concurrence.

    a. **Sources of test fish** (eels, herring, resident species).
    American eel. Mark Woythal had earlier recommended recommend that live eels for use as test specimens could be obtained locally from commercial fisherman or other sources (i.e., bait dealers). Curt further noted that bringing eels in from other states could pose issues relating to fish pathology policies and should be strictly avoided.

Blueback herring. It was discussed that the limited station operation due to the current turbine-generator outages would likely result in similarly limited attraction of migrating herring into the power canal as compared to flow and fish passage over the dam. Given that station operations would not return to a normal, full-availability (i.e., full station hydraulic capacity), until probably at least early to mid-October, studies of juvenile herring passage efficiency would be best postponed until 2010. If some juvenile herring should enter the canal and fishway during any fall 2009 testing related to other species, it may be possible to opportunistically collect fishway passage survival data.

Resident aquatic fish species. These fish species will be collected locally from project associated waters and contiguous reaches of the Mohawk river as necessary, in accordance with the study plan requirements, and any subsequent collection permit(s) must be obtained from the NYSDEC.

b. **Tentative schedule and responsibilities.** Bryan will initiate collectors permit applications for the study. Brandon will coordinate a conference call with USFWS, NYSDEC, Brookfield and KA later in August to further review study goals and agree on additional study details. Prior to the conference call, Brandon will email a copy of the study plan that was approved by the agencies and FERC in 2007.

It was discussed that fishway passage survival testing for eel and resident fish species can be conducted independently of station operational status as long as the fishway is functioning normally. These evaluations only require that test specimens be introduced via a fishway entrance, or within the fishway itself to evaluate survival and injury via specific components, and therefore is not dependent on project operation. It is anticipated that these survival studies can be initiated during September-October 2009 assuming necessary permits and gear can be obtained. As noted, juvenile herring survival data may also be opportunistically collected in 2009, but herring passage efficiency for both adults and juveniles will need to occur during 2010 pending resumption of normal station operation.

The meeting concluded at approximately 12:30

APPENDIX B

TABLES

Table 1. Location and water depth of each of the five stations along the 180ft long angled bar rack located at School Street Project Cohoes, NY.

Station	Location (distance from bank right (ft)	Depth (ft)
1	30	20.8
2	60	21.3
3	90	21.3
3	120	17.9
5	150	11

Table 2. Water velocity measurements at *top*, *mid* and *bottom* at each station along the 180ft long angled bar rack located at School Street Project Cohoes, NY (Scenario 1).

Station	Vertical Position	Average Velocity (ft/s)
1	*Top*	2.75
	Mid	Noise
	Bottom	Noise
2	*Top*	2.91
	Mid	1.54
	Bottom	0.98
3	*Top*	3.27
	Mid	1.62
	Bottom	1.09
4	*Top*	2.79
	Mid	1.72
	Bottom	0.73
5	*Top*	2.32
	Mid	1.14
	Bottom	0.86

Table 3. Water velocity measurements at the *immediate surface* and a *depth of three feet* at each station along the 180ft long angled bar rack located at School Street Project Cohoes, NY (Scenario 2).

Station	Vertical Position	Average Velocity (ft/s)
1	Surface	0.82
	3ft	1.10
2	Surface	0.95
	3ft	1.36
3	Surface	1.20
	3ft	1.89
4	Surface	1.34
	3ft	1.35
5	Surface	1.58
	3ft	1.34

Table 4. The water depth and location of water velocity measurements collected in front of the fishway intakes (Stations 6 and 7) at School Street Project Cohoes NY.

Station 6	Location	Depth (ft)	Station 7	Location	Depth
Outer Wall Intake	1	19	Bar Rack Intake	1	22
	2	22		1a	22
	3	22		1b	22
	4	21		2	22.5
	5	21		2a	22.5
	6	23		2b	22.5
	7	21		3	22
	8	21		3a	22
	9	21		3b	22
				4	22
				4a	22
				4b	22

Table 5. The water velocities as measured at 9 locations in front of the outer-wall fishway intake (Station 6) at the School Street Project Cohoes NY.

Location	Vertical Position	Water Velocity (ft/s)
1	Top	0.97
	Mid	0.69
	Bottom	0.19
2	Top	0.53
	Mid	0.54
	Bottom	0.07
3	Top	0.25
	Mid	0.37
	Bottom	0.25
4	Top	0.16
	Mid	0.12
	Bottom	0.22
5	Top	0.18
	Mid	0.16
	Bottom	0.11
6	Top	0.44
	Mid	0.27
	Bottom	0.06
7	Top	0.34
	Mid	0.29
	Bottom	0.31
8	Top	0.28
	Mid	0.29
	Bottom	0.24
9	Top	0.14
	Mid	0.18
	Bottom	0.15

Table 6. The water velocities as measured at 12 locations in front of the bar rack fishway intake (Station 7) at the School Street Project Cohoes NY.

Location	**Vertical Position**	**Average Water Velocities**
1	Top	0.85
	Mid	0.69
	Bottom	0.24
1A	Top	0.46
	Mid	0.40
	Bottom	0.21
1B	Top	0.64
	Mid	0.57
	Bottom	0.23
2	Top	0.54
	Mid	0.41
	Bottom	0.19
2A	Top	0.57
	Mid	0.31
	Bottom	0.30
2B	Top	0.43
	Mid	0.49
	Bottom	0.33
3	Top	0.58
	Mid	0.17
	Bottom	0.17
3A	Top	0.27
	Mid	0.17
	Bottom	0.17
3B	Top	0.48
	Mid	0.47
	Bottom	0.41
4	Top	0.49
	Mid	0.33
	Bottom	0.48
4A	Top	0.66
	Mid	0.23
	Bottom	0.28
4B	Top	0.50
	Mid	0.49
	Bottom	0.44

Table 7. List of control species abundance, size class and relative percentages of overall control group during the resident fish survival study at the School Street Project Cohoes, NY.

Common Name	Group	Length Class	Number Tested	Number Alive	Survival Rate
Bluegill	Centrarchid	L	1	1	100
Bluegill	Centrarchid	S	15	15	100
Channel Catfish	Soft Rayed Fish	L	1	1	100
Pumpkinseed	Centrarchid	L	1	1	100
Pumpkinseed	Centrarchid	S	6	6	100
Redbreast Sunfish	Centrarchid	S	2	2	100
Rock Bass	Centrarchid	S	6	6	100
Smallmouth Bass	Centrarchid	L	25	25	100
Smallmouth Bass	Centrarchid	S	4	4	100
Walleye	Percid	L	2	2	100
Yellow Perch	Percid	L	1	1	100

Table 8. School Street downstream fish passage effectiveness study. Water quality parameters measured at the School Street Project Cohoes, NY.

	Dissolved Oxygen (mg/L)		Conductivity (μSEM)		pH		Temperature (°C)	
Date	Holding Tank	Power Canal	Holding Tank	Power Canal	Holding Tank	Power Canal	Holding Tank	Power Canal
10/31/09	11.2	11.2	178	174	-	-	10.9	10.1
11/2/09	10.4	10.8	189	187	5.0	5.1	10.3	10.2
11/3/09	11.0	11.2	202	202	7.0	7.2	10.3	10.3
11/4/09	10.7	11.5	198	199	6.9	5.6	9.6	9.3
11/5/09	10.5	11.1	196	196	6.0	6.0	9.2	9.4
11/6/09	11.1	11.5	191	191	6.2	6.2	9.0	9.0
11/7/09	10.8	11.9	189	188	6.3	6.2	8.0	8.2

Table 9. Summary of test fish released at two release locations during the resident fish survival testing at the School Street Project Cohoes NY, November 2009.

Test #	Release Point	Release Date	Release Time	Collection Date	Collection Time	Specimen Count
1	Fishway Intake Structure	11/5/2009	14:40	11/5/09	16:08	30
2	Fish Return Weir Pool	11/5/2009	15:56	11/5/09	16:08	20
3	Fishway Intake Structure	11/6/2009	10:00	11/6/09	14:15	20
4	Fish Return Weir Pool	11/6/2009	11:00	11/6/09	14:15	78
5	Fish Return Weir Pool	11/6/2009	12:30	11/6/09	14:15	71

Table 10. Life stage designation (adult or juvenile) for 201 of the 220 test fish at the School Street Project Cohoes NY, November 2009.

Common Name	Adult	Juvenile	Size at Maturity (mm) (TL)	Source
Rock bass	11	17	120	Pajak & Neves, 1987
Yellow bullhead	0	1	140	Scott & Crossman, 1973
American eel	NA	NA	highly variable; 280 (males) 457 (females)	Hardy, 1978a
Freshwater drum	7	0	203 (males) 221 (females)	Daiber, 1953
White sucker	6	4	approx. 330-381	Scott & Crossman, 1973
Gizzard shad	1	0	highly variable; 178-279	Jones et al., 1978
Northern pike	1	0	highly variable; age III, 305-749 (males)	Smith, 1985; Scott & Crossman, 1973
Chain pickerel	0	2	297-391	Scott & Crossman, 1973
Cutlip minnow	0	1	114 (males)	Scott & Crossman, 1973
Channel catfish	2	0	267-406	Scott & Crossman, 1973
Redbreast sunfish	2	0	100 (males) 75 (females)	Hardy, 1978b
Pumpkinseed	20	0	102	Scott & Crossman, 1973
Bluegill	14	7	102-127	Scott & Crossman, 1973
Inland silverside	1	0	76	Scott & Crossman, 1973
Smallmouth bass	21	40	244-277	Scott & Crossman, 1973
Largemouth bass	8	0	279-305	Scott & Crossman, 1973
Redhorse	4	0	141-290	Scott & Crossman, 1973
Yellow perch	18	11	173-216	Scott & Crossman, 1973
Golden shiner	1	0	64-89	Scott & Crossman, 1973
Black crappie	0	1	highly variable; 152-254	Scott & Crossman, 1973
Fallfish	3	1	155-255	Trial et al., 1983
Walleye	4	3	280 (males) 356-432 (females)	Scott & Crossman, 1973

Table 11. List of test species abundance and relative percentages of the test group released during the resident fish survival testing at the School Street Project Cohoes, NY.

Common Name	Scientific Name	Group	Count	Percentage
Smallmouth bass	Micropterus dolomieu	Centrarchid	91	32.04
Bluegill	Lepomis macrochirus	Centrarchid	38	13.38
Rock bass	Ambloplites rupestris	Centrarchid	34	11.97
Yellow perch	Perca flavescens	Percid	30	10.56
Pumpkinseed	Lepomis gibbosus	Centrarchid	29	10.21
White sucker	Catostumus commersoni	Soft Rayed Fish	12	4.23
Walleye	Stizostedion vitreum	Percid	9	3.17
Largemouth bass	Micropterus salmoides	Centrarchid	8	2.82
Freshwater drum	Aplodinotus grunniens	Soft Rayed Fish	7	2.46
Redbreast sunfish	Lepomis auritus	Centrarchid	4	1.41
Redhorse spp.	Moxostoma spp.	Soft Rayed Fish	4	1.41
American eel	Anquilla rostrata	Anguillaform	3	1.06
Channel catfish	Ictalurus punctatus	Soft Rayed Fish	3	1.06
Fallfish	Semotilus corporalis	Soft Rayed Fish	3	1.06
Chain pickerel	Esox niger	Salmonid	2	0.70
Northern pike	Esox lucius	Salmonid	1	0.35
Gizzard shad	Dorosoma cepedianum	Clupeid	1	0.35
Golden shiner	Notemigonus crysoleucas	Soft Rayed Fish	1	0.35
Silverside spp.	Atherinidae spp.	Soft Rayed Fish	1	0.35
Black crappie	Pomoxis nigromaculatus	Centrarchid	1	0.35
Yellow bullhead	Ameiurus natalis	Soft Rayed Fish	1	0.35
Cutlips minnow	Exoglossum masillingua	Soft Rayed Fish	1	0.35

Table 12: Relative proportion of fish body types released and recaptured during the resident fish survival testing at the School Street Project Cohoes, NY.

Group	Count	Percentage
Centrarchid	205	72.18
Percid	39	13.73
Soft-Rayed Fish	33	11.62
Anguillaform	3	1.06
Salmonid	3	1.06
Clupeid	1	0.35

Table 13. Fish size summary of the five most common measured[1] (*test trial fish*) species at the School Street Project, Cohoes, NY.

Common Name	**Scientific Name**	**Group**	**Count**	**Mean Length (mm)**	**Standard Deviation (mm)**	**Max (mm)**	**Min (mm)**	**Range (mm)**
Smallmouth Bass	*Micropterus dolomieu*	Centrarchid	61	234.39	86.75	485	85	400
Yellow Perch	*Perca flavescens*	Percid	29	171.90	40.71	260	95	165
Rock Bass	*Ambloplites rupestris*	Centrarchid	28	122.71	16.71	165	105	60
Pumpkinseed	*Lepomis gibbosus*	Centrarchid	22	139.64	35.00	235	70	165
Bluegill	*Lepomis macrochirus*	Centrarchid	22	121.36	25.59	176	57	119

Table 14. Passage survival for fish body types grouped into size classes at the School Street Project Cohoes, NY (L= large; S = small. A = Alive).

Group	**Length Class**	**Status**	**Number Alive**	**Total by Class**	**Percentage**
Anguilliforme	L	A	3	3	100.00
Centrarchid	L	A	35	35	100.00
Centrarchid	S	A	48	53	90.57
Percid	L	A	16	18	88.89
Percid	S	A	8	9	88.89
Salmonid	L	A	2	3	66.67
Soft Rayed Fish	L	A	16	16	100.00
Soft Rayed Fish	S	A	3	3	100.00

[1] It is important to note that the statistics represented in this table are for measured fish only (*test trial fish*). The control fish were not measured rather they were lumped into two groups large (L) and small (S) with a length of 6” as a reference length.

Table 15. Fish collection efficiency at to release locations at the School Street Project, Cohoes, NY.

Test No	Station	Group	Number Released	Number Recaptured	Percent Recaptured
1	Fishway Intake Structure	Centrarchid	19	0	0
1	Fishway Intake Structure	Clupeid	1	0	0
1	Fishway Intake Structure	Percid	4	0	0
1	Fishway Intake Structure	Soft Rayed Fish	6	0	0
2	Fish Return Weir Pool	Centrarchid	8	4	50
2	Fish Return Weir Pool	Percid	7	6	86
2	Fish Return Weir Pool	Salmonid	1	1	100
2	Fish Return Weir Pool	Soft Rayed Fish	4	3	75
3	Fishway Intake Structure	Centrarchid	16	3	19
3	Fishway Intake Structure	Salmonid	1	1	100
3	Fishway Intake Structure	Soft Rayed Fish	3	0	0
4	Fish Return Weir Pool	Centrarchid	54	47	87
4	Fish Return Weir Pool	Percid	11	10	91
4	Fish Return Weir Pool	Salmonid	1	1	100
4	Fish Return Weir Pool	Soft Rayed Fish	12	10	83
5	Fish Return Weir Pool	Aunguilaform	3	3	100
5	Fish Return Weir Pool	Centrarchid	47	34	72
5	Fish Return Weir Pool	Percid	14	11	79
5	Fish Return Weir Pool	Soft Rayed Fish	7	6	86

Table 16. Passage survival by fish body type released during the Resident Fish testing at the School Street Project Cohoes, NY.

Group	Number Alive	Number Recollected	Percentage
Centrarchid	83	88	94.32
Percid	24	27	88.89
Soft Rayed Fish	19	19	100.00
Anguilliforme	3	3	100.00
Salmonid	2	3	66.67

Table 17. Bypassed test herring delay at the School Street Project Cohoes, NY.

	Bypass Delay		
ID	Passage and Fishway Delay (hrs)	Delay To Fishway (hrs)	Delay Inside Fishway (hrs)
10	73.3	26.4	46.9
13	24.8	19.5	5.3
14	10.1	9.9	0.3
17	20.6	4.7	15.8
20	4.1	4.1	0.0
21	21.7	12.8	8.9
22	26.3	26.2	0.1
23	33.5	10.3	23.2
24	0.8	0.8	0.0
25	10.7	1.0	9.7
26	3.0	2.9	0.0
28	2.2	0.9	1.3
30	24.3	17.9	6.4
32	4.6	4.3	0.3
33	1.7	1.4	0.3
34	7.5	7.4	0.1
36	10.4	3.7	6.6
39	5.4	5.4	0.1
40	16.1	1.6	14.5
41	12.7	4.9	7.8
42	4.3	4.2	0.1
44	10.7	10.2	0.5
47	33.5	13.1	20.4
48	7.5	6.6	0.9
51	3.7	1.2	2.4
56	3.0	2.9	0.1
59	3.3	3.3	0.0
60	1.7	0.5	1.2
61	5.9	2.7	3.2
62	4.3	4.3	0.0
63	29.0	7.1	21.9
64	2.0	0.6	1.4
65	3.4	3.3	0.0
66	6.7	6.6	0.0
67	1.0	0.7	0.3

Bypass Delay			
ID	Passage and Fishway Delay (hrs)	Delay To Fishway (hrs)	Delay Inside Fishway (hrs)
68	1.5	1.4	0.1
69	2.0	1.6	0.4
71	22.7	22.7	0.0
72	0.5	0.3	0.2
73	4.9	3.5	1.5
74	24.0	0.4	23.6
75	3.6	2.6	1.0
79	3.4	3.3	0.1
80	12.0	10.0	2.0
82	2.3	2.1	0.1
83	7.2	7.2	0.1
85	6.1	5.9	0.2
87	8.6	8.6	0.0
90	8.2	7.2	1.0
91	0.5	0.5	0.0
95	12.2	9.4	2.9
98	3.9	3.7	0.2
102	1.9	1.4	0.5
Mean Delay (hrs)	10.6	6.1	4.4
Median (hrs)	5.9	4.1	0.4
Min (hrs)	0.5	0.3	0.2
Max (hrs)	73.3	26.4	46.9
Standard Deviation	12.6	6.4	8.8

Table 18. Entrained test herring delay at the School Street Project Cohoes, NY.

Entrainment Delay	
ID	Delay (hrs)
49	0.3
46	0.9
106	1.2
43	2.3
52	2.5
89	24.0
81	25.2
94	43.4
38	44.6
37	93.1
Mean Delay (hrs)	23.8
Median (hrs)	13.3
Min (hrs)	0.3
Max (hrs)	93.1
Standard Deviation	30.0

Table 19. Water quality parameters measured in the power canal at the School Street Project Cohoes, NY.

Date	**Conductivity (μs/cm)**	**Dissolved Oxygen (mg/L)**	**pH**	**Temperature (°C)**
6/4/2010	361	6.86	6.9	23.3
6/7/2010	346	5.5	7.3	22.35
6/8/2010	369	6.1	7.4	22
6/9/2010	313	6.1	7.35	21.8
6/10/2010	280	6.2	7.3	21
6/11/2010	362	6.5	7.2	21.1
6/14/2010	248	8.1	7.1	20.41
6/15/2010	334	8.2	6.9	20.3
6/21/2010	284	7.7	7	22.3
6/25/2010	296	7.14	7.46	23.4
6/26/2010	310	8.1	7.3	24.3
7/2/2010	317	7.7	7.9	22.4
7/6/2010	302	7.5	7.6	25.4

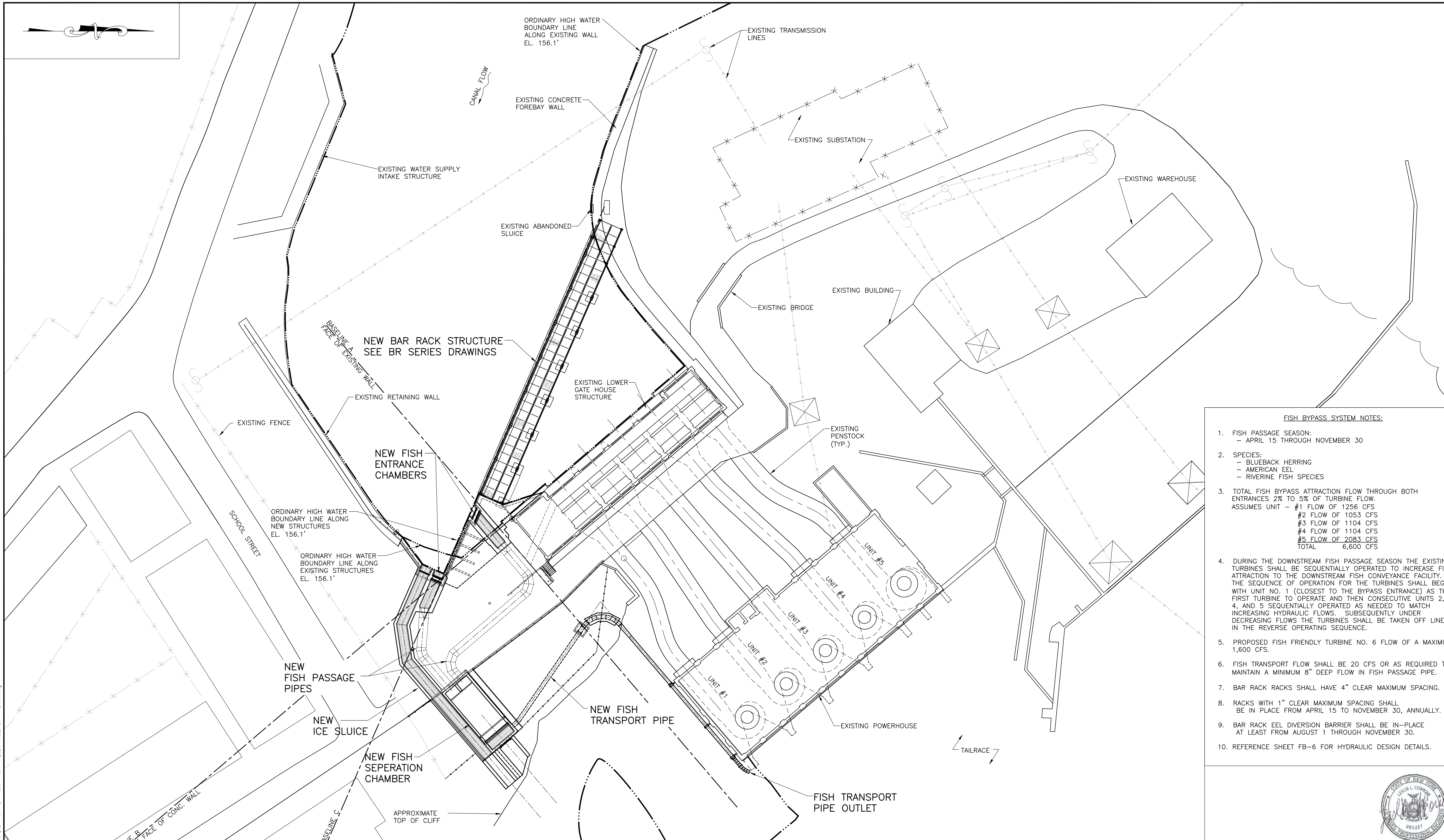
Table 20. Water quality parameters measured in each of the three herring holding tanks used at the School Street Project Cohoes, NY.

Tank	**Date**	**Conductivity (µs/cm)**	**Dissolved Oxygen (mg/L)**	**pH**	**Temperature (°C)**
1	5/19/2010	NA	NA	NA	NA
	6/4/2010	377	4.73	7.16	23.4
	6/7/2010	363	5.3	7.2	22.72
	6/8/2010	371	5.85	7.32	21.9
	6/9/2010	270	5.9	7.3	21.5
	6/10/2010	NA	4.1	7.2	18.8
	6/11/2010	353	6.2	7	21.1
2	6/4/2010	375	7.04	1.90	23.4
	6/7/2010	340	5.1	7.12	22.6
	6/8/2010	370	5.65	7.35	21.9
	6/9/2010	273	6.25	7.30	21.5
	6/10/2010	NA	3.51	7.00	18.6
	6/11/2010	363	6.2	7.10	21.1
3	6/4/2010	376	6.9	6.85	24.2
	6/7/2010	NA	NA	NA	NA
	6/8/2010	362	6.96	7.4	21.6
	6/9/2010	300	6.25	7.2	21.6
	6/10/2010	NA	3	7	18.63

APPENDIX C

FIGURES

Scale: AS SHOWN	BROOKFIELD RENEWABLE POWER LOCATION		1 of 1
Project No: 826110	SCHOOL STREET PROJECT FISHWAY BIOLOGICAL ASSESSMENT		
Filename: SiteLocus.mxd	SITE LOCUS		1
Drawn By: KPN	Kleinschmidt Energy & Water Resource Consultants	35 Pratt St. Sutie 201 Essex, CT 06426 Telephone: (860) 767-5069 Fax: (860) 767-5097 www.KleinschmidtUSA.com	
Date Drawn: 01-15-2009			



FISH BYPASS SYSTEM NOTES:

1. FISH PASSAGE SEASON:
   - APRIL 15 THROUGH NOVEMBER 30

2. SPECIES:
   - BLUEBACK HERRING
   - AMERICAN EEL
   - RIVERINE FISH SPECIES

3. TOTAL FISH BYPASS ATTRACTION FLOW THROUGH BOTH ENTRANCES 2% TO 5% OF TURBINE FLOW.
   ASSUMES UNIT – #1 FLOW OF 1256 CFS
   #2 FLOW OF 1053 CFS
   #3 FLOW OF 1104 CFS
   #4 FLOW OF 1104 CFS
   #5 FLOW OF 2083 CFS
   TOTAL 6,600 CFS

4. DURING THE DOWNSTREAM FISH PASSAGE SEASON THE EXISTING TURBINES SHALL BE SEQUENTIALLY OPERATED TO INCREASE FISH ATTRACTION TO THE DOWNSTREAM FISH CONVEYANCE FACILITY. THE SEQUENCE OF OPERATION FOR THE TURBINES SHALL BEGIN WITH UNIT NO. 1 (CLOSEST TO THE BYPASS ENTRANCE) AS THE FIRST TURBINE TO OPERATE AND THEN CONSECUTIVE UNITS 2, 3, 4, AND 5 SEQUENTIALLY OPERATED AS NEEDED TO MATCH INCREASING HYDRAULIC FLOWS. SUBSEQUENTLY UNDER DECREASING FLOWS THE TURBINES SHALL BE TAKEN OFF LINE IN THE REVERSE OPERATING SEQUENCE.

5. PROPOSED FISH FRIENDLY TURBINE NO. 6 FLOW OF A MAXIMUM 1,600 CFS.

6. FISH TRANSPORT FLOW SHALL BE 20 CFS OR AS REQUIRED TO MAINTAIN A MINIMUM 8" DEEP FLOW IN FISH PASSAGE PIPE.

7. BAR RACK RACKS SHALL HAVE 4" CLEAR MAXIMUM SPACING.

8. RACKS WITH 1" CLEAR MAXIMUM SPACING SHALL BE IN PLACE FROM APRIL 15 TO NOVEMBER 30, ANNUALLY.

9. BAR RACK EEL DIVERSION BARRIER SHALL BE IN-PLACE AT LEAST FROM AUGUST 1 THROUGH NOVEMBER 30.

10. REFERENCE SHEET FB-6 FOR HYDRAULIC DESIGN DETAILS.

STATE OF NEW YORK LESLIE L. CORROW 085257 LICENSED PROFESSIONAL ENGINEER

No.	Revision	Date
	ISSUED FOR AGENCY REVIEW	07-31-08
2	ADDED BASELINES	05-30-08
	ISSUED FOR BUILDING PERMIT	05-12-08
1	ADDED O.H.W. ELEVATION ISSUED FOR AGENCY REVIEW	05-02-08
	AGENCY REVIEW	4-11-08
0	RELEASED FOR CONSTRUCTION	2-15-08
A	ISSUED FOR CLIENT REVIEW	1-25-08

Scale:	AS SHOWN
Project No:	826-082
AutoCad Release:	2005
Filename:	826-082 SHT FB10.dwg
Design By:	KAM
Drawn By:	DBQ
Checked By:	LLC/TLK
Date Revised:	05-30-08

ERIE BOULEVARD HYDROPOWER L.P.
BROOKFIELD POWER NEW YORK

SCHOOL ST. SETTLEMENT UPGRADES
COHOES, NY

FISH BYPASS
SITE PLAN

Kleinschmidt
Energy & Water Resource Consultants

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STATE OF MAINE KEITH A. MARTIN No. 11566 LICENSED PROFESSIONAL ENGINEER

2

Figure 3. Newly installed angled fish guidance structure at the School Street Project Cohoes, NY.

Figure 4. One of two fishway intakes (*center distance*) and the debris/ice sluice intake (*adjacent to fishway intake to the right*) at the School Street Project Cohoes, NY.

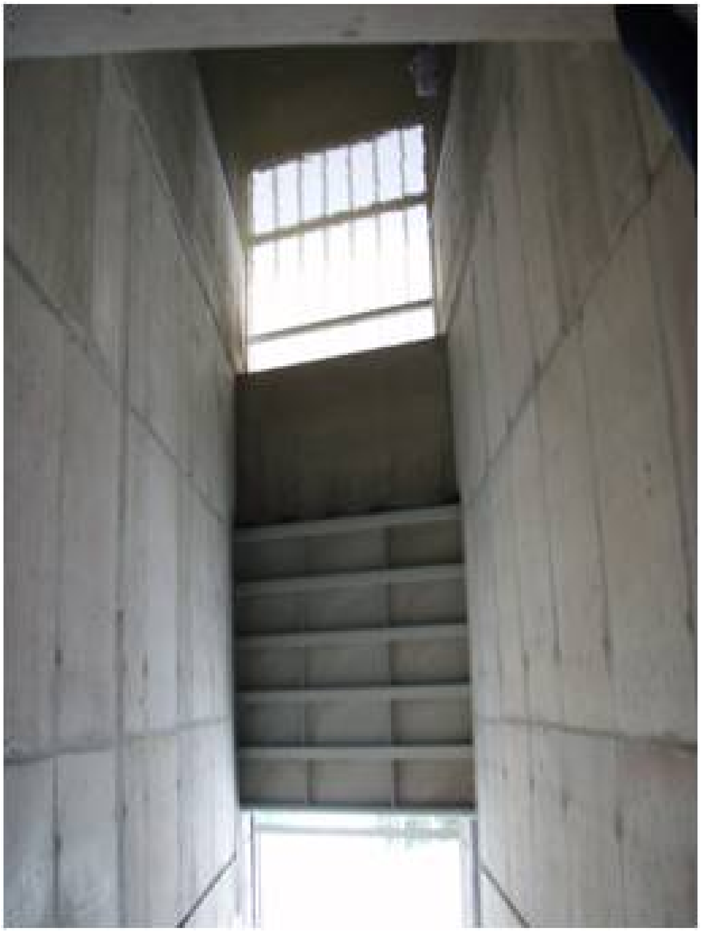


Figure 5. The multi level gate structure within the fishway intake structures at the School Street Project Cohoes, NY.

Figure 6. Fishway separation chamber at the School Street Project Cohoes, NY. Note that the photo on the right was taken prior to the installation of the fish separation screen.

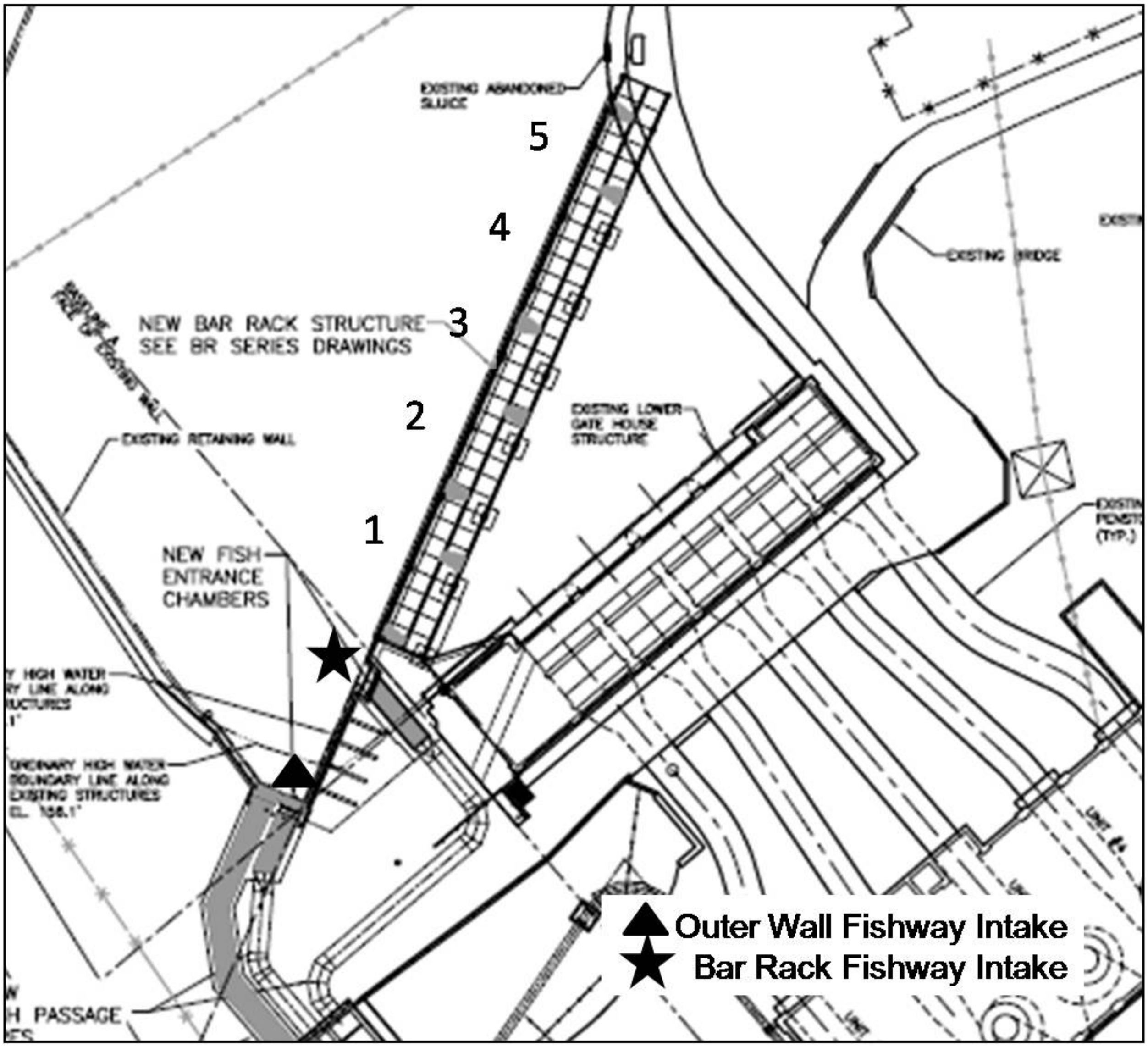


Figure 7. The location of velocity measurements collected at five stations along the angled bar rack and at 2 stations in front of the fishway intakes at the School Street Project Cohoes, NY.

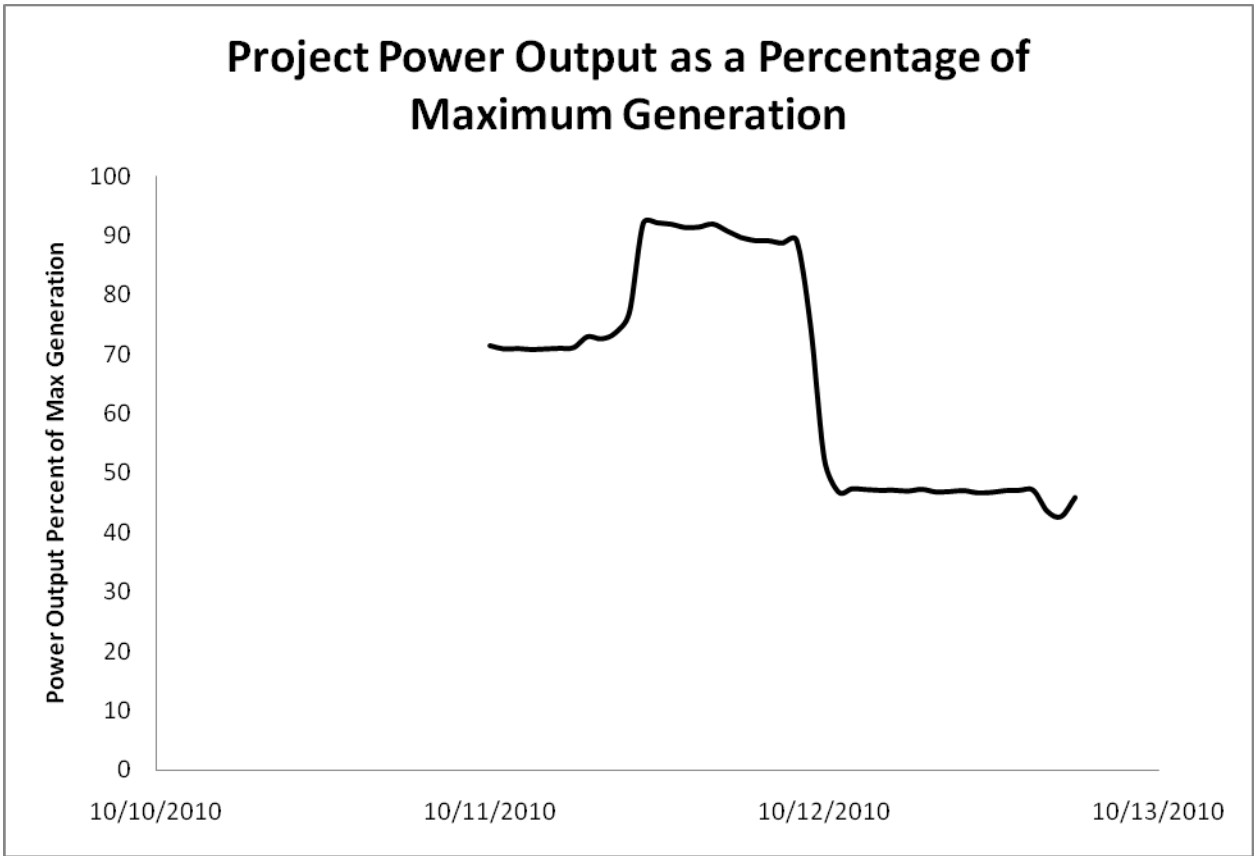


Figure 8. Project power output as a percentage of maximum generation (38.6MW) on October 11 and 12, 2010 at the School Street Project Cohoes NY.

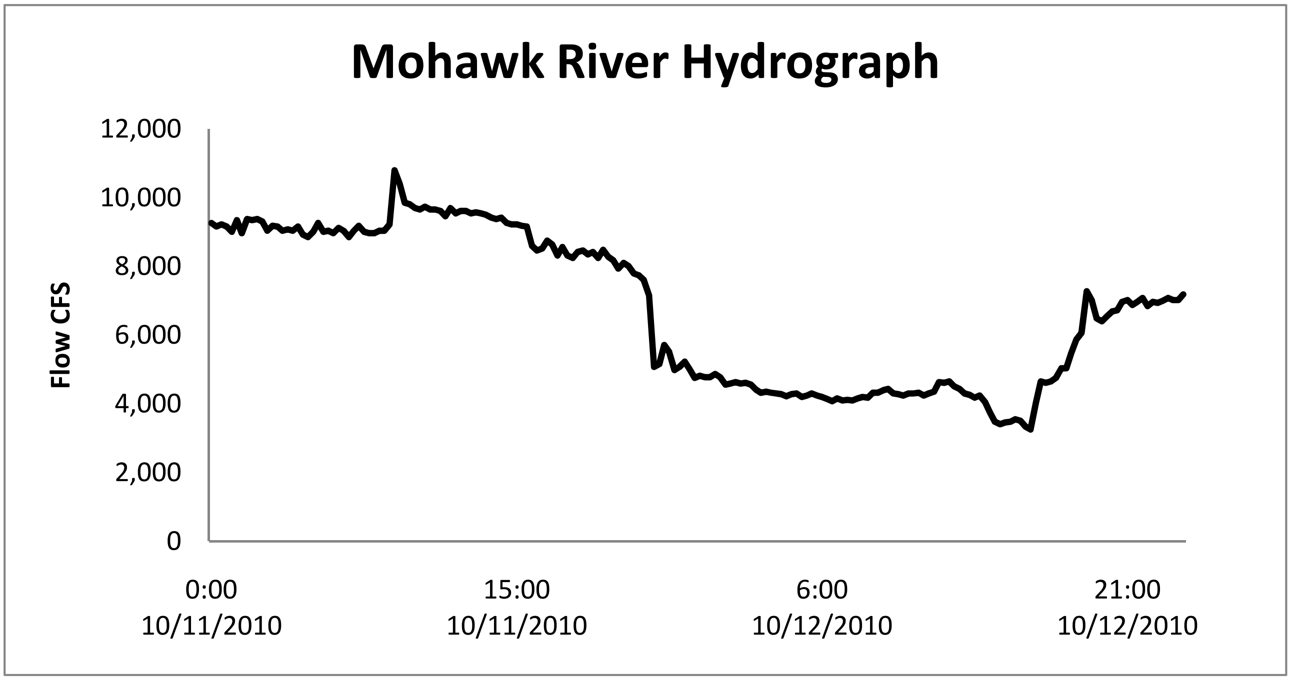


Figure 9. Hydrograph for the Mohawk River at Cohoes, NY October 11 and October 12, 2010 (source: USGS 01357500 MOHAWK RIVER AT COHOES NY).

Figure 10. The torpedo weight and flow meter combination used to collect velocity measurements in front of to the fishway intakes at the School Street Project Cohoes, NY.

Figure 11. The crane and tether used to position the flow meter probe in front of the fishway intakes at School Street Project Cohoes, NY.

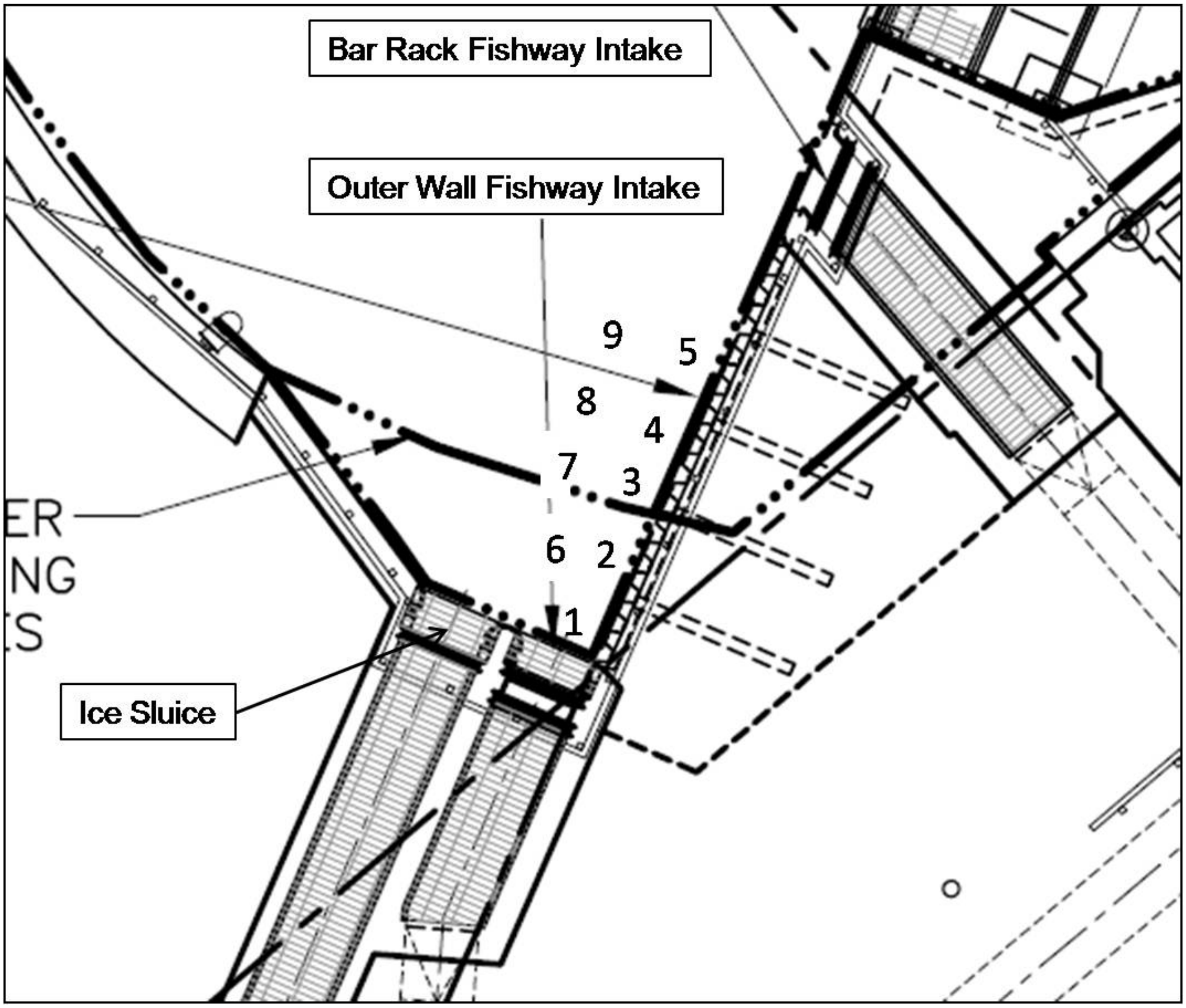


Figure 12[1]. The location of velocity measurements collected at Station 6 in front of the *outer-wall* fishway intake at the School Street Project Cohoes, NY.

[1] Measurements were collected immediately in front of fish way intake and extended out at 3ft increments as measured normal to the fishway entrance. Measurements were conducted are a regular interval with a spacing of ~3ft.

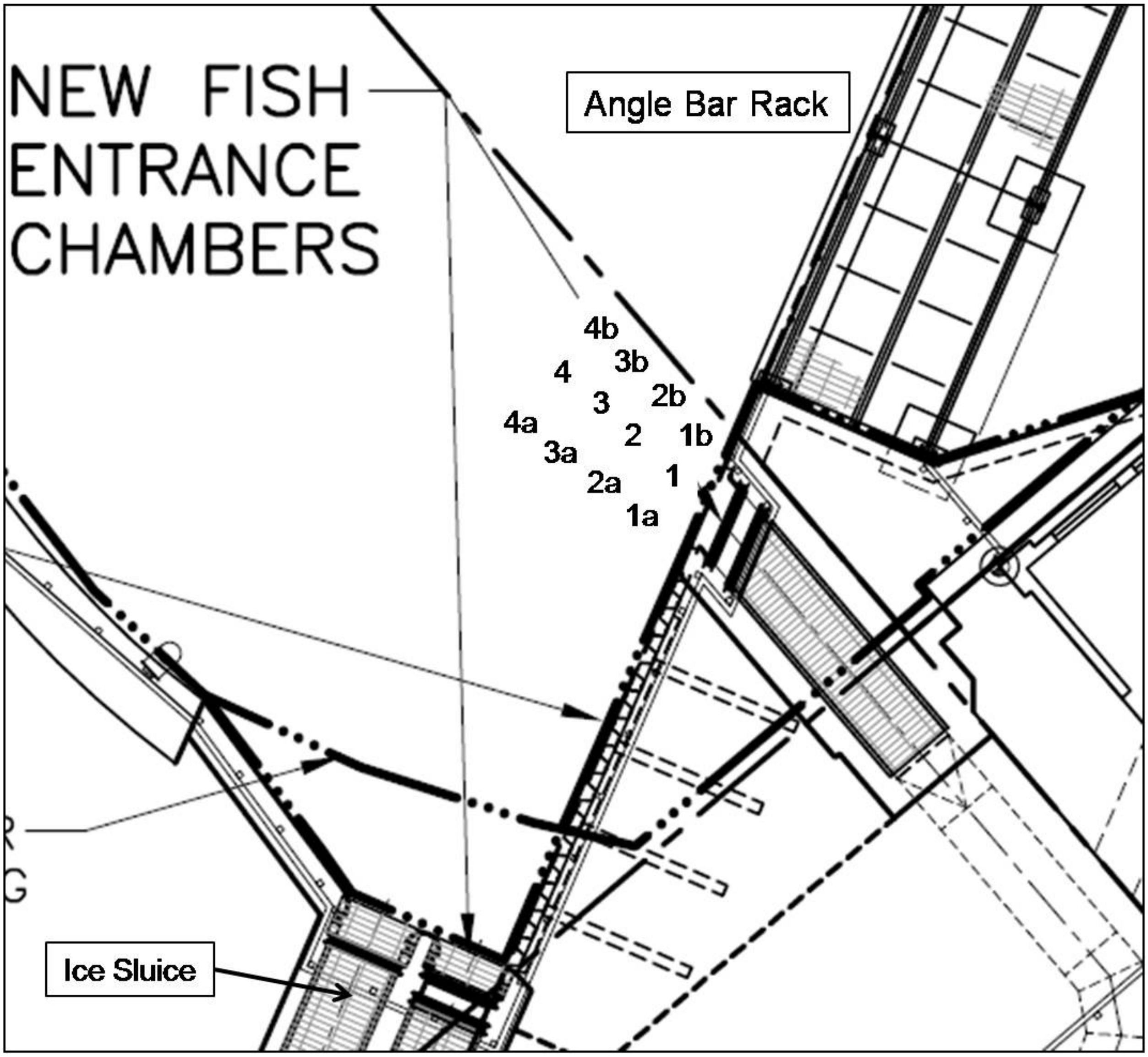


Figure 13[2]. The location of velocity measurements collected at Station 7 in front of the *bar rack* fishway intake at the School Street Project Cohoes, NY.

[2] Measurements were collected immediately in front of fish way intake and extended out at 3' increments as measured normal to the fishway entrance. Three measurements were conducted at each 3' increment and were spaced 18" apart.

Scale: AS SHOWN	BROOKFIELD RENEWABLE POWER QUEENSBURY, NY	1 of 1
Project No: 826110	SCHOOL STREET PROJECT FISHWAY BIOLOGICAL ASSESSMENT	
Filename: SiteLocus.mxd	SPECIMEN COLLECTION LOCATIONS	14
Drawn By: KPN	Kleinschmidt Energy & Water Resource Consultants 35 Pratt St. Sutie 201 Essex, CT 06426 Telephone: (860) 767-5069 Fax: (860) 767-5097 www.KleinschmidtUSA.com	
Date Drawn: 01-25-2010		

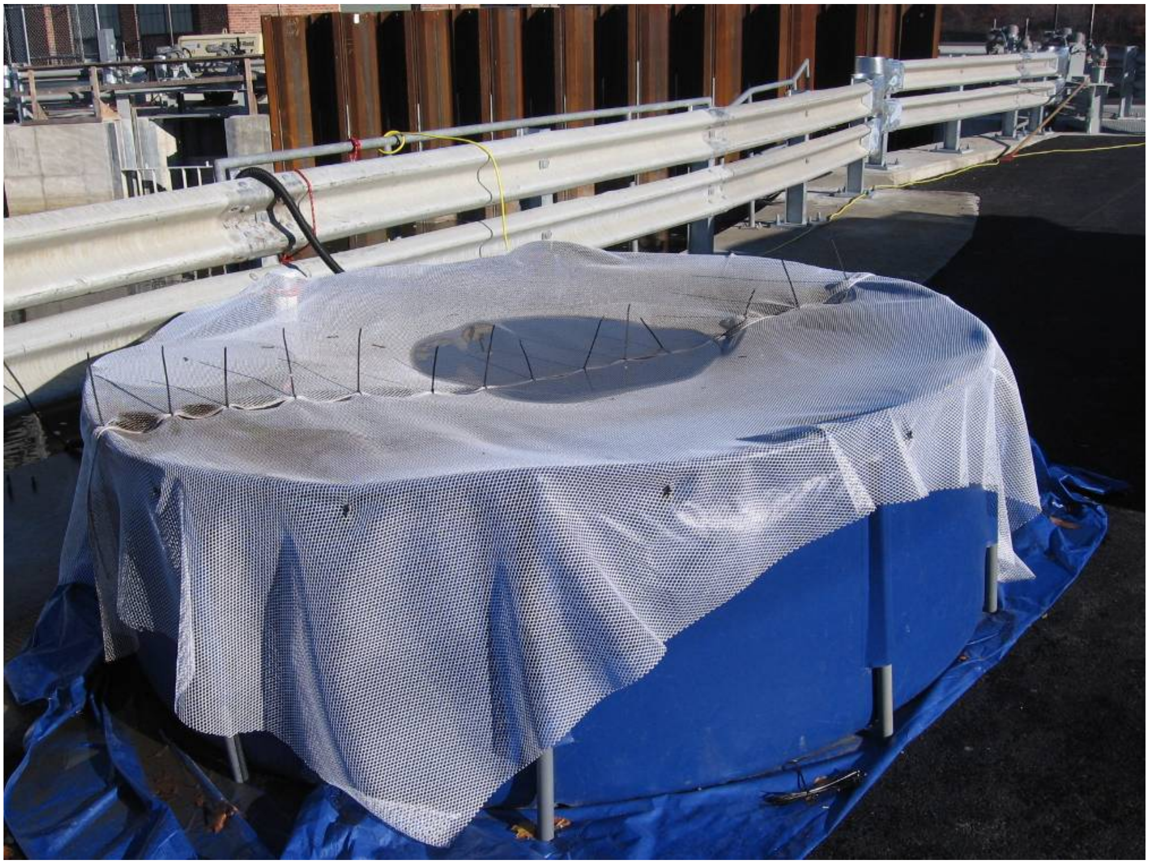


Figure 15. Fish holding tank at the School Street Project Cohoes, NY.

Figure 16. Net pen used to recollect/hold test fish at the School Street Project Cohoes, NY.

Figure 17. The antenna array mounted to the pedestrian bridge (telemetry array 2) at the School Street Project Cohoes, NY

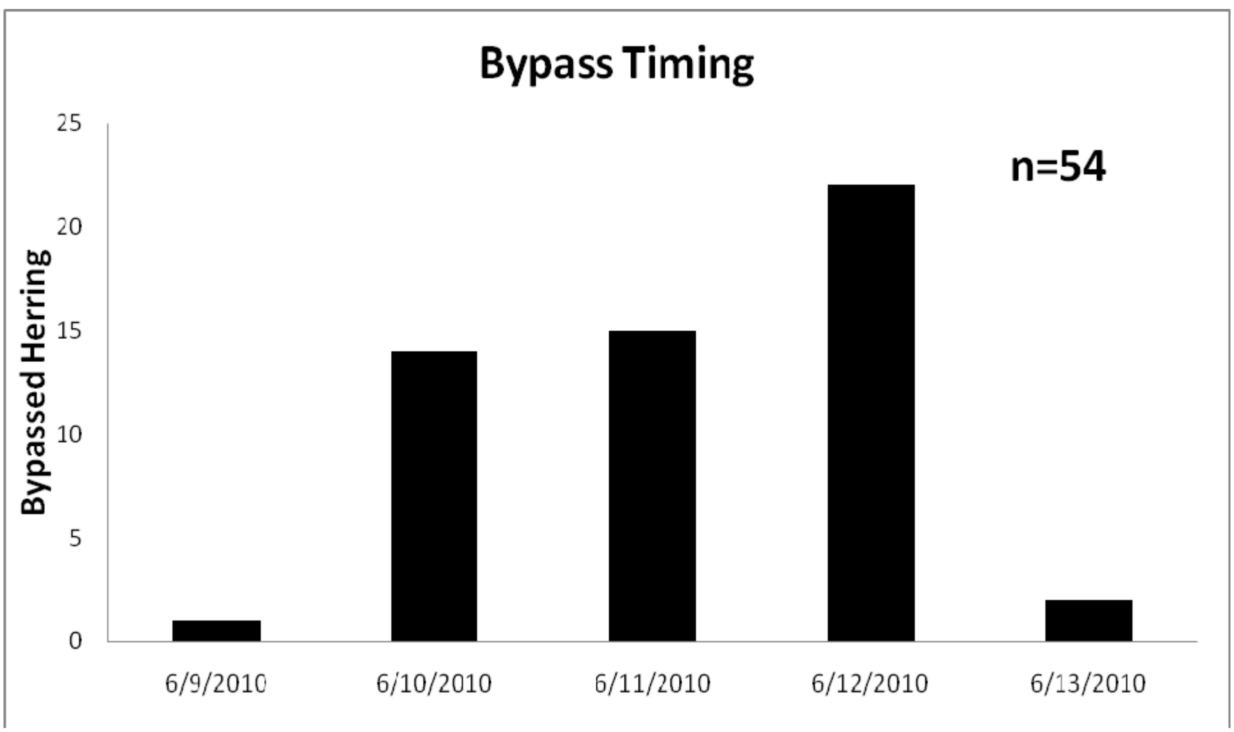


Figure 18. The number and timing of adult herring that bypassed the School Street Project Cohoes, NY.

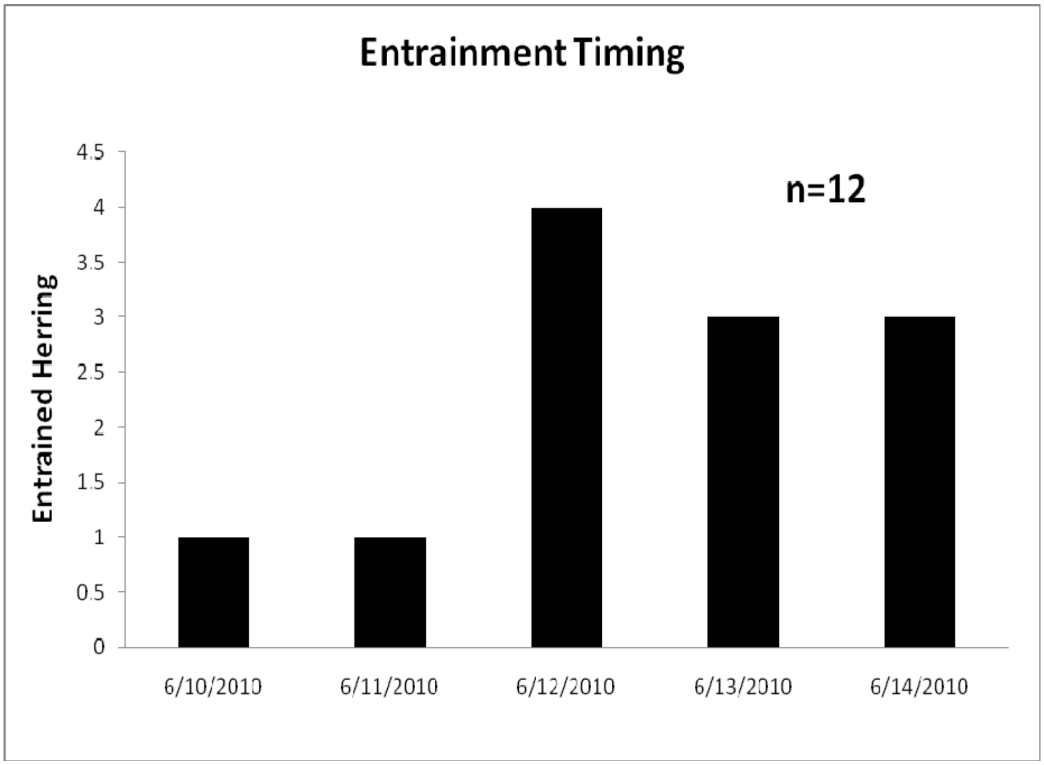


Figure 19. The number and timing of adult herring that were entrained via the lower gatehouse at the School Street Project Cohoes, NY.

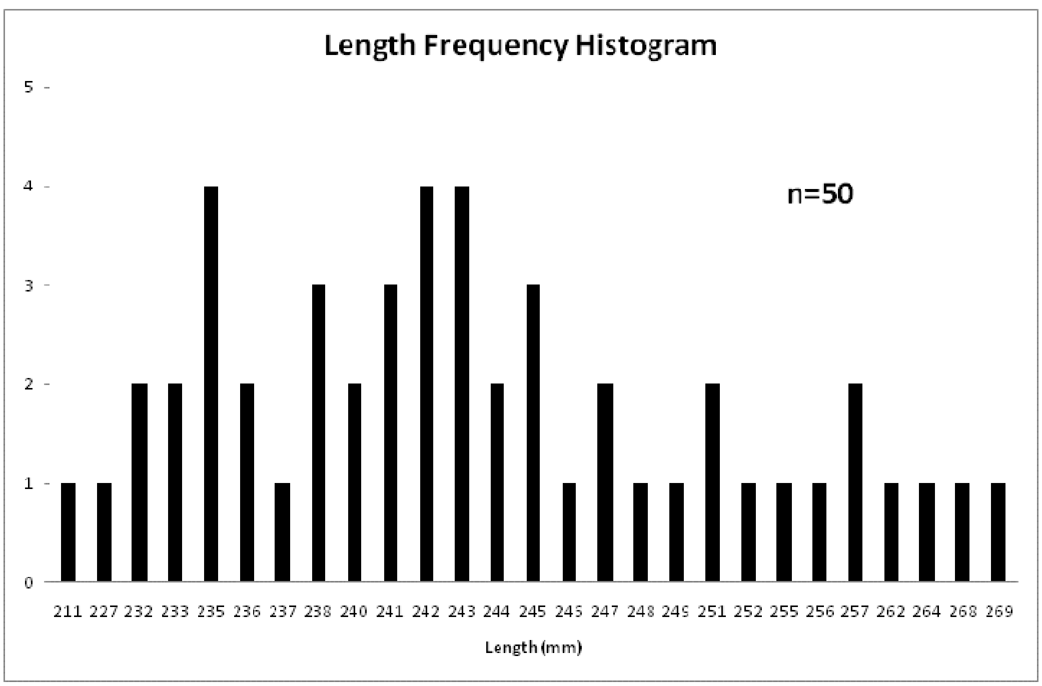


Figure 20. Length frequency distribution histogram of randomly selected adult herring collected for the outmigration study at the School Street Project Cohoes, NY, June 2010.

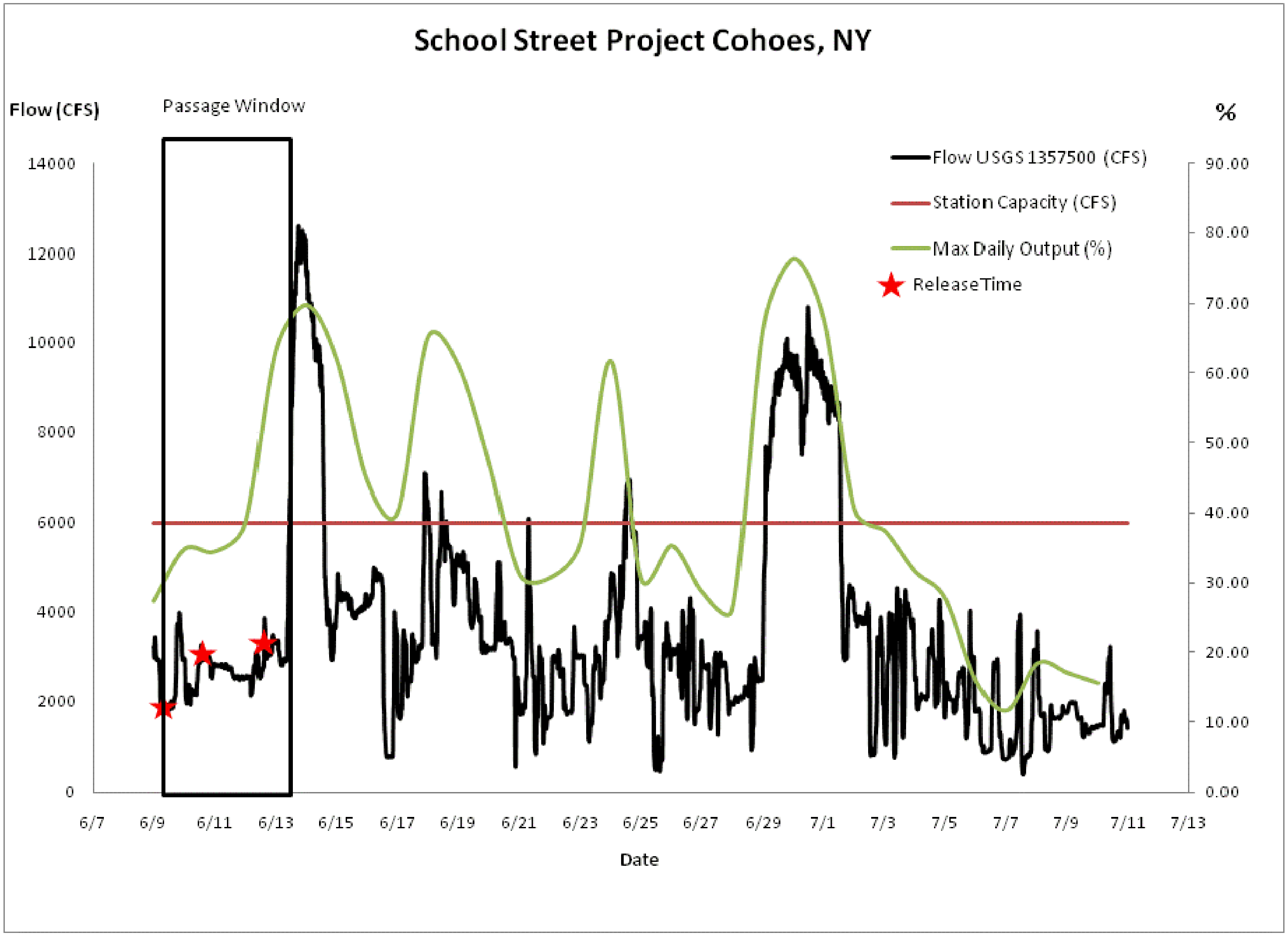


Figure 21. Flow (CFS) in the Mohawk River and the percentage of concurrent maximum daily power output at the School Street Project, Cohoes, NY.

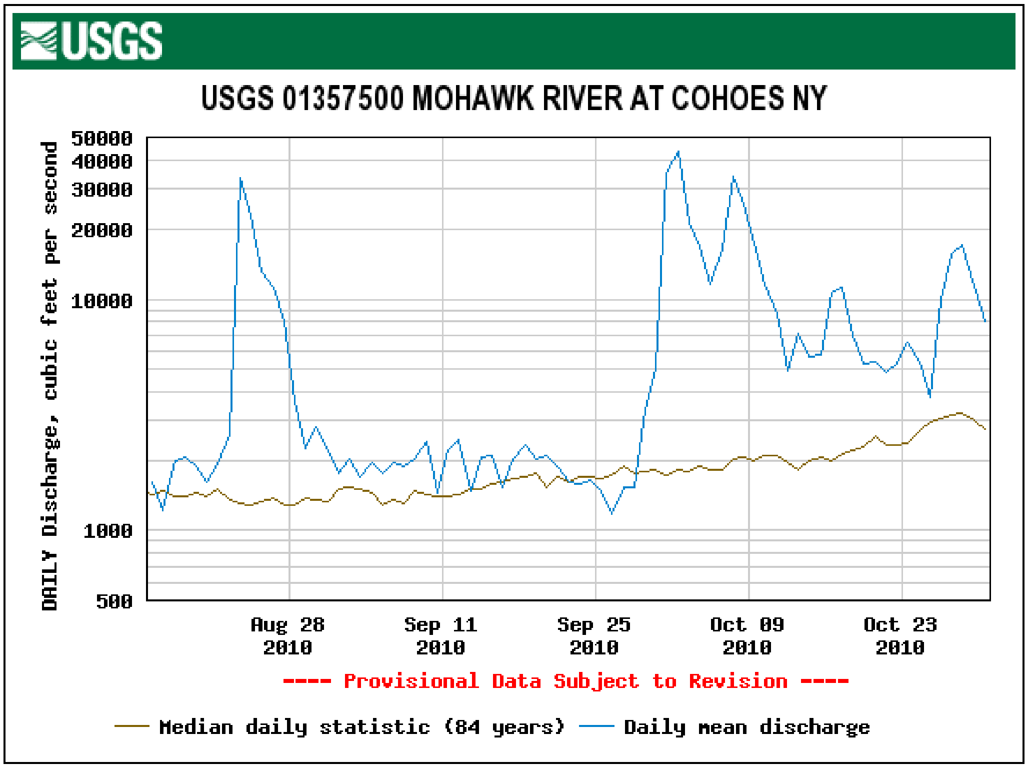


Figure 22. Average daily flow in the Mohawk River Cohoes, NY, August through October, 2010.

Figure 23. Placement of split-beam hydroacoustic detection systems in the turbine intakes at the School Street Project gatehouse, Cohoes, NY.

Figure 24. DIDSON placement and orientation in fish separation chamber at the School Street Project Cohoes, NY.

Figure 25. Hydroacoustic monitoring, data collection and storage computers located in the gatehouse at the School Street Project Cohoes, NY.

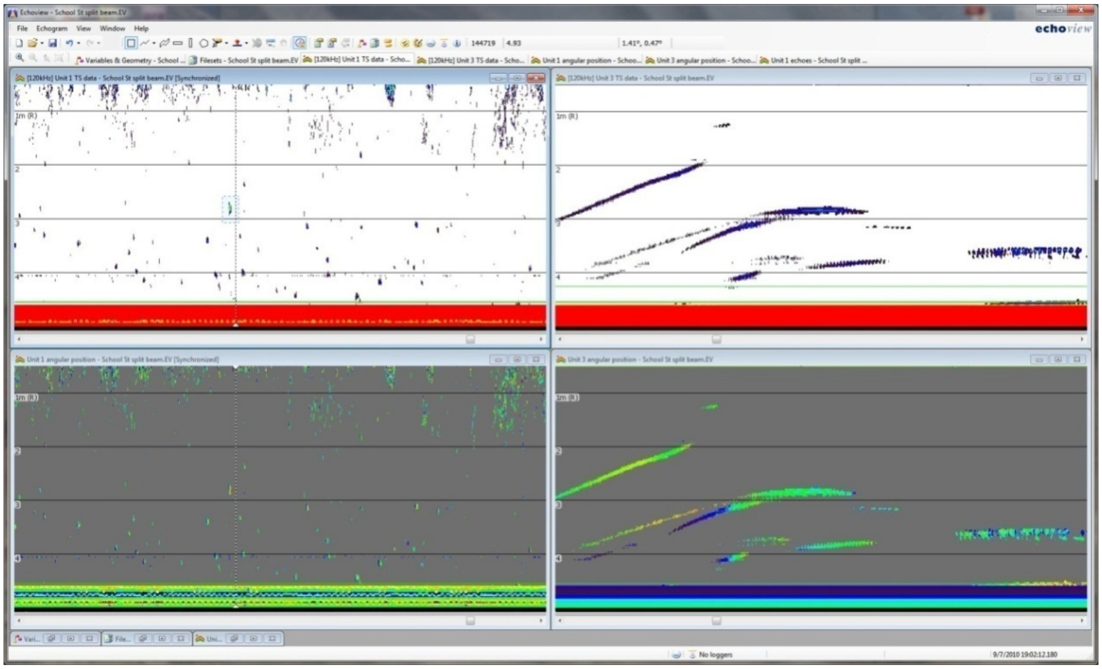


Figure 26. An example of split beam echograms from Unit 1 (left) during operation and Unit 3 (right) idle. The data were collected at the School Street Project Cohoes, NY, (Sept 7, 2010 at 1900 hours).

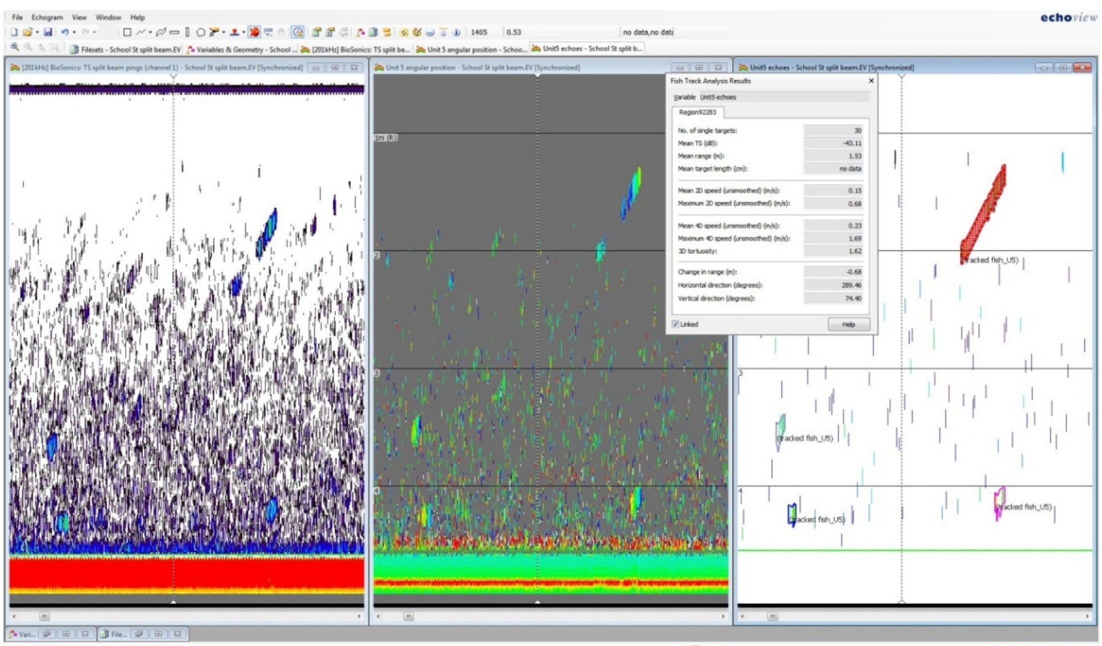


Figure 27. An example of split beam echograms from Unit 5, collected under high noise conditions when the unit was operating on Oct 1, 2010 2200 hours at the School Street Project Cohoes, NY.

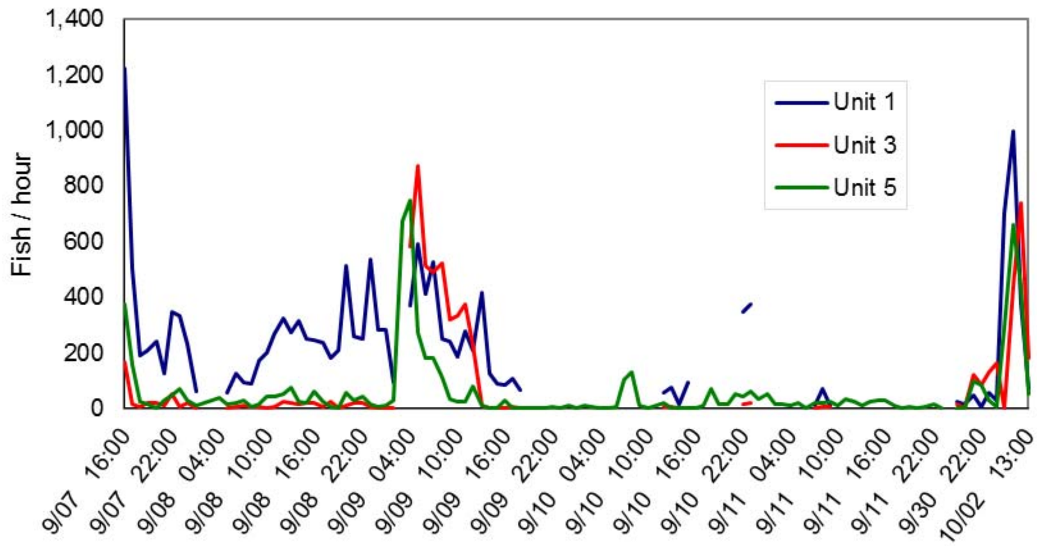


Figure 28. Time series of estimated fish relative abundance in the turbine intakes at the School Street Project, Cohoes, NY. The estimates are expanded to account for unsampled areas and summed by hour.

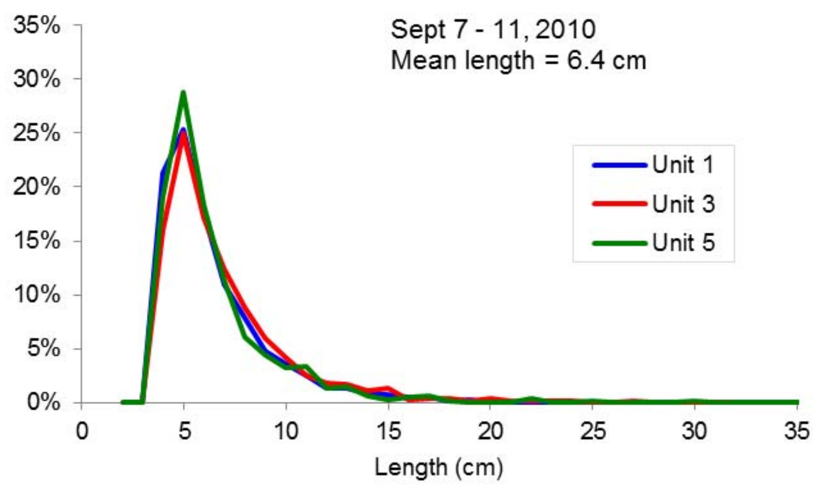


Figure 29. Histogram of the estimated size of tracked fish, observed between September 7 and 11, 2010 at the School Street Project Cohoes NY.

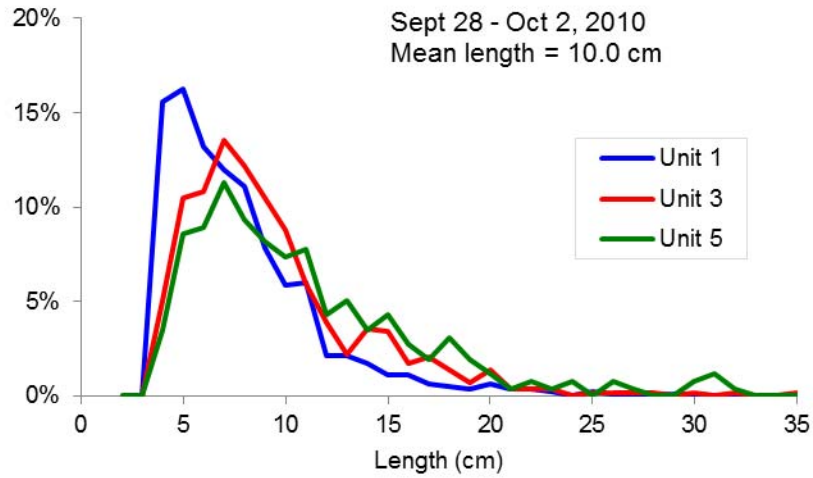


Figure 30. Histogram of the estimated size of tracked fish, observed between September 28 and October 2, 2010 at the School Street Project Cohoes NY.

Figure 31. Juvenile herring and debris on fish separation screen September 10, 2010 at the School Street Project Cohoes NY.

APPENDIX D

PERMITS AND AGENCY CONSULTATION DOCUMENTS

New York State Department of Environmental Conservation
Division of Fish, Wildlife and Marine Resources - Special Licenses Unit
625 Broadway
Albany, NY 12233-4752
Phone Number (518) 402-8985
Fax Number: (518) 402-8925

NEW YORK STATE FISH AND WILDLIFE LICENSE

Conditions:

3. A. The licensee and/or designated agents are authorized to collect, possess, transport, release and re-capture fish from the Mohawk River in the Towns of Cohoes and Waterford and in the Erie Canal below Lock 2 as part of the School Street Project (FERC No. 2539) as outlined in their license application on file with the NYS DEC Special Licenses Unit.

B. Fish may be collected pursuant to this license using boat electroshocking equipment, haul seine, trap and floating pens.

C. The licensee and/or designated agents are authorized to collect, temporarily possess, implant with radio transmitters and transport no more than 100 (one hundred) adult blueback herring. Fish so marked shall be released unharmed upstream in the project power canal.

D. The licensee and/or designated agents are authorized to collect, temporarily possess and release unharmed below the project, no more than 400 (four hundred) juvenile blueback herring.

E. The licensee and/or designated agents are further authorized to purchase, possess and release up to 90 (ninety) adult eel in the fish bypass which shall be obtained from Conroy's Bait in Watervliet, NY which shall be collected from the Hudson River between the lock in Stillwater and the I-90 bridge in Albany.

F. The licensee and/or designated agents are further authorized to collect, possess, tag, temporarily possess and release unharmed in the fish bypass no more than 100 (one hundred) resident species of fish

G. The licensee shall obtain an overland transport permit for all fish that do not have a fish health certificate from the NYSDEC Regional Office at 65561 State Route 10, Stamford, NY 12167, (607) 652-7367.

E. The licensee is authorized to designate agents to assist the licensee while conducting activities authorized pursuant to this license provided that the licensee submit a written request to the Special Licenses Unit containing the: a) name, b) address, c) age, and d) phone number of the person he or she is nominating as a designated agent

F. This license is not a license to trespass. The licensee and his or her designated agents must obtain permission from the appropriate landowner/land manager prior to conducting activities authorized pursuant to this license.

G. The licensee and/or designated agents must notify the appropriate Regional Environmental Conservation Officer at least 48 hours prior to conducting any collecting activity under this license, (518) 357-2047.

H. The licensee shall file a written annual report no less than thirty (30) days prior to the expiration date of this license. Such annual report shall contain: i) name of the licensee, ii) license number, iii) list of all collections made, iv) species collected, v) date and time of collection, vi) location of collection, vii) location of release, viii) species and numbers released and, ix) location, date of collection and number of eels caught for collections made by the Facility identified in Condition E.

I. The licensee shall submit a written request for the renewal of this license that shall include accurate copies of his or her annual report for the previous year no less than thirty (30) days prior to the expiration date listed on the license. This renewal paperwork must be sent to the NYSDEC, Special Licenses Unit, 625 Broadway, Albany, NY 12233-4752.

Brookfield

Brookfield Renewable Power, Inc.
NY East Regional Operating Center
399 Big Bay Road
Queensbury, NY 12804

Tel (518) 743-2017
Fax (518) 745-4292
www.brookfieldpower.com

March 30, 2010

Mr. Stephen Patch
U.S. Fish & Wildlife Service
New York Field Office (Region 5)
3817 Luker Rd.
Cortland, NY 13045

Mr. Curt Orvis
U.S. Fish and Wildlife Service
Fish Passage and Water Resources
300 Westgate Center Drive
Hadley, Massachusetts 01035-9589

Mr. Mark Woythall
NY State Department of Environmental Conservation
625 Broadway, 5th Floor
Albany, NY 12233-4756

Subject: Improvements to School Street Project Fishway Effectiveness Study Plan

Dear Steve/Curt/Mark,

Brookfield Renewable Power (Brookfield) will be continuing to conduct downstream fish bypass effectiveness testing at the School Street Project (FERC NO. 2539) in the spring, summer and fall of 2010 pursuant to FERC license Settlement Agreement Section 3.7 . One component of the 2010 evaluations will focus on passage efficiency and survival of downstream migrating adult blueback herring (*i.e.*, post-spawn) using radio telemetry methods. The earlier proposed scope and anticipated methodologies for this specific effort is identified in Section 3.2.1.1 of the previously approved *Phase I Fishway Effectiveness Testing Plan Addressing Settlement Agreement Sections 3.7, and 401 Water Quality Certification 13* (Study Plan).

The purpose of this letter is to outline proposed refinements to the Study Plan specific to post-spawn adult herring that have been identified by our contractor (Kleinschmidt Associates), and request your agency's comments and agreement. As the planning and implementation of this radio telemetry study effort is imminent (early to mid-May start ?), we would appreciate receiving any comments by April 23.

More specifically, Kleinschmidt is proposing to adjust the locations of several telemetry antenna arrays that will be used to detect and monitor radio tagged herring (test fish) in the vicinity of the newly constructed fish bypass facilities. Additionally, we propose to use radio tags with five unique frequencies (twenty tags on each of the five frequencies), rather than on one frequency as identified in the current Study Plan. The advent of digital receivers allows monitoring of multiple frequencies simultaneously, which will reduce the potential for signal collisions without the pitfall of timed analog signal scanning (i.e., with tags on one frequency). This use of digital receivers and multiple tag frequencies will reduce the potential for individual test fish to pass through the detection zones undetected.

With respect to the location of the antenna arrays, the Study Plan identifies eight anticipated radio antenna array locations, and associated detection zones, as follows:

1) upstream of the trash rack,
2) lower gatehouse entrance,
3) fishway entrance,
4) powerhouse,
5) tailrace,
6) fishway exit,
7) upper gatehouse entrance, and
8) a downstream location to demonstrate volitional movement after passage.

Of these initially identified locations, Kleinschmidt proposes to adjust the location of four of these arrays (and the corresponding detection zones): the lower gatehouse entrance array (2), the fishway entrance array(s) (3), the powerhouse array (4), and the fishway exit array (6). In addition, we have determined that for the array "upstream of the trash rack", the preferred location will be along or immediately adjacent to the new pedestrian bridge leading over the power canal (providing a good indication of when fish first pass down into the area upstream of the angled bar rack and fish bypass facilities).

The following changes to the location of the antenna arrays and detection zones will improve data quality by minimizing detection zone overlap while maintaining comprehensive test fish detection at the Project:

1) entrainment of test fish through the generating units will now be monitored by creating a detection zone in the immediate forebay of each of the five penstock entrances, rather than further upstream within the lower gatehouse (2) and in the powerhouse (4)). These penstock entrance detection zones will collect data as test fish approach and enter the penstocks (within the lower gate house), at which point they are committed to turbine passage.

   These detection zones will encompass an area within the entrances of the penstocks straddling a range of water velocities, which will ideally include a point of no return based on intake velocities (*i.e.*, detected fish will have no choice but to pass downstream through the penstock). This will eliminate the need for detection further upstream within the gatehouse or within the powerhouse itself, the latter of which produces significant radio noise interference that would almost certainly affect the quality of the telemetry data and ability to reliably detect test fish[1].

2) Antenna arrays and associated discrete detection zones were also previously identified for both the tailrace area (5) and the immediate area of the fishway exit (4). With the current configuration of the fish bypass exit pipe, these areas are now located very close together, *i.e.*, the fish bypass exit pipe discharges directly into the tailrace immediately adjacent to and/or within the powerhouse discharge.

   Based on reconnaissance conducted by Kleinschmidt, the close proximity of thess two areas makes it essentially impossible to establish discrete detection zones sufficient to pinpoint the passage route and/or specific location of test fish relative to the powerhouse versus fish bypass discharge. In addition, test fish will pass through the fish bypass pipe discharge area in the tailrace very quickly, increasing

[1] A radio noise survey was conducted by Kleinschmidt in February 2010, in preparation for the Spring 2010 adult blueback herring effectiveness evaluation at the School Street facility.

the potential to miss test fish using the bypass and/or misidentify their actual passage route (if missed but then detected in the tailrace).

As an alternative, Kleinschmidt proposes to detect test fish utilizing the fish bypass (versus passing through the generating units) by creating a discrete detection zone within the overflow weir pool located immediately downstream of the fish separation chamber and upstream of the entrance to the fish bypass exit pipe.

Fish passing over the overflow weir and into this pool are committed to downstream passage through the fishway because the adjustable overflow weir at the fish separation chamber outlet is a physical barrier to upstream fish movement. Fish detected in the area downstream of the overflow weir must eventually pass downstream to the tailrace via the exit pipe. This proposed adjustment to the location of the fishway exit detection zone (to immediately upstream of the exit pipe entrance) will eliminate the potential for overlapping detection zones within the Project tailwater, while maintaining comprehensive detection of entrained versus bypassed test fish.

3) The tailrace (5) and an area further downstream (8) will continue to be monitored as indicated in the Study Plan, further documenting when fish have successfully passed the Project facilities (via either entrainment or the fishway).

4) Kleinschmidt also proposes to move the detection array initially envisioned for immediately outside the fish bypass entrances (3) to the separation chamber, located a short distance downstream of the actual fishway entrances. This will ensure that detected fish have in fact entered the fishway (versus approaching the fishway entrance, being detected, but then not actually passing through the entrance), while still providing an indication of exactly when a test fish actually enters the fish bypass facility.

In summary, the proposed changes to the locations of the various antenna arrays will now provide for detection zones:

1. at the upper gatehouse (*to detect any upstream escapement after test fish are placed in the upper portion of the power canal*).
2. Upstream of the new trashracks (*along or in vicinity of new pedestrian bridge*).
3. Within the penstock intake areas in the lower gatehouse (*at entrainment points within the forebay to each unit*).
4. At the entrances to the fish bypass separation chamber (*indicating fish have entered the fishway*).
5. Immediately upstream of the fishway exit pipe and downstream of separation chamber overflow outlet weir (*to confirm downstream passage of fish via the fishway*).
6. Tailrace.
7. A downstream location (*to detect volitional downstream migration following passage*).

Brookfield is requesting your review, comment and concurrence with the above proposed changes to the location of the radio telemetry antenna arrays. These proposed changes will eliminate potential detection zone overlap and ensure that fish are in fact using the indicated downstream passage route, while also allowing for appropriate evaluation of passage efficiency and timing. This will improve the quality of data collected in support of evaluating the fish bypass facility and the downstream passage of blueback herring.

Please feel free to contact myself (518-743-2012) or Ms. Chris Tomichek (860) 767-5069 if you have any questions; alternatively, any questions, comments or an indication of your concurrence with these proposed changes can also be provided via email if you'd prefer (*timothy.lukas@brookfieldpower.com*).

Sincerely,

Tim Lukas
Compliance Specialist
for Erie Boulevard Hydropower, L.P.

cc: C. Tomichek, KA
B. Kulik, KA
T. Uncher

United States Department of the Interior

FISH AND WILDLIFE SERVICE
3817 Luker Road
Cortland, NY 13045

April 9, 2010

Tim Lukas, Compliance Specialist
Brookfield Power, Inc.
NY East Regional Operating Center
399 Big Bay Road
Queensbury, NY 12804

**RE: School Street Hydroelectric Project (FERC #2539)
Modifications to Fishway Effectiveness Study Plan**

Dear Mr. Lukas:

The U.S. Fish and Wildlife Service (Service) has reviewed the March 30, 2010, correspondence from Brookfield regarding modifications to the approved Fishway Effectiveness Study Plan for the School Street Project, located on the Mohawk River. Based on monitoring conducted last fall, Brookfield has proposed to modify the locations of several antenna arrays to better detect fish movements. The locations chosen and the rationale for modifying these locations are acceptable to the Service. However, we believe an additional array located along the trashrack would provide additional, useful data. These data would allow us to determine where fish that pass through the racks and are entrained are actually entering the racks. This information would allow us to determine specific modifications that might be required, such as an overlay on a short section of rack or a flow inducer to improve passage efficiency.

We appreciate the opportunity to review the proposed modifications to the study plan. If you have any questions or desire additional information, please contact Steve Patch at 607-753-9334.

Sincerely,

David A. Stilwell
Field Supervisor

cc: NYSDEC, Albany, NY (M. Woythal)
FWS, Hadley, MA (C. Orvis)

PERM 42 (09/09)

State of New York
Department of Transportation

Highway Work Permit

Permit No.: **20100116640**

Date Issued: **05/05/2010**

Project ID No.:

Expiration Date: 07/05/2010

***Permittee 1:**
KLEINSCHMIDT ASSOCIATES
BRYAN APELL
35 PRATTS ST., SUITE 201
ESSEX, CT 06466
Emergency Contact: CHRIS TOMICHEK
Emergency Number: 860-767-5069

Under the provisions of the Highway Law or Vehicle & Traffic Law, permission is hereby granted to the permittee to:

MOUNTING OF TWO (2) RADIO ANTENNAES ON THE DOWNSTREAM SIDE OF THE ROUTE 32 BRIDGE (BIN 1022500) IN THE TOWNS OF WATERFORD AND COHOES, NY. BILL HADERSBECK (518) 857-7509 MUST BE CONTACTED PRIOR TO INSTALLATION.

THE PERMITTEE IS RESPONSIBLE FOR TEMPORARY TRAFFIC CONTROL IN ACCORDANCE WITH THE NATIONAL MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES AND THE NYS SUPPLEMENT. ANYONE WORKING WITHIN THE HIGHWAY RIGHT-OF-WAY SHALL WEAR HIGH-VISIBILITY APPAREL MEETING THE ANSI 107-2004 CLASS II STANDARDS AND A HARD HAT.

County	Municipality	State Hwy	State Route	Beg Ref	End Ref
ALBANY	COHOES	-	32	32 11046018	-
SARATOGA	WATERFORD	-	32	32 15051001	-

as set forth and represented in the attached application at the particular location or areas, or over the routes as stated therein, if required; and pursuant to the conditions and regulations general or special, and methods of performing work, if any; all of which are set forth in the application and form of this permit. See additional conditions on PAGE 2.
THIS PERMIT IS ISSUED BASED ON ALL LOCAL, STATE, AND FEDERAL REQUIREMENTS BEING SATISFIED.

Dated at: **Albany** **Date Signed:** **05/05/2010** **Commissioner of Transportation** **By:** Mark Kennedy **Mark Kennedy**

IMPORTANT:

THIS PERMIT, WITH APPLICATION AND DRAWING (OR COPIES THEREOF) ATTACHED, SHALL BE PLACED IN THE HANDS OF THE CONTRACTOR BEFORE ANY WORK BEGINS. THE HIGHWAY WORK PERMIT SHALL BE AVAILABLE AT THE SITE DURING CONSTRUCTION.

BEFORE WORK IS STARTED AND UPON ITS COMPLETION, THE PERMITTEE ABSOLUTELY MUST NOTIFY THE RESIDENT ENGINEER: BILL HADERSBECK (518)857-7509

"UPON COMPLETION OF WORK", SECOND TO LAST PAGE, MUST BE COMPLETED, SIGNED BY THE PERMITTEE, AND DELIVERED TO THE RESIDENT ENGINEER.

The issuing authority reserves the right to suspend or revoke this permit at its discretion without a hearing or the necessity of showing cause, either before or during the operations authorized.
The Permittee will cause an approved copy of the application to be and remain attached hereto until all work under the permit is satisfactorily completed, in accordance with the terms of the attached application. All damaged or disturbed areas resulting from work performed pursuant to this permit will be repaired to the satisfaction of the Department of Transportation.

*** Upon completion of the work within the state highway right-of-way authorized by the work permit, the person, firm, corporation, municipality, or state department or agency, and his/her or its successors in interest, shall be responsible for the maintenance and repair of such work or portion of such work as set forth within the terms and conditions of the work permit.**

Permit Fee :		$25.00			
Insurance Fee:		$0.00			
Total Fees:		$25.00			
Amt Rec'd 1:		$50.00	Check Num:	63746 Check Date:	03-MAY-10
UOF:	App 1:	No	App 2:	No	

Attachments and additional requirements to this Highway Work Permit include:

PERM 33 - Highway Work Permit Application for Non_Utility Work

PERM 41-1d - Method of Performing Work within the State Right of Way

END OF ATTACHMENTS

PERM 42 (09/09)

State of New York
Department of Transportation

Highway Work Permit

Permit No.: 20100116640

Date Issued: 05/05/2010

Project ID No.:

Expiration Date: 07/05/2010

Return this page to:

Mike Johnson , Resident Engineer
Intersection Rt. 155 & Rt. 85A
Voorheesville, NY 12186

Permittee 1: KLEINSCHMIDT ASSOCIATES
BRYAN APELL
35 PRATTS ST., SUITE 201
ESSEX , CT 06466 -

UPON COMPLETION OF WORK AUTHORIZED, THIS PAGE OF THE PERMIT MUST BE COMPLETED, SIGNED BY THE PERMITTEE, AND DELIVERED TO THE RESIDENT ENGINEER.
Work authorized by this permit has been completed. Refund of deposit or return/release of bond is requested.

DATE PERMITTEE AUTHORIZED AGENT (if any)

TO BE COMPLETED BY NYSDOT:

Work authorized by this permit has been satisfactorily completed and is accepted. **Inspection Report must be completed.**

- ☐ Refund of Deposit is authorized
- ☐ Return of Bond is authorized
- ☐ Unable to meet schedule as specified in bid proposal
- ☐ Amount charged against Bond may be released.
- ☐ Retain bond for future permits
- ☐ Forfeit of Guarantee Deposit is authorized
- ☐ Other

DATE RESIDENT ENGINEER

☐ Mailing address of refund has been verified.
If different, list new address:

The Regional Office will forward this form to the Main Office with the appropriate box checked.

- ☐ Permit closed
- ☐ Bond returned/released
- ☐ Refund of Guarantee Deposit on this permit is authorized
- ☐ Forfeit Guarantee Deposit to NYSDOT
- ☐ Other

DATE REGIONAL TRAFFIC ENGINEER

INSPECTION REPORT

For each Highway Work Permit issued, inspections will be performed. The following report must be completed for each site visit, indicating the date, inspector, and hours spent on inspection. **If the total inspection time exceeds 1 hour, then a FIN 12 (PERMIT INSPECTION FOR DEPARTMENT SERVICES) is REQUIRED.**

INSPECTION REPORT LOG

HOURS WORKED BY DATE									HOURS	
Inspector Name	Date Inspected								Regular	Overtime
	Regular									
	Overtime									
Inspector Name	Date Inspected								Regular	Overtime
	Regular									
	Overtime									
Inspector Name	Date Inspected								Regular	Overtime
	Regular									
	Overtime									

Complete hours for each date inspected.
Add regular hour numbers across rows, and then overtime hours across rows.
Add hour columns down for total hours of permit inspection time.

COMMENTS/OBSERVATIONS:

I HEREBY CERTIFY THAT THE INFORMATION CONTAINED ABOVE IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE.

NAME: ______________________ **TITLE:** ______________________

PERM 33 (8/01)

STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION
HIGHWAY WORK PERMIT APPLICATION FOR NON-UTILITY WORK

PREPARE 3 COPIES (photocopies acceptable)

Application is hereby made for a highway work permit:

Name Bryan Apell (Kleinschmidt Associates)

Address 35 Pratt St, Suite 201

City Essex State CT Zip 06426

Federal I.D. No. or Social Security No. 010371466

Applicant Telephone No. (860) 575-0507

Contact person in case of emergency Chris Tomichek

Telephone No. of contact person (860) 767-5069

For Joint application, name and address of Second Applicant below:

Name

Address

City State Zip

Project Identification No.

Highway Work Permit No.

RETURN PERMIT TO (If different from above):

Name

Address

City State Zip

RETURN OF DEPOSIT/BOND TO (Complete only if different from permittee):

Name

Address

City State Zip

1. Estimated cost of work being performed in state highway right-of-way $ $500.00

2. Anticipated duration of work: From 5/11 20, 10 thru 7/5, 20 10, to apply to the operation(s) checked on the reverse side.

3. Protective Liability Insurance covered by Policy No. ; expires on 20

4. A $20.00 fee will be charged for checks returned by the bank.

PROPOSED WORK (Brief description): Mounting of two (2) radio antennas on the downstream side of the Rt 32 bridge (BIN 1022500) in the towns of Waterford and Cohoes, NY.

ATTACHED: Plans ✓ Specifications ✓ LOCATION: State Route 32 State Highway

between Reference Marker 32 1104 6018 and Reference Marker 32 1505 1001

Town of: Waterford / Cohoes County of: Albany

SEQR REQUIREMENTS (Check appropriate item):

- [x] Exempt
- [ ] Ministerial
- [ ] Type 11
- [ ] EIS or DEIS

Lead Agency

If project is identified to be ministerial, exempt, or TYPE 11, no further action is required.

If project is determined to be other than ministerial, exempt, or TYPE 11, refer to M.A.P.7.12-2, Appendix A SEQR REQUIREMENTS FOR HIGHWAY WORK PERMITS.

Acceptance of the requested permit subjects the permittee to the restrictions, regulations and obligations stated on this application and on the permit.

Applicant Signature Bryan Apell Date 5/4 20 10.

Second Applicant Signature Date 20 .

Approval recommended 05.05 2010, By Resident Engineer 457 M C Hufelbek Residency No. 1-2

Approved 20 , By Regional Traffic Engineer Region No.

PERMIT IS ISSUED CONTINGENT UPON LOCAL REQUIREMENTS BEING SATISFIED.

CHECK TYPE OF OPERATION	Permit Fee	Insurance Fee	Perm 17 or Under Taking	Total Amount of Fee and/or Insurance	Guarantee Deposit and/or Bond Amount
5. ☐ Single job – Permit issued for each job					
a. ☐ Driveway or roadway					
1. ☐ Residential	$ 15	$ 25			
2. ☐ Commercial – Minor	550	175			
a. ☐ Home Business	100	75			
3. ☐ Commercial – Major – (Less than 100,000 square feet Gross Building Area)	1400	N/A			
4. ☐ Commercial – Major – (100,000 square feet Gross Building Area and Greater)	Actual cost with Minimum of $2000 upon permit app.	N/A			
5. ☐ Subdivision Street	900	N/A			
6. ☐ Temporary access road or street	200	150			
b. ☐ Improvement					
1. ☐ Residential	15	25			
2. ☐ Commercial					
Check additional description below:					
a. ☐ Install sidewalk, curb paving, stabilized shoulder, drainage, etc.	200	150			
b. ☐ Grade, seed, improve land contour, clear land of brush, etc.	100	75			
c. ☐ Resurface existing roadway or driveway	50	50			
d. ☐ Annual resurfacing of residential and commercial roadways or driveways.					
1. ☐ Per County	150	N/A			
2. ☐ Per Region	400	N/A			
c. ☐ Tree Work					
1. ☐ Residential	15	25			
2. ☐ Commercial (not required for pruning if utility has annual maintenance permit)	25	50			
Check additional description below:					
a. ☐ Removal or planting					
b. ☐ Pruning, applying chemicals to stumps, etc.					
3. ☐ Vegetation control for advertising signs	150/sign	75			
d. ☐ Miscellaneous Construction					
1. ☐ Beautifying ROW – (for Civic Groups only)	NC	25			
2. ☐ Temporary signs, banners, holiday decorations					
a. ☐ Not-for-profit organizations	NC	25			
b. ☐ Organizations other than not-for-profit	25	25			
3. ☐ Traffic control signals	500	175			
4. ☐ Warning and entrance signs	25	50			
5. ☐ Miscellaneous – Requiring substantial review	400	175			
6. ☐ Miscellaneous	25	50			
6. ☐ Encroachment caused by D.O.T. acquisition of property	25	50			
7. ☐ Compulsory permit required for work performed at the request of D.O.T.					
a. ☐ Building demolition or moving requested by D.O.T.	NC	25			
1. ☐ Demolition 2. ☐ Moving					
b. ☐ Improvement to meet Department standards	NC	25			
8. ☒ Miscellaneous	25	25		$50	
9. ☐ Adopt a Highway	NC	N/A			

Guarantee Deposit Check Number or Bond Number ______________________

PERM 33 (8/01)
REVERSE

Kleinschmidt

Energy & Water Resource Consultants

April 14, 2010

VIA ELECTRONIC MAIL

Mr. Tom Hoffman, P.E.
Region One Structures Engineer
(518)-388-0317
Fax (518)-388-0218

Mr. Hoffman

Thank you for taking the time to speak with me about placing radio telemetry equipment on the RT. 32 Bridge (BIN 1022500) in the towns of Cohoes and Waterford, NY. This letter addresses the information you requested during our Tuesday (4/13/2010) morning conversation.

Kleinschmidt Associates (Kleinschmidt) is conducting an evaluation of the newly installed downstream fish bypass structure at the School Street Project (FERC NO. 2539) located in the town of Cohoes, NY. The project is owned and operated by Brookfield Renewable Power (Brookfield). The evaluation of the fish bypass structures is being conducted in consultation with; US Fish and Wildlife Service (USFWS), the Federal Energy Regulatory Commission (FERC) and New York State Department of Environmental Conservation (NYSDEC) to meet the terms of the Settlement Agreement Section 3.7 and 401 Water Quality Certification Condition 13.

As part of the ongoing evaluation Kleinschmidt will conduct a study in the Spring of 2010 (May-June) to compare the proportion of outmigrating adult blueback herring that bypass the project using the fish bypass structure to the proportion that are entrained through the project. Radio telemetry techniques will be used in the evaluation.

Kleinschmidt, on behalf of Brookfield requests authorization from the New York State Department of Transportation (NYSDOT) to temporarily install two (2) Yagi antennas (Figure 1) to the bridge. The Yagi antennas are approximately 4' by 2' in dimension and are made of aluminum metal with an individual weight of approximately 7 pounds. Kleinschmidt Proposes to install the antennas at a central location using appropriate concrete lag bolts on the downstream side of the bridge. The antennas will be affixed to a short length (~4') of 1 1/2" galvanized steel pipe. Each antenna will require one coaxial cable for signal transition to a data logger located onshore in the town of Cohoes (exact location to be determined). Kleinschmidt proposes to run the coax cable along the outside of the concrete guide rail on the downstream side of the bridge. The coax cable will be temporarily fixed to the bridge using zip ties. This installation will in no way intrude into the travel lanes or pedestrian walkway and the required coax cable installation does not represent any electrical hazards to the public even if vandalized.

All equipment installed on the bridge will be removed at the culmination of the study (Late June). Any holes created during the mounting of the radio telemetry equipment will be sealed using an appropriate concrete grout to minimize the impact on the bridge.

If you have need for more information please contact me at (860) 767-5069 or email; Bryan.Apell@KleinschmidtUSA.com. Thank you for your consideration.

Sincerely,

KLEINSCHMIDT ASSOCIATES,

Bryan Apell

Bryan Apell
Aquatic and Fisheries Ecologist

BRA:sdm

\\Eagle\Jobs\826\110\Docs\Telemetry\Tom Hoffman DOT Letter.doc

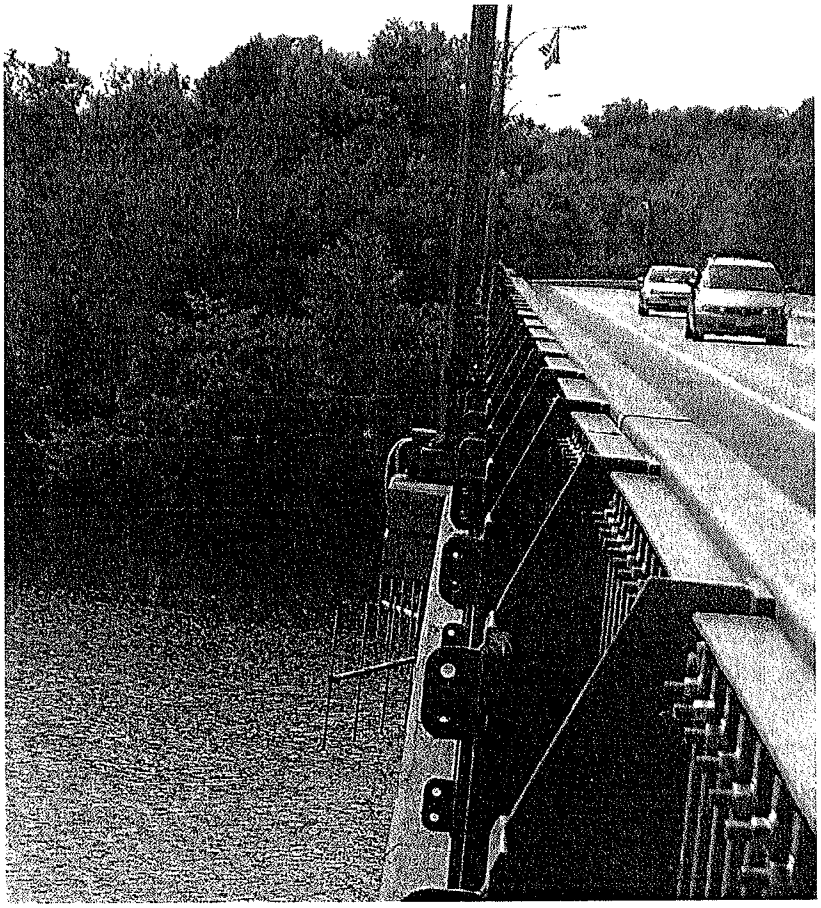
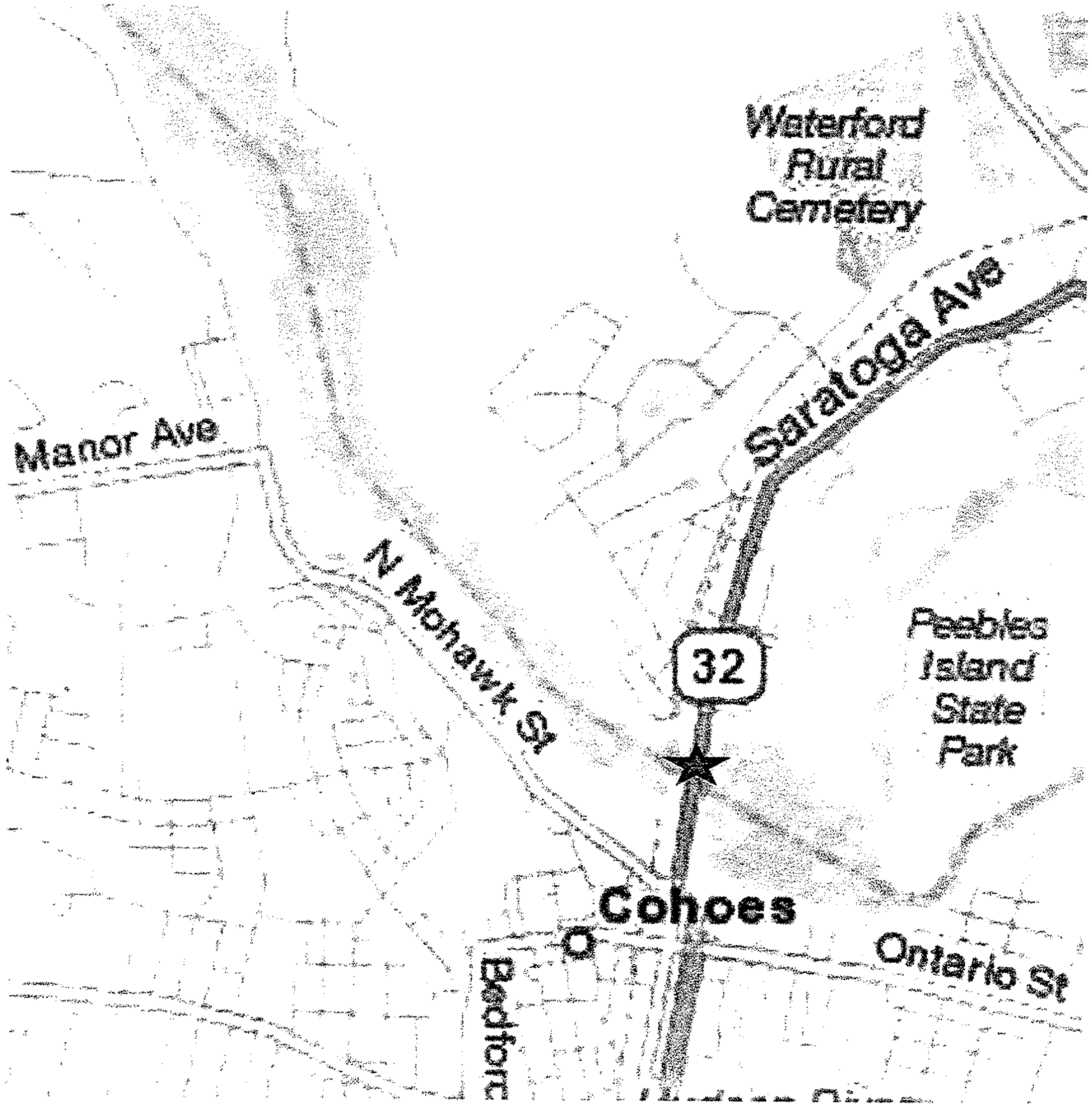


Figure 1: Example of the Yagi antenna proposed for use on the RT. 32 Bridge (1022500) in the towns of Cohoes and Waterford, NY.



★ Proposed mounting location

Feasibility Test and Recommendations
Juvenile Herring Bypass Efficiency Study
at School Street Station, Cohoes, NY
June 14th – 15th, 2010

We conducted a site visit, June 14th – 15th, 2010, to examine the feasibility of using hydroacoustic equipment at School Street Station, Cohoes, for the purpose of estimating the bypass efficiency of juvenile blueback herring. The focus of the site visit was to find locations that provide a good view of the fish, sufficient coverage and low ambient noise levels. Furthermore, fish passing the location should either clearly bypass the turbines or clearly become entrained (i.e., areas where fish mill are to be avoided).

Turbine intakes

For monitoring fish entrainment we tested a split-beam system in the intake bays of units 1, 3, and 5. The transducer was mounted in a down-looking orientation on a vertical 2-inch aluminum pipe that was attached to the front of the grate covering each bay. All three intake bays that we tested had very low ambient noise levels. There should be no problem detecting fish of an acoustic target size of -56 dB or greater, which for alewives translates into approximately 1 inch in length (based on Warner, Rudstam, and Klumb. 2002. In situ target strength of alewives in freshwater) fish. The water velocity appeared sufficiently fast to prevent fish from milling. Given the positive outcome of this test we did not further pursue the less desirable alternative of sampling along the angled bar rack.

Based on the feasibility test we recommend that fish entrainment be sampled in the intake bay of unit 1, 3 and 5. The transducer mounts should be similar to what Brookfield Power provided for the feasibility test. A tab can be added to the mounting plate to provide space for the attachment of a safety cable. Each transducer will be accompanied by a surface unit that can be placed on the top of the bay cover (grate). Each surface unit will have a power cable that will be plugged into one of the CFI outlets at the backwall of the gatehouse. In addition each surface unit will have an ethernet cable to connect to the master computer located at the entrance of the gatehouse. The ethernet cables can be run along the existing pipes.

Split-beam sampling setup in turbine intakes.

Aquacoustics will provide a float switch for each sonar. The float switch will turn off the power to the sonar in the event that the water level drops below the transducer. This will prevent transducer damage caused by overheating.

During our visit Brookfield Power indicated that unit 5 and the flow pattern it generates differ from that of the 4 other units. We will therefore change the estimation procedure from the previously proposed linear interpolation between units 1, 3 and 5 to proxy estimation, where fish entrainment in unit 2 will be assumed to be the same as in unit 1, and that in unit 4 will be assumed to be the same as in unit 3.

Fish bypass

For the fish bypass we tested a DIDSON acoustic camera in the fish separation chamber. The DIDSON camera was mounted on a vertical pole similar to the one used for the split-beam transducers. The pole was manually held over the side wall of the separation chamber, immediately downstream of the winch operating the fish separation screen. The DIDSON camera was aimed across the chamber such that the board at the downstream end of the screen was visible over more than ¾ of its length.

This board provided a good marker for the point of no return for downstream moving fish. At the time of our visit adult blueback herring were holding above the angled screen. Most of the fish were holding in the current, facing upstream, but were eventually swept downstream. Most of the fish seemed to be congregating on the side where the chamber exits to the fish transport pipe. Downstream moving fish crossing the board were clearly visible by eye from above as well as on the DIDSON image. Because of the shallow water column available above the screen the DIDSON camera had to be fitted with an 8º concentrator lens to narrow the vertical extent of its view and thus reduce the interference from the water surface, especially at the far end where the water spilling over the board introduces noise into the image.

Approximate coverage of the DIDSON camera sampling across the fish separation chamber.

The images collected during the feasibility test indicated that juvenile blueback herring should be clearly visible as they cross the board at the end of screen. To prevent fish from passing outside the field of view or within the area masked by noise, a screen should be added that guides fish approximately 4 feet off the wall on the west side of the chamber (i.e., the side where the DIDSON camera will be mounted) and approximately 2 feet on the opposite side. The position of the acoustic beam relative to the water surface is critical for sampling fish close to the surface: when the beam is aimed too high the surface creates too much interference; when aimed too low fish may be missed. Therefore, it will help significantly if the water elevation in the fish separation chamber can be held as constant as possible. Aquacoustics will supply a float switch to automatically shut off the DIDSON system and prevent it from overheating in the event the underwater unit becomes exposed.

For the study period, Brookfield Power will provide a pole mount that is attached to the chamber wall, approximately 6 – 8 inches upstream of the cross board. The pole will be mounted vertically in a sleeve that allows the pole to be rotated as well as raised and lowered. We need to be able to raise it far enough so we can access the DIDSON camera from the walkway. (This could perhaps be accomplished by designing the sleeve such that it can be opened and closed from above.) Once in place, the DIDSON camera needs to be stable. Excessive vibration blurs the images.

Kleinschmidt will provide a weather proof container to house the DIDSON breakout box. This container has to be placed within 50 ft of the DIDSON camera and be within reach of a GFI protected outlet. The DIDSON data will be written to a computer in the gatehouse. The computer will be connected to the DIDSON through an ethernet cable that needs to be run from the gatehouse to the breakout box.

Because of the milling behavior of fish entering the separation chamber it will probably not be possible to quantify the schools as described in the original proposal. Instead fish will be counted as they cross the board.

Internet connection

Brookfield Power will provide high-speed internet access for the data collection computers. The connection should have a minimum speed of 320 Kbps for upload and 1 Mbps for download. This will allow Aquacoustics to monitor data collection remotely and to assist with troubleshooting if necessary.

Schedule

After consultation with Kleinschmidt and Brookfield Power the start of the field study has been tentatively scheduled for September 7 - 10, 2010. Sampling will take place from September 10 through October 12 and the equipment will then be removed by Kleinschmidt and Brookfield Power and returned to Aquacoustics.

MEETING MINUTES

SCHOOL STREET PROJECT
PHASE I DOWNSTREAM FISH PROTECTION AND FISHWAY STUDY PROGRESS REVIEW

NYSDEC, ALBANY, NY

ATTENDEES: Mark Woythal, NYS Dept. of Environmental Conservation (NYSDEC)
Stephen Patch, U.S. Fish and Wildlife Service (USFWS)
Curt Orvis, USFWS
Tim Lukas, Brookfield Renewable Power (Brookfield)
John McVaigh, Brookfield
Chris Tomichek, Kleinschmidt Associates
Bryan Apell, Kleinschmidt Associates
Brandon Kulik, Kleinschmidt Associates

DATE: May 17, 2011

INTRODUCTIONS

Tim opened the meeting and stated that the purpose was to review the results of the fish bypass studies as presented in the recently distributed study report, prior to agency comments on the report provided, and to also reach a consensus on the status of various aspects of the study and future study needs and methods. Tim noted that Brookfield will finalize the draft report based on comments received from the agencies following the meeting, and will file it with FERC. Bryan circulated copies of the meeting agenda, a map of the study area, and drawings of key project features.

RESIDENT FISH PASSAGE

Brandon summarized the results of the resident fish survival testing. Survival assessment was based on mark and recapture method, and best collection efficiency was achieved when fish were released in the chamber directly above the passage pipe entrance. Test fish were initially released into the fishway entrance at the canal, but low velocities and a lack of downstream migratory behavior enabled these fish to reside in the fish passage system or escape. Bryan showed a series of movie clips and photos showing how water exited the fish passage pipe and spirals into the tailwater, and how the net pen was deployed to collect test fish. The curve at the end of the pipe introduces a spiral to the flow that results in a wide scatter pattern of the exit flow.

Resident fish survival was tested in fall 2009, using available fish collected from the Mohawk River in the vicinity of the project. Fish sizes and body types were representative of fish that would typically be exposed to entrainment and passage at the School Street site. Mark recommended developing a table summarizing the length frequencies of each fish group and a table that identified resident test fish as either *juvenile* or *adult* based on length criteria. Brandon asked if the data collected for this task satisfied agency requirements. Mark and Steve concurred

Kleinschmidt
Energy & Water Resource Consultants

that they were satisfied with the resident fish evaluation effort. They agreed that no further resident fish survival studies are required at this time.

AMERICAN EEL

Brandon reported that the eel survival study has not been conducted due to the lack of available eels in the study area or in nearby waters of the Hudson River. Eel collection was attempted in fall 2009 (in conjunction with resident fish collection) and in 2010, but very few eels could be found in the lower Mohawk River or nearby waters of the Hudson River. Brandon inquired if eel testing could be postponed pending sampling data showing adequate abundance existed to justify the study. Both Mark and Steve felt that testing should not be delayed for this species as it is important for fishery management purposes. Thus, they indicated that this survival test should proceed, provided that an acceptable source of eels is available per NYSDEC requirements.

The group discussed how NYSDEC policy generally discourages importing of test eels from other water bodies to avoid spreading pathogens. However, the group recalled that some past studies have allowed for eels to be imported for experimental purposes. Mark noted that collection permit rules may be flexible enough to allow eel to be collected from the lower Hudson, and then used for study in the Mohawk, but he will need to check into this further. He will also check to see what past precedents from other studies might be applicable and if the existing collection permit can be amended accordingly. Mark noted that this may be acceptable since the eels would be kept in an enclosed holding facility or briefly in the net pen, so they are not likely to escape to the river.

Mark and Bryan will follow up with Joe Therrian of NYSDEC, and Jeff Lukins of the warmwater fish division. It may also be possible to import eels then hold them for a quarantine period. Everyone agreed that due to the availability problem we may need to be flexible on the size and number of test specimens. It was also agreed the release point for introducing the eel test fish should be modified from the originally proposed entrance site to the fishway exit pipe entrance, as was done for resident fish, to minimize risk of eel escapement and to maximize collection efficiency in the net pen.

HYDRAULIC ASSESSMENT

Brandon summarized the results of both the velocity measurements taken in front of the new one-inch trash racks as well as those in front of the fishway entrance. Bryan and Tim described the process by which measurements were taken. Trashrack velocities at full station flow were below the 2 ft/sec criterion everywhere but on the surface, where velocities ranged from 2 ft/sec to slightly over 3 ft/sec. However, at reduced station flow (unit 5 off) velocities were less than 2 ft/sec at all measurement points. Velocities in front of the fishway were measured at approximately 2% of total station capacity entering the fishway (*i.e.* approx. 130 cfs). A defined and observable flow field existed in front of both fishway entrance locations, with the highest velocities nearest to the fishway entrance. Mark and Curt noted that no velocities measurements were obtained at a fishway flow of 5% of station capacity. Brandon noted that the rationale was to test the fishway efficiency at 2% and increase to a higher percent if attraction behavior of fish indicated more attraction was needed. Mark noted that the study plan calls for determining optimum attraction flow based on the fishway studies[1]. Curt asked if decreasing the opening area

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[1] This was further discussed under the Juvenile Blueback Herring Assessment.

of the fishway entrance would induce higher entrance velocities. Tim noted that velocities at the fishway entrances are dependent on the interplay between inflow and outflow gate adjustments. The entrance gates were set at what appeared to maximize the flow field in front of the surface entrances while also allowing for the 2% flow into the fishway. Tim noted that as the gate opening was reduced, it restricted the total volume of flow into and through the fishway, but appeared to have little effect on the flow field pattern. The group agreed that no further velocity data sets are required until such time as an attraction flow test of 5% is conducted in association with the testing of juvenile blueback herring passage.

ADULT BLUEBACK HERRING ASSESSMENT

Brandon summarized the results of the blueback herring adult assessment. Overall fish bypass efficiency was measured at approximately 82%, based on a total release of 93 radio-tagged fish. Of these 93 test fish, more than 60 were documented as having moved downstream past the School Street facility. Testing was conducted at a 2% attraction flow setting. Brandon noted that although mean delay time was reported, most of the recorded test fish moved into and through the fishway in a relatively short amount of time, and that the few fish that took more than 24 hours to do so increased the mean travel time. Mark stated that outmigration delay for post-spawned adult blueback adults was not as great a concern as it might be for juvenile herring. Brandon and Bryan also described that the survival evaluation, which was to be inferred from the number of fish detected as passing the Cohoes-Waterford Bridge (Route 32) located downstream of the Project, was inconclusive due to a combination of signal scatter and a receiver/data logger failure. The group discussed various options for revising and re-testing adult blueback herring survival. Tim asked if this test could be delayed until such time as a decision was made on the fish-friendly turbine, as that was the purpose for determining passage survival through the fishway. Mark indicated that this test was not a high priority, and that it was OK to postpone this aspect of the study. It was noted that this could possibly be more cost-effectively performed concurrent with any subsequent Phase II study of the fish-friendly turbine survival. Steve indicated that concurred with Mark.

JUVENILE BLUEBACK HERRING ASSESSMENT

Brandon noted that passage efficiency for juvenile blueback herring was to be quantified by developing a ratio of fish passing via the fishway vs. the turbine intakes by means of two simultaneous and independent hydroacoustic counts of juvenile blueback herring. A DIDSON camera system was deployed in the fishway collection and separation chamber immediately upstream of the outlet weir, and split-beam transducers monitored a representative portion of the turbine intakes. Brandon and Bryan explained that this study was inconclusive due to the absence of significant numbers of juvenile herring in the river during the study period. Bryan showed and narrated excerpts of DIDSON video clips showing downstream passage of small fish (presumably herring), and Brandon noted that the DIDSON could potentially over-count fish as some milling and recycling of fish could occur due to the transducer position upstream of the overflow weir. Given the very spotty episodes of observed juvenile herring passage and inherent acoustic monitoring problems associated with the fishway and the intake locations, the group discussed alternative ways to quantify fishway efficiency for juvenile herring.

Chris suggested the possibility of a PIT tag study in which a number of tagged YOY herring would be released in the canal, with a PIT tag antenna deployed in the fishway, likely at the entrance to the exit pipe, which would record passage of tagged fish. Any fish not detected would have to conservatively be assumed to have passed via the turbines unless other data was available to show to what extent predation or other mortality in the canal post-release factored into evaluation. Bryan noted that holding control specimens could be evaluated to assess handling and tagging mortality.

Brandon noted that passage survival of juvenile blueback herring was also not possible due to the lack of available juvenile outmigrants. Mark confirmed that this is a high priority aspect of the studies and important for blueback management, and could not be postponed as was agreed to for the adult blueback herring survival testing. He also reiterated that at some point effectiveness optimization should be studied, *i.e.* determine if there is a correlation between passage efficiency and a particular volume of attraction flow within the 2-5% range. The current study plan calls for unmarked juvenile herring passing through the fishway to be gathered in the tailrace net pen and then held briefly for a few hours. Survival of these fish would then be evaluated. The group discussed how this approach may need to be modified given current experience with the net pen as juvenile herring may be subject to injury due to the significant hydraulic forces within the net pen when the fishway is operation and associated net abrasion and impingement. One option discussed was to allow juvenile herring to accumulate in the separation chamber, and once sufficient numbers were present, direct them over the outlet weir and into the fishway exit pipe, and operate the fishway briefly, only long enough to re-capture the test herring. This would allow the herring to remain in the net pen without being subjected to the prolonged influence of the exit pipe discharge. It was agreed that Brookfield would work on study plan revisions and consult further with USFWS and NYSDEC.

SCREEN BACK-FLUSHING

Mark indicated that a plan should be developed to address those fish residing in the fish separation chamber during cleaning, in order to minimize the number of fish that would be discharge over the cliff when the screen was rotated. Tim and John explained that an aerator system was installed that would be used to loosen and remove debris collected on the fish separation screen. This “bubbler” system will minimize the need to rotate the screen for cleaning, and thus minimize the potential to discharge fish over the cliff. Tim indicated that the aeration system had not yet been tested or evaluated as the fishway had only recently been placed in operation, but it’s effectiveness would be evaluated this year. Mark agreed that this approach may be an effective way to address the issue and asked to be updated once the system had been tested and evaluated.

The meeting concluded at approximately 4:30 PM.

AGENCY COMMENT AND RESPONSE

Bryan Apell

From: Stephen_Patch@fws.gov
Sent: Wednesday, May 25, 2011 1:56 PM
To: Bryan Apell
Cc: Brandon Kulik; Bryan Apell; Chris Tomichek; Curtis_Orvis@fws.gov; McVaigh, John; Mark Woythal; Lukas, Timothy
Subject: Re: School Street Meeting Summary

To the best of my recollection, the meeting minutes appear to be accurate.

Steve Patch
Fish & Wildlife Biologist
U.S. Fish & Wildlife Service
New York Field Office (Region 5)
3817 Luker Rd.
Cortland, NY 13045
(607) 753-9334 (voice)
(607) 753-9699 (fax)
http://nyfo.fws.gov (web)
stephen_patch@fws.gov (email)

Bryan Apell <Bryan.Apell@KleinschmidtUSA.com>

05/24/2011 03:49 PM

To Mark Woythal <mswoytha@gw.dec.state.ny.us>, "Curtis_Orvis@fws.gov" <Curtis_Orvis@fws.gov>, Steve Patch <Stephen_Patch@fws.gov>

cc "Lukas, Timothy" <timothy.lukas@brookfieldpower.com>, "McVaigh, John" <john.mcvaigh@brookfieldpower.com>, Chris Tomichek <Chris.Tomichek@KleinschmidtUSA.com>, Brandon Kulik <Brandon.Kulik@KleinschmidtUSA.com>, Bryan Apell <Bryan.Apell@KleinschmidtUSA.com>

Subject School Street Meeting Summary

From: Curtis_Orvis@fws.gov
Sent: Wednesday, May 25, 2011 3:23 PM
To: Bryan Apell
Cc: Brandon Kulik; Bryan Apell; Chris Tomichek; McVaigh, John; Mark Woythal; Steve Patch; Lukas, Timothy
Subject: Re: School Street Meeting Summary
Attachments: pic26308.gif

Bryan and others,
We were running out of time, but the other point of clarification was in the operation of the entrance gates to the downstream bypass. During the riverine/resident fish tests, it was my understanding that the right-most, bottom gate at the power canal wall (Gate 4) was being operated and the bottom gate at the downstream end of the bar rack (Gate 3) was closed to avoid debris. It was unclear whether the same operation was used during the adult blueback herring testing? Depending upon the flow field at the sampler it might be possible to close the bottom gates during the juvenile blueback herring passage period and transfer the flow to the surface. The PIT tags will be able to determine whether the juveniles are sounding through the bottom entrance. The other complication would come from an overlap in movement periods for various target species. Perhaps the discussion can be part of the upcoming revised study plan for juvenile blueback herring and American eel.

Otherwise as long as Steve and Mark are OK with the notes, I have no further comments.

Best regards,

Curt Orvis
US Fish and Wildlife Service
Fisheries - Fish Passage and Water Resources
300 Westgate Center Drive
Hadley, Massachusetts 01035-9589
Tel: 413-253-8288
Fax: 413-253-8488
mailto: curtis_orvis@fws.gov
Bryan Apell <Bryan.Apell@KleinschmidtUSA.com>

Bryan Apell
<Bryan.Apell@KleinschmidtUSA.com>

05/24/2011 03:49 PM

To Mark Woythal <mswoytha@gw.dec.state.ny.us>, "Curtis_Orvis@fws.gov" <Curtis_Orvis@fws.gov>, Steve Patch <Stephen_Patch@fws.gov>

cc "Lukas, Timothy" <timothy.lukas@brookfieldpower.com>, "McVaigh, John" <john.mcvaigh@brookfieldpower.com>, Chris Tomichek <Chris.Tomichek@KleinschmidtUSA.com>, Brandon Kulik <Brandon.Kulik@KleinschmidtUSA.com>, Bryan Apell <Bryan.Apell@KleinschmidtUSA.com>

Bryan Apell

From: Curtis_Orvis@fws.gov
Sent: Thursday, May 26, 2011 1:50 PM
To: Bryan Apell
Cc: Brandon Kulik; Chris Tomichek; McVaigh, John; Mark Woythal; Steve Patch; Lukas, Timothy
Subject: RE: School Street Meeting Summary
Attachments: pic32209.gif

Thanks for the clarification. We will look forward to your study plan.

Curt
Bryan Apell <Bryan.Apell@KleinschmidtUSA.com>

Bryan Apell
<Bryan.Apell@KleinschmidtUSA.com>

05/26/2011 11:28 AM

To"Curtis_Orvis@fws.gov" <Curtis_Orvis@fws.gov>

ccBrandon Kulik <Brandon.Kulik@KleinschmidtUSA.com>, Chris Tomichek <Chris.Tomichek@KleinschmidtUSA.com>, "McVaigh, John" <john.mcvaigh@brookfieldpower.com>, Mark Woythal <mswoytha@gw.dec.state.ny.us>, Steve Patch <Stephen_Patch@fws.gov>, "Lukas, Timothy" <timothy.lukas@brookfieldpower.com>

SubjectRE: School Street Meeting Summary

Hi Curt

I re-checked my notes on the gate configuration during the adult BBH passage evaluation. The gates were operated to provide flow over the weir at a depth of 4-6 inches. The gates were set as referenced in section 4.1.2 of the report with the following exceptions: The bottom gates (2 and 4) were open 2ft and the top gates (1 and 3) were at full gate, that is there was no differential between the canal water level and the fishway water level. I will make the correction in the final report. Tim and I spoke this morning about your idea to operate the fishway with the bottom gates closed during the juvenile BBH evaluation. We have concerns about this operation scheme as the juvenile BBH emigration overlaps the eel emigration potential resulting in a conflict of passage, as you mentioned in your email. Our tentative approach will be to evaluate the percent passage of JBBH through the fishway using PIT tags at two fishway flow scenarios, i.e. at 2% (~130 CFS) and 5% (~300 CFS). We will be developing a study plan that will address these goals and will submit a draft to you, Mark and Steve for comment, review and approval.

Bryan

Bryan Apell

Fisheries & Aquatic Ecologist
Kleinschmidt Associates
Energy & Water Resources Consultants
35 Pratt Street, Suite 201
Essex, CT 06426
tel: (860) 767-5069
fax: (860) 767-5097

Bryan Apell

From: Mark Woythal [mswoytha@gw.dec.state.ny.us]
Sent: Wednesday, May 25, 2011 2:27 PM
To: Curtis_Orvis@fws.gov; Steve Patch; Bryan Apell
Cc: John McVaigh; Timothy Lukas; Brandon Kulik; Chris Tomichek
Subject: Re: School Street Meeting Summary

Bryan,

This reflects the meeting that I was at. Thanks. Only one thing, and that's the spelling of Jeff Loukmas.

Mark

Bryan Apell

From: Mark Woythal [mswoytha@gw.dec.state.ny.us]
Sent: Thursday, May 26, 2011 2:25 PM
To: Bryan Apell
Subject: RE: School Street Meeting Summary

Sounds good.

>>> Bryan Apell <Bryan.Apell@KleinschmidtUSA.com> 5/26/2011 11:28 AM >>>
Hi Curt

I re-checked my notes on the gate configuration during the adult BBH passage evaluation. The gates were operated to provide flow over the weir at a depth of 4-6 inches. The gates were set as referenced in section 4.1.2 of the report with the following exceptions: The bottom gates (2 and 4) were open 2ft and the top gates (1 and 3) were at full gate, that is there was no differential between the canal water level and the fishway water level. I will make the correction in the final report. Tim and I spoke this morning about your idea to operate the fishway with the bottom gates closed during the juvenile BBH evaluation. We have concerns about this operation scheme as the juvenile BBH emigration overlaps the eel emigration potential resulting in a conflict of passage, as you mentioned in your email. Our tentative approach will be to evaluate the percent passage of JBBH through the fishway using PIT tags at two fishway flow scenarios, i.e. at 2% (~130 CFS) and 5% (~300 CFS). We will be developing a study plan that will address these goals and will submit a draft to you, Mark and Steve for comment, review and approval.

Bryan

Bryan Apell
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Essex, CT 06426
tel: (860) 767-5069
fax: (860) 767-5097

Faxed 5/20/11

United States Department of the Interior

FISH AND WILDLIFE SERVICE
3817 Luker Road
Cortland, NY 13045

May 20, 2011

RECEIVED
MAY 25 2011
b.s 1:15pm

Tim Lukas, Compliance Specialist
Erie Boulevard Hydropower, LP
Hudson River Operations
399 Big Bay Road
Queensbury, NY 12804

RE: School Street Hydroelectric Project (FERC #2539)
Review of Phase I Fishway Effectiveness Testing and Hydraulic Survey

Dear Mr. Lukas:

The U.S. Fish and Wildlife Service (Service) has reviewed the April 12, 2011, Draft Report for the School Street Project entitled *Phase I Fishway Effectiveness Testing and Hydraulic Survey.* The results of the study and proposed future studies were discussed at an interagency meeting held in Albany, New York, on May 17, 2011. Several options for obtaining American eels and a variety of options for tagging and monitoring juvenile blueback herring were discussed. As a result of that meeting, Erie Boulevard Hydropower, LP, intends to provide the Service and the New York State Department of Environmental Conservation with proposals on the best way to accomplish the juvenile blueback herring and American eel testing.

We have no comments on the existing report. We look forward to reviewing the proposals for future studies. Any modifications to the fishway or its operations can be determined after all the study results have been reviewed.

The Service appreciates the opportunity to review the draft report. If you have any questions or desire additional information, please contact Steve Patch at 607-753-9334.

Sincerely,

Anne L. Secord

for David A. Stilwell
Field Supervisor

cc: NYSDEC, Albany, NY (M. Woythal)
FWS, Hadley, MA (C. Orvis)

From: Mark Woythal [mailto:mswoytha@gw.dec.state.ny.us]
Sent: Wednesday, June 08, 2011 1:41 PM
To: Lukas, Timothy
Subject: Re: FW: 20110520-DOI-01

Tim,

I have no additional comments on the School Street Fish Bypass Evaluation Report beyond those provided at the meeting. The meeting minutes accurately reflected the issues and outcomes discussed at the meeting.

Mark

Mark Woythal
Instream Flow Unit Leader

NY Dept of Environmental Conservation
Div. of Fish Wildlife & Marine Resources
Bureau of Habitat
625 Broadway, Albany, NY 12233-4756
mswoytha@gw.dec.state.ny.us
P (518) 402-8847
F (518) 402 9825

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APPENDIX E

TELEMETRY DATA SUMMARY

Appendix E Radio-Telemetry Data Summary

Tag Frequency (149.)	ID	Status	Release Date	Release Time	Passage Date	Passage Time	Entrainment Date	Entrainment Time	Delay (D)	Delay (D_E)	Delay (D_{FW})	Detected Downstream (D_{Bridge})
780	10	Bypassed	6/9/2010	12:20	6/12/2010	14:46:43	NA	NA	73.3	26.4	46.9	yes
340	11	Not Detected	6/9/10	12:20	NA	NA	NA	NA	NA	NA	NA	NA
480	12	Did Not Migrate	6/9/10	12:20	NA	NA	NA	NA	NA	NA	NA	NA
740	13	Bypassed	6/10/2010	10:26	6/11/2010	21:54:03	NA	NA	24.8	19.5	5.3	yes
760	14	Bypassed	6/9/2010	12:20	6/10/2010	0:45:19	NA	NA	10.1	9.9	0.3	No
340	16	Did Not Migrate	6/9/10	12:20	NA	NA	NA	NA	NA	NA	NA	NA
480	17	Bypassed	6/9/2010	12:20	6/10/2010	10:09:20	NA	NA	20.6	4.7	15.8	No
740	18	Escaped Upstream	6/9/10	12:20	NA	NA	NA	NA	NA	NA	NA	NA
760	19	Not Detected	6/10/2010	10:26	NA	NA	NA	NA	NA	NA	NA	NA
780	20	Bypassed	6/9/2010	12:20	6/9/2010	17:14:02	NA	NA	4.1	4.1	0.0	yes
340	21	Bypassed	6/10/2010	10:26	6/11/2010	9:39:00	NA	NA	21.7	12.8	8.9	Unknown
480	22	Bypassed	6/11/2010	16:55	6/12/2010	21:07:10	NA	NA	26.3	26.2	0.1	No
740	23	Bypassed	6/10/2010	10:26	6/11/2010	20:59:02	NA	NA	33.5	10.3	23.2	yes
760	24	Bypassed	6/11/2010	16:55	6/12/2010	19:48:35	NA	NA	0.8	0.8	0.0	No
780	25	Bypassed	6/9/2010	12:20	6/10/2010	18:12:04	NA	NA	10.7	1.0	9.7	Unknown
340	26	Bypassed	6/11/2010	16:55	6/11/2010	20:50:05	NA	NA	3.0	2.9	0.0	No
480	27	Not Detected	6/9/10	12:20	NA	NA	NA	NA	NA	NA	NA	NA
740	28	Bypassed	6/10/2010	10:26	6/10/2010	22:12:01	NA	NA	2.2	0.9	1.3	Unknown
760	29	Did Not Migrate	6/9/10	12:20	NA	NA	NA	NA	NA	NA	NA	NA
780	30	Bypassed	6/9/2010	12:20	6/10/2010	20:48:01	NA	NA	24.3	17.9	6.4	Unknown
480	32	Bypassed	6/10/2010	10:26	6/10/2010	22:22:04	NA	NA	4.6	4.3	0.3	Unknown
740	33	Bypassed	6/10/2010	10:26	6/11/2010	21:53:43	NA	NA	1.7	1.4	0.3	yes
760	34	Bypassed	6/10/2010	10:26	6/10/2010	18:14:02	NA	NA	7.5	7.4	0.1	Unknown
780	35	Not Detected	6/11/2010	16:55	NA	NA	NA	NA	NA	NA	NA	NA
340	36	Bypassed	6/9/2010	12:20	6/10/2010	14:51:41	NA	NA	10.4	3.7	6.6	No
480	37	Entrained	6/9/10	12:20	NA	NA	6/14/2010	8:58:01	93.1	NA	NA	NA
740	38	Entrained	6/11/2010	16:55	NA	NA	6/13/2010	13:51:40	44.6	NA	NA	NA
760	39	Bypassed	6/11/2010	16:55	6/12/2010	0:15:05	NA	NA	5.4	5.4	0.1	yes
760	40	Bypassed	6/10/2010	10:26	6/13/2010	22:07:04	NA	NA	16.1	1.6	14.5	No
780	41	Bypassed	6/10/2010	10:26	6/12/2010	20:44:34	NA	NA	12.7	4.9	7.8	No
340	42	Bypassed	6/11/2010	16:55	6/12/2010	20:33:28	NA	NA	4.3	4.2	0.1	yes
480	43	Entrained	6/11/2010	16:55	NA	NA	6/12/2010	2:25:04	2.3	NA	NA	NA
740	44	Bypassed	6/10/2010	10:26	6/10/2010	22:06:02	NA	NA	10.7	10.2	0.5	Unknown
760	45	Not Detected	6/10/2010	10:26	NA	NA	NA	NA	NA	NA	NA	NA
780	46	Entrained	6/11/2010	16:55	NA	NA	6/10/2010	17:52:17	0.9	NA	NA	NA
340	47	Bypassed	6/10/2010	10:26	6/11/2010	21:01:01	NA	NA	33.5	13.1	20.4	yes
480	48	Bypassed	6/10/2010	10:26	6/10/2010	22:20:02	NA	NA	7.5	6.6	0.9	Unknown
740	49	Entrained	6/10/2010	10:26	NA	NA	6/12/2010	1:17:01	0.3	NA	NA	NA
760	50	Did Not Migrate	6/10/2010	10:26	NA	NA	NA	NA	NA	NA	NA	NA
780	51	Bypassed	6/10/2010	10:26	6/10/2010	22:09:23	NA	NA	3.7	1.2	2.4	Unknown
340	52	Entrained	6/10/2010	16:55	NA	NA	6/11/2010	20:49:59	2.5	NA	NA	NA
480	53	Impinged	6/10/2010	10:26	NA	NA	NA	NA	NA	NA	NA	NA
740	54	Impinged	6/10/2010	10:26	NA	NA	NA	NA	NA	NA	NA	NA
760	55	Entrained	6/10/2010	10:26	NA	NA	6/13/2010	13:43:44	NA	NA	NA	NA
780	56	Bypassed	6/10/2010	10:26	6/10/2010	21:50:49	NA	NA	3.0	2.9	0.1	Unknown
340	57	Did Not Migrate	6/11/2010	16:55	NA	NA	NA	NA	NA	NA	NA	NA
480	58	Not Detected	6/10/2010	10:26	NA	NA	NA	NA	NA	NA	NA	NA
740	59	Bypassed	6/10/2010	10:26	6/10/2010	13:46:38	NA	NA	3.3	3.3	0.0	No
760	60	Bypassed	6/11/2010	16:55	6/12/2010	17:27:02	NA	NA	1.7	0.5	1.2	yes
780	61	Bypassed	6/10/2010	10:26	6/11/2010	21:01:14	NA	NA	5.9	2.7	3.2	No
340	62	Bypassed	6/10/2010	10:26	6/12/2010	19:57:01	NA	NA	4.3	4.3	0.0	No
480	63	Bypassed	6/10/2010	10:26	6/11/2010	21:19:39	NA	NA	29.0	7.1	21.9	yes

740	64	Bypassed	6/10/2010	10:26	6/12/2010	7:02:03	NA	NA	2.0	0.6	1.4	No
760	65	Bypassed	6/10/2010	10:26	6/10/2010	14:08:33	NA	NA	3.4	3.3	0.0	No
780	66	Bypassed	6/10/2010	10:26	6/11/2010	2:59:38	NA	NA	6.7	6.6	0.0	Unknown
340	67	Bypassed	6/11/2010	16:55	6/12/2010	21:05:47	NA	NA	1.0	0.7	0.3	yes
480	68	Bypassed	6/10/2010	10:26	6/12/2010	1:14:58	NA	NA	1.5	1.4	0.1	No
740	69	Bypassed	6/10/2010	10:26	6/11/2010	8:29:02	NA	NA	2.0	1.6	0.4	Unknown
780	71	Bypassed	6/10/2010	10:26	6/12/2010	19:40:31	NA	NA	22.7	22.7	0.0	No
340	72	Bypassed	6/11/2010	16:55	6/12/2010	21:27:02	NA	NA	0.5	0.3	0.2	yes
480	73	Bypassed	6/10/2010	10:26	6/11/2010	21:16:04	NA	NA	4.9	3.5	1.5	No
740	74	Bypassed	6/10/2010	10:26	6/12/2010	20:20:04	NA	NA	24.0	0.4	23.6	yes
340	75	Bypassed	6/11/2010	16:55	6/11/2010	22:17:25	NA	NA	3.6	2.6	1.0	yes
480	76	Did Not Migrate	6/11/2010	16:55	NA	NA	NA	NA	NA	NA	NA	NA
740	77	Did Not Migrate	6/11/2010	16:55	NA	NA	NA	NA	NA	NA	NA	NA
760	78	Did Not Migrate	6/11/2010	16:55	NA	NA	NA	NA	NA	NA	NA	NA
780	79	Bypassed	6/11/2010	16:55	6/12/2010	19:48:08	NA	NA	3.4	3.3	0.1	No
340	80	Bypassed	6/11/2010	16:55	6/12/2010	16:55:03	NA	NA	12.0	10.0	2.0	yes
480	81	Entrained	6/11/2010	16:55	NA	NA	6/12/2010	20:29:01	25.2	NA	NA	NA
740	82	Bypassed	6/11/2010	16:55	6/13/2010	0:22:47	NA	NA	2.3	2.1	0.1	yes
760	83	Bypassed	6/11/2010	16:55	6/12/2010	21:48:46	NA	NA	7.2	7.2	0.1	yes
780	84	Did Not Migrate	6/11/2010	16:55	NA	NA	NA	NA	NA	NA	NA	NA
340	85	Bypassed	6/11/2010	16:55	6/12/2010	19:01:47	NA	NA	6.1	5.9	0.2	No
740	87	Bypassed	6/11/2010	16:55	6/12/2010	21:37:03	NA	NA	8.6	8.6	0.0	yes
760	88	Impinged	6/11/2010	16:55	NA	NA	NA	NA	NA	NA	NA	NA
780	89	Entrained	6/11/2010	16:55	NA	NA	6/14/2010	8:58:04	24.0	NA	NA	NA
340	90	Bypassed	6/11/2010	16:55	6/12/2010	19:49:57	NA	NA	8.2	7.2	1.0	No
480	91	Bypassed	6/11/2010	16:55	6/11/2010	17:57:07	NA	NA	0.5	0.5	0.0	No
740	92	Did Not Migrate	6/11/2010	16:55	NA	NA	NA	NA	NA	NA	NA	NA
760	93	Impinged	6/11/2010	16:55	NA	NA	NA	NA	NA	NA	NA	NA
780	94	Entrained	6/11/2010	16:55	NA	NA	6/13/2010	12:50:08	43.4	NA	NA	NA
340	95	Bypassed	6/11/2010	16:55	6/12/2010	19:19:00	NA	NA	12.2	9.4	2.9	yes
480	96	Bypassed	6/11/2010	16:55	6/11/2010	19:41:53	NA	NA	NA	NA	NA	yes
740	97	Did Not Migrate	6/11/2010	16:55	NA	NA	NA	NA	NA	NA	NA	NA
760	98	Bypassed	6/11/2010	16:55	6/11/2010	22:53:55	NA	NA	3.9	3.7	0.2	No
480	100	Escaped Upstream	6/11/2010	16:55	NA	NA	NA	NA	NA	NA	NA	NA
740	101	Impinged	6/11/2010	16:55	NA	NA	NA	NA	NA	NA	NA	NA
780	102	Bypassed	6/11/2010	16:55	6/12/2010	15:16:06	NA	NA	1.9	1.4	0.5	No
760	103	Did Not Migrate	6/11/2010	16:55	NA	NA	NA	NA	NA	NA	NA	NA
780	104	Unknown	6/11/2010	16:55	NA	NA	NA	NA	NA	NA	NA	NA
480	105	Passed Route Unknown	6/11/2010	16:55	NA	NA	NA	NA	NA	NA	NA	NA
740	106	Entrained	6/11/2010	16:55	NA	NA	6/12/2010	16:53:38	1.2	NA	NA	NA
780	107	Entrained	6/11/2010	16:55	NA	NA	6/14/2010	12:01:03	NA	NA	NA	NA

PHASE 1 FISHWAY EFFECTIVENESS TESTING JUVENILE BLUEBACK HERRING AND ADULT AMERICAN EEL SURVIVAL EVALUATION REPORT

SCHOOL STREET PROJECT

FERC NO. 2539

PREPARED FOR:

BROOKFIELD RENEWABLE POWER
QUEENSBURY, NY

PREPARED BY:

Kleinschmidt
Energy & Water Resource Consultants

FEBRUARY 2012

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SCHOOL STREET PROJECT
FERC NO. 2539

1.0 INTRODUCTION

The School Street Hydroelectric Project (Project) (FERC No. 2539) is owned and operated by Brookfield Renewable Power (Brookfield). The Project was issued a new FERC License on February 15, 2007. Downstream fish passage for anadromous and catadromous fish, as well as resident fish, was required as part of the new license agreement (Section 3.5). A fishway effectiveness testing plan (*Final Plan*) was submitted and approved by the applicable Federal and state agencies in September 2007. The *Final Plan* included requirements for testing downstream passage survival for resident fish, adult American eels, and juvenile and adult blueback herring; passage efficiency of juvenile and adult blueback herring; an inspection of the fishway conveyance structures; and a hydraulic survey to document flow field and approach velocities in front of the angled bar rack and fishway entrances (Appendix A of the *Phase 1 Fishway Effectiveness Testing and Hydraulic Survey* Report) (Kleinschmidt 2011).

On August 5, 2009, Brookfield and agencies conducted an inspection of the fishway conveyance system, and subsequently performed a study to estimate downstream bypass survival of resident fish in early November 2009. In 2010, an evaluation of downstream Project passage efficiency for adult and juvenile blueback herring, passage survival for adult blueback herring and a hydraulic survey was conducted. The methods and results of these studies are detailed in the *Phase 1 Fishway Effectiveness Testing and Hydraulic Survey* Report (Kleinschmidt 2011).

A supplemental study plan (*Study Plan*) (Appendix A) was drafted in consultation with state and Federal agencies recommending augmentation to the *Final Plan*. The changes to the *Final Plan* were the result of experience gained during studies conducted at the Project in 2009 and 2010. Both the state and Federal agencies reviewed the *Study Plan* prior to field studies in 2011 and concurred with the proposed changes to the methodologies (Agency Correspondence, Appendix B).

Kleinschmidt conducted downstream bypass survival evaluations of juvenile blueback herring and adult American eel at the Project in the summer and fall of 2011. An evaluation of downstream Project bypass efficiency of juvenile blueback herring was scheduled; however, this evaluation could not be conducted due to a limited survey window that coincided with extensive flooding in the Mohawk River as a result of heavy rains from Tropical Storm Irene (Figure 1). This report details the methods and results of the survival evaluations, as well as a status summary of the juvenile herring bypass efficiency evaluation.

1.1 PROJECT DESCRIPTION AND FISH PASSAGE FACILITIES

The Project is located on the Mohawk River, 2.5 river miles upstream of its confluence with the Hudson River in Cohoes, New York (Figure 2). It is composed of the following components:

1) A stone masonry gravity dam extending 1,280 ft across the Mohawk River, 16 ft in height, completed in 1865;
2) A reservoir with a surface area of approximately 100 acres at a normal maximum water surface elevation of 156.1 ft, and a gross storage capacity of 788 acre-ft;
3) A power canal extending approximately 4,400 ft from the dam to the powerhouse, 150 ft wide and 14 ft deep;
4) An upper gatehouse structure that currently includes nine slide gates and three steel tainter gates to control the diversion of flow into the canal;
5) A lower gatehouse with five steel headgates to control flow into the five penstocks; and
6) A powerhouse measuring 170 ft long by 78 ft wide, housing five generating units with vertical shaft Francis turbines rated at 92 ft of head, with a total maximum capacity of 38.8 megawatts.

The fishway consists of an angled bar rack with one inch clear spacing and a fish conveyance system. The angled bar rack is located in the power canal just upstream of the lower gatehouse (Figure 3). The rack leads fish to the entrance of a fish conveyance system that transports fish around the powerhouse and discharges to the Project tailwater. The rack structure is angled approximately 45 degrees from the upstream face of the existing lower gatehouse. The lower portion of the rack includes a solid, two-foot high, concrete, eel diversion berm to guide emigrating American eel toward the bypass entrance at the downstream end of the rack.

The fishway conveyance structure is located near the downstream end of the angled bar rack. It has two intake portals and includes a multi-level gate with top and bottom entrances (Figures 4 and 5). Attraction flow to the fishway entrances can vary from two to five percent of the Project's total hydraulic capacity. Conveyance pipes from both entrances converge in a fish separation chamber part-way along the fish conveyance structure (Figure 6). The chamber reduces the volume of the bypass flow by guiding fish along a wire floor screen and directing them into a fish return weir pool. The excess attraction water flows through the screen and is discharged downstream of the Project. A gate valve at the downstream end of the fish separation chambers provides hydraulic control within the fish conveyance structure. An adjustable weir is located at the entrance to the fish return weir pool. The weir provides fine-tune adjustment to the depth of water cascading over the weir, as well as the overall bypass flow (design flow 40 CFS). Once in the fish return weir pool, fish are guided to the entrance of the return pipe and are deposited into the tailwater of the Project.

2.0 AMERICAN EEL SURVIVAL ASSESSMENT

2.1 METHODS AND MATERIAL

An adult American eel survival evaluation of the downstream fish bypass was conducted on October 12 and 13, 2011. The methods detailed in this section were guided by the scope of study defined in the *Final Plan* and *Study Plan* and were drafted in consultation with the USFWS and NYSDEC. Furthermore, the importation of adult female American eels to support survival studies was conducted under the terms and condition of the New York Fish and Wildlife License to Collect or Possess No. 1378 and Permit to Transport Uncertified Fish as required by Part 188 and Part 10 of Title 6 of New York State Code of Rules and Regulations (NYCRR), respectively (Permits, Appendix C).

2.1.1 TEST EELS

American eel have a catadromous life history in which juveniles of marine origin enter estuaries, freshwater streams, and rivers to develop into adults. Males typically inhabit coastal areas whereas females migrate great distances inland. Eels undergo metamorphosis prior to the onset of maturity in preparation for the long reproductive migration to the Sargasso Sea. The commercial fishery in Maine and Canada targets these emigrating eels using large weirs in coastal rivers. The test eels used in the survival evaluation were adult silver phase (emigrating) American eels and were collected by a commercial fisherman in Newport, ME on the Sebasticook River. A total of 150 eels were purchased weighing approximately 413 pounds. The eels were transported by truck to Watervliet, NY and were held for 42 days in complete isolation at Conroy’s Bait Supply pending a fish health inspection.

Kennebec River Biosciences conducted viral and pathogen evaluations on a subsample of 45 eels including VHS, Spring Viremia of Carp Virus, Furunculosis, Enteric Red Mouth, and Infectious Pancreatic Necrosis (IPN). All tests were negative (Fish Health Certificate, Appendix B) for the presence of the tested pathogens at a 95% confidence interval and met the requirements to be deemed as *certified* in the State of New York. After these evaluations were completed, a total of 105 eels remained for the fishway evaluation.

2.1.2 MARK-RECAPTURE

Test eels were released into the fishway and recaptured using a custom floating net pen (Figure 7). The net pen was custom built for the School Street Project and its design and construction included an over-vertical eel corral to minimize escapement potential throughout testing and holding periods (Figure 8). The major components of the net pen include the following:

1) A collection/holding area (12 x 28 ft) enclosed with 3/8” heavy duty mesh netting to a depth of 6 ft;
2) A 2 ft high angled eel corral with 3/8” mesh netting; and
3) A floating work platform.

Prior to conducting survival tests, the net pen was lowered by crane into the Project tailwater and positioned under the bypass discharge. The net pen was secured using heavy duty line (safe work load of 6,000 pounds) and a series of six strategically located tie-off points.

The adult American eels were released into the fish return weir pool via a bucketed lift system (Figure 9). Prior to release, the eels were visually inspected and evaluated to verify their fitness. Only those eels that appeared to be free of injury, exhibited normal swimming behavior and responded to external stimulus such as a handling response were used in the evaluation. The location of the test release in the fish return weir pool was immediately upstream from the entrance to the fish return discharge pipe to optimize the probability that test fish would exit downstream. This location also ensured that eels were unable or unlikely to escape upstream due to the physical barrier afforded by the adjustable weir. Deployment of test eels occurred over approximately 30 minutes. Once all of the eels were released, the fishway was operated for approximately 15 minutes. The fish return pool was then dewatered to evaluate the status of any test eels that may have not exited the weir pool. This process was repeated several times until all test eels had successfully exited the weir pool. The total duration of the release and recapture process was slightly greater than one hour.

Recaptured eels were held in the net pen overnight and recollected using long handled dip nets. The test eels were then evaluated as alive or dead and the results were recorded in a dedicated field book. Those eels that demonstrated normal swimming behavior and an avoidance response to recollection were deemed as alive. Those that did not meet the requirement were deemed as dead. A suite of water quality parameters were measured *in situ* in the Project power canal and recorded including water temperature, dissolved oxygen, pH, conductivity, flow, and the predominant weather conditions.

2.1.3 Test Eel Final Deposition

Some escapement into the Mohawk River did occur (n=49). As required by the NYSDEC, the remaining 56 test eels were recaptured at the conclusion of the study and disposed of as specified in the NYSDEC permit.

2.1.4 Fishway Operation

During the evaluation, the fishway was operated in a typical manner to provide the desired guidance flows within the fishway conveyance structure, as well as maintain an appropriate water level within the system to facilitate passage over the movable weir and into the fish passage weir pool. Section 4.1.2 of the *Phase 1 Fishway Effectiveness Testing and Hydraulic Survey Report* (Kleinschmidt 2011) details the operational configuration of the fishway with the following exceptions: the bottom gates (2 and 4) were open 2 ft and the top gates (1 and 3) were at full gate. The total flow of the fishway was approximately130 CFS, or about 2% of the Project capacity of 6,600 CFS. Following the recapture of the test eels in the tailrace, the final return pipe was dewatered during the holding period in order to minimize the hydraulic stresses within the net pen related to the discharge of the bypass flow. The remainder of the fishway remained watered during the holding period with all flow discharged through the attraction water gate (Gate 6).

2.1.5 Data Analysis

Passage survival, defined as the percentage of fish that are conveyed via the fishway and recovered alive after a minimum 12-hour holding period, was calculated using a simple proportion. That is, the number of recaptured fish evaluated to be alive (A) divided by the total number of all fish recaptured (R) (including Alive, Stressed, and Dead) and multiplied by 100 (Equation 1).

Equation 1: Passage Survival (%) = (A/R) x 100

Further, recapture efficiency was calculated using a similar proportion:

Equation 2: Recapture Efficiency (%) = (R/N_r) x100

Where R is the number of eels recaptured and N_r is the number eels released in the fish return weir pool.

2.2 RESULTS

The release-recapture procedure began at 1600 hrs on October 12, 2011; eels were recovered from the net pen and evaluated on the morning of October 13, 2011 after a 15.5 hr holding period. A total of 105 eels was released in the fish return weir pool, of which 56 were recaptured, held and evaluated. All 56 recaptured eels were alive, yielding a bypass survival of 100%.

The recapture efficiency of the net pen was 53.8%; however, this percentage does not accurately reflect the recapture efficiency of the collection system during the test as 29 of the 49 eels escaped when the fish return weir pool was dewatered to evaluate the status of the released eels that remained in the fish return weir pool. It was necessary to dewater the weir pool as the turbulence in the pool during normal fishway operation completely obscured any observation. As the weir pool was dewatered, the discharge plume decreased to a trickle. Under these conditions, a group of eel (~29) was observed to exit the weir pool and, in the absence of a plume of discharging water, missed the net pen and discharged into the tailwater. Though the target sample size of 90 adult eels was not met; 56 eel were successfully evaluated and exhibited 100% survival, suggesting that bypass survival is not a limiting factor to successful downstream passage of adult American eel at the Project.

Water quality in the power canal was measured using an YSI 556 multi-meter probe. Prior to measurement, the meter was calibrated to the manufacturer's specifications. Water quality was measured in the Project power canal on October 12 and 13, 2011 (Table 1). The predominant weather conditions included overcast skies and showers on October 12 and 13, respectively. The river flow as measured in the tailwater (USGS Gauge 01357500 Mohawk River at Cohoes, NY) ranged from 650 to 5,200 and 3,200 to 4,000 on October 12 and 13, 2011, respectively (Figure 10). The low flow period on the 12th of October was the result of Project operation as the hydroelectric units were locked out to facilitate net pen deployment and promote safety.

2.3 SUMMARY AND CONCLUSION

Brookfield conducted a downstream bypass survival evaluation at the School Street Project on October 12 and 13, 2011. The evaluation included the release of 105 adult American eels within the fish return weir pool. A total of 56 eels was recaptured and evaluated as alive or dead. All 56 recaptured eels were alive, yielding a bypass survival of 100%. Approximately 29 eels were observed to exit the weir pool during dewatering activities. The escapement of the remaining 20 eels was not observed and the method of escapement is unknown.

The evaluation did not meet the target sample size of 90 eels; however, the 56 eels that were evaluated exhibited 100% survival. Since no variability among results were observed, it is likely that test conditions were not a limiting factor for successful evaluation of bypass survival of adult American eel at the Project.

3.0 JUVENILE BLUEBACK HERRING SURVIVAL EVALUATION

3.1 METHODS AND MATERIAL

A juvenile blueback herring survival evaluation of the downstream fish bypass was conducted on August 26, 2011. The methods detailed in this section were guided by the scope of study defined in the *Final Plan* and the *Study Plan* and were drafted in consultation with the USFWS and NYSDEC.

3.1.1 FISH COLLECTION

Blueback herring is an anadromous species in which individuals spend the majority of their lives in the marine environment, returning to freshwater for spawning each spring beginning at age 3 or 4 (Collette and Klein-MacPhee 2002). Some spent adult fish return to the sea shortly after spawning, and newly hatched larvae remain near or just downstream of nursery grounds until transformation to juveniles during early summer (Collette and Klein-MacPhee 2002). Emigrating juveniles leave nursery habitat in the fall, are physically fragile and susceptible to stress factors such as but not limited to water quality, impediments to migration and predation.

While the Cohoes Falls is a natural barrier to upstream migration, construction of the Waterford Flight canal allowed blueback herring to expand their range above Cohoes Falls in the Mohawk River. Adult herring ascend upstream of the Project typically in May and June via the Waterford Flight canal during boat lockage. Surviving spent adults emigrate downstream past the Project typically from late-May through -August, while the young-of-year herring descend downstream past the project typically in late August through October.

Juvenile blueback herring were collected to support survival testing as required by the School Street Project Settlement Agreement Section 3.7 and 401 Water Quality Certification Condition 13, and in accordance with the terms and conditions of the New York Fish and Wildlife License No. 1378 (Appendix B, Permit) on the morning of August 25, 2011.

Approximately 1,200 test fish were initially collected in the fish bypass separation chamber using long handled dip nets and were immediately placed into two of three 1,000 gallon live tanks supplied with pump-through water from the Project power canal (pump rate ~2,000 gallons/hr) (Figure 11). The third tank was reserved for the holding of marked fish prior to release. The holding tanks were covered with fine mesh netting to prevent escape and predation, as well as to provide shading. Water quality measurements including *in situ* water temperature, conductivity, dissolved oxygen, and pH were recorded for each tank, as well as the power canal and recorded in a dedicated field book.

3.1.2 Mark Recapture

The survival evaluation was conducted using mark-recapture methods in which test herring were released into the fishway and recaptured using a custom floating net pen (Section 2.1.2) (Figure 7). Test fish were released into the fish return weir pool via a bucketed lift system, similar to that used in the American eel evaluation. The location of the test fish release in the fish return weir pool was immediately upstream from the entrance to the fish return discharge pipe to optimize the probability that test fish would exit downstream. This location also ensured that the herring were unable or unlikely to escape upstream due to the physical barrier afforded by the adjustable weir. Test fish were released all at once under normal fishway operating conditions.

Prior to release, the test fish were visually inspected and evaluated to verify their fitness. Only those herring that appeared to be free of injury (no or little visible hemorrhaging or descaling), exhibited normal swimming behavior and responded to external stimulus, such as a handling response were used in the evaluation. Due to the fragility of blueback herring at the juvenile stage and the stress induced by collection and handling, only about 20 percent of the individuals initially collected survived and were determined to be suitably robust condition for use in the study.

The fishway was operated for an additional five minutes after the release and was then dewatered to minimize turbulence and hydraulic stresses to the fish within the net pen during the holding period. The test fish were held for approximately three hours and were removed from the net pen using long handled dip nets and evaluated as alive or dead. Those fish that exhibited normal swimming behavior and were free of notable injury were deemed as alive. All others were deemed as dead.

3.1.3 CONTROL GROUP

A control group of 126 individual fish was established to quantify hydraulic stresses within the net pen affecting the test herring survival during the release-recapture process. The control group was held and handled in a similar manner as the test fish group and was marked using caudal fin clips. The control group was transported via a 90 gallon live well and released directly into the net pen and not subjected to fishway passage. The fish return weir pool and final discharge pipe were then re-watered and the test fish (N=126) were released. The deployment of the control group in the net pen, re-watering of the fishway, test fish release-recapture was completed in approximately 90 minutes.

3.1.4 LENGTH FREQUENCY

Length frequency of the test fish population was determined by measuring the total length of 110 individuals from the holding tanks.

3.2 DATA ANALYSIS

Passage survival, defined as the percentage of fish that were conveyed via the fishway and recovered alive after a 2-hour minimum holding period, was calculated using a simple proportion. That is, the number of recaptured fish evaluated to be alive (A) divided by the total number of fish recaptured (R) (Alive, Stressed, or Dead) and multiplied by 100 (Equation 1).

Equation 1: Passage Survival (%) = (A/R) x 100

Further, recapture efficiency was calculated using a similar proportion:

Equation 2: Recapture efficiency (%) = (R/N_r) x100

Where R is the number of herring recapture and N_r is the number herring released in the fish return weir pool.

The bypass survival calculation was corrected based on the results of the control group;

Equation 3: $((Z/r) \times B)$ = equivalent herring mortality

Where Z equals the number of dead control fish and r equals the total number of control fish released. The control mortality proportion (Z/r) is then multiplied to the number of herring in the test group (B) to calculate *equivalent herring mortality* or M_{eh} within the test group.

Finally, M_{eh} is added to the number of *Alive* test fish (A) and using Equation 1 the corrected Passage Survival is calculated thus;

$$\text{Passage Survival (\%)} = (M_{eh} + A)/R \times 100$$

3.3 RESULTS AND DISCUSSION

Prior to the release of the juvenile blueback herring, 126 control fish were released directly into the net pen to evaluate hydraulic stress as discussed in Section 3.1.3 above. After the release of the test fish, a total of 126 juvenile blueback herring were released in the fish return weir pool late in the morning of August 26, 2011, of which all 126 were recaptured, held and evaluated. The herring were recovered from the net pen and evaluated later that afternoon following a three-hour holding period. The test group exhibited an unadjusted passage survival of 29.4% and a recapture efficiency of 100%. The control group survival was 80.2% and used to calculate the corrected passage survival (hence forth referred to as the passage survival) of 43.3%. Observed injuries to the dead test fish included hemorrhaging and descaling. However, some deceased test fish exhibited no observable injuries.

Length frequency data of a representative group of 110 test herring are presented in Figure 12. Test herring ranged in size from 60 to 91 mm; however, the majority (93%) of fish measured between 65 and 85 mm.

The sample size of test fish met the requirement to test a minimum of 100 juvenile blueback herring as stipulated in the *Final Plan*. However, the study plan proposed several replicate test runs to increase the overall sample size, demonstrate repeatability and investigate variation in bypass survival temporally, throughout the course of the migration season. Unfortunately, additional test runs were impossible in 2011 due to high flows resulting from Tropical Storm Irene, which washed juvenile herring from the river (Figure 1).

The passage survival of herring conveyed through the downstream fish bypass was low (43.3%); however, natural mortality rates for juvenile river herring are often very high. Though little data are available on juvenile river herring mortality rates, one study conducted in Rhode Island reported mortality as high as 75% (Klauda et al. date unknown). Further, the passage survival demonstrated by this evaluation represents survival of just one test group under one set of biotic and abiotic conditions. Varying factors such as river flow, migration timing and water quality parameters, particularly water temperature and dissolved oxygen, may play a role in passage survival. Flow in the Mohawk River ranged from approximately 2,000 to 7,800 CFS during the course of the evaluation (Figure 1). Water quality was monitored in each of the three holding tanks, as well as in the Project power canal, and is detailed in Table 2. Water temperature and dissolved oxygen in the Project power canal ranged from 23.35 to 22.49°C and 5.64 to 5.02 mg/L, respectively. These parameters are within the range tolerated by juvenile blueback herring (Greene 2009).

Juvenile herring are intolerant of handling stress. Stress related to working with and handling herring likely impacted the survival of both the test and control groups. This can lead to highly variable results. Handling of the test group and control group was similar in method and duration and thus handling mortality for each group was considered equivalent. However, the survival of the test and control population overall was likely affected by handling stresses, though to what degree is unknown. Additional replicate tests were not possible, but would potentially reduce some uncertainty and/or provide an opportunity to better account for handling mortality.

3.4 SUMMARY AND CONCLUSION

Brookfield conducted a downstream bypass survival evaluation of juvenile blueback herring at the School Street Project on August 26, 2011. The evaluation included the release of 126 test herring within the fish return weir pool and 126 control herring directly into the net pen. The control group was included in the evaluation to investigate mortality rates associated with the hydraulic stresses within the net pen during recapture as opposed to the mortality rate associated with conveyance through the fishway itself. A total of 126 test herring was recaptured and evaluated as alive or dead, yielding a recapture efficiency and passage survival of 100% and 43.3%, respectively.

Juvenile blueback herring are inherently fragile fish subject to injury and mortality due to their soft body, and delicate skeletal structure. Adults tend to spawn in low-gradient river reaches above tide water and are thus poorly adapted for migrating to and from high gradient river habitat including falls/rapids, but more typically spawning in runs and riverine pools in the lower reaches of rivers.

In the Hudson-Mohawk drainage, Cohoes Falls represents a 90-ft high natural barrier that historically prevented this anadromous fish population from entering the Mohawk River. Construction and operation of the Waterford Flight canal enabled this species to invade the upper Mohawk, which means that post-spawned adult and outmigrating juvenile fish must now negotiate an instantaneous 90-ft drop in elevation either by passing Cohoes Falls or by descending the fishway at School Street. Descent over such a drop is an unnatural occurrence for this species and introduces fish to inherently high levels of turbulence, collision with rocks, ledge, structures and shear forces resulting from kinetic water energy associated with such high head. These forces induce significant mortality for fragile fish such as YOY blueback herring that the species would not normally encounter in its native range.

Although project passage survival was generally low in the current study, natural mortality rates of juvenile herring are often high. The relatively small sample size and lack of replicate test runs over the course of the emigration may have skewed the survival results obtained in 2011. Brookfield plans to repeat the juvenile blueback herring passage survival test by conducting at least two additional replicates in 2012 to satisfy requirements of the *Study Plan.*

4.0 JUVENILE BLUEBACK HERRING BYPASS EFFICENCY EVALUATION

An evaluation of juvenile blueback herring bypass efficiency was scheduled for the 2011 migration season. However, environmental conditions created by Tropical Storm Irene during the second half of the migration season made the evaluation incomplete due to high flow and the lack of test fish availability (Figure 1). Further, the efficiency evaluation could not be conducted concurrently with the survival evaluation because of the need to manipulate the fishway operation outside of normal operating conditions in support of survival testing. The juvenile blueback herring bypass efficiency evaluation remains an outstanding evaluation requirement and will be conducted in 2012 as stipulated in the *Study Plan*.

5.0 REFERENCES

Erie Boulevard Hydropower, L.P. 2007. Phase I Fishway Effectiveness Testing Plan Addressing Settlement Agreement Section 3.7, and 401 Water Quality Certification Condition 13, FERC Project No. 2539.

Greene, K. E., J. L. Zimmerman, R. W. Laney, and J. C. Thomas-Blate. 2009. Atlantic coast diadromous fish habitat: A review of utilization, threats, recommendations for conservation, and research needs. Atlantic States Marine Fisheries Commission Habitat Management Series No. 9, Washington, D.C.

Klauda, R.J., Fischer, S.A., Hall, L.W. Jr., and Sullivan, J.A. Unknown Date. Alewife and Blueback Herring *Alosa pseudoharengus and Alosa aestivalis*. University of Maryland. Agriculture Experiment Station, Wye research and Education Center. Queenstown, Maryland.

Kleinschmidt. 2011. Phase 1 Fishway Effectiveness Testing and Hydraulic Survey Report. School Street Hydroelectric Project. Prepared by Kleinschmidt Associates. Essex, CT.

APPENDIX A

SUPPLEMENTAL STUDY PLAN

Kleinschmidt
Energy & Water Resource Consultants

July 15, 2011

VIA E-MAIL

Mr. Mark Woythal
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625 Broadway
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School Street Project (FERC No. 2539);
Phase I Fishway Effectiveness Testing Supplemental Study Plan

Gentlemen:

Please find the attached Draft *Phase I Fishway Effectiveness Testing Supplemental Study Plan* for your review and comment, prepared for Brookfield Renewable Power by Kleinschmidt Associates.

We request that you review the Supplemental Study Plan and provide comments by Monday, August 8, 2011. We would appreciate a timely review and response in order to address your comments prior to beginning the studies, which have been scheduled to commence in August 2011. Comments will be incorporated into the Final Supplemental Study Plan that will be submitted to the Federal Energy Regulatory Commission in August.

Please do not hesitate to contact me at (860) 767-5069 if you have any questions or require additional information.

Sincerely,

KLEINSCHMIDT ASSOCIATES

Bryan Apell

Bryan Apell
Fisheries Ecologist

BRA:SDM

Attachment: Phase I Fishway Effectiveness Testing
Supplemental Study Plan

cc: Tim Lukas, Brookfield
Chris Tomichek, Kleinschmidt
Brandon Kulik, Kleinschmidt

PHASE I FISHWAY EFFECTIVENESS TESTING

SUPPLEMENTAL STUDY PLAN

SCHOOL STREET PROJECT

FERC NO. 2539

PREPARED FOR:

BROOKFIELD RENEWABLE POWER
QUEENSBURY, NY

PREPARED BY:

Kleinschmidt
Energy & Water Resource Consultants

JULY 2011

PHASE I FISHWAY EFFECTIVENESS TESTING
STUDY PLAN

SCHOOL STREET PROJECT
FERC NO. 2539

PREPARED FOR:

BROOKFIELD RENEWABLE POWER
QUEENSBURY, NY

PREPARED BY:

Kleinschmidt
Energy & Water Resource Consultants

JULY 2011

PHASE I FISHWAY EFFECTIVENESS TESTING
STUDY PLAN

SCHOOL STREET PROJECT
FERC NO. 2539

BROOKFIELD RENEWABLE POWER
QUEENSBURY, NY

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1.0 INTRODUCTION

The School Street Hydroelectric Project (Project) (FERC No. 2539) is owned and operated by Brookfield Renewable Power (Brookfield). The Project is located on the Mohawk River, 2.5 river miles upstream of its confluence with the Hudson River in Cohoes, New York. The Project was issued a new FERC License on February 15, 2007. Downstream fish passage protection and bypass facilities for anadromous and catadromous fish, as well as resident fish, is required as part of the new license (Phase I).

In September 2007, a Final Plan was developed to investigate the Phase I fishway effectiveness (Appendix A, Kleinschmidt 2007). The Final Plan included requirements for testing downstream passage survival for resident fish, American eels, juvenile and adult blueback herring; passage efficiency of juvenile and adult blueback herring; an inspection of the conveyance structures; and a hydraulic survey to document flow field and approach velocities in front of the angled bar rack and fishway entrances.

Brookfield conducted a resident fish and adult herring survival evaluation, adult and juvenile herring passage efficiency evaluation, an inspection of the conveyance structures and a hydraulic survey to document flow field and approach velocities in front of the angled bar rack and fishway entrances in 2009 and 2010. The methods and results of these evaluations are available in the report entitled “Phase I Fishway Effectiveness Testing and Hydraulic Survey” (Kleinschmidt, 2011).

The 2010 juvenile herring evaluation was not completed due to high flow conditions, and lack of test fish availability. American eel downstream passage survival evaluation was also not completed due to a lack of test fish. This Supplemental Study Plan was drafted in consultation with NYDEC and the USFWS and details the methods that Brookfield will employ to address these outstanding requirements in 2011, including revisions to some components to the Final Plan based on experience. This Study Plan is intended to guide field studies; however some flexibility in schedule and procedures may be necessary as dictated by Project operation, prevailing weather, river flow conditions and test fish availability.

2.0 PROJECT DESCRIPTION

The Project consists of:

1) a stone masonry gravity dam extending 1,280 ft across the Mohawk River, 16 ft in height, completed in 1865;
2) a reservoir with a surface area of approximately 100 acres at a normal maximum water surface elevation of 156.1 ft, and a gross storage capacity of 788 acre-feet;
3) a power canal extending approximately 4,400 ft from the dam to the powerhouse, approximately 150 ft wide and 14 ft deep;
4) an upper gatehouse structure that currently includes nine slide gates and three steel tainter gates to control the diversion of flow into the canal;
5) a lower gatehouse with five steel headgates to control flow into the five penstocks;
6) fish passage and protection structures including a full depth angled bar rack with 1 inch clear spacing and downstream fishway; and
7) a powerhouse measuring 170 ft long by 78 ft wide, housing five generating units with vertical shaft Francis turbines rated at 92 ft of head, with a total maximum capacity of 38.8 megawatts.

3.0 FISHWAY DESCRIPTION

The fishway conveyance structure is located near the downstream end of the angled bar rack. It has two intake portals and includes a multi-level gate with top and bottom entrances (Figures 1 and 2). Attraction flow to the fishway entrances can vary between 2 – 5% of the Project's total hydraulic capacity. Conveyance pipes from both entrances converge in a fish separation chamber part-way along the fish conveyance structure (Figure 3). The chamber reduces the volume of the bypass flow and guides fish along a wire floor screen, directing them into a fish return weir pool. The excess attraction water flows through the screen and is discharged downstream of the Project. A gate valve at the downstream end of the fish separation chamber provides hydraulic control within the fish conveyance structure. An adjustable overflow weir is located at the inlet to the fish return weir pool. The weir provides fine-tune adjustment to the depth of water cascading over the weir as well as the final discharge flow (design flow 45 CFS). Once in the fish return weir pool, fish have access to the entrance of the final return pipe, and are deposited into the tailwater of the Project.

4.0 DOWNSTREAM BYPASS EFFICIENCY EVALUATION OF JUVENILE BLUE BACK HERRING

Juvenile herring are fragile and therefore were considered by the original study team to be difficult to reliably test using methods requiring fish handling such as telemetry or mark and recapture. Therefore, the Final Plan proposed to use passive methods to evaluate bypass efficiency. An evaluation was conducted in 2010 using a combination of a DIDSON camera and hydroacoustic methods. In addition to problems associated with high flows and a lack of test fish, the hydroacoustics sampling environment was not particularly conducive to quantifying passage of juvenile herring through the powerhouse intake versus the fishway due to the lack of reliable signal recognition between target fish and incidental noise in the data set.

Based on experience from 2010, Brookfield proposes an alternate approach to conduct the blueback herring bypass efficiency evaluation. A mark-recapture study will be conducted using Passive Integrated Transponder (PIT) tag technology to detect juvenile herring as they pass through the fish return pipe. Test fish would be released in the power canal upstream from the gatehouse and fishway, and allowed to select a downstream passage route. Passage efficiency will be based on the proportion of test fish using the fish bypass. If feasible, this evaluation will yield a conservative estimate of fishway bypass efficiency, as any fish not detected in the bypass will be assumed to have passed via the powerhouse although there will be an unknown detection loss due to mortality of test fish from incidental sources, such as predation and handling stress.

4.1 MONITORING SYSTEM DESIGN AND HERRING EVALUATION

PIT tag technology relies on radio-frequency identification (RFID) to relay information from a tag to a monitoring receiver. Each tag is coded at the factory with a unique identification number. When a PIT tag interacts with the magnetic field generated by an antenna the tag produces a low frequency radio signal. The antenna receives the radio signal and the unique identification number is decoded and stored by the receiver, along with date and time information. Such an antenna and receiver system will be deployed at the intake to the fishway discharge pipe (Figure 4).

The discharge pipe is located downstream of the weir pool thus any test fish identified by the monitoring system will have already navigated the fishway to a point of no return. The relatively small area (2ft diameter) of the discharge pipe makes it an ideal location to detect test fish with a PIT monitoring system as the detection efficiency should be high in this confined space.

There are two types of PIT systems currently available; full duplex (FDX) and half duplex (HDX). There are advantages and disadvantages to both. Given the site specific conditions and the small size and finicky nature of juvenile herring the FDX monitoring system is likely the best option as it will provide the fastest read rates (30 per second) and offers the smallest tags (9mm x 1.4mm). One drawback of the FDX system is the potential to experience radio interference which can confound data.

Brookfield conducted a pilot study on July 8, 2011 to determine the feasibility of using FDX tags at the School Street Project. The pilot study consisted of installing a temporary antenna at the proposed monitoring location and repeatedly passing a PIT tag through the antenna field. Testing of the FDX PIT tag system proved effective and exhibited very little detection loss related to Project interference. The water velocity at the intake to the discharge pipe is approximately 10ft/s. The PIT tag manufacture (Oregon RFID) recommends that the PIT tag monitoring system detects the PIT tag at least twice as tagged individual pass through the antenna. Based on our preliminary evaluation, lab testing and the pilot study, both the FDX and HDX monitoring systems will provide a read rate and zone of detection that meets the manufactures recommendations. The FDX PIT tag monitoring system will be employed at School Street as it will afford the smallest available PIT tag (9mm x 1.4mm) and was not hindered by ambient Project interference during the pilot study.

Feasibility studies at a fishway on the Saco River, Maine have shown that the larger tag size (12mm x 2.4mm) can be effectively utilized on juvenile alewives without excessive mortality[1] (Tim Welch, NextEra, *personal communication*), however these fish were somewhat larger than Mohawk River herring. Brookfield believes that it is likely that minimizing tag size will be critical to avoiding handling mortality.

[1] Next Era's feasibility evaluation exhibited a remarkable survival rate. Tagged juvenile alewife exhibited 97% survival; 39 out of 40.

The selected PIT tag system will be tested again to determine the efficiency with which the system is able to detect the FDX PIT tag. This test will be conducted prior to the full scale study and will consist of injecting a minimum of 100 tagged juvenile herring into the fishway weir pool and evaluating what proportion of those test fish were detected by the FDX monitoring system. The result of the efficiency evaluation will be used to offset error associated with undetected tags. For example, should we find that 85% of the test tags were read by the system than the final estimate of the number of herring that used the fishway (x) will be multiplied by 1.15 in order to account for the 15% not detected due to signal collision and/or interference.

4.2 Test Fish Collection

Juvenile herring will be collected in the fish separation chamber. The fishway will be operated so that attraction flow will induce downstream movement of juvenile herring into the separation chamber while the outlet weir gate will be adjusted concurrently to provide no egress out of the chamber. Based on previous observation and experience, juvenile herring are likely to stack up in the separation chamber in sufficient numbers to be collected using long handled dip nets. The herring will be placed in a 90 gallon aerated live well and transported a short distance (approximately 500ft) to one of three 1000 gallon tanks for holding. The water in the holding tanks will be continuously replenished using a minimum of 1 sump pump per tank at an estimated flow of 2000 gallons per hour. This pump-through system will be located adjacent to the power canal which will provide the source of the circulation flow. It is estimated that approximately 2000 juvenile herring will be required for the evaluation. The study team will work with the NYSDEC Special Licenses Department to modify the current collection permit to include the required number of juvenile herring for this evaluation.

4.3 Sample Size and Methodology

Brookfield proposes to tag at least 1100 juvenile herring. Four hundred herring will be released at each of the two fishway attraction flow scenarios: 2% and 5% of station capacity. A minimum of 30 observations total will be required for a statistical comparison between the two test groups (i.e. those released at 2% fishway flow (120-130 CFS) vs. those released at 5% fishway flow (300-330 CFS)). It is anticipated that a total sample size of 800 individuals will yield enough observations to provide a statistically robust comparison of bypass efficiency at 2% and 5%

fishway flow. Further, at least 100 test fish will be tagged and held as a control group to determine tagging mortality. The control group will be tagged as a first step and held for a minimum of 8 hrs prior to evaluation. A survival of greater than or equal to 80% will be deemed sufficient for full scale tagging to proceed. Should tagging mortality exceed 20% and no incidental factors such as water quality issues can be identified, than the process will be re-evaluated and refined based on experience from the first tag group. A second control group will be tagged and evaluated. Should tagging mortality exceed 20% in the second control group and no incidental factors such as water quality issues can be identified, than the method will be deemed impractical and the evaluation will be aborted.

Prior to tagging, test fish will be anesthetized in a solution of water and MS-222 at a concentration of 45.0-50.0 mg/L. This concentration range provides moderately rapid anesthesia and allows fish to be tagged within 2 minutes of being placed in an anesthetic bath. At this concentration, fish can be placed in the anesthetic for up to 30 minutes without risk of mortality. Test fish will be fitted with a PIT tag by surgical insertion in the anterior abdomen via a small pinhole incision with the tip of a surgical blade. Following tag implantation, test fish will be returned to a dedicated 1000 gallon pump-through tank and held for a minimum of 4hrs to recover prior to release. A control group consisting of at least 100 individuals will be established for each of the two test scenarios i.e. 2% and 5% station capacity.

Tagged test fish will be transported to a live car located in the power canal downstream of the pedestrian bride. The test fish will be allowed to acclimate in the live car and resume normal schooling behavior. The duration of the holding time within the live car will be dependent on the behavior of the test fish, but it is anticipated that 30 minutes will be adequate. The release location will be sufficiently upstream to allow test fish to resume normal schooling behavior prior to encountering the fish conveyance structures.

The herring will be released in four groups of 100 tagged fish. Additional non-tagged fish will be released concurrently with the tagged fish to form an aggregate in order to encourage schooling within the test group and reduce the potential for any one test fish to be targeted for predation. The exact number of additional fish will be dependent on availability but is anticipated to be at least an additional 100 individuals for a total of 200 herring per release. Test fish releases will occur approximately every 2 hours to provide time for previously released test fish to navigate the fishway thus minimizing the potential for non-detections due to signal collision as can occur when large groups of test fish encounter the PIT system simultaneously.

4.4 Data Collection and Analysis

Data will be downloaded from the receiver daily during the study. It will be initially stored on a dedicated field laptop computer and backed up and archived nightly on the Kleinschmidt data server. In addition to the PIT data: water and air temperature, dissolved oxygen, conductivity and pH will be recorded on a daily basis. Water quality will be monitored in the power canal and the fish holding tanks. Further, station operation information will be documented as well as river flow (CFS) and precipitation events.

The PIT tag data will be analyzed to determine the percentage of test herring released in the canal that passed the PIT tag detector. All such fish will have found and navigated the fishway and bypassed the Project. Any test fish not detected in the fishway will be considered entrained. The relative entrained proportion will be corrected for the incidental handling mortality quantified through control groups as well as the PIT tag system detection efficiency coefficient.

5.0 DOWNSTREAM BYPASS SURVIVAL EVALUATION OF JUVENILE BLUE BACK HERRING

Downstream bypass survival of juvenile blueback herring will be evaluated in the late summer early fall of 2011 during the out-migration. The exact schedule will be dictated by downstream herring migration as well as the predominate weather and flow condition at the study site. The objective of this evaluation will be to determine what proportion of bypassed juvenile herring survive passage through the fishway. The study team will work with the NYSDEC Special Licenses Department to amend the current collection permit to include previsions to collect juvenile blueback herring to support this effort.

5.1 Methods

The evaluation of juvenile herring passage survival will be conducted using the custom made floating net pen described in section 4.1.1 of the Phase I Fishway Effectiveness Testing and Hydraulic Survey Report (Kleinschmidt 2011). The net pen will be used to collect and hold naturally out-migrating juvenile herring that pass through the fishway.

Prior to the study period, the fishway will be operated so that attraction flow will induce downstream movement of juvenile herring into the separation chamber while the weir gate will be adjusted concurrently to provide no egress through the discharge pipe. Once an adequate number of test fish are observed in the fish separation chamber the weir gate will be lowered, providing access to the final discharge pipe. A minimum of 100 juvenile herring will be crowded (using a long handled nets) out of the fish separation chamber and into the fish outlet weir pool and recollected in the tailrace net pen. Once the test herring have been collected, the fishway discharge will be closed to minimize turbulence and hydraulic stresses within the net pen. The test fish will be held in the net pen for a minimum of 2 hrs prior to the evaluation of their condition. Test fish will be determined as Alive or Dead using criteria described in the original Final Plan. Further, a control group of at least 100 test fish will be transported via live well and deployed in the net pen immediately prior to the initiation of the test. The control group will be marked using dye and provide information about mortality associated with the hydraulic conditions within the net pen rather than interactions with the fishway structures and the final decent and discharge into the tailrace.

5.2 DATA COLLECTION AND ANALYSIS

All survival data will be recorded in a dedicated field book. In addition to the survival data: water and air temperature, dissolved oxygen, conductivity and pH will be recorded as well as any pertinent field observations on a daily basis. Survival will be calculated by developing a proportion between those test fish that survived the fishway passage divided by the total number of fish recollected. Should the control group yield evidence that some level of mortality is attributable to the hydraulics in the net pen then the proportion of herring that survived will be corrected to account for those incidental losses. Survival will be presented as a percentage of the test fish that survived passage via the fishway discharge pipe.

6.0 BYPASS SURVIVAL EVALUATION OF ADULT AMERICAN EEL

Downstream passage survival of adult American eel will be evaluated in the fall of 2011. The objective of this evaluation will be to determine what proportion of bypassed adult American eels survive passage through the fishway. The exact schedule will be dictated by the availability of suitable American eel test specimens and flow condition at the study site.

6.1 ACQUISITION OF TEST EELS AND PERMIT REQUIREMENTS

Brookfield will work with the NYSDEC Special Licenses Department to amend the current collection permit to include provisions to utilize American eel from a source outside of the Mohawk River watershed. The source of test eel will likely include those purchased from a commercial source. Test eel will be transported by truck in secure refrigerated coolers to a bait dealer located in Watervliet, NY. The eels will be held in two dedicated tanks, and quarantined for a period of no less than 30 days. The test eels will be located indoors (garage) in a closed aerated and re-circulated system and held in complete isolation and independent from other sources of bait kept at the supply store. The holding water source will be obtained from a protected groundwater source and poses no potential to harbor infectious fish pathogens.

A subsample of eels will be delivered to a fish health lab. The Lab will inspect and test for VHS, Spring Viremia of Carp Virus, Furunculosis, Enteric Red Mouth, and Infectious Pancreatic Necrosis (IPN) as required by Part 188 of Title 6 of New York State Code of Rules and Regulations (NYCRR). Should the subsample be found to be free of pathogens, the test eel will be considered certified and therefore available for this study.

6.2 METHODS

The evaluation of adult American eel passage survival will be conducted using the same floating net pen described in Section 4.1.1 of the Phase I Fishway Effectiveness Testing and Hydraulic Survey Report. The net pen will be used to collect and hold adult sized test eels released into the fishway within the weir pool. Injecting the test eels at this location will ensure that the eel’s only source of egress is through the final discharge pipe as upstream movement will be restricted by the movable weir. A total of 90 eel will be injected into the fishway and will be re-captured in the tailrace using the net pen. Prior to injection, the test eels will be visually inspected in order to identify any prior injuries. Once all of the eels have moved through the fishway, the weir pool and final discharge pipe will be dewatered to minimize turbulence and hydraulic stresses within the net pen. The test eels will be held for a minimum of 12 hrs in the net pen after which their condition will be evaluated as *Alive* or *Dead* using criteria described in the original Final Study plan. Brookfield will commit every effort to recapture all test eel at the culmination of the evaluation. Prior work conducted at the Project has demonstrated a high recapture efficiency of resident fish species using the net pen, including a 100% collection efficiency of three adult sized American eels. Further, the net pen was specifically designed to hold eels which are known to be prone to escape. The over-vertical eel corral will likely minimize the potential for escapement (Figure 5). We anticipate that all of the test eels will be re-captured, however, there is potential for escapement. The recaptured eels will be disposed of in accordance with state regulations and will not be returned to the Project waters.

6.3 DATA COLLECTION AND ANALYSIS

All survival data will be recorded in a dedicated field book. In addition to the survival data: water and air temperature, dissolved oxygen, conductivity and pH will be recorded as well as any pertinent field observations daily. Survival will be calculated by developing a proportion between those test fish that survived the fishway divided by the total number of fish tested. Survival will be presented as a percentage (i.e. the percent of the test fish that survived the fishway and were recaptured).

7.0 SAFETY CONSIDERATIONS

Safety is of paramount importance when conducting field studied. All activities conducted during these evaluations will be governed by Brookfield's Health and Safety Procedure. The onsite project manager and crew that will be conducting these activities have extensive experience working at hydroelectric facilities and working around water in general. Further, at least two members of the team will be trained in CPR and first aid. A study specific health and safety plan will be developed prior to field activities and will identify and address any safety concerns related to the evaluation. A job and safety briefing will be conducted daily prior to the start of work. Changing weather and flow condition at the study site can confound safety parameters. The onsite project manager and Brookfield reserve the right to postpone or abandon activities that have been deemed unsafe until such time that condition become favorable or the safety risk is otherwise mitigated.

8.0 REPORTING

A draft report will be submitted to Brookfield for review by December 15, 2011. A draft report will be generated and distributed to USFWS and the NYSDEC for review and comment (target date: the end of February 2012). A final report incorporating agency comment will be prepared for submittal to FERC within one month of receipt of final agency comment.

9.0 REFERENCES

Kleinschmidt. 2011. Phase I Fishway Effectiveness Testing and Hydraulic Survey. Final Kleinschmidt Associates Report to Brookfield Renewable Power Queensbury, NY.

Kleinschmidt. 2007. Phase I Fishway Effectiveness Testing Plan Addressing Settlement Agreement Section 3.7, And 401 Water Quality Certification Condition 13 Study Plan, Final Plan. Final Kleinschmidt Associates Study Plan to Erie Boulevard Hydropower, L.P. Liverpool, New York.

Brookfield Power

New York Operations
225 Greenfield Parkway, Suite 201
Liverpool, NY 13088

Tel (315) 413-2700
Fax (315 461-8577
www.brookfieldpower.com

June 8, 2007

To: Attached Distribution List

Subject: **School Street Hydroelectric Project FERC Project P-2539**
License Article 401, 401 Water Quality Certification Condition 13 and Settlement Agreement Section 3.7

Dear Mr./Ms.:

In accordance with Article 401 of the Federal Energy Regulatory Commission's February 15, 2007 *Order on Offer of Settlement and Issuing New License* (License), Condition 13 of the New York State Department of Environmental Conservation (NYSDEC) 401 Water Quality Certification (WQC) and the Section 3.7 of Settlement Agreement for the School Hydroelectric Project (FERC P-2539), enclosed is Erie Boulevard Hydropower, L.P.'s (Erie) **draft** *Phase I Fishway Effectiveness Testing Plan.*

Erie would appreciate receiving your comments within 30 days of the date of this letter. Upon receipt of your comments, Erie will revise as appropriate the above referenced plan and submit the revised version to FERC.

At the suggestion of Erie, Agency (USFWS, NYSDEC, and NOAA fisheries) personnel were contacted to begin informal discussions concerning the plan to be utilized to evaluate the effectiveness of the Phase I downstream fish passage facility. This process was a continuation of the collaborative settlement process utilized at the School Street Project. Representatives of the three agencies were initially contacted by a Brookfield representative; NOAA deferred to the USFWS and NYSDEC and indicated that it would review the draft plan developed as part of those discussions. Representatives of USFWS, NYSDEC, and Brookfield Power participated in a series of conference calls during March and April 2007 that resulted in the development of the attached June 2007 Draft of the *Phase I Fishway Effectiveness Testing Plan*. The attached Draft document has been submitted to you to begin the formal consultation process required by the Settlement.

If you should have any questions or comments regarding the attached, please do not hesitate to contact the undersigned at (315) 413-2769 or e-mail at Ken.Kemp@BrookfieldPower.com.

Sincerely,

Ken Kemp

Kenneth N. Kemp, P.E.
for Erie Boulevard Hydropower, L.P.

Enclosure

xc: Distribution List
T. Uncher
R. Wingert
J. Sabattis

Faxed 7/3/07

United States Department of the Interior

FISH AND WILDLIFE SERVICE
3817 Luker Road
Cortland, NY 13045

July 2, 2007

Mr. Kenneth N. Kemp, P.E.
Erie Boulevard Hydropower, L.P.
225 Greenfield Parkway, Suite 201
Liverpool, NY 13088

RE: School Street Hydroelectric Project (FERC #2539)
Draft Phase I Fishway Effectiveness Testing Plan

Dear Mr. Kemp:

The U.S. Fish and Wildlife Service (Service) has reviewed the June 8, 2007, Draft Fishway Effectiveness Testing Plan (Plan) for the School Street Hydroelectric Project. The Plan was based on discussions held earlier this year among the licensee, the New York State Department of Environmental Conservation, and the Service. The Plan generally incorporates the issues addressed during these discussions.

Some details of the Plan cannot be resolved until the structures are completed and field studies commence. In addition, based on recent migrations, there is a strong likelihood that Brookfield may be unable to obtain an adequate number of test specimens of some species. The Final Plan will need to include contingencies for resolving these problems if they occur. The study may need to extend into an additional field season if adequate test specimens cannot be obtained.

We appreciate the opportunity to review the Plan. If you have any questions or desire additional information, please contact Steve Patch at 607-753-9334.

Sincerely,

David A. Stilwell

David A. Stilwell
Field Supervisor

cc: NYSDEC, Albany, NY (M. Woythal)
FWS, Hadley, MA (C. Orvis)

New York State Department of Environmental Conservation
Division of Environmental Permits, 4th Floor
625 Broadway, Albany, New York 12233-1750
Phone: (518) 402-9167 • **FAX:** (518) 402-9168
Website: www.dec.ny.gov

Alexander B. Grannis
Commissioner

August 8, 2007

Kenneth Kemp, P.E.
Brookfield Power
225 Greenfield Parkway, Suite 201
Liverpool, New York 13088

RE: **School Street Hydroelectric Project**; DEC#:4-0103-00027/00001; Draft Phase I Fishway Effectiveness Testing Plan

Dear Mr. Kemp:

This letter is response to your request for the NYS Department of Environmental Conservation ("Department") to review the above referenced plan for modifications at the School Street Hydroelectric Project. The WQC issued for the School Street Project , and the subsequent FERC license requires Erie to implement downstream fish passage at the project. The Settlement Agreement for this project identified a two stepped process.

The Settlement Agreement for this project identified a two stepped process. The initial Phase I requires Erie to submit to the FERC a plan and schedule for evaluating effectiveness of the Phase I downstream fish passage facilities. The plan was to include:

- a method for evaluating the guidance and attraction of fish after they have entered the head of the canal during power plant operations,
- specific measures, methods and schedules to evaluate fish passage efficiency and fishway survival/mortalities for passage through both the fishway bypass and the fish friendly turbine as appropriate, and
- methods that will allow a rigorous statistical comparison of the results between the Phase I fish bypass structure and the Phase II new "fish friendly" turbine.

Based on a review of the documents completed by staff the Department's offers the following comments regarding the plan;

Phase I Fishway Effectiveness Testing Plan. The Department has reviewed the Draft Phase I FishwayEffectiveness Testing Plan and has determined that it accurately reflects consultation discussions that Erie held with DEC and the United states Fish and Wildlife Service during March and April 2007. The proposed Phase I fishway designs are consistent with the terms of the Settlement, providing an angled guidance system in the power canal just upstream of the lower gatehouse. The goal of the consultation discussions was to develop a fishway effectiveness study to estimate fish passage efficiency, survival, and duration at the Phase I fishway that can be statistically compared to future post-construction tests once the fish-friendly turbine has been installed.

The Department has determined that the proposed study plan sufficiently meets this goal. The methods described, including the pre-operational physical assessment of the fishway and the biological assessment of the fishway are adequate to address the passage efficiency, survival, and delay of the fish species of concern (primarily blueback herring and American eel). The schedule for installation of the fishway, implementation of the study, and report submissions are acceptable.

Please contact me by e-mail at cmhogan@gw.dec.state.ny.us or by phone at (518) 402-9151 if you have any questions regarding the Department's comments related to the above referenced plans.

Sincerely,

Christopher M. Hogan
Project Manager

cc: via e-mail
M. Woythal
W. Little
J. Fraine
W. Clarke
R. Wingert
F. Bifera

APPENDIX B

FIGURES

Figure 1. One of two fishway intakes (*center distance*) and the debris/ice sluice intake (*adjacent to fishway intake to the right*) at the School Street Project Cohoes, NY.

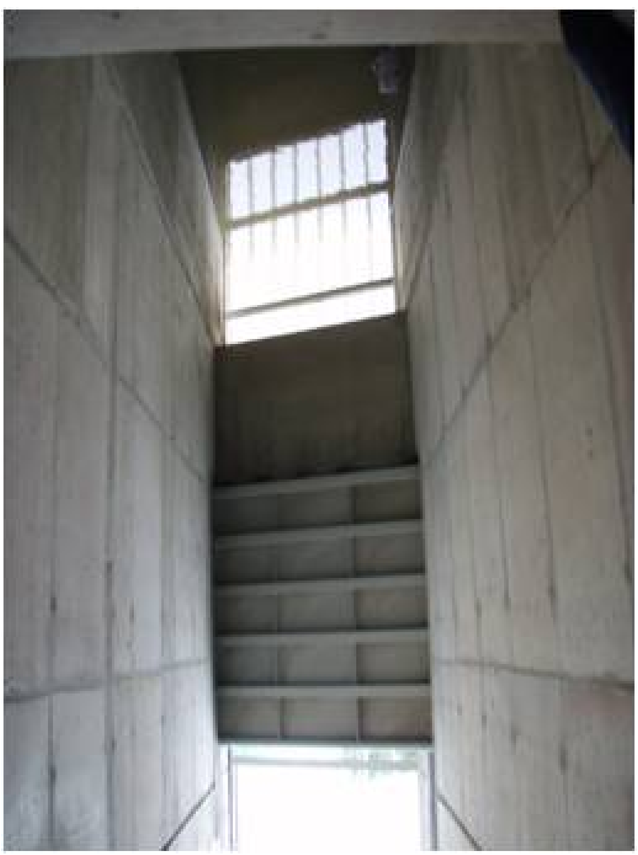


Figure 2. The multi level gate structure within the fishway intake structures at the School Street Project Cohoes, NY.

Figure 3. Fishway separation chamber at the School Street Project Cohoes, NY.

Figure 4. Proposed location for the deployment of the PIT system antenna at the School Street Project Cohoes, NY.

Figure 5. The custom built net pen used to recapture test fish in the discharge of the fishway. The red arrow denotes the over-vertical eel corral.

APPENDIX B

PERMITS, AGENCY CONSULTATION DOCUMENTS AND FISH HEALTH CERTIFICATE

United States Department of the Interior

FISH AND WILDLIFE SERVICE
3817 Luker Road
Cortland, NY 13045

August 1, 2011

Bryan Apell, Fisheries Ecologist
Kleinschmidt Energy and Water Resource Consultants
35 Pratt Street, Suite 201
Essex, CT 06426

RE: School Street Hydroelectric Project (FERC #2539)
Review of Phase I Fishway Effectiveness Testing Supplemental Study Plan

Dear Mr. Apell:

The U.S. Fish and Wildlife Service (Service) has reviewed the July 15, 2011, *Phase I Fishway Effectiveness Testing Supplemental Study Plan* (Plan) for the School Street Project. We concur with the proposed plan of study. The Service has no further comments on the Plan.

We appreciate the opportunity to review the Plan. If you have any questions or desire additional information, please contact Steve Patch at 607-753-9334.

Sincerely,

David A. Stilwell
Field Supervisor

cc: NYSDEC, Albany, NY (M. Woythal)
FWS, Hadley, MA (C. Orvis)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
Division of Fish, Wildlife & Marine Resources
625 Broadway, 5th Floor, Albany, New York 12233-4750
Phone: (518) 402-8924 •**Fax:** (518) 402-8925
Website: www.dec.ny.gov

Joe Martens
Commissioner

August 5, 2011

Bryan Apell
Kleinschmidt Associates
35 Pratt Street, Suite 201
Essex, CT 06426

RE: School Street hydroelectric Project; FERC# 2539
Comments on "Phase I Fishway Effectiveness Testing Supplemental Study Plan

Dear ~~Mr. Apell~~ Bryan:

The New York State Department of Environmental Conservation (DEC) has had opportunity to review the "Phase I Fishway Effectiveness Testing Supplemental Study Plan" for the School street Hydroelectric Project (FERC# 2539), submitted to us on July 15, 2011.

The Supplemental Plan was necessary as the 2010 juvenile herring evaluation was not completed due to high flow conditions, and lack of test fish availability. American eel downstream passage survival evaluation was also not completed due to a lack of test fish.

It is our opinion that the Supplemental Plan adequately details the methods that Brookfield will use to address the outstanding requirements in 2011. DEC agrees with the built-in flexibility in schedule and procedures that may be necessary to complete the study as dictated by Project operation, prevailing weather, river flow conditions and test fish availability.

Please feel free to contact me at any point during the study period should additional consultation be necessary, and I look forward to reviewing the study results.

Sincerely,

Mark S. Woythal

Mark S. Woythal
Instream Flow Unit Leader

cc: Tim Lukas; Brookfield Renewable Power
Norm McBride; DEC, Stanford
Roy (JR) Jacobson; DEC, Albany
Bill Little; DEC, Albany
Steve Patch; USFWS, Cortland

2011 Year of the Turtle

New York State Department of Environmental Conservation

NOTICE OF LICENSE AMENDMENT REQUESTED BY LICENSEE

This is NOT a License

Date: 7/21/2011

License#: 1378

License Type: License to Collect or Possess: Scientific

Applicant: CHRISTINE A TOMICHEK
KLEINSCHMIDT ASSOCIATES
35 PRATT ST, STE 201
ESSEX, CT 06426

Owner ID: 1617687

Amendment Description:
At your request, in a letter or correspondence dated 7/21/2011, the department has amended your license. The following changes have been made:

1) Licensee request to add or remove authorized species

Additional Information:

Quantity of Blue back herring authorized under your license has been increased to 2000.

Agency Contact:

CHRIS D SCHIRALLI
Special License Analyst
NYSDEC - SPECIAL LICENSES UNIT
ALBANY, NY 12233-4752

Telephone Number: (518) 402-8985
Email Address: fwslu@gw.dec.state.ny.us

LICENSE
Under the Environmental Conservation Law (ECL)

Licensee Information

License Issued To:
CHRISTINE A TOMICHEK
KLEINSCHMIDT ASSOCIATES
35 PRATT ST, STE 201
ESSEX, CT 06426

(860) 767-5069

DEC Contact Information

DIVISION OF FISH, WILDLIFE AND MARINE RESOURCES
SPECIAL LICENSES UNIT
625 BROADWAY, ALBANY, NEW YORK 12233-4752
PHONE: (518) 402-8985 FAX: (518) 402-8925
WEBSITE: www.dec.state.ny.us

License Authorizations

License to Collect or Possess: Scientific
License # 1378

New License	Effective Date: 1/14/2011	Expiration Date: 1/13/2012
Modification # 1	Effective Date: 7/18/2011	Expiration Date: 1/13/2012
Modification # 2	Effective Date: 7/21/2011	Expiration Date: 1/13/2012

NYSDEC Approval

By acceptance of this license, the licensee agrees that the license is contingent upon strict compliance with the ECL, all applicable regulations, and all conditions included as part of this license.

License Regulations

6 NYCRR Part 175
ECL 11-0515 (1)

6 NYCRR Part 189

LICENSE TO COLLECT OR POSSESS: SCIENTIFIC - LICENSE CONDITIONS

1. **LCPSCI - Authorizations** The licensee is authorized to collect, possess, transport, release and re-capturefish from the Mohawk River in the Towns of Cohoes and Waterford and in the Erie Canal below Lock 2 as part of the School Street Project (FERC No. 2539) as outlined in their license application on file with the NYSDECSpecial Licenses Unit.

2. **Scientific Collection - Authorized Activities** The licensee is authorized to possess the collected species for the following activity(ies): Compliance Work

3. **LCPSCI - Resident Fish** The licensee is authorized to collect, possess, tag, temporarily possess and release unharmed in the fish bypass no more than 100 (one hundred) resident species of fish.

4. **LCPSCI - Blue Back Herring** The licensee is authorized to collect, temporarily possess and release unharmed below the project, no more than 2000 (two-thousand) juvenile blueback herring.

5. **LCPSCI - Blue Back Herring (Transmitters)** The licensee is authorized to collect, temporarily possess, implant with radio transmitters and transport no more than 100 (one hundred) adult blueback herring. Fishs marked shall be released unharmed upstream in the project power canal.

6. **LCPSCI - American Eel (Maine Imporation)** The licensee is authorized to import up to one-hundred and forty (140) female American eel from Commercial fishing operations on the Sebasticook River in Maine. A overland transport permit is required to import any uncertified eels and additional permits may be required for holding eels. For information on overland transport permits please contactyour Regional Fisheries Manager.

   Regional Fisheries Manager
   NYSDEC REGION 4 STAMFORD SUB-OFFICE
   65561 ST RTE 10
   STAMFORD, NY12167 -9503

7. **LCPSCI - American Eel (Conroy's Biat)** The licensee is authorized to purchase, possess and release up to one-hundred and forty (140) adult eel in the fish bypass which shall be obtained from Conroy's Bait in Watervliet, NY which shall be collected from the Hudson River between the lock in Stillwater and the I-90 bridge in Albany.

8. **LCPSCI - Over Land Transport Permit** The licensee shall obtain an overland transport permit for all fish that do not have a fish health certificate from the NYSDEC Regional Office at 65561 StateRoute 10, Stamford, NY 12167, (607) 652-7367.

9. **Scientific Collection - Authorized Fish Collection Equipment** The licensee shall only collect fish using
boat electroshocking equipment, haul seine, trap and floating pens.

10. **Scientific Collection - Biosafety Protocol** The licensee shall conform with all guidelines contained in the NYS DEC Bureau of Fisheries Sampling, Survey, Boat and Equipment Protocol, attached to this license as

Appendix I. Any questions regarding the protocols may be directed to the Regional Fisheries Manager at:

Regional Fisheries Manager
NYSDEC REGION 4 STAMFORD SUB-OFFICE
65561 ST RTE 10
STAMFORD, NY12167 -9503

11. Scientific Collection – Gear Marking and Monitoring The licensee shall mark all gear deployed with the licensee's name, resident address and license type and number. All traps and nets shall be checked no less than once every twenty-four (24) hours.

12. Scientific Collection - LCP - No Endangered or Threatened Species No endangered/threatened species may be collected or possessed pursuant to this license.

13. Scientific Collection - Federal and Local Licensing Requirements The licensee shall determine if a corresponding Federal or local Permit is required to exercise the authority granted in this license. If a corresponding Federal or local Permit is required, the licensee shall obtain a valid Federal or local Permit before conducting any activity pursuant to this license.

14. Scientific Collection - Law Enforcement Notification The licensee shall notify the appropriate Regional Environmental Conservation Officer at least 48 hours prior to conducting activities pursuant to this license and within 24 hours upon the loss or theft of any collecting gear. (518) 357-2047

15. Collection from the Wild - Authority to Designate Agents The licensee is authorized to designate agents to assist the licensee with the activities authorized pursuant to this license provided that:

a. the licensee submits a written request to the NYSDEC Special Licenses Unit at the address listed on the front of this license containing the:
i) name
ii) address
iii) age
iv) phone number of the person he or she is nominating as a designated agent, and;

b. the licensee receives an amended license from the Special Licenses Unit listing the designated agent(s) he or she has nominated before that person can conduct activities authorized by this license.

16. Scientific Collection - Reporting Requirement - Prior to Expiration The licensee shall file a written annual report prior to the expiration date of this license. Such annual report shall contain: a) name of the licensee, b) license number, c) common name of the listed animals collected, d) location(s) of collection, e) date(s) of collection, f) biological data collected and g) final disposition of collected animals. The licensee shall send this report to the NYSDEC Special Licenses Unit 625 Broadway, Albany, NY 12233-4752.

GENERAL CONDITIONS - Apply to ALL Authorized Licenses

1. GC – Licensee Shall Read All Conditions The licensee shall read all license conditions prior to conducting any activities authorized pursuant to this license.

2. GC – Reasons for Revocation This license may be revoked for any of the following reasons:

i. licensee provided materially false or inaccurate statements in his or her application, supporting documentation or on required reports;
ii. failure by the licensee to comply with any terms or conditions of this license;
iii. licensee exceeds the scope of the purpose or activities described in his or her application for this license;
iv. licensee fails to comply with any provisions of the NYS Environmental Conservation Law, any other State or Federal laws or regulations of the department directly related to the licensed activity;
v. licensee submits a check, money order or voucher for this license or application for this license that is subsequently returned to the department for insufficient funds or nonpayment after the license has been issued.

3. **GC – Licensee Shall Carry Copy of License** The licensee shall carry a copy of this license or a document provided by the department, if relevant, when conducting activities pursuant to this license.

4. **GC – Licensee Shall Notify of Change of Address** The licensee shall notify the Special Licenses Unit in writing, by mail or email, within five (5) days of the official change of residence.

5. **GC – License is Not Transferrable** This license is not transferrable and is valid only for the person identified as the licensee.

6. **GC – Licensee is Liable for Designated Agents** If designated agents are authorized pursuant to this license, the licensee shall be liable and responsible for any activities conducted by designated agents pursuant to this license or any actions by designated agents resulting from activities authorized by this license.

7. **GC – Licensee Renewal** The licensee shall submit a written request for the renewal of this license prior to the expiration date listed on the license. The licensee shall include accurate and complete copies of any required reports with their renewal request. This renewal paperwork shall be sent to:

NYSDEC
Special Licenses Unit
625 Broadway
Albany, NY 12233-4752.

This license is deemed expired on the date of expiration listed on the license.

NOTIFICATION OF OTHER LICENSEE OBLIGATIONS

MN– Licensee is Liable
The licensee shall be liable and responsible for any activities conducted under the authority of this license or any actions resulting from activities authorized by the license.

MN – Access by Law Enforcement
The licensee shall allow representatives of the NYS DEC Division of Law Enforcement to enter the licensed premises to inspect his or her operations and records for compliance with license conditions.

Trespassing Prohibited

This license is not a license to trespass. The licensee shall obtain permission from the appropriate landowner/land manager prior to conducting activities authorized pursuant to this license

NYS DEC Division of Fish, Wildlife and Marine Resources, Special Licenses Unit

This document is an official addendum to the attached license, and shall be kept with the license at all times.

Appendix I. NYS DEC Bureau of Fisheries Sampling, Survey, Boat and Equipment Protocol

Sampling and Survey work should be conducted with clean, dry and/or completely disinfected equipment.

For all survey work in streams and rivers where the status of ANS is unknown, sampling should start at the upper most reach, and then work downstream. This will help ensure that non motile ANS will not be transported on boots and gear to uninfected upstream reaches. In streams where the infestation is systemwide, survey order is less important. If the stream or river is already known to be infested with ANS but the extent of infestation is not clear, particular care should be taken to replace or completely disinfect boots and gear before consecutive surveys are conducted.

In general, lakes and ponds which are connected by channels or streams with or without barriers, should be surveyed starting at the uppermost location in the system. Dry or disinfected gear should always be used for lake or pond surveys.

When traveling from a lake or pond to another water body, or from a stream/river site to one that is not downstream in the same system, the following procedures must be followed for boats, trailers and all other gear that comes in contact with the water. *(Note: additional REQUIRED procedures are listed in this protocol for use when moving from whirling disease or zebra mussel positive waters to waters not known to have these organisms.)*

- **Upon launching boat:**
  - **Trailers with carpeted bunks** should be disinfected after the boat is launched and the trailer removed from the water - use a spray bottle with Lysol solution or full-strength vinegar for carpeted trailer bunks.
  - Keep the disinfectant bottle in the truck so the driver can treat the trailer bunks after deploying the boat.

- **Prior to leaving launch site:**
  - Inspect and remove visible aquatic plants, animals and mud from the boat, trailer and equipment at the sampling location.
  - Drain all water from the live well, bilge, etc.
  - Do not transfer any aquatic animals, plants or water from one water body to another.

- Do not store dissolved oxygen probes or other water chemistry gear in lake water - bring distilled or chlorinated tap water for this purpose (follow manufacturers directions).

- **Upon returning to equipment storage area OR before launching in any other water body that is not immediately downstream of prior location (whichever comes first):**

    - Nets, anchors, lines, boots and waders can be dried for 5 days . *When felt soled waders are used special care needs to be taken to ensure that they are totally dry or they must be disinfected as outlined below*) **OR**
    - **All** equipment can be disinfected using one of the following techniques (*Note: for boats this includes surface, motor, bilge, pumps and live wells. All equipment must subsequently be rinsed with clean water. Disinfection must take place away from water bodies*):
        - **In zebra mussel/whirling disease waters - use 10% bleach solution***
        - In all other waters - 1% Virkon Aquatic** is acceptable **OR**
        - Boats, trailers and **all** other equipment can be disinfected using a high temperature pressure washer (steam power washer)- *(Note: this technique is approved for zebra mussel/whirling disease waters;* see Appendix 1 for boat disinfection guidelines).
        -

* **Chlorine bleach**: When handling 10% chlorine bleach solution, be sure to wear protective gear (masks, gloves, goggles, etc.) and use in a well ventilated area (follow precautions on Material Safety Data Sheets (MSDS)). Remove all visible debris from equipment and gear. Spray equipment and gear with the solution so that it is saturated or immerse gear in solution. If equipment or gear is porous (i.e., felt bottomed or neoprene waders) let soak in solution for 10 minutes. Rinse equipment and gear with tap water or with water from the next water body you will be sampling. Dispose of waste chlorine bleach solution away from bodies of water and drinking water sources (follow protocol in MSDS).

** **Virkon Aquatic:** Wear a dust mask and rubber gloves when handling the powder. Mix a 1% (1:100) solution. Remove all visible debris from equipment and gear. Spray equipment and gear with the solution so that it is saturated or immerse gear in solution. If equipment or gear is porous (i.e., felt bottomed or neoprene waders) let soak in solution for 10 minutes. Rinse equipment and gear with tap water or with water from the next water body you will be sampling. Dispose of waste Virkon solution away from bodies of water and drinking water sources (follow protocol in MSDS).

NYSDEC Bureau of Fisheries
Biosecurity Protocol

Boat hulls, anchors, and trailers:

- Always drain the bilges of the boat by removing the drain plug. Bilge pumps are not capable of removing all water from those areas. Wet wells, live wells, and any other compartments that could hold water from an infested field collection site should be drained of water at the field site, and if possible, flushed with hot water, steam or disinfectant solution and allowed to dry before the next use. If appropriate, the field site water may be drained back into the original body of water, as long as conditions and the decontaminant used are such that this would not cause chemical or biological contamination. Otherwise, such water containing disinfectant solutions must be drained into a suitable container for treatment prior to final disposal. Field crews may elect to not drain the bilge area until they return to the storage lot if they are not going to any other bodies of water until decontamination is completed.
- If the bilge water is drained and collected, it must be disinfected and then disposed of by suitable means to avoid causing environmental damage or contamination.
- After draining contained water, all compartments that held water should be washed with a high temperature pressure washer or disinfectant solution and left open to completely dry prior to use in the next site.
- All boats, anchors, trailers used in field sampling will be cleaned using a high temperature pressure washer working from fore to aft and gunnels to keel in a thorough manner.
- While using the high temperature pressure washer, particular attention should be paid to the cooling water intakes on the lower unit of the motor.
- Particular attention should be paid to the carpeted trailer bunks since they can hold water for extended periods of time. These areas should have already been treated with a disinfectant solution when the boat was unloaded into the lake but should be washed with a high temperature pressure washer anyway.
- Lower the motor to drain all water from the lower unit. Replace the motor into the "transom saver" when this is accomplished.

*OWRB, Oklahoma Water Resources Board. 2005. Decontamination Protocol for Aquatic Nuisance Species. Technical Report 05-157.

New York State Department of Environmental Conservation
Division of Fish, Wildlife and Marine Resources, Region 4
Bureau of Fisheries
65561 State Highway 10, Suite 1, Stamford, NY 12167-9503
Phone: (607) 652-7366 • **Fax:** (607) 652-2342
Website: www.dec.ny.gov

NEW YORK STATE FISH AND WILDLIFE PERMIT

Commissioner

1.License Type **PERMIT TO TRANSPORT UNCERTIFIED FISH**

2.Licensee:

Chris Tomichek
Kleinschmidt Associates
35 Pratt Street, Suite 201
Essex, CT 06426

3. Effective Date(s):	August 1 – November 1, 2011
4. Shipment:	Adult American eels
5. From (location):	Newport, Maine
6. To (location):	Conroy's Bait Supply 711 19th Street Watervliet, NY 12189
7. Authority:	Norman D. McBride

9. STATUTORY AUTHORITY

Section 35.3 of Title 6 NYCRR Part 10

Bait fish taken from any water body pursuant to section 35.2 of 6 NYCRR Part 10 shall only be possessed, sold, offered for sale, bartered, transferred or used in the same water body from which such bait fish were taken, and shall not be possessed, sold, offered for sale, bartered, transferred or used in any other water body, except….pursuant to permit issued by the Department in its discretion.

10. CONDITIONS (General Conditions on page 2)

(1) The permittee must retain this permit in his/her possession during transportation of bait fish. No bait fish will be transported overland by motorized vehicle except in accordance with the provisions of this permit and appropriate provisions of the Environmental Conservation Law and associated regulations.

(2) The permittee will maintain a manifest describing the shipment (quantity/type) of bait fish and documenting the departure and arrival dates, times and locations. Following delivery of the bait fish, all manifests shall be maintained at the permittee's place of business for 120 days after transport of bait fish and will be made available for inspection and copying during normal business hours upon request of any representative of the Department.

(3) Containers used for transport of uncertified bait fish shall be conspicuously marked with the words "Uncertified Bait Fish" on all sides of the container.

(4) Containers used to transport uncertified bait fish will be sanitized in a 1% Virkon or 10% bleach solution after transport is completed and before transport of any other bait fish.

(5) No facilities shall possess both certified and uncertified bait fish.

(6) All bait fish transported beyond the location(s) specified in this permit must be dead, preserved by a method other than freezing, commercially packaged and labeled (name of business, address and description of contents).

(7) The permittee shall notify the Department's Division of Law Enforcement at least 24 hours prior to transport of uncertified bait fish by calling 1-877-457-5680. The permittee will state to the Dispatcher his or her name and indicate that he or she will be transporting uncertified bait fish, the DEC Region in which the bait fish will be transported, the date the bait fish will transported, the make, model and color of the vehicle and the specific locations the bait fish will be transported from and to.

(8) Environmental Conservation Officers may seize any bait fish possessed in violation of this permit. No action for damages shall lie for such seizure, and disposition of seized bait fish shall be at the discretion of the Department.

(9) Environmental Conservation Officers and other representatives of the Department may inspect all facilities and vehicles used to store and/or process bait fish upon request.

7/25/11
Date

Norman D. McBride
Regional Fisheries Manager

GENERAL TERMS AND CONDITIONS

1. Any person issued a New York State Fish and Wildlife Permit assumes all liability and responsibility for any activity conducted under the authority of such permit or actions resulting from activities authorized by the permit.

2. This permit may be revoked for any of the following reasons:

    a. Permittee provided materially false or inaccurate statements in his or her application, supporting papers or on required reports;

    b. Failure by the permittee to comply with any terms or conditions of this permit;

    c. Permittee exceeds the scope of the purpose or activities described in his or her application for the permit;

    d. The permittee fails to comply with any provisions of the New York State Environmental Conservation Law, any other State or Federal laws or regulations of the Department directly related to the permit activity;

3. The renewal of this permit is the responsibility of the permittee.

DIRECT ALL QUESTIONS CONCERNING THIS PERMIT TO THE BUREAU OF FISHERIES AT (607) 652-7366

FHCR ID:

Department Use Only

State of New York
Department of Environmental Conservation

Fish Health Certification Report

[1]CASE# M11083101

[2]Business

Name: BIG INDIAN BAIT	
Owner/Manager: BRYAN APELL/DAVE WHITTEN	
Address: 391 ST. ALBANS RD.	
Town/City: PALMYRA	
State: NY	Zip: 04965
Phone: (860) 767-5069	Fax: ( ) -
Permit or License #:	

[3]Testing Facility / Diagnostic Lab

Name: Kennebec River Biosciences, Inc.	
Owner/Manager: William Keleher	
Address: 41 Main Street	
Town/City: Richmond	
State: ME	Zip: 04357
Phone: (207) 737 - 2637	Fax: (207) 737 - 4504

[4] Wild Fish Sample - Water Body Source

Water Body: SEBASTICOOK RIVER	State: ME	County: SOMERSET

[5]Fish Sample				[6]Testing Results — ENTER: "Pos" if disease is found or "Neg" if disease is tested for but not found							
				Salmonids And Other Species					Salmonids Only		
Species	Lot #	Lot Size	Sample Size	VHS	BF	ERM	IPN	SVC	WD	BKD	IHN
Aguilla rostrata	M11-477	UNK	45	NEG	NEG	NEG	NEG	NEG			

VHS – Viral Hemorrhagic Septicemia
BF – Bacterial Furunculosis
ERM – Enteric Redmouth
IPN – Infectious Pancreatic Necrosis
SVC – Spring Viremia of Carp
WD – Whirling Disease
BKD – Bacterial Kidney Disease
IHN – Infectious Hematopoietic Necrosis

[7]Sample Collector Statement

I certify that my qualifications to make this collection are in accordance with Section 188.2 of the New York Code of Rules and Regulations. I further certify that the fish for this inspection were collected in accordance with the standard procedures identified in:
American Fisheries Society Blue Book ☑ **OIE Manual of Diagnostic Tests for Aquatic Animals** ☐

Company/Agency Name	Address	Phone
KENNEBEC RIVER BIOSCIENCES	41 MAIN ST; RICHMOND, ME 04357	207-737-2637

Collected By (please print)	Collector's Signature	Title	Collection Date
WILLIAM KELEHER	William Keleher	FISH HEALTH INSPECTOR	8/31/11

[8]Inspector's Statement

I certify that my qualifications to make this inspection are in accordance with Section 188.2 of the New York Code of Rules and Regulations. I further certify that the fish from the business above were diagnosed in accordance with the standard procedures identified in:
American Fisheries Society Blue Book ☑ **OIE Manual of Diagnostic Tests for Aquatic Animals** ☐

Company/Agency Name	Address	Phone
Kennebec River Biosciences, Inc.	41 Main Street; Richmond, ME 04357	(207) 737-2637

Inspected By (please print)	Inspector's Signature	Title	Date
WILLIAM KELEHER	William Keleher	FISH HEALTH INSPECTOR	9/29/11

Fish Health Inspection Report

Company: Kleinschmidt Associates
Facility : Big Indian Bait
Location: 391 St. Albans Road
Palmyra, ME 04965
USA

Site Manager: Bryan Apell
Phone: (860) 767-5069

Water Source: River
Water Treatment: None

Current Inspection: 31-Aug-11
Prior Inspections:

Type of Fish Examined: Feral

Lab Accession: M11083101

Species	Lot ID	Age	Number in Lot	Eggs (E) or Fish (F) Origin	Sample Date(s)	*Pathogens - Methods and Results								
						Viruses					Bacteria		Parasites	
						IPNV	LMBV	SVCV	VHSV	VNNV	BF	BRM	HSP	B. ach.
Anguilla rostrata american eel	M11-477	5+	unk	(F) Sebasticook River - east branch (ME)	31-Aug-11	I24B		I42B	I42B		A1A	A1A		
						45		45	45		45	45		
						neg		neg	neg		neg	neg		

Notes: * See other side of sheet for explanations of Pathogens - Methods and Results coding

All lots were tested according to American Fisheries Society-Fish Health Section's "Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens" (2010 protocols.

Samples Collected By: W. Keleher
Affiliation: Kennebec River Biosciences, Inc.
Telephone: (207) 737-2637
Client Reference #:
Inspecting Biologist William Keleher

William R. Keleher, Jr., Fish Health Inspector

FOOTNOTES:

PATHOGEN ABBREVIATIONS

IPNV	Infectious Pancreatic Necrosis virus
IHNV	Infectious Hematopoietic Necrosis virus
VHSV	Viral Hemorrhagic Septicemia virus
VEN	Viral Erythrocytic Necrosis virus
HPV	Herpesvirus salmonis
SVCV	Spring Viremia Carp virus
YTV	Yamame Tumor virus
EEV	Epizootic Epitheliotropic virus
ISAV	Infectious Salmon Anemia virus
EHNV	Epizootic Haematopoietic Necrosis virus
BF	Aeromonas salmonicida
BRM	Yersinia ruckeri
BKD	Renibacterium salmoninarum
WD	Myxobolus cerebralis
CS	Ceratomyxa shasta
PKD	Proliferative Kidney Disease
HSP	Heterosporis spp.
B. ach.	Bothriocephalis acheilognathi (Asian Tapeworm)

In lots of fish less than one year of age, the age is listed in arabic numerals followed by mo. for month; for fish older than one year, the age is expressed in arabic numerals followed by a plus sign to indicate "older than".

Findings are reported in columns from top to bottom for each lot as follows: number of fish examined; methods used; results. Positive results include the number of positiv individuals (or pools).

RESULTS ARE REPORTED AS (-) IF NEGATIVE AND AS # +/ # SAMPLED IF POSITIVE.

FOR BKD, APPROXIMATE LEVELS OF INFECTION ARE ALSO REPORTED (e.g., 10/ 50 fields)

VIRAL PATHOGENS:

First letter = sampling method

A = whole fry homogenates(minus head, tail, yolk sac if present)
B = whole visceral homogenates
C = kidney/spleen
D = ovarian fluids
E = kidney/spleen/heart
F = kidney/spleen/liver
G =kidney/spleen/heart/liver/pyloric caeca/gill
H = kidney/spleen/swim bladder
I = kidney/spleen/heart/liver
J = brain/eye
K = kidney/spleen/pyloric caeca/gill
L = kidney/spleen/heart/swim bladder
M= kidney/spleen/liver/swim bladder
N = kidney/spleen/heart/liver/swim bladder
O = kidney/speenl/heart/pyloric caeca/gill

Numbers = continuous cell lines used

1 = RTG-2 (rainbow trout gonad)
2 = CHSE-214 (chinook salmon embryo)
3 = FHM (fathead minnow)
4 = EPC (epithelioma papillosum cyprini)
5 = BF-2 (bluegill fry)
6 = SHK 1/3 (salmon head kidney)
7 = ASK (atlantic salmon kidney)
8 = SSN-1 (striped snake head) 9
= KF-1 (koi fin)
10 = CCO (Channel Catfish Ovary)

Last letter = Pooling of samples

A = individual fish
B = five fish pools
C = Other___________________

PROTOZOAN/PARASITIC PATHOGENS:

A = Digestion method
B = Plankton centrifuge method
C = Examination of stained smear
D = Gross Examination
E = PCR (Polymerase Chain Reaction)
F = Microscopic Examination

BACTERIAL PATHOGENS:

Encoded as follows:

First letter = Health of fish sampled

A = Live, healthy fish
B = Moribund fish
C = Mortalities

Number = Material sampled

1 = kidney
2 = hindgut
3 = lesion
4 = gill
5 = ovarian fluid
6 = seminal fluid
7 = Other___________________

Last letter = technique used for:

Primary Isolation

A = Standard culture medium TSA/BHI
B = Cytophaga agar
C = KDM2/SKDM2
D = Kidney smear/impression

Presumptive Diagnosis

E = Gram stain, kidney smears (BKD)
F = Standard biochemical/physical testing
G = Giemsa stain

Confirmatory diagnosis

H = Slide agglutination
I = Direct fluorescent antibody test
J = Indirect fluorescent antibody test
K = ELISA
L = Immunodot
M = Fluorescent immunoassay
N = PCR

APPENDIX C

FIGURES

APPENDIX C

FIGURES

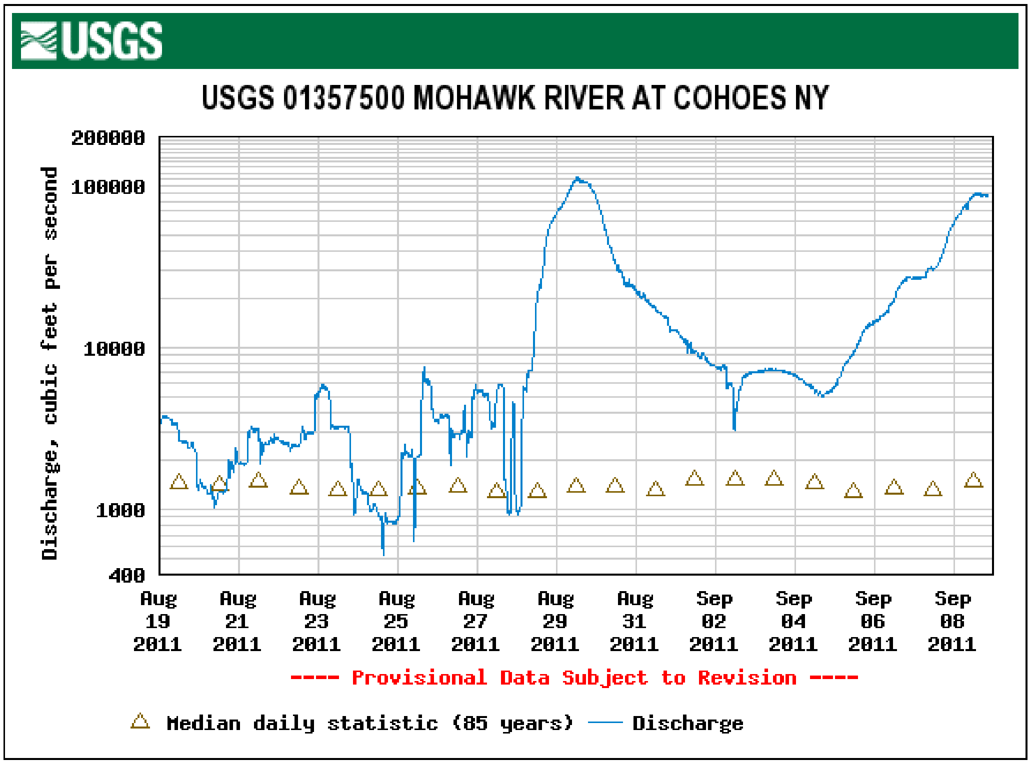
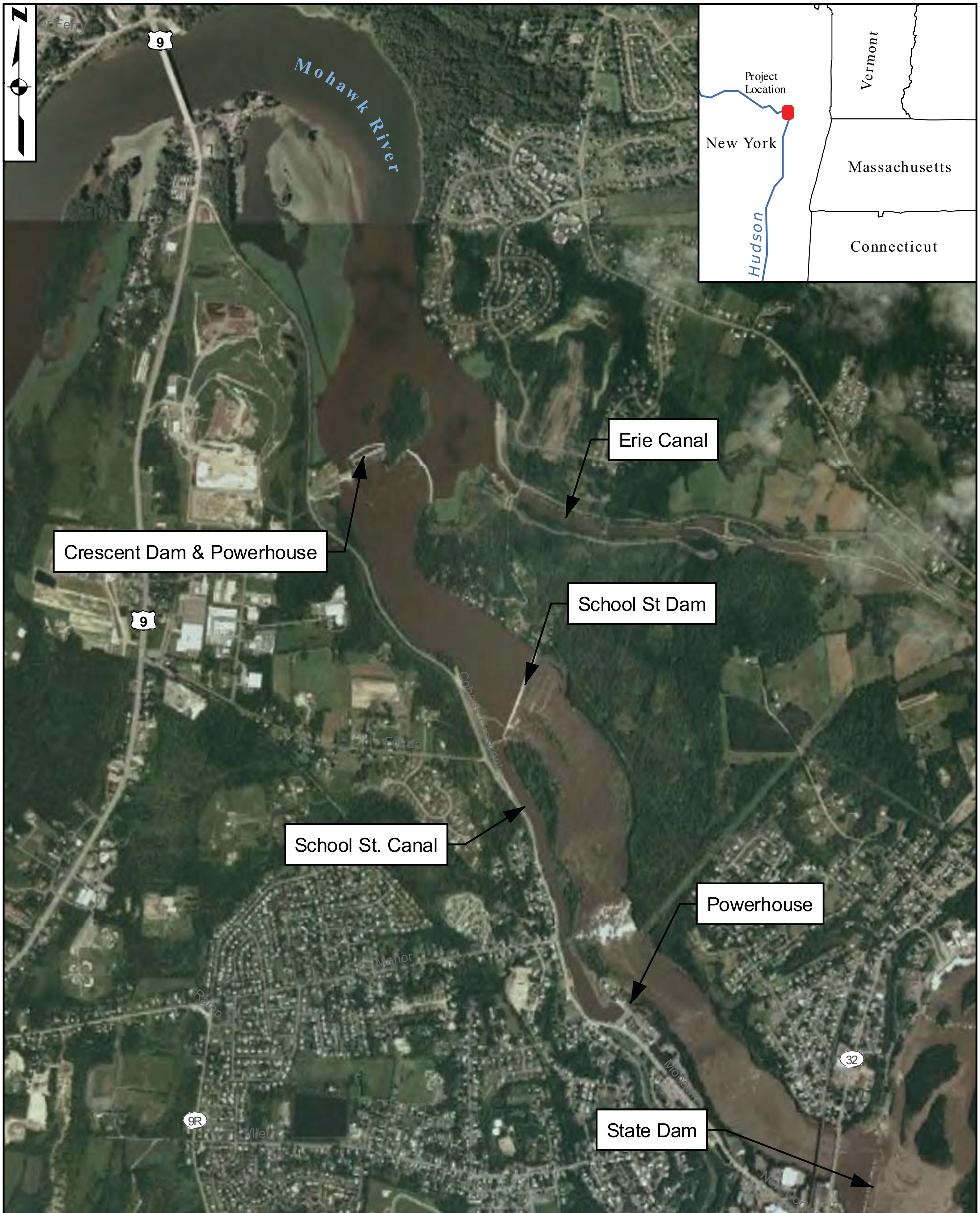


Figure 1. The flow record for the Mohawk River as measured at the USGS Gauge 01357500 Mohawk River at Cohoes, NY. The high flow event between August 29 and August 31, 2011 was the result of Tropical Storm Irene.



Scale: AS SHOWN	BROOKFIELD RENEWABLE POWER LOCATION
Project No: 826110	SCHOOL STREET PROJECT FISHWAY BIOLOGICAL ASSESSMENT
Filename: SiteLocus.mxd	SITE LOCUS
Drawn By: KPN	Kleinschmidt Energy & Water Resource Consultants 35 Pratt St. Sutie 201 Essex, CT 06426 Telephone: (860) 767-5069 Fax: (860) 767-5097 www.KleinschmidtUSA.com
Date Drawn: 01-15-2009	

1 of 1

2

Figure 3. The angled fish guidance structure at the School Street Project, Cohoes, NY.

Figure 4. One of two fishway intakes (*center*) and the debris/ice sluice intake (*adjacent to fishway intake to the right*) at the School Street Project, Cohoes, NY.

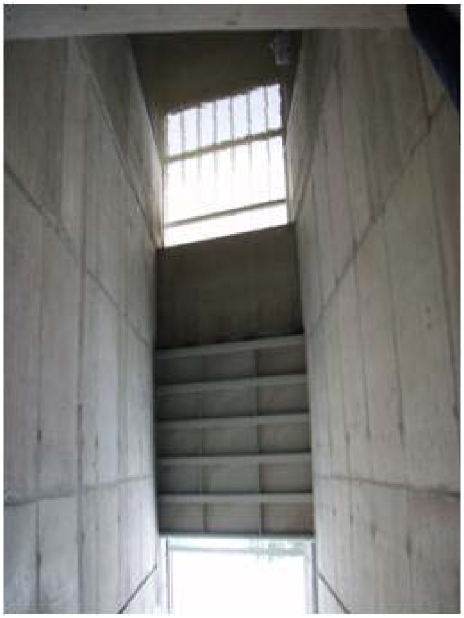


Figure 5. The multi level gate structure within the fishway intake structures at the School Street Project, Cohoes, NY.

Figure 6. The fishway separation chamber at the School Street Project, Cohoes, NY. Note that the photo on the right was taken prior to the installation of the fish separation screen.

Figure 7. The net pen used to recapture test eels and herring at the School Street Project, Cohoes, NY. Note the eel captured in the center of the photo.

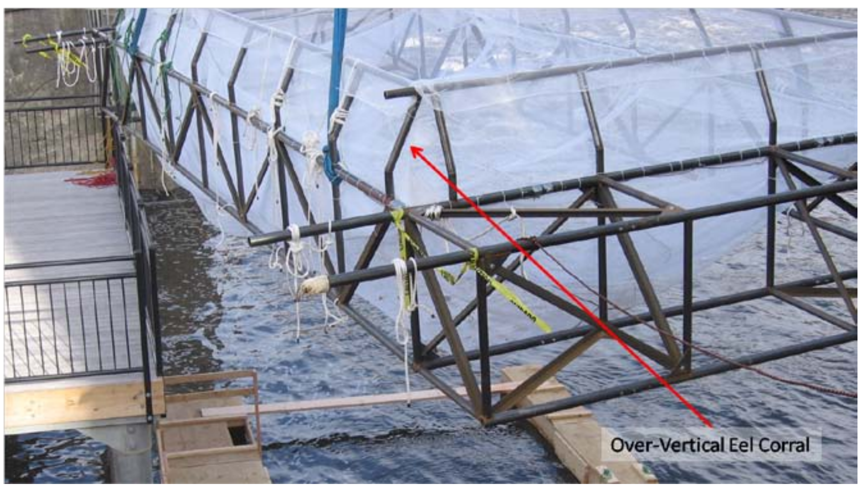


Figure 8. The over-vertical eel corral constructed to minimize escapement during eel testing and holding periods at the School Street Project, Cohoes, NY.

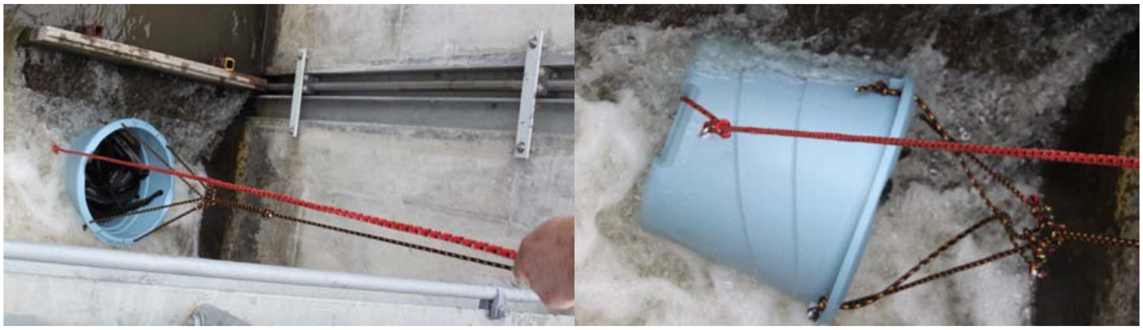


Figure 9. American eel bucketed lift system used to deploy test eels during the American eel survival evaluation at the School Street Hydroelectric Project, Cohoes, NY.

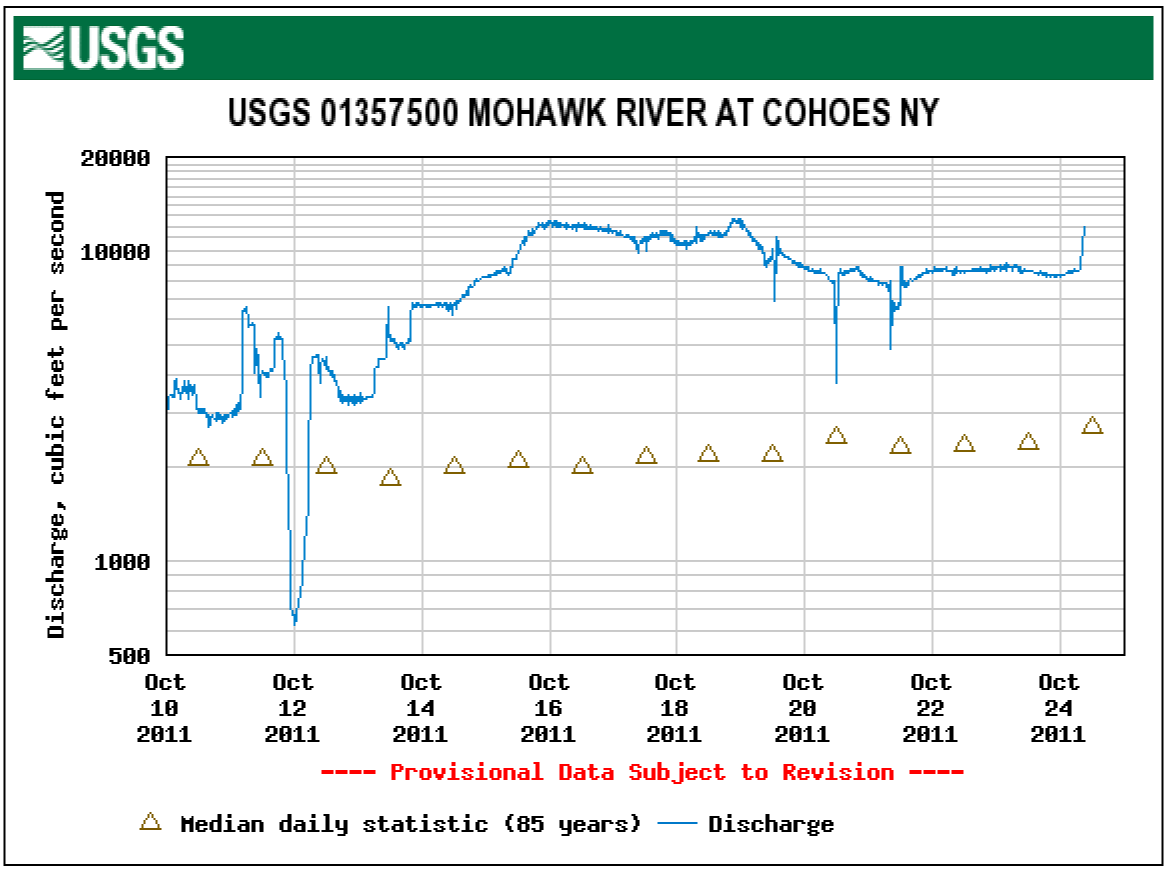


Figure 10. The flow record for the Mohawk River as measured at the USGS Gauge 01357500 Mohawk River at Cohoes, NY. The low flow period on October 12 was the result of the hydroelectric unit lock-out to promote safety and to facilitate the deployment of the net pen.

Figure 11. Fish holding tank system at the School Street Project, Cohoes, NY.

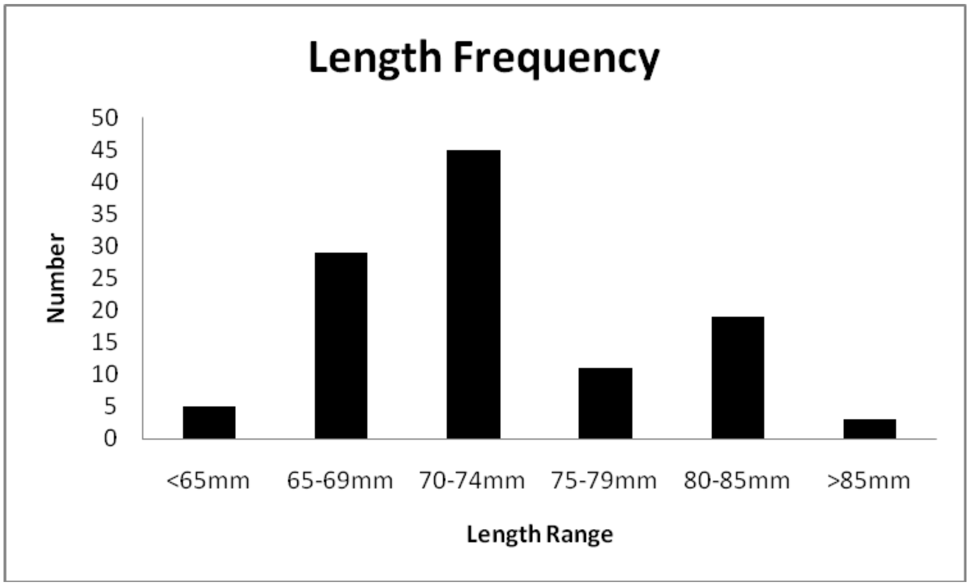


Figure 12. Length frequency of a representative group of test herring used in the bypass survival evaluation at the School Street Project, Cohoes, NY.

APPENDIX D

TABLES

APPENDIX D

TABLES

Table 1. Water quality parameters measured in the School Street Project power canal during the bypass survival evaluation of American eel Cohoes, NY.

Water Quality Parameters	10/12/2011	10/13/2011
Temperature (°C)	15.19	15.34
D.O. (mg/L)	9.1	10.22
Conductivity (µS/cm)	273	268
pH	8.1	8.2

Table 2. Water quality parameters measured in each of the three herring holding tanks and the School Street Project power canal Cohoes, NY.

Date	Water Quality Parameters	Holding Tanks 1	2	3	Power Canal
8/24/2011	Temperature (°C)	23.08	23.12	23.15	23.05
(Morning)	D.O. (mg/L)	5.80	5.25	6.60	5.15
	Conductivity (µS/cm)	330	330	330	330
	pH	6.89	7.21	7.32	7.02
8/24/2011	Temperature (°C)	23.9	23.9	23.8	23.35
(Afternoon)	D.O. (mg/L)	6.1	5.56	6.33	5.19
	Conductivity (µS/cm)	337	337	336	333
	pH	6.95	7.2	6.43	6.95
8/25/2011	Temperature (°C)	22.64	22.64	22.69	22.71
	D.O. (mg/L)	6.33	5.27	7.33	5.9
	Conductivity (µS/cm)	327	328	329	330
	pH	6.71	6.89	7.23	7.21
8/26/2011	Temperature (°C)	22.32	22.27	22.31	22.49
	D.O. (mg/L)	5.9	4.54	5.57	5.64
	Conductivity (µS/cm)	349	347	347	350
	pH	6.79	7.17	7.24	7.28

JUVENILE BLUEBACK HERRING DOWNSTREAM PASSAGE EFFICIENCY STUDY

SCHOOL STREET PROJECT
FERC NO. 2539

Prepared for:

Brookfield Renewable Power
Queensbury, NY

Prepared by:

Kleinschmidt

October 2012

Juvenile Blueback Herring Downstream Passage Efficiency Study

School Street Project
FERC No. 2539

Prepared for:

Brookfield Renewable Power
Queensbury, NY

Prepared by:

Kleinschmidt

October 2012

JUVENILE BLUEBACK HERRING DOWNSTREAM PASSAGE EFFICIENCY STUDY

SCHOOL STREET PROJECT
FERC NO. 2539

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1.0 INTRODUCTION

The School Street Hydroelectric Project (Project) (FERC No. 2539) is owned and operated by Brookfield Renewable Power (Brookfield). The Project is located on the Mohawk River, 2.5 river miles upstream of its confluence with the Hudson River in Cohoes, New York. The Project was issued a new FERC License on February 15, 2007. Downstream fish passage for anadromous and catadromous fish, as well as resident fish, was required as part of the new license. In September 2007, a Final Plan was developed to investigate the phase I fishway effectiveness. The Final Plan included requirements for testing downstream passage survival for resident fish, American eels, juvenile and adult blueback herring; passage efficiency of juvenile and adult blueback herring; an inspection of the conveyance structures; and a hydraulic survey to document flow field and approach velocities in front of the angled bar rack and fishway entrances.

To date, Brookfield has met their obligations to investigate the phase I fishway effectiveness as described in the Final Plan (Kleinschmidt 2007) and Phase I Fishway Effectiveness Testing Study Plan (Study Plan) (Kleinschmidt 2011), with one exception; the evaluation of downstream bypass efficiency of juvenile blueback herring (JBBH). Further, as detailed in the Study Plan, Brookfield proposed to re-evaluate downstream passage survival of JBBH in 2012 due to the relatively low survival estimated in the 2011 study. Brookfield chose not to conduct the survival evaluation in 2012; therefore, survival is not addressed in this report. Brookfield may revisit the survival study in 2013.

In 2012, Brookfield conducted a study to evaluate downstream passage efficiency of JBBH at the Project. The following report details the downstream passage efficiency study background, materials and methods used in the evaluation, the results and conclusions.

2.0 BACKGROUND

The Final Plan requires the evaluation of downstream passage of JBBH at the Project and prescribed the use of passive study techniques. Brookfield first investigated the use of hydroacoustic and DIDSON camera technologies to evaluate passage efficiency. In the summer of 2010, Brookfield conducted a feasibility assessment of these technologies. The feasibility assessment demonstrated that hydroacoustic and DIDSON technologies could be used to evaluate passage efficiency at the Project. Brookfield, mobilized to conduct the full scale study in August of 2010. The study did not meet its objective of evaluating passage efficiency due to high water, low test fish availability and site specific conditions. Significant resources were dedicated to this effort with little result.

In July 2011, Brookfield proposed an alternative approach; a Passive Integrated Transponder (PIT) tag based study to evaluate downstream passage at the Project. The proposed methodology was detailed in a Study Plan and submitted to the New York State Department of Environmental Conservation (NYDEC) and the United State Fish and Wildlife Service (USFWS) for review, comment and approval (Kleinschmidt 2011). The agencies concurred with Brookfield’s revised approach (Appendix A).

Prior to the start of the 2011downstream passage season, Brookfield conducted a feasibility assessment of the Full Duplex (FDX) PIT tag technology. The assessment concluded that the FDX PIT technology could be effectively used at the Project. As such, Brookfield mobilized to conduct the efficiency evaluation during the 2011 downstream passage season. However, the 2011 study was aborted due to unseasonably high flow conditions in the Mohawk River caused by tropical storm Irene. The study was reengaged in 2012, which is the emphasis of this report.

3.0 METHODS

A JBBH passage efficiency evaluation of the downstream fish bypass facilities was conducted in August and September, 2012. The methods detailed in this section were guided by the scope of study defined in the Study Plan (2011) and were drafted in consultation with the USFWS and NYSDEC.

3.1 MONITORING SYSTEM

A FDX PIT antenna and receiver (manufactured by Oregon RFID) were deployed on August 7, 2012 at the entrance to the final return pipe located immediately downstream of the fish return weir (Figure 1). This location was considered ideal for monitoring test fish that have successfully located and navigated the fish bypass facilities to a point of no return. Further, the relatively small return pipe entrance (diameter ~26 inches) provides a consolidated area in which tagged fish can be effectively monitored using a FDX PIT system. A wooden frame constructed of 4” x 4” pine was mounted between the PIT antenna and the concrete wall that houses the entrance to the final return pipe. This wooden frame provided the spacing necessary to minimize antenna interactions with the steel return pipe and steel rebar in the concrete. Once installed, the PIT antenna efficiency was tested to investigate the adequacy of the precautions taken to minimize radio interference from ambient sources at the Project. The test consisted of passing a PIT tag through the antenna repeatedly and noting the ratio of total detection per total passes through the antenna. Refinements to the FDX PIT monitoring system were made, including grounding of the receiver and antenna, and shortening and rerouting the twin axial cabling between the antenna and receiver to minimize length and proximity to metal infrastructure.

Three, 1000 gallon fish holding tanks were deployed at the Project (Figure 2). The water in the holding tanks was continuously replenished using three submersible pumps, one pump for each of the three holding tanks. The holding tanks and pump-through system were located adjacent to the power canal, which provided the source of the circulation flow. Water quality was monitored daily in each of the three tanks, as well as the power canal. Water quality parameters were measured using an YSI 556 water quality meter, which was calibrated in accordance with the manufacturer’s specifications. Water quality parameters measured included water temperature, conductivity, dissolved oxygen (DO), and pH, and all parameters were recorded in a dedicated field book.

3.2 TEST FISH COLLECTION

Test herring became available in collectable numbers in mid-September. Beginning on September 15, the fish separation chamber was operated so that attraction flow induced downstream movement of JBBH into the separation chamber while the weir gate was adjusted concurrently to provide no egress over the weir. This operational strategy, enticing herring into the separation chamber while providing no downstream route of egress, helped to concentrate fish within the confined space of the chamber for collection.

On September 21, 2012, test herring were collected in accordance with the permit issued by the NYDEC (Appendix C). The test fish collection was conducted in the separation chamber using long handled dip nets. The test fish were transferred from the dip net to a 15 gallon tank and transported to one of the three 1,000 gallon holding tanks. This process was repeated approximately 20 times for a total collect of approximately 1,000 JBBH. The test herring were held overnight in two of the three holding tanks (Tanks 1 and 2) (~500 JBBH per tank) to investigate latent mortality associated with the collection method. The third tank (Tank 3) was reserved for holding tagged fish. The holding tanks were covered with fine mesh netting to prevent escapement and predation, as well as to provide shading. Twenty five pounds of salt (sodium chloride) was added to the holding tanks daily to reduce holding stress.

3.3 TAGGING FEASIBILITY

Two groups of JBBH, Groups 1 and 2, were tagged on September 22 and 23, 2012 respectively, to investigate the feasibility of implanting PIT tags into the peritoneal cavity of JBBH. A small test group of 10 fish was placed in an anesthesia solution of water and MS-222 at a concentration of 40mg/L. The test group was observed and the length of time for the onset of sedation was recorded. The group of sedated test fish was then transferred to a recovery tank containing river water and were observed. The length of time for recovery (e.g. a return to normal swimming behavior) and the condition of the test fish was noted (alive or dead).This test was conducted to investigate the concentration of MS-222 that would adequately anesthetized the test herring without inducing significant mortality.

Once an appropriate anesthetic medium was established, a group of 147 fish (Group 1) were anesthetized and tagged with a FDX PIT tag measuring 9mm x 1.4mm (Figure 3). The PIT tag was injected into the peritoneal cavity using PIT tag injectors. The injectors were sterilized between each tagging in a solution of 60% isopropyl alcohol and water. After tagging, the fish were temporarily placed in a recovery tank containing river water and observed. Those fish that recovered from the tag implantation were then placed into a 1,000 gallon holding tank and held overnight to investigate latent mortality associated with the tagging process. Tags were recovered from those fish that did not survive the initial tagging process and were sterilized and re-injected. The status of Group 1 was evaluated on the morning of September 23, 2012 as alive or dead and tallied. Survival was calculated by the simple proportion:

Equation 1. $$\text{Survival} = 100(n_a/n_t)$$

Where; n_a = the number of alive tagged fish, and
n_t = the total number of fish tagged.

A second group of 100 test fish (Group 2) were tagged on the afternoon of September 23, 2012. The same procedure was follow for Group 2 with one exception; anesthesia was not used to sedate Group 2 in an attempt to increase survival by minimizing compounding handling stressors. The tagged fish were held overnight and evaluated on the morning of September 24, 2012. The survival of the second test group was calculated using Equation 1.

A group of 103 fish was selected at random and measured (total length) to establish a representative length frequency distribution of test fish. All test fish used in the evaluation were visually inspected and free from visible injury, significant descaling and/or stress related behavior (i.e. torpid swimming). All surplus test fish were returned alive to the Mohawk River.

4.0 RESULTS

The FDX monitoring system efficiency was tested on August 8, 2012. The initial read efficiency was poor, 33%. Adjustments were made to the FDX monitoring system to minimize ambient radio noise and retesting resulted in complete detection (100%).

PIT tag testing was conducted between September 22 and September 24, 2012. A small test group of 10 fish were anesthetized in a solution of MS-222 and water at a concentration of 40mg/L. Sedation occurred between 30 seconds and 1 min in the anesthetic, depending on the individual fish. Recover period, in a tank of river water, ranged between 1 and 2.5 minutes. Nine of 10 fish survived the anesthetization and recovery test, for a survival of 90%.

Group 1 consisted of 147 fish, of which 22 did not survive the initial tagging procedure, resulting in an initial survival of 85%. The remaining 125 fish were held for an additional 18 hours and re-evaluated. Twenty of 125 fish survived the holding period for a latent survival of 16%. Group 2 consisted of 107 fish, of which 7 did not survive the tagging procedure and resulted in an initial survival of 93.5%. The remaining 100 fish were held for an additional 19 hours and re-evaluated. 1 of 100 fish survived the holding period for a latent survival of 1%. Tag retention was high, of the 225 test herring that were held to investigate latent mortality (hold time 18-19hrs) 222 retained their tags for retention of 98.6%. The study team was unable to reach the goal of an 80% tagging survival and the approach was deemed unfeasible and the study was discontinued as stipulated in the Study Plan.

Water quality was measured daily in each tank as well as the power canal (Table 1). Water quality was generally good and within the suitable range for JBBH and other aquatic life occurring in the Mohawk River system. Water temperature ranged from a low of 18.92°C to a high of 20.97°C, dissolved oxygen ranged from a low of 9.10 mg/L in the power canal to a high of 12.05 mg/L and pH ranged from 7.6 to 7.89. Figure 4 depicts the Mohawk River flow during the study, which ranged from a low of approximately 585 CFS to a high of approximately 3200 CFS.

Fish health was monitored daily and those that died in the holding tanks were set aside for evaluation. Of these dead fish, a group of 103 was chosen at random and measured; their length frequency distribution is depicted in Figure 5. Holding loses in the supply tanks (1 and 2) occurred at a rate of ~5% or 50 fish per day. Total length ranged from 43 mm to 80 mm with an average of 65.9 mm. JBBH length data collected at School Street during the 2011 out migration resulted in an average length of 72.5 mm (n=110). The average length of JBBH was 66 mm or 10% less in 2012 when compared to the previous year.

5.0 DISCUSSION

Blueback herring (BBH) are a diadromous species of fish that seasonally enter freshwater streams and rivers in New York for reproductive and rearing purposes. As with most clupeid species, the BBH is fragile and particularly susceptible to handling stresses. However, the School

Street Study Team (Study Team) has had success handling BBH at the Project in previous years. Based on the Study Team's experience, combined with advances in FDX PIT tag technology that has resulted in smaller tag size, Brookfield chose to investigate the feasibility of using PIT tag methods to evaluate downstream passage efficiency of JBBH at the Project. This approach, while sound in methodology, had not been well-vetted for use with JBBH. Prior work conducted in Maine by NextEra demonstrated that juvenile alewives (similar in size and character to JBBH) could be PIT tagged and lent credence to the approach.

The Study Team was not able to achieve a tagging survival of 80% as was required by the Study Plan in order to continue with the efficiency evaluation and the study was therefore discontinued. There are a number of factors that can affect the survival of fish during the tagging , including but not necessarily limited to fish health; water quality parameters (i.e. water temperature and dissolved oxygen); handling and collection techniques; tagging methods; and holding methods (CBFWAPTSC 1999).

The study team took great care to minimize any potential impact to tagging survival, posed by the factors listed above. As such, only those fish that exhibited normal swimming behavior, with no signs of physical damage (i.e. significant descaling, abrasions, lesions and/or other physical abnormalities) were selected for use in the evaluation. Water quality was monitored daily and was generally well within the suitable range for JBBH in the Mohawk River system. The water quality parameters in the pump-through fish holding system were similar to or better than those measured in the power canal. The amount of dissolved oxygen in the holding tanks was notably higher than that of the power canal in most cases. The elevated DO in the holding tanks resulted from the mixing of atmospheric oxygen in the water by the cascading flow of the circulation pumps and provided ample available oxygen. The water temperature in the holding tanks was similar to that of the power canal. However, water temperatures were well in excess of optimal, between 5 and 10°C, and as the temperature increases above 15 degrees, fish become stressed very easily. Water temperature may have contributed to the poor latent survival by stressing the test herring. The ambient water temperature of the Mohawk River was in excess of 15°C during the evaluation, which was outside of control of the Study Team as the timing of the evaluation was dictated by the availability of emigrating JBBH and not water temperature criteria. Handling and holding stresses were also likely contributors to mortality during the evaluation. The Study Team attempted to minimize these potential stressors by working with only a few fish at a time so as to not overcrowd the test fish. Tagged fish were placed in a 1,000 gallon tank which was recirculated twice per hour, during the holding period. The largest number of fish held in this holding tank at any one time was 125 resulting in a maxim density of 0.125 fish/gallon or 8 gallons/fish. Fish held at this density are not likely to experience stress from overcrowding.

One unexpected variable that may have also contributed to the poor survival of the tagged test fish was their small size. On average, available test fish were 10% smaller that those sampled in 2011, which is particularly surprising considering that the 2012 test fish collection was conducted later in the growing season (September 21, 2012) than those of the 2011 study (August 25, 2011). The cause of the departure in average size between 2011 and 2012 was not investigated and is outside of the scope of this study. However, this factor may be profound in this study, where the test fish small size was considered to be an important factor in surviving the tagging process. The unexpected reduction in average test fish size was likely a contributing factor to the poor tagging survival. However, those tagged fish that did survive the holding period were only slightly larger (66.5 mm) than the average (65.9 mm). Much larger fish (~90 mm or 27% larger on average) were used in the successful tagging of juvenile alewives as report by NextEra (Tim Welch, NextEra, *personal communication)* (Figure 6)**.**

The Group 1 test fish were tagged using an anesthetic; Group 2 was not in an attempt to maximize survival by reducing the compounding effects of handling and chemical stressors. Further, the Study Team found the eliminating the use of anesthetic did not make the tagging process any more difficult or less efficient. The initial survival increase from 85% to 93.5%, respectively but decreased in latent survival from 16% to 1%. This result was somewhat confounding and it is unclear if eliminating the use of anesthesia was beneficial.

6.0 CONCLUSION

The study concluded that while the FDX PIT monitoring system was capable of detecting PIT tags in the downstream fish bypass, the evaluation of the bypass overall was not feasible due to the poor tagging survival of the juvenile blueback test herring. The poor survival was likely due to several factors including, the fragility of JBBH; water temperatures in excess of 15°C; handling and holding stresses; and the unexpectedly small size of available test fish. These compounding factors negatively affected the fitness of the test group and combined, resulted in poor tagging survival and ultimately the conclusion that under the conditions described herein that the use of FDX PIT technologies to evaluate downstream passage efficiency at the School Street Project is not feasible.

7.0 LITERATURE CITED

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Kleinschmidt. 2007. Phase I Fishway Effectiveness Testing Plan Addressing Settlement Agreement Section 3.7, and 401 Water Quality Certification Condition 13, FERC Project No. 2539. Prepared for: Erie Boulevard Hydropower, L.P.

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APPENDIX A

AGENCY CONSULTATION

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
Division of Fish, Wildlife & Marine Resources
625 Broadway, 5th Floor, Albany, New York 12233-4750
Phone: (518) 402-8924 •**Fax:** (518) 402-8925
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Joe Martens
Commissioner

August 5, 2011

Bryan Apell
Kleinschmidt Associates
35 Pratt Street, Suite 201
Essex, CT 06426

RE: School Street hydroelectric Project; FERC# 2539
Comments on "Phase I Fishway Effectiveness Testing Supplemental Study Plan

Dear ~~Mr. Apell~~ Bryan!

The New York State Department of Environmental Conservation (DEC) has had opportunity to review the "Phase I Fishway Effectiveness Testing Supplemental Study Plan" for the School street Hydroelectric Project (FERC# 2539), submitted to us on July 15, 2011.

The Supplemental Plan was necessary as the 2010 juvenile herring evaluation was not completed due to high flow conditions, and lack of test fish availability. American eel downstream passage survival evaluation was also not completed due to a lack of test fish.

It is our opinion that the Supplemental Plan adequately details the methods that Brookfield will use to address the outstanding requirements in 2011. DEC agrees with the built-in flexibility in schedule and procedures that may be necessary to complete the study as dictated by Project operation, prevailing weather, river flow conditions and test fish availability.

Please feel free to contact me at any point during the study period should additional consultation be necessary, and I look forward to reviewing the study results.

Sincerely,

Mark S. Woythal

Mark S. Woythal
Instream Flow Unit Leader

cc: Tim Lukas; Brookfield Renewable Power
Norm McBride; DEC, Stanford
Roy (JR) Jacobson; DEC, Albany
Bill Little; DEC, Albany
Steve Patch; USFWS, Cortland

2011 Year of the Turtle

United States Department of the Interior

FISH AND WILDLIFE SERVICE
3817 Luker Road
Cortland, NY 13045

August 1, 2011

Bryan Apell, Fisheries Ecologist
Kleinschmidt Energy and Water Resource Consultants
35 Pratt Street, Suite 201
Essex, CT 06426

**RE: School Street Hydroelectric Project (FERC #2539)
Review of Phase I Fishway Effectiveness Testing Supplemental Study Plan**

Dear Mr. Apell:

The U.S. Fish and Wildlife Service (Service) has reviewed the July 15, 2011, *Phase I Fishway Effectiveness Testing Supplemental Study Plan* (Plan) for the School Street Project. We concur with the proposed plan of study. The Service has no further comments on the Plan.

We appreciate the opportunity to review the Plan. If you have any questions or desire additional information, please contact Steve Patch at 607-753-9334.

Sincerely,

David A. Stilwell

David A. Stilwell
Field Supervisor

cc: NYSDEC, Albany, NY (M. Woythal)
FWS, Hadley, MA (C. Orvis)

APPENDIX B

TABLES AND FIGURES

Figure 1. Full Duplex PIT antenna mounted at the entrance to the final fish return pipe, located within the downstream fish passage facilities at the School Street Project Cohoes, NY.

Figure 2. The three 1000 gallon holding tanks used to store test fish at the School Street Project Cohoes, NY.

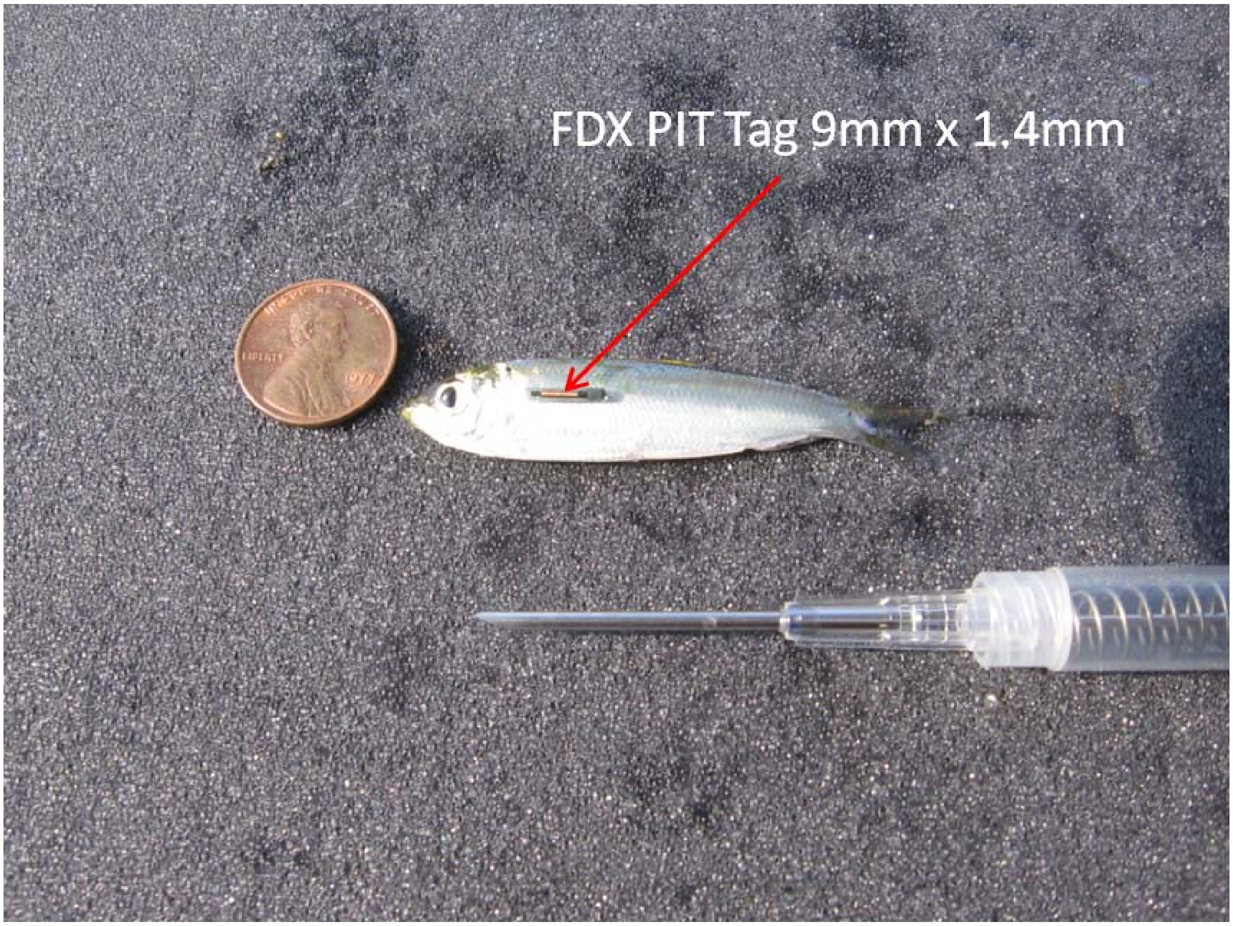

Figure 3. Depicts a typical JBBH used in the tagging survival evaluation Cohoes, NY. Note the JBBH size relative to the size of the FDX PIT tag and injector.

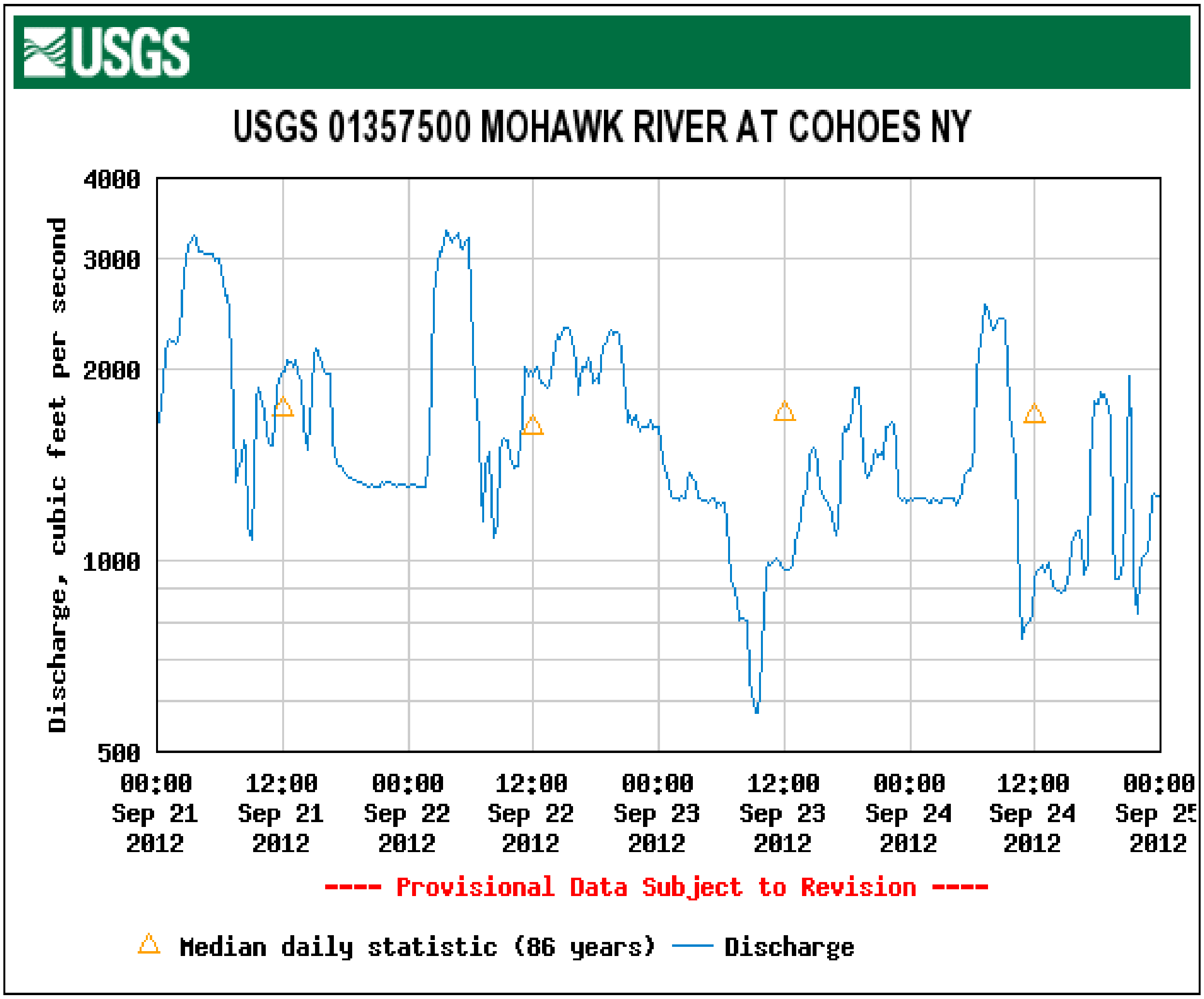

Figure 4. Mohawk River Flow at Cohoes, NY, September 21-24, 2012.

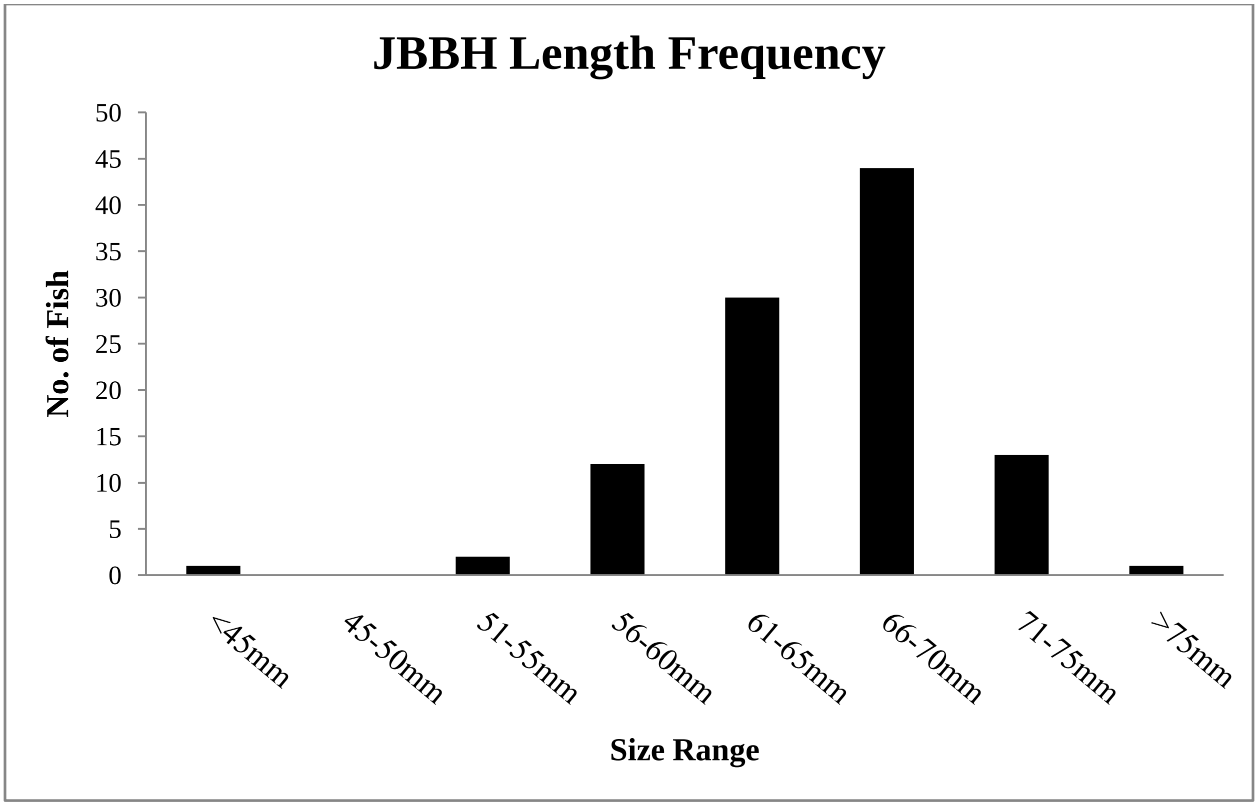

Figure 5. Length frequency of a randomly selected group (n=103) of juvenile blueback herring collected at the School Street Project on September 21, 2012 in the city of Cohoes, NY.

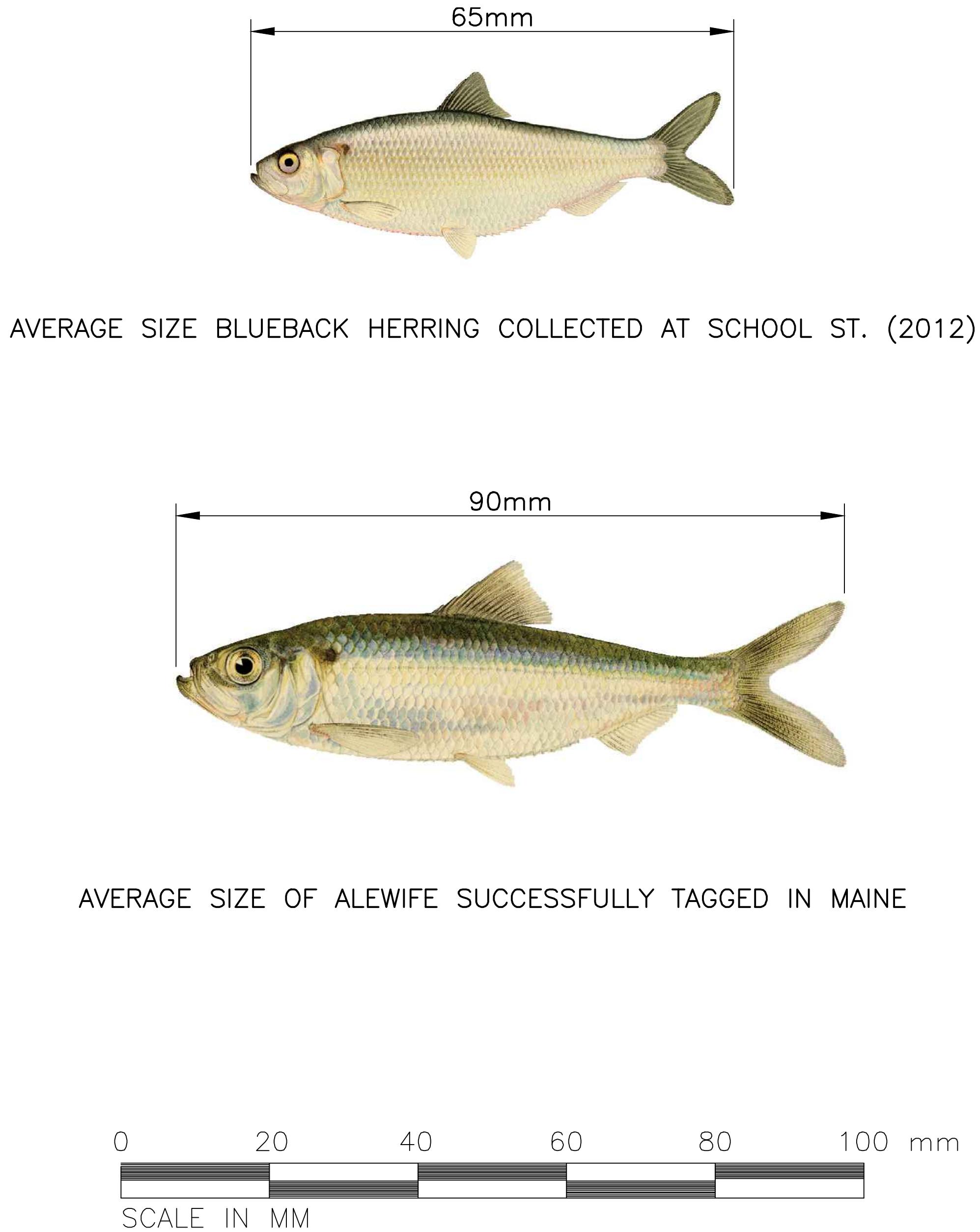

Figure 6. Comparison of the size of the blueback herring juveniles collected at School Street Station in 2012 and the alewives that were successfully PIT tagged in Maine.

Table 1. Water quality parameters measured in the test fish holding tanks and the power canal at the School Street Project Cohoes, NY.

Date	Location	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/L)	pH
9/21/2012	Tank 1	20.67	9.92	475	7.60
	Tank 2	20.84	9.78	-	7.63
	Tank 3	20.97	9.74	484	7.73
	Canal	20.21	9.84	477	7.74
9/22/2012	Tank 1	19.49	11.59	458	7.77
	Tank 2	19.42	11.37	472	7.76
	Tank 3	19.43	12.05	478	7.73
	Canal	19.52	9.72	470	7.68
9/23/2012	Tank 1	19.06	10.88	311	7.78
	Tank 2	19.05	10.57	311	7.76
	Tank 3	18.92	10.10	312	7.89
	Canal	19.25	10.20	312	7.70
9/24/2012	Canal	19.03	9.10	315	7.76

JUVENILE BLUEBACK HERRING DOWNSTREAM PASSAGE EFFICIENCY REPORT

SCHOOL STREET PROJECT
FERC NO. 2539

Prepared for:

Brookfield Renewable Energy Group
Queensbury, New York

Prepared by:

Kleinschmidt

Essex, Connecticut
www.KleinschmidtGroup.com

March 2015

Juvenile Blueback Herring
Downstream Passage Efficiency Report

School Street Project
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Prepared for:

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Queensbury, New York

Prepared by:

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March 2015

JUVENILE BLUEBACK HERRING
DOWNSTREAM PASSAGE EFFICIENCY REPORT

SCHOOL STREET PROJECT
FERC NO. 2539

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JUVENILE BLUEBACK HERRING
DOWNSTREAM PASSAGE EFFICIENCY STUDY

SCHOOL STREET PROJECT
FERC NO. 2539

1.0 INTRODUCTION

The School Street Hydroelectric Project (Project) (FERC No. 2539) is owned and operated by Brookfield Renewable Energy Group (Brookfield). The Project is located on the Mohawk River, 2.5 river miles upstream of its confluence with the Hudson River in Cohoes, New York. The Project was issued a new FERC License on February 15, 2007. Downstream fish passage for anadromous and catadromous fish, as well as resident fish, was required as part of the new license. In September 2007, a Final Plan was developed to investigate the phase I fishway effectiveness. The Final Plan included requirements for testing downstream passage survival for resident fish, American eels, juvenile and adult blueback herring; passage efficiency of juvenile and adult blueback herring; an inspection of the conveyance structures; and a hydraulic survey to document flow field and approach velocities in front of the angled bar rack and fishway entrances.

To date, Brookfield has met their obligations to investigate the phase I fishway effectiveness as described in the Final Plan (Kleinschmidt 2007) and Phase I Fishway Effectiveness Testing Study Plan (Study Plan) (Kleinschmidt 2011), with one exception; the evaluation of downstream bypass efficiency of juvenile blueback herring (herring or juvenile herring). In 2013, Brookfield conducted a study to evaluate downstream passage efficiency of herring at the Project using hydroacoustic technologies; however, an unusually low abundance of outmigrating herring in the river system, possibly due to high flows during the spawning season, prevented the collection of meaningful data to adequately assess passage efficiency in 2013 (Kleinschmidt 2014). Therefore, the study was repeated in 2014. The following report details the 2014 downstream passage efficiency study, including compliance background, the materials and methods used in the evaluation, the results, a discussion of the results and conclusions.

2.0 OBJECTIVES

The goal of this study was to investigate the efficiency of downstream passage of herring by providing a quantitative estimate of the proportion of juvenile blueback herring that uses the fishway (bypassed) vs. the proportion that passes through the turbines (entrained). Passage efficiency was to be evaluated and compared over two bypass flow regimes, 2% and 5% of station capacity.

3.0 PROJECT DESCRIPTION

The Project consists of:

1) A stone masonry gravity dam extending 1,278 ft across the Mohawk River, 16 ft in height;
2) A reservoir with a surface area of approximately 100 acres at a normal maximum water surface elevation of 156.1 ft, and a gross storage capacity of 788 acre-feet;
3) A power canal extending approximately 4,400 ft from the dam to the powerhouse, approximately 150 ft wide and 14 ft deep;
4) An upper gatehouse structure that currently includes nine slide gates and three steel tainter gates to control the diversion of flow into the canal;
5) A lower gatehouse with five steel head gates to control flow into the five penstocks; and
6) A powerhouse measuring 170 ft long by 78 ft wide, housing five generating units with vertical shaft Francis turbines rated at 92 ft of head, with a total maximum capacity of 38.8 megawatts.

4.0 FISHWAY DESCRIPTION

The fishway conveyance structure is located near the downstream end of the angled bar rack. It has two intake portals and includes a multi-level gate with top and bottom entrances (Figures 1 and 2). Attraction flow to the fishway entrances can vary between two to five percent of the Project's total hydraulic capacity. Conveyance pipes from both entrances converge in a fish separation chamber part-way along the fish conveyance structure (Figure 3). The chamber reduces the volume of the bypass flow and guides fish along a wire floor screen, directing them into a fish return weir pool. The excess attraction water flows through the screen and is discharged downstream of the Project. A gate valve at the downstream end of the fish separation chamber provides hydraulic control within the fish conveyance structure. An adjustable weir is located at the inlet to the fish return weir pool (Figure 4). The movable weir provides fine-tune adjustment to the depth of water cascading over the weir as well as the bypass discharge flow (design flow 25 cfs). Once in the fish return weir pool, fish are guided to the entrance of the final return pipe, and are deposited into the tailwater of the Project.

5.0 BACKGROUND

The Final Plan described the evaluation of downstream passage of herring at the Project and recommended the use of passive study techniques. In the summer of 2010, Brookfield conducted a proof of concept study (Feasibility Study) to investigate the feasibility of using DIDSON (Dual-Frequency Identification Sonar) and split-beam hydroacoustic technologies to investigate bypass efficiency. The Feasibility Study demonstrated that DIDSON and split-beam hydroacoustic technologies could be used to effectively compare the quantity of herring passage through the downstream bypass vs. the quantity entrained. As such, Brookfield mobilized to conduct the full scale evaluation during the *fall* outmigration in September and October of 2010. Unfortunately, the effort did not meet the objective of evaluating passage efficiency due to high water, low test fish availability, and site specific conditions. Significant resources were dedicated to this effort with no results.

In 2011, Brookfield consulted with the New York State Department of Environmental Conservation (NYSDEC) and United States Fish and Wildlife Service (USFWS) to develop an alternative approach to investigate downstream bypass efficiency. Brookfield proposed to employ Passive Integrated Transponder (PIT) technologies to evaluate downstream passage at the Project. The proposed methodology was detailed in the *Phase I Fishway Effectiveness Testing Study Plan* (Kleinschmidt 2011) and distributed to the NYSDEC and USFWS for comment and approval. The agencies concurred with Brookfield's revised approach and the study was conducted in the late summer and early fall of 2012 when out-migrating herring became available. The study team found that the small size, high ambient water temperature and fragile nature of the herring made it difficult to effectively tag due to high tagging and handling mortality and the effort had to be abandoned.

In January 2013, Brookfield met with the NYSDEC and USFWS to explore alternatives for a successful evaluation in 2013. It was agreed that hydroacoustic methods should be reemployed to meet compliance objectives relative to downstream passage efficiency at the Project. As such, Brookfield developed a hydroacoustic based study designed to investigate the efficiency of downstream passage of herring by providing a quantitative estimate of the proportion of juvenile blueback herring that uses the fishway (bypassed) vs. the proportion that passes through the turbines (entrained) at two bypass flow regimes, 2% and 5% of station capacity. The study was detailed in a Study Plan titled *Juvenile Blueback Herring Downstream Passage Efficiency Evaluation Study Plan* (Study Plan) (Kleinschmidt 2012, Appendix A). The Study Plan was distributed to the NYSDEC and USFWS for comment and approval. The agencies concurred with Brookfield's approach and the study was conducted in August and September 2013. As indicated above, the lack of meaningful results in 2013 due to very low numbers of out-migrating juvenile herring necessitated an additional year of study, which was conducted in August-September 2014.

6.0 METHODS

The methods detailed in this section were developed in consultation with the NYSDEC and the USFWS. Brookfield employed hydroacoustic technologies to monitor juvenile herring passage through the downstream fish bypass and through the Project units. Acoustic camera technologies were employed to monitor the downstream bypass, whereas split-beam hydroacoustic technologies were employed in the intake area of three of the five units at the Project. Monitoring was conducted between August 19, and September 18, 2014.

6.1 FISHWAY MONITORING

Herring passage through the downstream bypass was monitored using an ARIS 3000 acoustic camera (ARIS) manufactured by Sound Metrics Inc. The ARIS is the latest model of acoustic camera developed by Sound Metrics providing higher resolution images than those of the DIDSON used in the 2010 study. The fishway was operated at two attraction flow scenarios during the study; 2% (120 cfs) from August 19 to September 11 (1030); and 3.83% (230 cfs) from September 11 (1040) to September 18, 2014 of the station's design capacity of 6,000 cfs. A weir extension board was installed to reduce the area in which outmigrating herring could pass over the weir (Figure 5). This arrangement ensured that the ARIS would provide complete monitoring coverage of the passable area. The ARIS employs a relatively wide field of view (29° horizontal) and was mounted to the weir extension and oriented such that fish could be monitored as they approach the weir as well as provide a record of passage as they cascade over it (Figure 5). The ARIS employed a concentrator lens to reduce the vertical beam angle from 14° to 8° and was tilted downward slightly (~2°) to minimize interference with the water surface as well as to detect the top of the submerged weir board to provide a physical reference point by which to evaluate passage over the weir (Figure 6). The fish return weir and cascading flows created a physical barrier to upstream movement and served as a *point of no return* where fish were obligated to continue downstream and bypass the Project.

The ARIS camera was operated at high frequency (3.0 MHz) to provide the greatest possible image resolution and automated to record data continuously throughout the monitoring period. The focal length was set to automatically alternate between two focal zones; 2 and 3.5 meters, at 15-minute intervals so as to not bias data collection efforts to near-field only. All targets were imaged however, just like an optical camera; resolution was greatest at those targets that occurred within the focal zone. The ARIS was operated from a dedicated field laptop and data were archived on external hard drives. The ARIS monitoring system employed an internet connection, which allowed the investigators to access the system remotely via a *Go To MY PC* account. The ARIS system was checked daily throughout the course of the study to ensure proper operation, monitor data storage capacity, and to check for the presence of herring within the fish separation chamber.

In addition to the ARIS, a video monitoring system was employed in the fish separation chamber to verify targets detected by the ARIS. The system employed a Delta Vision Series Camera manufactured by Ocean Systems. Video data were recorded on a dedicated DVR System by Everfocus. The video camera was deployed at the downstream end of the fish separation chamber (Figure 5) and oriented such that the field of view covered the entire passable area over the weir (Figure 7). Peak bypass events were reviewed to verify the identity of acoustic targets.

6.2 INTAKE MONITORING

The School Street Station is typically operated such that Unit 1 is the first-on last-off, with Units 2 through 5 going online sequentially, as station inflow allows. Generally speaking, inflow to the Project during the juvenile herring out-migration period is seasonally low with the majority of generation produced from Units 1, 2 and 3. As such, Brookfield targeted these units for monitoring. Each of the turbine intakes was monitored using DT-X split-beam system manufactured by BioSonics, which employed 200 kHz transducers with a 6.7-6.8° beam.

A transducer was installed at each of the three intake bays at Units 1, 2 and 3 (Figure 8). The transducers were mounted on 2-inch diameter vertical aluminum pipes, attached to the front of the grating covering each bay and positioned in a downward-looking orientation (Figure 9). The transducers were deployed as shallow as possible (~2.0 ft) to maximize the effective sampling area of the conical beam such that each transducer sampled approximately 10% of the penstock opening (Figure 10). The split-beam monitoring system was controlled by a dedicated field computer, which also stored the data. The automated system employed a sampling scheme in which each unit was monitored independently for 20 minutes of each hour of the day (i.e., 20 min at Unit 1, 20 min at Unit 2, and 20 min at Unit 3 for a combined total of 60 min of data per hour). The sampling scheme was employed to reduce the volume of data generated, while maintaining an adequate sample size in which to make hourly comparisons between downstream passage rates via the bypass and Project entrainment rate. Data were collected at a ping rate of 18 pings per second and pulse duration of 0.2 milliseconds with an intensity threshold of -80dB.

The split-beam monitoring system employed an internet connection which allowed the investigators to access the system remotely via a *Go To MY PC* account. The split-beam system was checked daily throughout the course of the study to ensure proper operation, monitor data storage capacity, and to check for the presence of herring moving through the Project intakes.

6.3 DATA ANALYSES

Data collected within the fishway and at the intakes were used to develop estimates of passage (i.e. bypassed and entrainment) over time, such that an estimate of Project passage efficiency (PPE) was calculated as follows:

$$PPE = \sum (\text{bypassed}/(\text{bypassed} + \text{entrained})) * 100$$

The PPE estimates used in the calculation of the PPE reflect the sum of passage over distinct intervals of time in which direct comparisons between the bypass and entrainment could be made and does not provide a comprehensive estimate of the seasonal passage. The proportion was calculated during periods in which both the split-beam (intake) and the acoustic camera (fish bypass) data were valid. In other works, if data were invalid at either monitoring location than it was eliminated from the calculation because a direct comparison could not be made.

6.3.1 ACOUSTIC CAMERA DATA

ARIS data were processed with ARIS Fish software by Sound Metrics Inc. The data were sub-sampled such that fifteen minutes of each hour of data recorded throughout the monitoring period were processed and alternated between the two focal lengths sampled. In other words, 15 minutes of Hour 1, in which the focal length was set to 2 m, were processed, followed by 15 minutes of Hour 2, in which the focal length was set to 3.5 m, and then back to processing 15 minutes of Hour 3 in which focal length was 2 m; and so on. The number of juvenile herring observed during sub-sampling were tallied and multiplied by 4 to estimate the total number of fish passed during the monitoring period. Fish were differentiated from debris based on size, shape and type of motion as indicted in the study plan.

6.3.2 SPLIT-BEAM DATA

Split-beam data were processed in Myriax Echoview software. After applying an intensity threshold of -54dB, the data were analyzed with an α,β-tracking algorithm, which identifies the series of echoes that were returned by an individual fish over successive pings. The tracking results were reviewed on the echogram and exported as a database containing time, target strength and 3-D positional information for each fish detected. This database was further filtered to remove all fish (or other targets) with a mean target strength of -54dB or less, which translates into fish approximately 3.8 cm in length or smaller (Warner et al., 2002).The overall estimate of entrainment include those targets that ranged between 3.8 cm and 10.0 cm, only. This size range was based on the results of the 2012 evaluation at which time length data were collected on 103 individuals and ranged from 4.5 to 7.5 cm. The range was explained (i.e. between 3.8 cm and 10.0 cm) to account for annual variability in juvenile herring length.

Fish counts were expanded for the non-sampled area of the intake cross-section as follows: An expansion factor was calculated for each individual fish as a function of its effective beam width at the range it was observed. This effective beam width depends on the acoustic beam pattern and the size of the target. Thus, for a given transducer, at any given range, a large fish can be detected over a wider portion of the intake cross-section than a smaller fish. The expansion factor compensates for this differential detection probability. For each fish *i* the expansion factor x_i was calculated as:

$$x_i = \frac{w}{b_i}$$

where w is width (m) of the turbine intake, and b_i is the effective width (m) of the sonar beam for fish *i* at the range at which it is observed. For example, if for a given time period, one fish is observed at a range where its effective beam width is half the width of the intake, its expansion factor is 2. Thus, it is estimated that 2 fish passed (1 observed in the portion of the intake that was effectively covered by the sonar beam, 1 unobserved in the portion that was not). The expansion factors are summed over all fish observed in a given time period to estimate the total number of fish *F* that passed through the intake:

$$F = \sum_i x_i$$

The fish counts were further expanded to account for sampling 1/3 of each hour by multiplying the counts by 3. The fish passage rates were calculated by dividing the fish counts expanded for the unsampled area and time by the percentage of the time in each hour when the units operated.

Echogram examples of the split-beam data collected in the turbine intakes are shown in Figure 11 and Figure 12. Each echogram plots echoes over time (x-axis) and range (y-axis), with range increasing from top to bottom. The strong signal at the bottom of each echogram is the echo reflected by the intake floor. In Figure 11, the colors in the top two echograms relate to target strength; the warmer the color the stronger the echo. The strong echo of the intake floor is shown in red. The colors in the bottom two echograms relate to the angle at which the target was detected. Targets that move downstream (as do all targets shown in Figure 11) leave echo traces that change (over time) from cool to warm colors; whereas targets that move upstream generate traces that progress through the color spectrum in the opposite direction (example shown in Figure 12). Traces that show no change in angle color are echoes reflected by a stationary object such as the intake floor. Note that the echo traces in the echogram from Unit 1 (Figure 11, left) are short because the targets move quickly through the beam due to the high speed of the current. When a turbine is idle, as in the case of Unit 3 (Figure 11, right), the speed of the current is low and fish or other targets remain in the beam for a longer time and therefore generate longer echo traces. The diffuse clouds of echoes seen at the top of the echograms from Unit 1 are noise from entrained air. The short solid traces towards the bottom half of the Unit 1 echograms and most of the long solid traces in the Unit 3 echograms are fish.

Echogram examples of split-beam data collected in the intake of Unit 2, under high noise conditions, is shown in Figure 12. The target strength echogram (Figure 12, left), angle echogram (Figure 12, middle) and the so-called “single target” echogram (Figure 12, right), which displays the filtered data that is used by the fish tracking algorithm, are depicted. Note that for Unit 2, the angles are reversed; a change in angle color from warm to cold indicate downstream movement. Four tracked fish are outlined in color on the “single target” echogram (Figure 12, right). The angle echogram indicates that the three fish near bottom are travelling downstream (Figure 12, middle), while the fish that is closer to the surface is swimming upstream.

Units 1-3 were monitored for 20 minute each of every hour throughout the study period. Total entrainment for each unit was estimated by multiplying the 20 minute entrainment rate by three to estimate entrainment over the entire hour. Units 4 and 5 were not monitored, nor did Unit 5 operate during the study period. Entrainment estimates for Unit 4, which has the same configuration as Units 1-3, were extrapolated based on the mean entrainment rate calculated for Units 1-3. All estimates were weighted based on unit operation in any given hour. For example, if Unit 2 was operational for only 30 minutes within an hour than the entrainment estimate for that hour was reduced by 50%.

7.0 RESULTS

The Project intakes (Units 1-3) were monitored between August 21, and September 18, 2014 (27 days) and the downstream fishway was monitored between August 19, and September 18, 2014 (30 days). During this period two bypass test flow scenarios were investigated; 120 cfs and 230 cfs. The entrainment magnitude, bypass magnitude and bypass efficiency (PPE) were calculated during periods when direct comparisons between the bypass and entrainment could be made. This equated to 86.14% of the data collected. The entrainment magnitude, bypass magnitude and bypass efficiency during the 120 cfs scenario (20 day period) were; 372,246 herring, 27,292 herring and 6.83%, respectively. The entrainment magnitude, bypass magnitude and bypass efficiency during the 230 cfs scenario (7 day period) were; 64,142 herring, 10,328 herring and 13.87%, respectively.

7.1 SPLIT-BEAM

Entrainment rates were generally less than 2,500 herring per hour except for a few peaks (Figure 13). Early in the study period peak entrainment events occurred at Unit 3, whereas Unit 2 exhibited peak events later in the study period. In all cases peak events were short in duration (generally, less than 1 hour). River discharge did not appear to affect entrainment rates (Figure 13). Entrained fishes of various sizes were detected by the spilt-beam monitoring system ranging from 4 cm to 26 cm in length (Figure 14). Most (74%) were within the target length range (i.e. 3.8 – 10.0 cm) (Figure 15). The water surface elevation of the canal is operated at or near elevation 154.5 ft. The elevations at which fishes were entrained varied between Units and were widespread with fishes documented at most elevations between the top (elevation 150 ft) and the bottom (elevation 137 ft) of the intake (Figure 16).

7.2 ARIS ACOUSTIC CAMERA

The ARIS acoustic camera ran continuously throughout the study period but was occasionally ineffective due to a drop in canal surface water elevation, which dewatered the camera. This occurred during less than 13% of the study period. In most cases herring were observed in schools of varying size and density (Figure 17). Passage over the bypass weir typically occurred in schools rather than one at a time. Overall, passage via the fishway was low with peak events in which large numbers of herring pass in schools (Figure 18). Peak passage events through the fish bypass and Units did not appear to be correlated.

7.3 RIVER FLOW AND OPERATIONS

River flow at the Project ranged from a low of approximately 420 cfs on August 30 to a high of approximately 24,700 cfs on August 22, 2014 as measured at the USGS gage number 01357500 Mohawk River at Cohoes, NY (Figure 19). Flow in the Mohawk River was high during the study period with an average discharge of 3,697 cfs and a mean of 2,430 cfs; exceeding the median daily statistic, which ranges from approximately 1,500 cfs to 1,800 cfs as calculated from 88 years of record.

The School Street station operated throughout the study period generating with Units 1-4; Unit 5 did not operate. Units 1-4 are of the same design and capacity; Unit 2 generated most frequently (Figure 20) during the study period, followed by Unit 3, Unit 4 and Unit 1 (Figure 21). Unit 1 was inoperable for most of the study period (95.7%) due to electromechanical issues and did not operate until the final few days of the study period (Figure 22). Unit 3 operated frequently throughout the study period and generally followed the flow trends in the Mohawk River and storage supply within the impoundment exhibiting periods of generation and non-generation (Figure 23). Unit 4 operated frequently throughout the course of the study but often for only short periods interspersed by longer periods of non-generation (Figure 24). The pond elevation was well controlled throughout most of the study period; the two exceptions were in late August and mid-September during which time inflow exceeded the station hydraulic capacity and spill occurred. Spill events were generally short in duration and magnitude except during a three day period beginning on August 21, 2014, in which as much as 2.08 ft of spill occurred.

8.0 DISCUSSION

Entrainment rates and bypass rates reported herein were based on periods in which valid data were available at both monitoring location (i.e. the fish bypass and intakes). The majority of data collected was valid and calculations of Project passage rates were based on 86% of the effective monitoring period which extended from August 21 through September 18, 2014. During this time two fish bypass flows were tested 2% (120 cfs) and 3.83% (230 cfs). Bypass rates were greatest during the high attraction flow scenario (PPE 13.87%). A test flow of 5% station capacity (300cfs) was planned and attempted but inflow from the canal was insufficient to maintain a sufficient water surface elevation within the fish separation chamber resulting in shallow spill (a few inches) over the fish return weir and dewatering the acoustic camera. The highest attraction flow achievable that also provided adequate depth of spill over the weir and effective monitoring conditions was 230 cfs. The 230 cfs flow scenario resulted in greater turbulence and entrained air within the monitoring area when compared to the 120 cfs flow scenario. The entrained air degraded the quality of the ARIS imagery, though fish targets were still distinguishable. An unexpected result of the high flow scenario was increased inundation and leakage within the power house along the downstream wall due to the attraction water spill. This condition is expected to create undue deterioration to the Project infrastructure.

Unit 1 intake is located closest the fish bypass entrances. Typically, it is operated as first on, last off to guide emigrating fishes to the bypass entrance. The majority (95.7%) of the study was conducted during a period in which Unit 1 was inoperable due to electromechanical issues and may have affected fish's ability to be effectively guided to the bypass.

Video data were collected within the fish separation chamber to help confirm acoustic targets monitored by the ARIS camera. The camera was operation throughout the entire study period but subsequent review of the video data revealed that the video monitoring system was ineffective at confirming acoustic targets; the primary reasons for this were attributable to glare from the water surface and turbulence generated by bypass flow. However, observations made by the study team confirmed that juvenile blueback herring were present within the study area and were often observed in the vicinity of the bypass intake as well as areas upstream within the canal where the characteristic surface water dimpling was observed. Few if any observations of juvenile herring were made in the unit intake areas suggesting that herring do not delay as they approach the generator intakes as they seem to at the fishway intakes.

During previous years of investigation flood events and/or other high-water events as well as low herring abundance hindered and ultimately prevented a successful evaluation at the School Street Project. No such anomalous events occurred during the 2014 study effort. However, discharge in the Mohawk River exceeded its average through the entire study period. Several peak flow events were evident during the study period but were generally low in magnitude and duration. The most significant flow event occurred over a three day period beginning on August 21, 2014, which appeared to be correlated with an increase in herring abundance in the fishway and intakes.

At the two attraction flows tested, most of the juvenile blueblack herring exited the canal through the intakes. Fish survival rates though turbines can be very high. Results of turbine mortality studies of juvenile clupeids at hydroelectric facilities with Francis turbines have demonstrated high turbine survival for clupeid species in the same length range. Survival ranged from 77% to 95% for juvenile clupeids for Francis turbine survival data available from Hi-Z tag turbine survival studies (RMC 1992; NAI 1996, 1997, 2001, and 2012).

9.0 CONCLUSION

The 2014 study conducted at the School Street Project was effective at evaluating juvenile blueback herring passage efficiency. The majority of herring that pass the Project do so via the intake turbines. Previous Francis turbine mortality studies demonstrated high turbine survival for juvenile clupeids. Of the two fishway flow scenarios tested (120 cfs and 230 cfs) the higher flow scenario was most effective at bypassing juvenile herring. The downstream fish bypass provides an alternative route to entrainment and was used by a significant number of herring. The inoperable status of Unit 1 may have reduced fishway passage effectiveness by eliminating the guidance effect of a presumable key flow field within close proximity to the fishway intakes.

10.0 LITERATURE CITED

Kleinschmidt. 2013. Juvenile Blueback Herring Downstream Passage Efficiency Evaluation Study Plan School Street Project FERC No. 2539. Prepared Brookfield Renewable Power.

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Normandeau Associates, Inc. 1996. Estimation of survival and injuries of juvenile American shad in passage through a Francis turbine at the Vernon Hydroelectric Station, Connecticut River. Prepared for New England Power Co., Westborough, MA.

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Warner, D.M., L.G. Rudstam, and R.A. Klumb. 2002. In situ target strength of alewives in freshwater. Transactions of the American Fisheries Society 131:212–223.

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APPENDIX A

STUDY PLAN

JUVENILE BLUEBACK HERRING DOWNSTREAM PASSAGE EFFICIENCY EVALUATION STUDY PLAN

SCHOOL STREET PROJECT
FERC NO. 2539

Prepared for:

Brookfield Renewable Power
Queensbury, NY

Prepared by:

Kleinschmidt

February 2013

Juvenile Blueback Herring Downstream Passage Efficiency Evaluation Study Plan

School Street Project
FERC No. 2539

Prepared for:

Brookfield Renewable Power
Queensbury, NY

Prepared by:

Kleinschmidt

February 2013

JUVENILE BLUEBACK HERRING DOWNSTREAM PASSAGE EFFICIENCY EVALUATION STUDY PLAN

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JUVENILE BLUEBACK HERRING DOWNSTREAM PASSAGE EFFICIENCY EVALUATION STUDY PLAN

1.0 INTRODUCTION

The School Street Hydroelectric Project (Project) (FERC No. 2539) is owned and operated by Brookfield Renewable Power (Brookfield). The Project is located on the Mohawk River, 2.5 river miles upstream of its confluence with the Hudson River in Cohoes, New York. The Project was issued a new FERC License on February 15, 2007. Downstream fish passage for anadromous and catadromous fish, as well as resident fish, was required as part of the new license. In September 2007, a Final Plan was developed to investigate the Phase I fishway effectiveness (See Appendix A of Appendix A, *Phase I Fishway Effectiveness Testing*). The Final Plan included requirements for testing downstream passage survival of resident fish, American eels, juvenile and adult blueback herring; passage efficiency of juvenile and adult blueback herring; an inspection of the conveyance structures; and a hydraulic survey to document flow field and approach velocities in front of the angled bar rack and fishway entrances.

To date, Brookfield has met their obligations to investigate the Phase I fishway effectiveness as described in the Final Plan (see Appendix A, Kleinschmidt 2011) and Phase I Fishway Effectiveness Testing Study Plan (Study Plan) (Kleinschmidt 2011a), with one exception; the evaluation of downstream bypass efficiency of juvenile blueback herring (JBBH).

In the summer of 2010, Brookfield conducted a proof of concept study (Feasibility Study) to investigate the feasibility of using DIDSON (Dual-Frequency Identification Sonar) and split-beam hydroacoustic technologies to investigate bypass efficiency. The Feasibility Study demonstrated that DIDSON and hydroacoustic (split-beam) technologies could be used to effectively compare herring passage through the bypass vs. Project entrainment. As such, Brookfield mobilized to conduct the full scale evaluation during the *fall* outmigration in September and October of 2010. Unfortunately, the effort did not meet the objectives due to flooding events and the lack of test fish availability. In 2011, Brookfield consulted with the New York State Department of Environmental Conservation (NYSDEC) and United States Fish and Wildlife Service (USFWS) to develop an alternative approach to investigate downstream bypass efficiency. Brookfield submitted a study plan, *Phase I Fishway Effectiveness Testing* (Appendix A), to NYSDEC and the USFWS for comment and approval. The study plan was approved by the agencies and prescribed the use of passive integrated transponder (PIT) technologies. The study was conducted in the late summer and early fall of 2012 when outmigrating JBBH became available. The study team found that the small size and fragile nature of the JBBH made it difficult to effectively tag due to high tagging and handling mortality and the effort was abandoned.

This document details Brookfield's plan to revisit a DIDSON and hydroacoustic-based approach to effectively assess the efficiency of the downstream bypass to convey outmigrating JBBH around the Project and was developed in consultation with the NYSDEC and USFWS. The proposed study will be conducted during the fall out-migration season in the months of August and September, 2013.

2.0 OBJECTIVES

The goal of this study is to investigate the efficiency of downstream passage of JBBH by providing a quantitative estimate of the proportion of juvenile blueback herring that uses the fishway (bypassed) vs. the proportion that passes through the turbines (entrained). Passage efficiency will be evaluated and compared over two bypass flow regimes, 2% and 5% station capacity.

3.0 PROJECT DESCRIPTION

The Project consists of:

1) A stone masonry gravity dam extending 1,278 ft across the Mohawk River, 16 ft in height;
2) A reservoir with a surface area of approximately 100 acres at a normal maximum water surface elevation of 156.1 ft, and a gross storage capacity of 788 acre-feet;
3) A power canal extending approximately 4,400 ft from the dam to the powerhouse, approximately 150 ft wide and 14 ft deep;
4) An upper gatehouse structure that currently includes nine slide gates and three steel tainter gates to control the diversion of flow into the canal;
5) A lower gatehouse with five steel head gates to control flow into the five penstocks; and

6) A powerhouse measuring 170 ft long by 78 ft wide, housing five generating units with vertical shaft Francis turbines rated at 92 ft of head, with a total maximum capacity of 38.8 megawatts.

4.0 FISHWAY DESCRIPTION

The fishway conveyance structure is located near the downstream end of the angled bar rack. It has two intake portals and includes a multi-level gate with top and bottom entrances (Figures 1 and 2). Attraction flow to the fishway entrances can vary between two to five percent of the Project's total hydraulic capacity. Conveyance pipes from both entrances converge in a fish separation chamber part-way along the fish conveyance structure (Figure 3). The chamber reduces the volume of the bypass flow and guides fish along a wire floor screen, directing them into a fish return weir pool. The excess attraction water flows through the screen and is discharged downstream of the Project. A gate valve at the downstream end of the fish separation chamber provides hydraulic control within the fish conveyance structure. An adjustable weir is located at the inlet to the fish return weir pool (Figure 4). The weir provides fine-tune adjustment to the depth of water cascading over the weir as well as the final discharge flow (design flow 25 CFS). Once in the fish return weir pool, fish are guided to the entrance of the final return pipe, and are deposited into the tailwater of the Project.

5.0 DOWNSTREAM BYPASS EFFICIENCY EVALUATION OF JUVENILE BLUE BACK HERRING

Brookfield proposes to use acoustic monitoring technologies to evaluate downstream Project passage efficiency at the School Street Station. These technologies will provide a means to monitor fish as they move downstream of the Project. An acoustic camera will be used to monitor downstream passage through the fishway. The acoustic camera will provide high resolution acoustic images of JBBH as they are conveyed downstream. The newly developed ARIS 3000 acoustic camera, manufactured by Sound Metrics Inc., is the preferred instrument for data collection, as it provides the highest resolution acoustic images currently available and is ideal for distinguishing small targets such as JBBH. However, availability is limited and currently, only three units are available for lease in the United States. Should the ARIS be unavailable, the study will employ a DIDSON acoustic camera instead. The DIDSON camera operates at a lower frequency (1.8 MHz) when compared to the ARIS (3.0 MHz), but still provides acoustic imagery capable of distinguishing small targets.

Brookfield proposes to monitor the intakes using a split-beam hydroacoustic system, manufactured by either BioSonics or Simrad. The split-beam system will employ transducers that operate between 200 and 400 kHz with an acoustic beam angle ranging from 7º to 10º. The split-beam monitoring system has a greater range than the acoustic camera and operates at a ping rate that is fast enough to capture a sufficient number of echoes from fast moving fish. It will be used to quantify schooling as well as single fish and is less expensive than an acoustic camera.

5.1 Monitoring System Design and Herring Evaluation

5.1.1 Turbine Intake Monitoring

The School Street Station is typically operated such that Unit 1 is the first-on last-off, with Units 2 through 5 going online sequentially, as station inflow allows. Generally speaking, inflow to the Project during the JBBH outmigration period is seasonally low with the majority of generation produced from Units 1, 2 and 3. As such, Brookfield proposes to monitor fish passage through the turbines with 3 split-beam transducers, one in each of the intake bays at Units 1, 2 and 3 (Figure 5). Should operation of Units 4 and 5 occur during the evaluation, passage will be estimated based on a linear interpolation of the passage observed through the adjacent intakes. The transducers will be mounted on vertical aluminum pipes attached to the front of the grating covering each bay and positioned in a downward-looking orientation (Figure 6). The transducer will be deployed as shallow as possible to maximize the effective sampling area of the conical beam such that each transducer will sample approximately 10% of the penstock opening. The geometry of the intake forebays is such that surface oriented fishes like JBBH are obligated to descend in the water column as they approach the penstock openings (Figure 7). This is advantageous in monitoring entrainment with split-beam technologies as entrained fish must pass through the monitoring area low in the water column, which increases the distance between the transducers and its targets in this relatively confined area. The conical nature of the acoustic beam is such that the cross-sectional area of beam increases as a function of the distance from the transducer. Therefore, separation between the transducer and targets is essential to maximizing the effective monitoring area of the split-beam transducer.

5.1.2 FISHWAY MONITORING

Migrating JBBH will be monitored within the fish separation chamber as they cascade over the fish return weir. The fish return weir and cascading flows create a physical barrier to upstream movement. Fish monitored at this location have reached *a point of no return* and are obligated to continue downstream. Therefore fish detected at this location will be deemed as having bypassed the Project.

An acoustic camera will be deployed to monitor migrating JBBH in the fishway. The acoustic camera will be installed on the eastern sidewall of the fish separation chamber, immediately upstream of the weir board at the downstream end of the fish separation screen (Figure 8). The acoustic camera will be oriented slightly downstream to provide a field of view across the separation chamber. The orientation of the acoustic camera and the relatively wide (anticipated to be ~29°) field of view will allow for monitoring of herring as they approach the weir, as well as provide a record of project passage as they cascade over it (Figure 9). For the purposes of this evaluation, fish monitoring in the shallow cascading flow of the weir is critical to determining passage and will require the acoustic camera to be deployed in very shallow water. As such, an 8° vertical concentrator lens may be employed to narrow the vertical acoustic beam, reducing the acoustic interference from the water surface. The acoustic camera will be tilted downward slightly (anticipated to be ~ 2°) such that the top of the submerged weir board will be detectable by the acoustic camera (Figure 10). The acoustic detection of the weir board will provide a physical reference point by which to evaluate passage over the weir. Downstream passage monitoring will be conducted with the aid of vertical weir extensions as depicted in Figure 10. The extension will prevent fish from passing within three feet of the transducer, where the field of view is too narrow, or too close to the opposite wall where the images can be masked by noise.

The acoustic camera will be connected through a transducer cable to a break-out box housed in a water-tight box on the operating deck of the chamber. From there, an Ethernet cable will connect the acoustic camera to a data collection computer in the gatehouse. Acoustic data are anticipated to be collected in high frequency mode (3.0 or 1.8 MHz) with a frame rate of 15 frames per second, start range of 0.4 m, and a window length of 5 m. Data will be recorded continuously over the proposed monitoring period.

A video camera will be mounted in the fish separation chamber such that fish cascading over the weir are observable. The camera will be positioned in a downward looking orientation and will provide confirmation of the identity of targets detected by the acoustic camera. The video data will be recorded continuously during daylight hours. The data will be stored on a dedicated DVR system located in the lower gatehouse. The video data will be subsampled as necessary to confirm the identity of acoustic camera targets.

5.2 REMOTE CONTROL AND DATA STORAGE

The sonar systems will be monitored and controlled remotely via the internet. Data will be stored onsite on a dedicated computer and automatically backed up to external hard drives of adequate storage capacity. This study is anticipated to generate 40 Gb of data daily and will require a total storage capacity of approximately 2 Tb.

6.0 DATA COLLECTION AND ANALYSIS

Based on our experience with clupeids, we expect the juvenile blueback herring to be most active at dusk and dawn. A sub-sampling scheme for the data analysis will be developed based on field observations and a preliminary review of a sub-sample of the acoustic data.

Data collected within the fishway and at the intakes will be used to develop estimates of passage (i.e. bypassed and entrainment) over time. Passage for each route (i.e. bypassed vs. entrainment) will be directly compared over the same time periods to provide an estimate of Project passage efficiency (PPE) as follows:

$$PPE = \sum (bypassed/(bypassed + entrained)) * 100$$

The comparison of passage data, over time, will depend on data availability, quality, and comparability. Passage estimates used in the calculation of the PPE will reflect the sum of passage over distinct intervals of time in which direct comparisons between the bypass and entrainment can be made but will not provide a comprehensive estimate of the seasonal passage.

6.1.1 SPLIT-BEAM INTAKE MONITORING

Split-beam data will be processed with Myriax Echoview software. The data will be reduced by applying an intensity threshold of -60 dB and analyzed with an α,β-tracking algorithm, which identifies the series of echoes that were returned by an individual fish over successive pings. The tracking results will be reviewed on the echogram and exported as a database containing time, target strength, and 3-D positional information for each fish detected. This database will be further filtered to remove all fish (or other targets) with a mean target strength of -52 dB or less, which translates into fish approximately 1.5 inches (~38 mm) in length or smaller (Warner et al. 2002).

Fish counts will be expanded for the non-sampled area of the intake cross-section. An expansion factor will be calculated for each individual fish as a function of its effective beam width at the range it was observed. This effective beam width depends on the acoustic beam pattern and the size of the target. Thus, for a given transducer, at any given range, a large fish can be detected over a wider portion of the intake cross-section than a smaller fish. The expansion factor compensates for this differential detection probability. For each fish *i* the expansion factor x_i will be calculated as:

$$x_i = \frac{w}{b_i}$$

where w is width (m) of the turbine intake, and b_i is the effective width (m) of the sonar beam for fish *i* at the range at which it is observed. For example, if for a given time period, one fish is observed at a range where its effective beam width is half the width of the intake, its expansion factor is 2. Thus, it is estimated that 2 fish passed (1 observed in the portion of the intake that was effectively covered by the sonar beam, 1 unobserved in the portion that was not). The expansion factors will be summed over all fish observed in a given time period to estimate the total number of fish (*F*) that passed through the intake:

$$F = \sum_i x_i$$

6.1.2 ACOUSTIC CAMERA DATA

DIDSON data will be processed with Myriax Echoview software. Fish will be differentiated from debris based on size, shape and type of motion. Individual fish can be distinguished from objects that have different shapes (e.g., clumps of grass, air bubbles, and branches). Objects that have a similar shape (e.g., similar sized piece of wood) are more difficult to distinguish unless their type of motion is distinct. Schools of herring will be obvious at the proposed sampling range. Whenever possible, individual fish targets will be quantified. However, the quantification of dense schools with DIDSON data is, at this point, still in its infancy. Brookfield proposes to use a simple approach of determining the image area of each fish school detected and then sum the area of all schools to obtain a relative measure of fish passage. This approach should provide an adequate relative measure and would work well if the schooling behavior is similar in the two routes that are to be compared (entrainment versus bypass).

7.0 SAFETY CONSIDERATIONS

Safety is of paramount importance when conducting field studies. All activities conducted during these evaluations will be governed by Brookfield's EHS requirements. The onsite project lead and crew that will be conducting these activities have experience working at hydroelectric facilities and working around water in general. Further, at least two members of the team will be trained in CPR and first aid. A task specific project safety plan will be developed prior to field activities and will identify and address any safety concerns related to the evaluation. A job safety and environmental plan (JSEP) will be conducted daily prior to the start of work. Changing weather and flow conditions at the study site can confound safety parameters. The onsite project lead reserves the right to postpone or abandon activities that have been deemed unsafe until such time that condition become favorable or the safety risk is otherwise mitigated.

8.0 REPORTING

A draft report will be generated and distributed to USFWS and the NYSDEC for review and comment by the end of February 2014. A final report incorporating agency comment will be prepared for submittal to FERC within one month of receipt of final comments.

9.0 SCHEDULE

The study will be conducted during the 2013 JBBH outmigration season in late summer and early fall. Brookfield proposes to install and make ready the monitoring equipment in mid August with data collection beginning once JBBH begin to migrate in appreciable numbers. The monitoring period will be of sufficient length to provide data of adequate quality and comparability by which to evaluate fishway passage versus entrainment at two fishway flow scenarios, 2% and 5% station capacity. Brookfield shall provide notification, via email, of the suspension of data collection to the USFWS and NYSDEC within 48hrs.

10.0 REFERENCES

Brookfield. 2011. Phase I Fishway Effectiveness Testing and Hydraulic Survey. Final Report. Kleinschmidt Associates Report to Brookfield. Queensbury, NY.

Brookfield. 2011a. Phase I Fishway Effectiveness Testing. Study Plan. Prepared by Kleinschmidt Associates. Queensbury, NY.

Warner, Rudstam, and Klumb. 2002. In situ target strength of alewives in freshwater, TAFS 131:212–223.

ATTACHMENT 1

CORRESPONDENCE

Brookfield Power

New York Operations
225 Greenfield Parkway, Suite 201
Liverpool, NY 13088

Tel (315) 413-2700
Fax (315 461-8577
www.brookfieldpower.com

June 8, 2007

To: Attached Distribution List

Subject: **School Street Hydroelectric Project FERC Project P-2539 License Article 401, 401 Water Quality Certification Condition 13 and Settlement Agreement Section 3.7**

Dear Mr./Ms.:

In accordance with Article 401 of the Federal Energy Regulatory Commission's February 15, 2007 *Order on Offer of Settlement and Issuing New License* (License), Condition 13 of the New York State Department of Environmental Conservation (NYSDEC) 401 Water Quality Certification (WQC) and the Section 3.7 of Settlement Agreement for the School Hydroelectric Project (FERC P-2539), enclosed is Erie Boulevard Hydropower, L.P.'s (Erie) **draft** *Phase I Fishway Effectiveness Testing Plan.*

Erie would appreciate receiving your comments within 30 days of the date of this letter. Upon receipt of your comments, Erie will revise as appropriate the above referenced plan and submit the revised version to FERC.

At the suggestion of Erie, Agency (USFWS, NYSDEC, and NOAA fisheries) personnel were contacted to begin informal discussions concerning the plan to be utilized to evaluate the effectiveness of the Phase I downstream fish passage facility. This process was a continuation of the collaborative settlement process utilized at the School Street Project. Representatives of the three agencies were initially contacted by a Brookfield representative; NOAA deferred to the USFWS and NYSDEC and indicated that it would review the draft plan developed as part of those discussions. Representatives of USFWS, NYSDEC, and Brookfield Power participated in a series of conference calls during March and April 2007 that resulted in the development of the attached June 2007 Draft of the *Phase I Fishway Effectiveness Testing Plan*. The attached Draft document has been submitted to you to begin the formal consultation process required by the Settlement.

If you should have any questions or comments regarding the attached, please do not hesitate to contact the undersigned at (315) 413-2769 or e-mail at Ken.Kemp@BrookfieldPower.com.

Sincerely,

Ken Kemp

Kenneth N. Kemp, P.E.
for Erie Boulevard Hydropower, L.P.

Enclosure

xc: Distribution List
T. Uncher
R. Wingert
J. Sabattis

Faxed 7/3/07

United States Department of the Interior

FISH AND WILDLIFE SERVICE
3817 Luker Road
Cortland, NY 13045

July 2, 2007

Mr. Kenneth N. Kemp, P.E.
Erie Boulevard Hydropower, L.P.
225 Greenfield Parkway, Suite 201
Liverpool, NY 13088

RE: School Street Hydroelectric Project (FERC #2539)
Draft Phase I Fishway Effectiveness Testing Plan

Dear Mr. Kemp:

The U.S. Fish and Wildlife Service (Service) has reviewed the June 8, 2007, Draft Fishway Effectiveness Testing Plan (Plan) for the School Street Hydroelectric Project. The Plan was based on discussions held earlier this year among the licensee, the New York State Department of Environmental Conservation, and the Service. The Plan generally incorporates the issues addressed during these discussions.

Some details of the Plan cannot be resolved until the structures are completed and field studies commence. In addition, based on recent migrations, there is a strong likelihood that Brookfield may be unable to obtain an adequate number of test specimens of some species. The Final Plan will need to include contingencies for resolving these problems if they occur. The study may need to extend into an additional field season if adequate test specimens cannot be obtained.

We appreciate the opportunity to review the Plan. If you have any questions or desire additional information, please contact Steve Patch at 607-753-9334.

Sincerely,

David A. Stilwell

David A. Stilwell
Field Supervisor

cc: NYSDEC, Albany, NY (M. Woythal)
FWS, Hadley, MA (C. Orvis)

New York State Department of Environmental Conservation
Division of Environmental Permits, 4th Floor
625 Broadway, Albany, New York 12233-1750
Phone: (518) 402-9167 • **FAX:** (518) 402-9168
Website: www.dec.ny.gov

Alexander B. Grannis
Commissioner

August 8, 2007

Kenneth Kemp, P.E.
Brookfield Power
225 Greenfield Parkway, Suite 201
Liverpool, New York 13088

RE: **School Street Hydroelectric Project**; DEC#:4-0103-00027/00001; Draft Phase I Fishway Effectiveness Testing Plan

Dear Mr. Kemp:

This letter is response to your request for the NYS Department of Environmental Conservation ("Department") to review the above referenced plan for modifications at the School Street Hydroelectric Project. The WQC issued for the School Street Project , and the subsequent FERC license requires Erie to implement downstream fish passage at the project. The Settlement Agreement for this project identified a two stepped process.

The Settlement Agreement for this project identified a two stepped process. The initial Phase I requires Erie to submit to the FERC a plan and schedule for evaluating effectiveness of the Phase I downstream fish passage facilities. The plan was to include:

- a method for evaluating the guidance and attraction of fish after they have entered the head of the canal during power plant operations,
- specific measures, methods and schedules to evaluate fish passage efficiency and fishway survival/mortalities for passage through both the fishway bypass and the fish friendly turbine as appropriate, and
- methods that will allow a rigorous statistical comparison of the results between the Phase I fish bypass structure and the Phase II new "fish friendly" turbine.

Based on a review of the documents completed by staff the Department's offers the following comments regarding the plan:

Phase I Fishway Effectiveness Testing Plan. The Department has reviewed the Draft Phase I FishwayEffectiveness Testing Plan and has determined that it accurately reflects consultation discussions that Erie held with DEC and the United states Fish and Wildlife Service during March and April 2007. The proposed Phase I fishway designs are consistent with the terms of the Settlement, providing an angled guidance system in the power canal just upstream of the lower gatehouse. The goal of the consultation discussions was to develop a fishway effectiveness study to estimate fish passage efficiency, survival, and duration at the Phase I fishway that can be statistically compared to future post-construction tests once the fish-friendly turbine has been installed.

The Department has determined that the proposed study plan sufficiently meets this goal. The methods described, including the pre-operational physical assessment of the fishway and the biological assessment of the fishway are adequate to address the passage efficiency, survival, and delay of the fish species of concern (primarily blueback herring and American eel). The schedule for installation of the fishway, implementation of the study, and report submissions are acceptable.

Please contact me by e-mail at cmhogan@gw.dec.state.ny.us or by phone at (518) 402-9151 if you have any questions regarding the Department's comments related to the above referenced plans.

Sincerely,

Christopher M. Hogan
Project Manager

cc: via e-mail
M. Woythal
W. Little
J. Fraine
W. Clarke
R. Wingert
F. Bifera

APPENDIX B

FIGURES

Figure 1. One of two fishway intakes (*center distance*) and the debris/ice sluice intake (*adjacent to fishway intake to the right*) at the School Street Project Cohoes, NY.

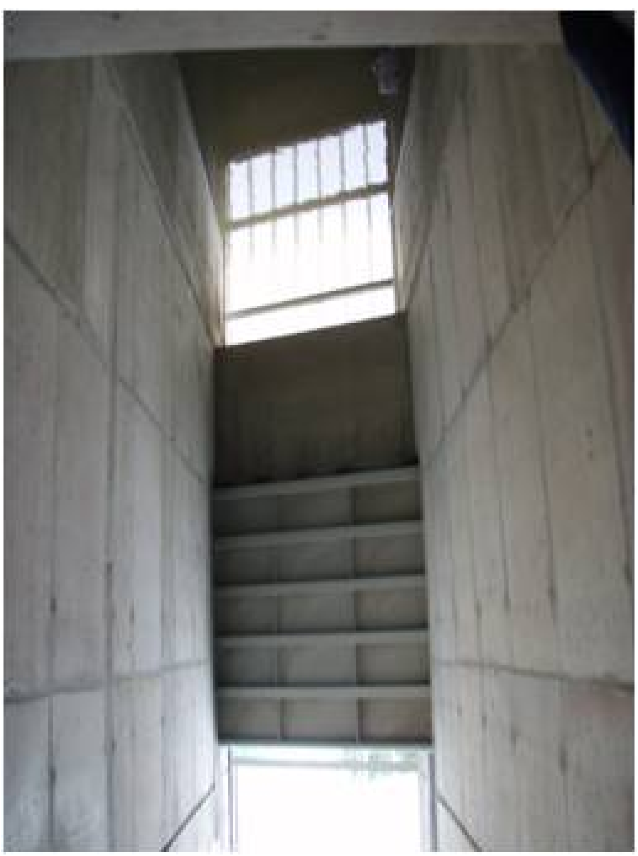


Figure 2. The multi level gate structure within the fishway intake structures at the School Street Project Cohoes, NY.

Figure 3. Fishway separation chamber at the School Street Project Cohoes, NY.

Figure 4. Proposed location for the deployment of the PIT system antenna at the School Street Project Cohoes, NY.

Figure 5. The custom built net pen used to recapture test fish in the discharge of the fishway. The red arrow denotes the over-vertical eel corral.

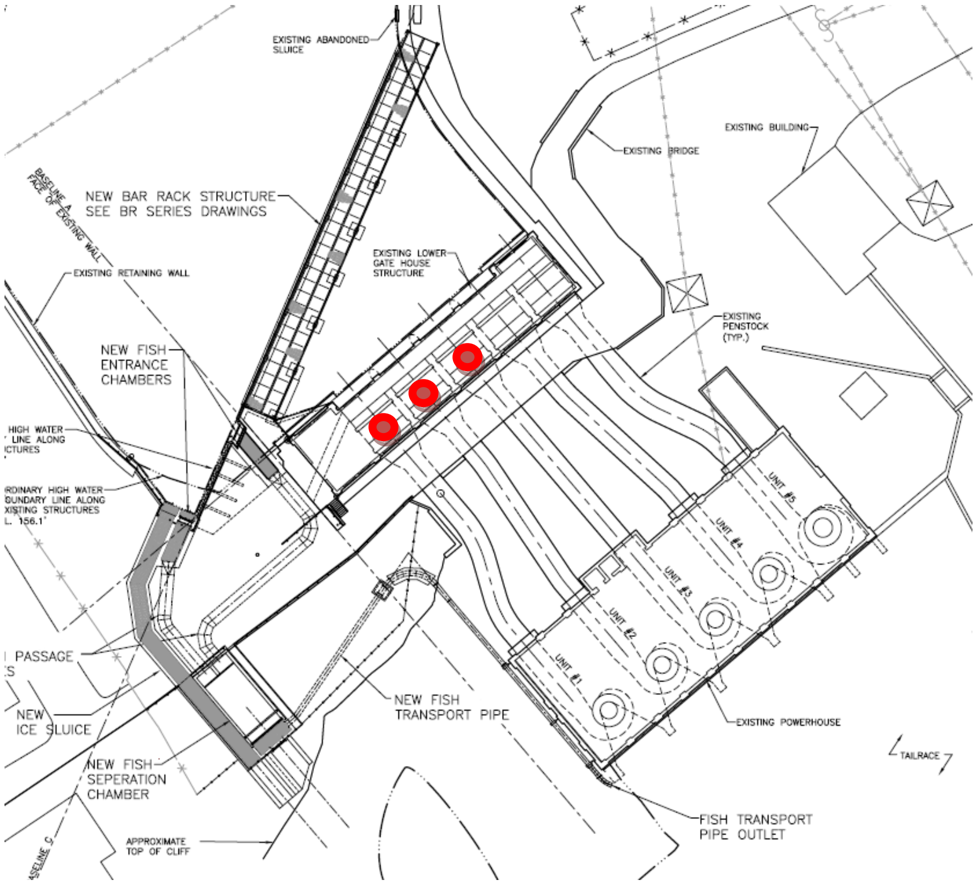


FIGURE 5 **THE PROPOSED LOCATION OF THE THREE SPLIT-BEAM TRANSDUCERS THAT WILL MONITOR ENTRAINMENT AT THE SCHOOL STREET STATION COHOES, NY.**

FIGURE 6 **PLACEMENT OF SPLIT-BEAM SYSTEMS IN THE INTAKE BAYS AT THE SCHOOL STREET PROJECT COHOES, NY.**

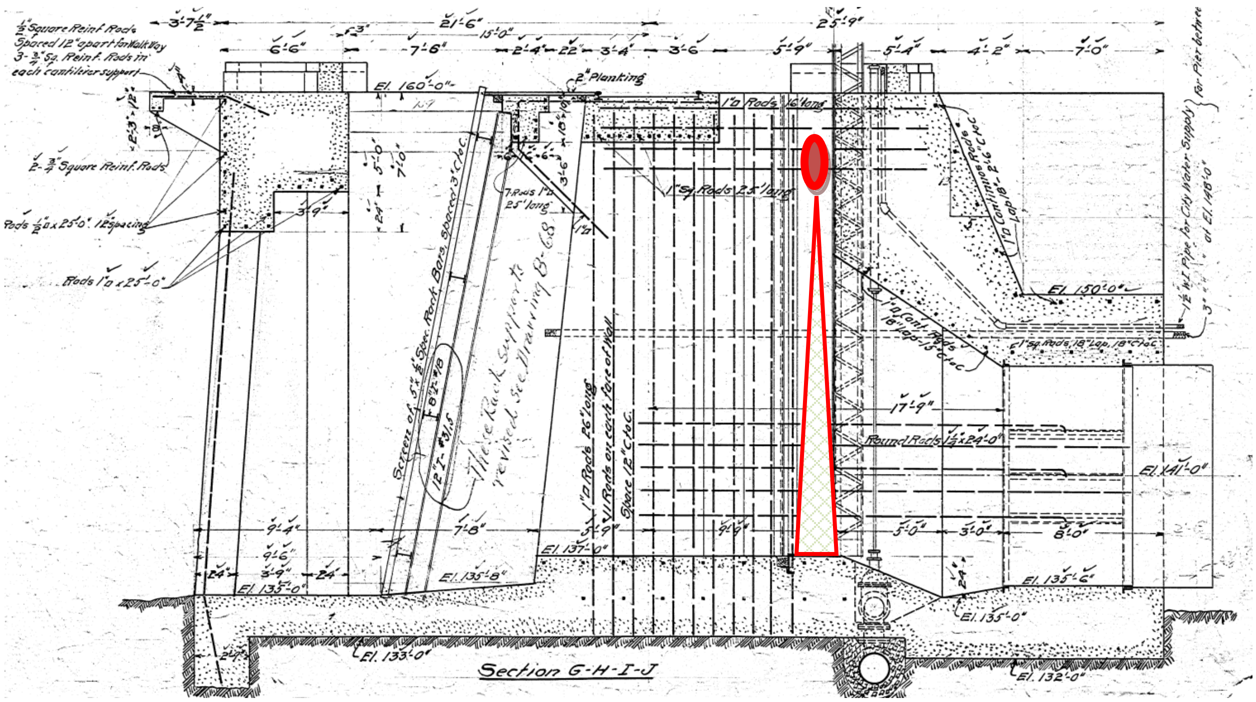


FIGURE 7 **SIDE VIEW DESIGN DETAIL OF UNIT 4 (SAME AS UNITS 1-3) AT THE SCHOOL STREET STATION COHOES, NY. DEPICTS THE PROPOSED INSTALLATION LOCATION OF THE SPLIT-BEAM TRANSDUCER AND ACOUSTIC BEAM (ESTIMATED SAMPLE AREA ~10% OF THE INTAKE AREA) (NOT TO SCALE). THE MEAN HIGH SURFACE WATER ELEVATION IS 156.1'.**

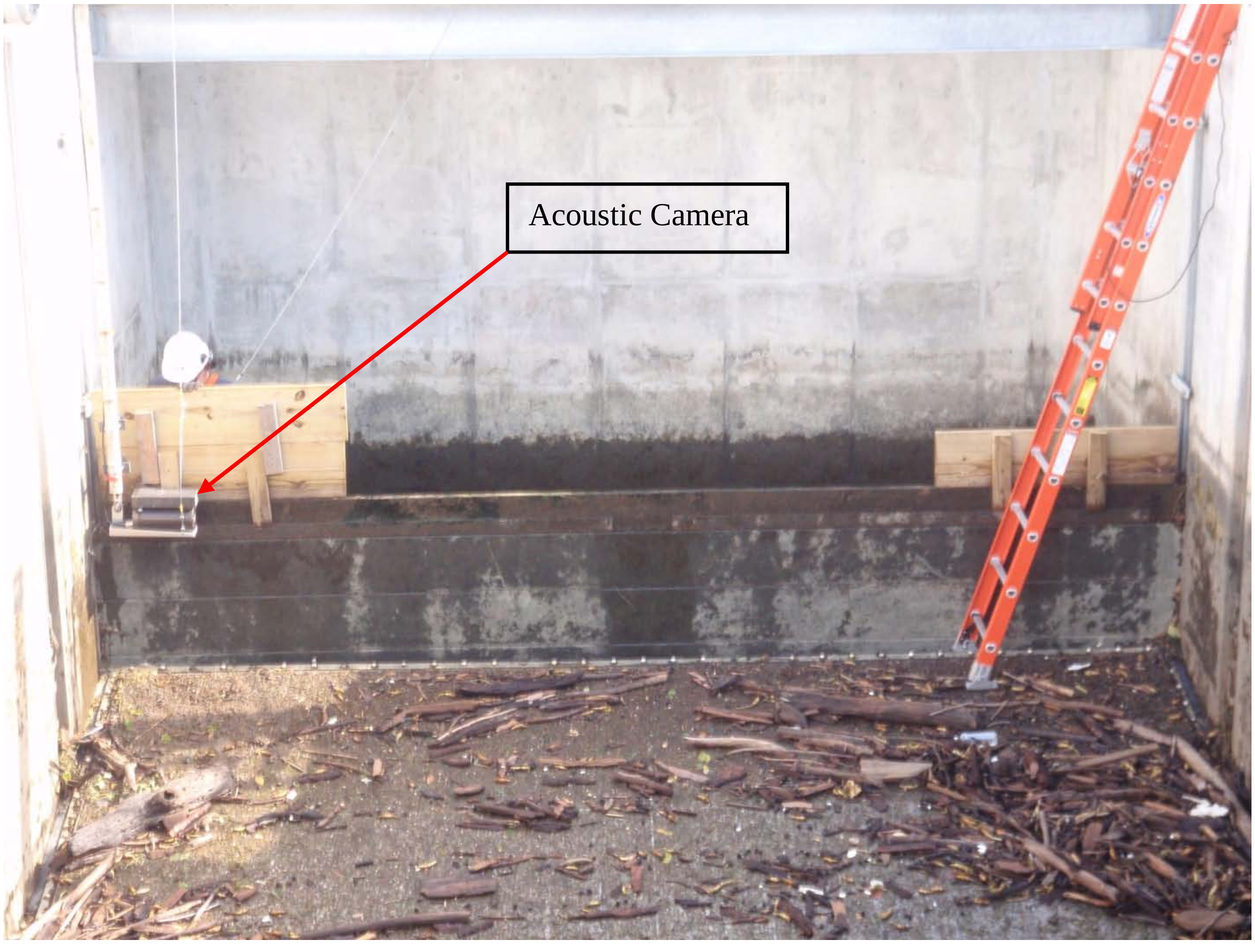


FIGURE 8 **THE PROPOSED LOCATION OF THE ACOUSTIC CAMERA WITHIN THE FISH SEPARATION CHAMBER AT THE SCHOOL STREET PROJECT COHOES, NY.**

FIGURE 9 **DEPICTS THE PROPOSED LOCATION OF THE ACOUSTIC CAMERA AND RESULTING MONITORING AREA AT THE SCHOOL STREET PROJECT COHOES, NY.**

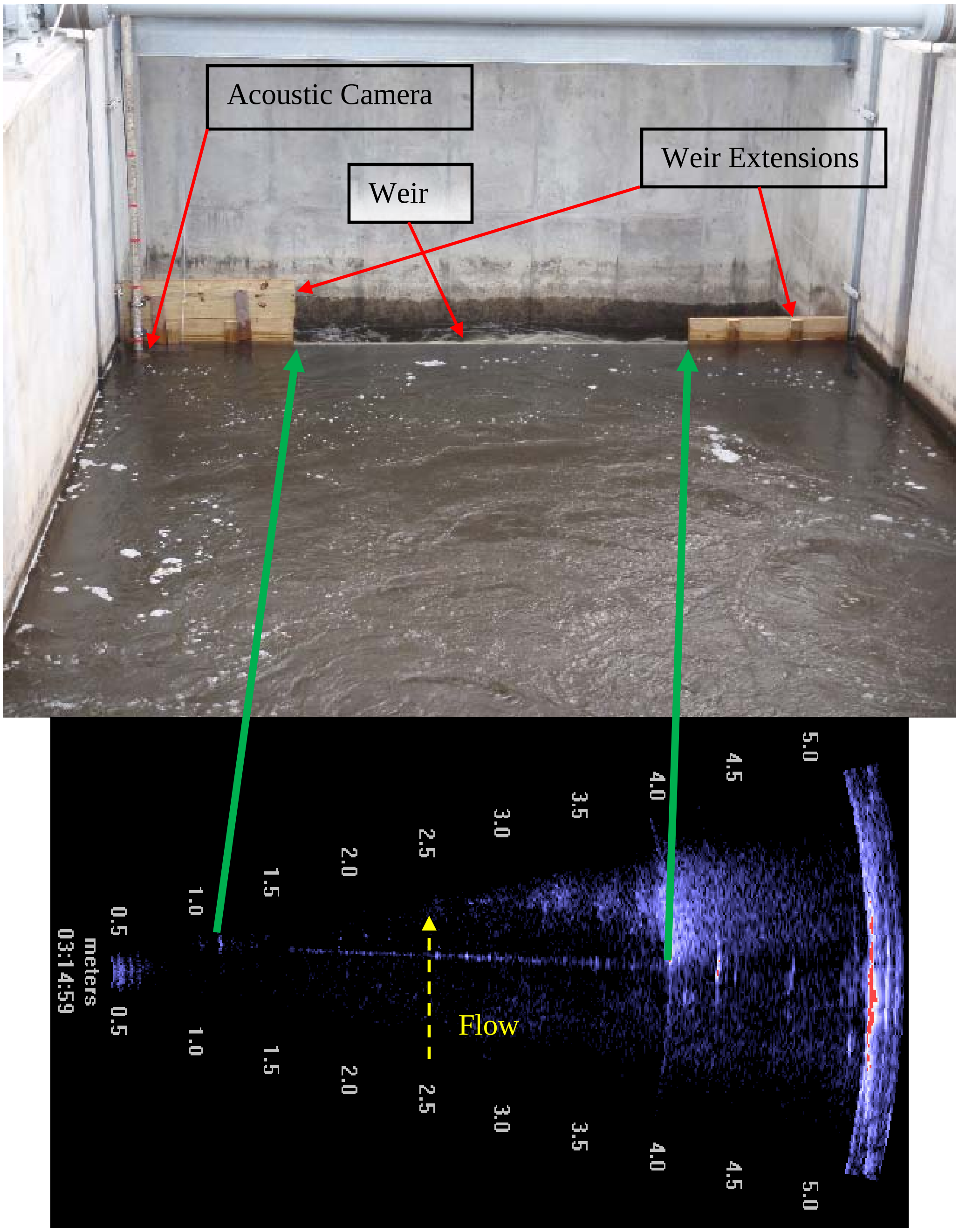


FIGURE 10 **AN EXAMPLE ACOUSTIC IMAGE OF THE PROPOSED MONITORING AREA WITHIN THE FISH SEPARATION CHAMBER AT THE SCHOOL STREET PROJECT COHOES, NY. THE AREA BETWEEN THE TWO GREEN ARROWS REPRESENTS THE EFFECTIVE PASSAGE MONITORING AREA.**

FIGURE 1 ONE OF TWO FISHWAY INTAKES (CENTER DISTANCE) AND THE DEBRIS/ICE SLUICE INTAKE (ADJACENT TO FISHWAY INTAKE TO THE RIGHT) AT THE SCHOOL STREET PROJECT COHOES, NY.

FIGURE 2 THE MULTI LEVEL GATE STRUCTURE WITHIN THE FISHWAY INTAKE STRUCTURES AT THE SCHOOL STREET PROJECT COHOES, NY.

FIGURE 3 **FISHWAY SEPARATION CHAMBER AT THE SCHOOL STREET PROJECT COHOES, NY.**

FIGURE 4 **FISHWAY SEPARATION CHAMBER, HIGHLIGHTING THE ADJUSTABLE WEIR AT THE SCHOOL STREET STATION COHOES, NY.**

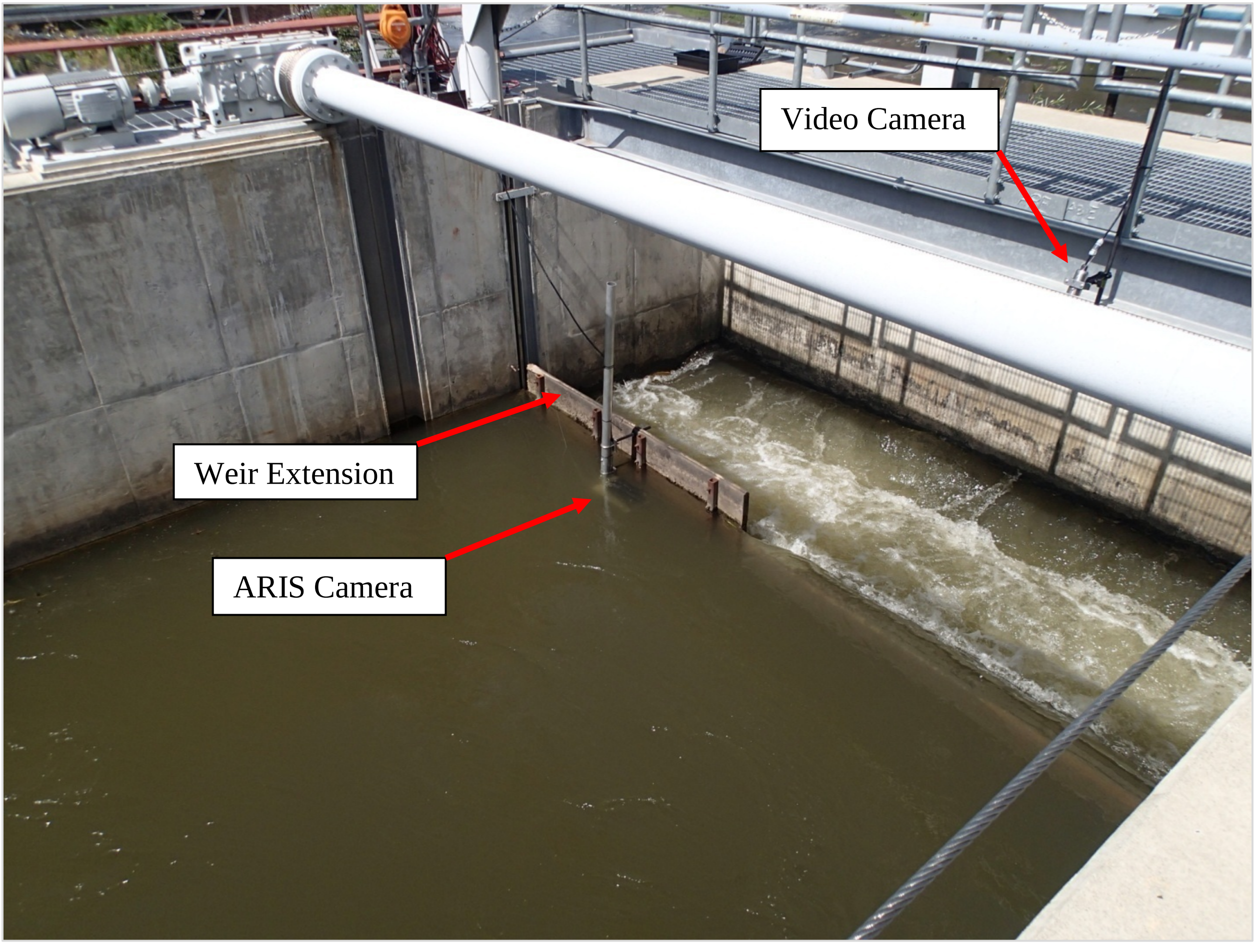


FIGURE 5 **MONITORING EQUIPMENT DEPLOYED IN THE FISH SEPARATION CHAMBER AT THE SCHOOL STREET PROJECT COHOES, NY.**

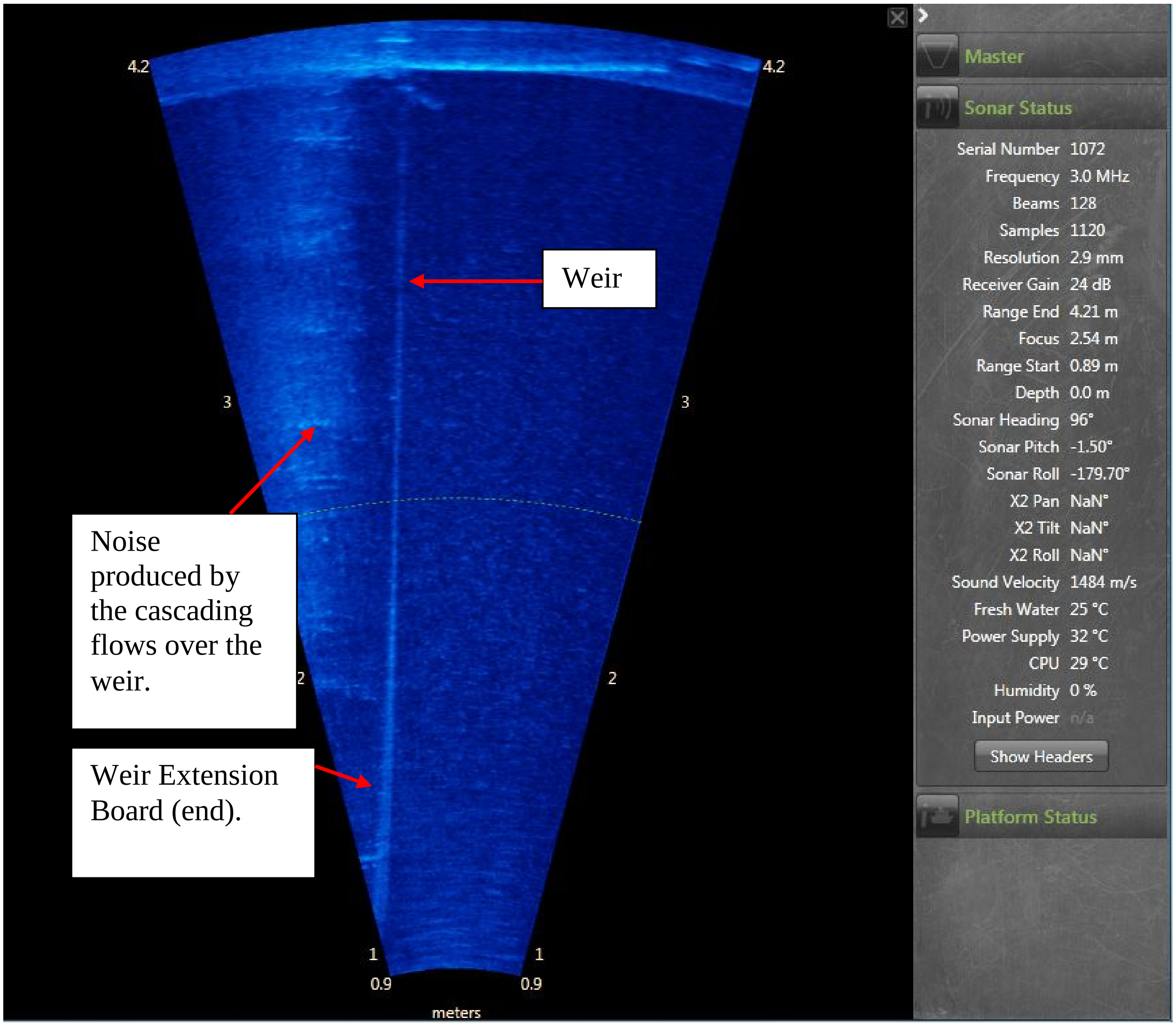


FIGURE 6 **EXAMPLE FIELD OF VIEW PRODUCED BY THE ARIS AS MOUNTED IN THE FISH SEPARATION CHAMBER AT THE SCHOOL STREET PROJECT COHOES, NY.**

FIGURE 7 EXAMPLE FIELD OF VIEW PRODUCED BY THE VIDEO AS MOUNTED ABOVE THE FISH SEPARATION CHAMBER AT THE SCHOOL STREET PROJECT COHOES, NY.

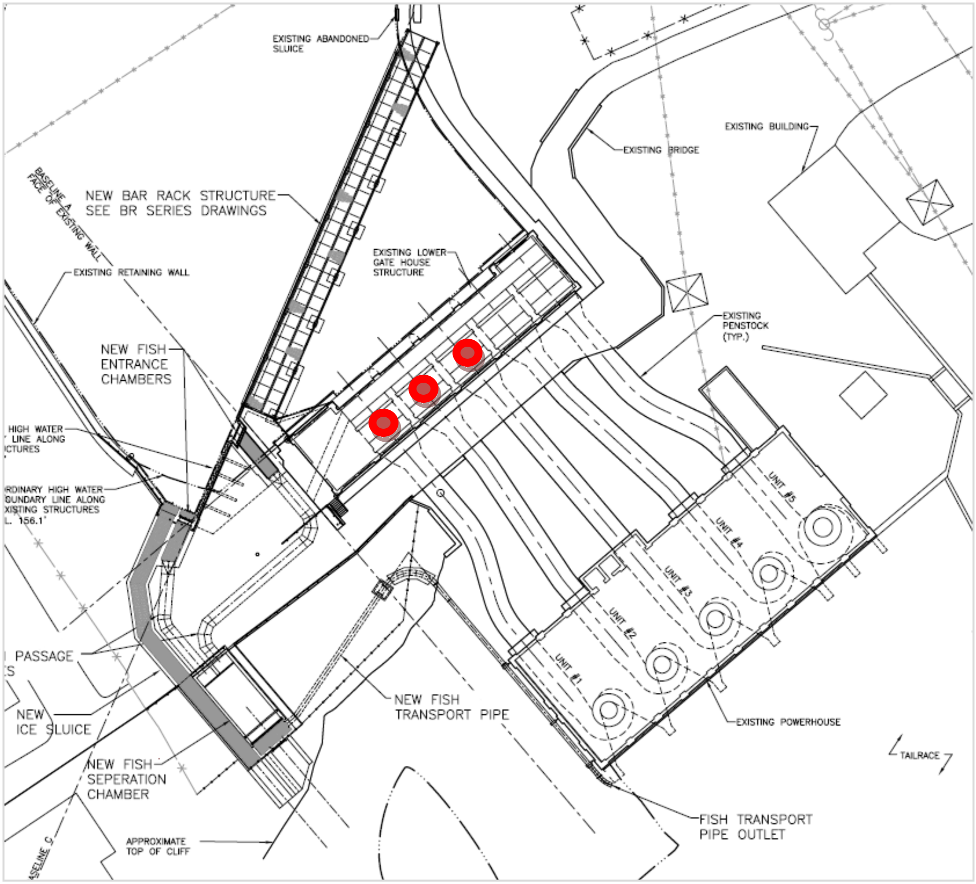
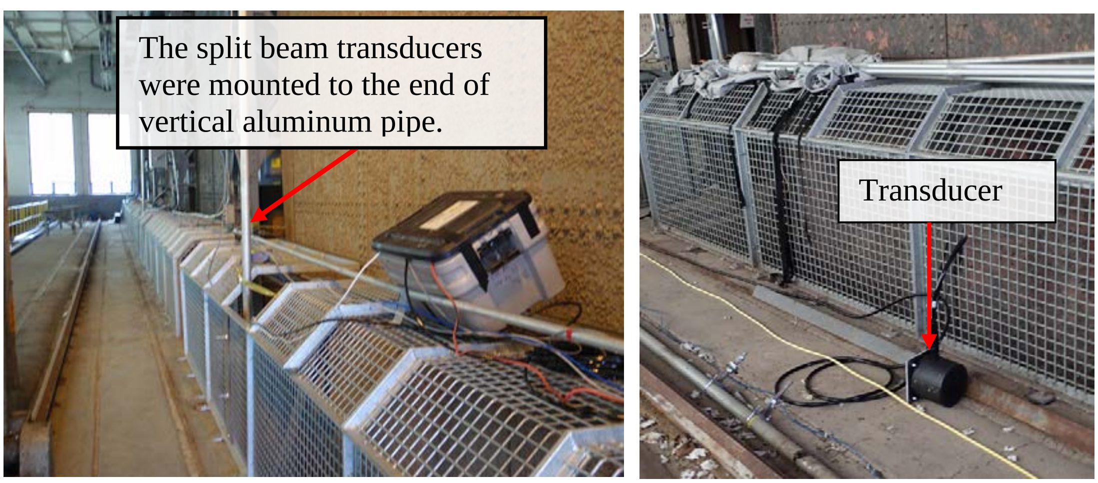


FIGURE 8 **THE LOCATION OF THE THREE SPLIT-BEAM TRANSDUCERS USED TO MONITOR ENTRAINMENT AT THE SCHOOL STREET STATION COHOES, NY.**



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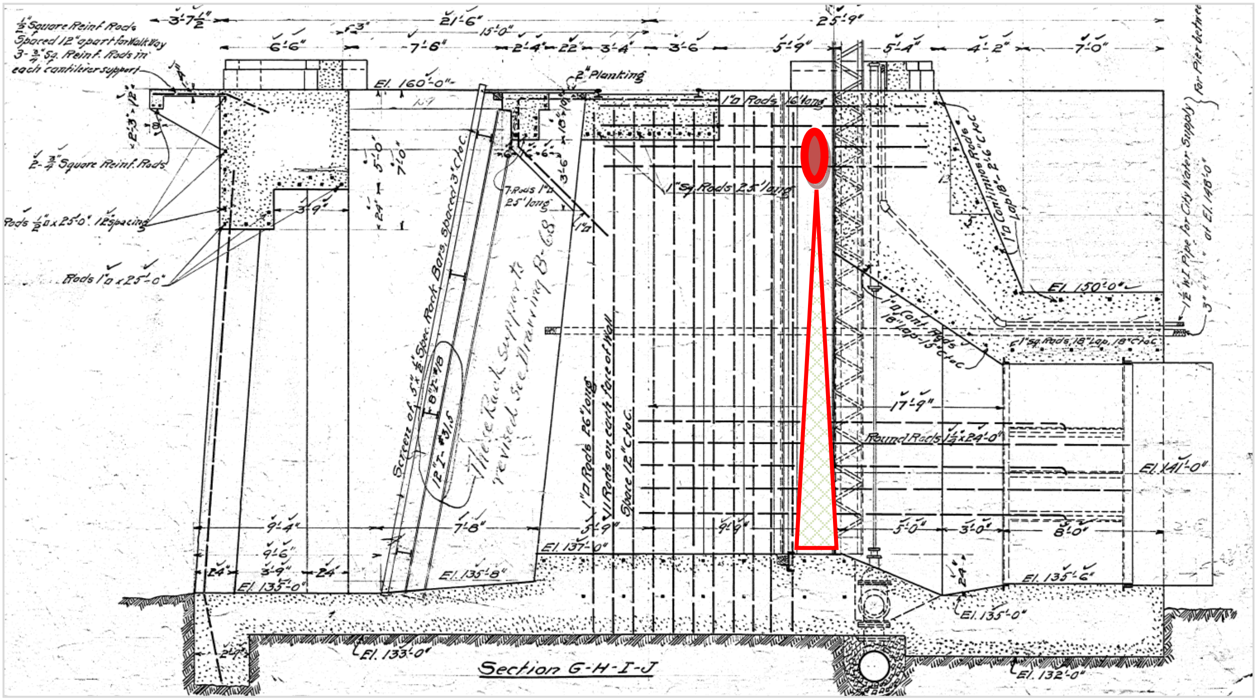

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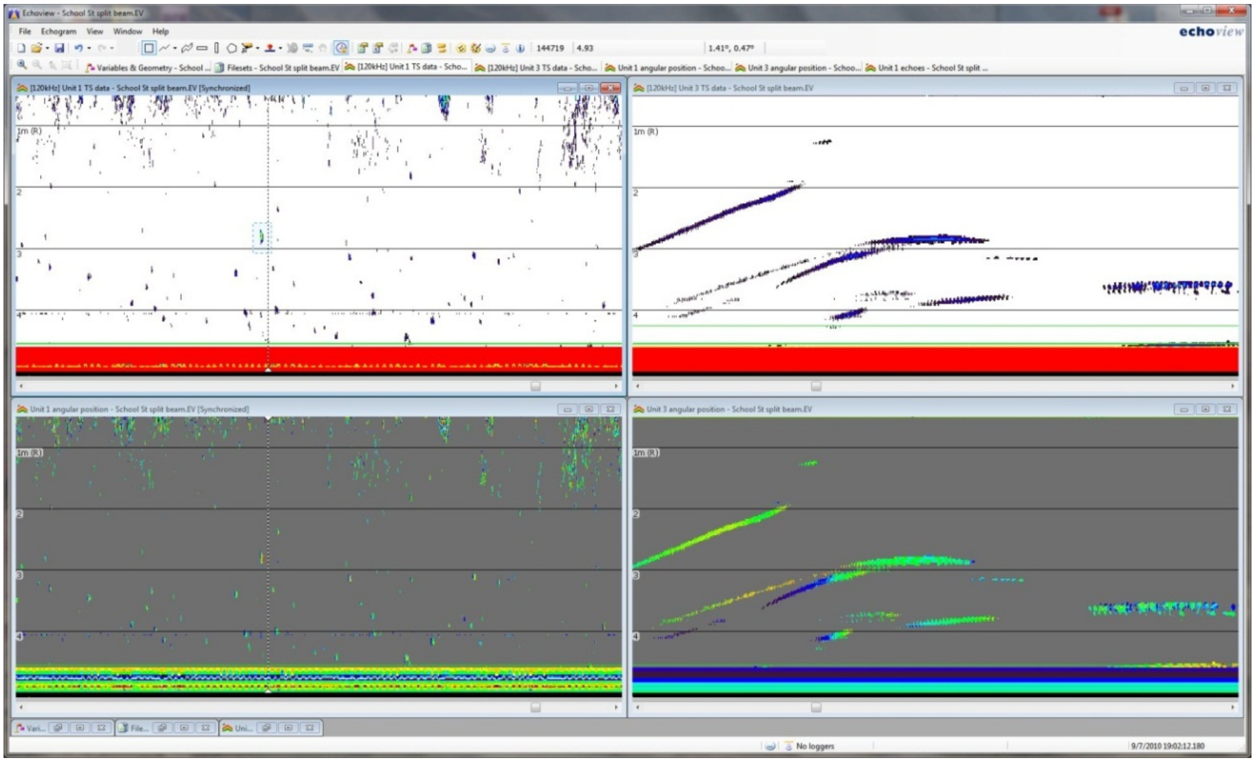

FIGURE 11 EXAMPLE ECHOGRAMS FROM UNIT 1 (LEFT) WHEN IT WAS OPERATING AND UNIT 3 (RIGHT) WHEN IT WAS IDLE.

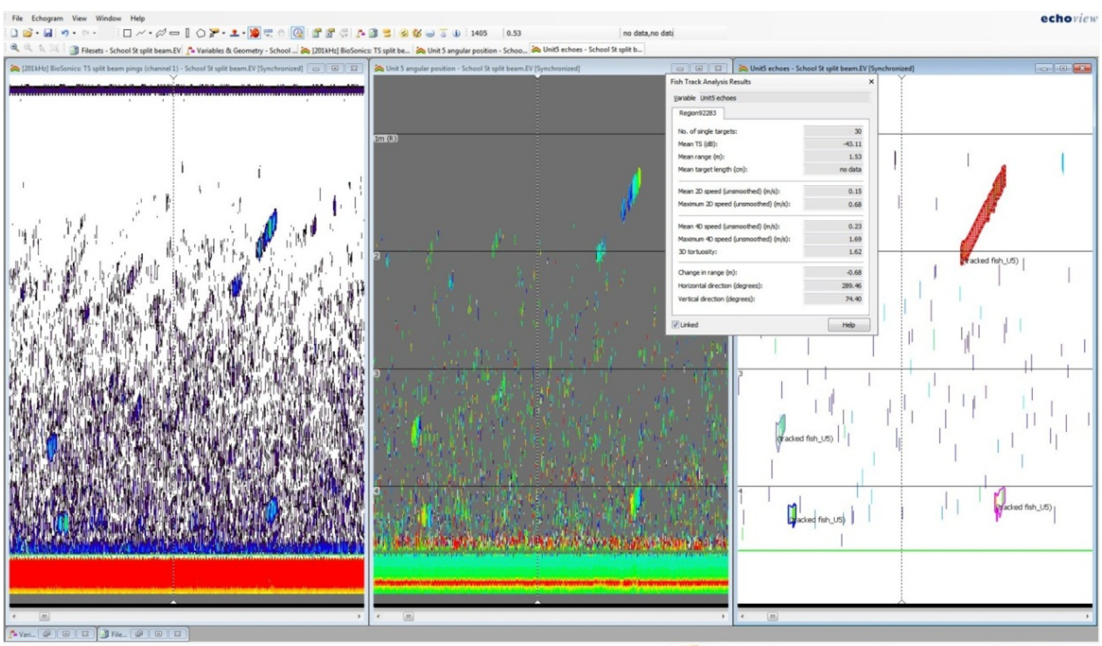

FIGURE 12 EXAMPLE ECHOGRAMS, COLLECTED UNDER HIGH NOISE CONDITIONS WHEN THE UNIT WAS OPERATING.

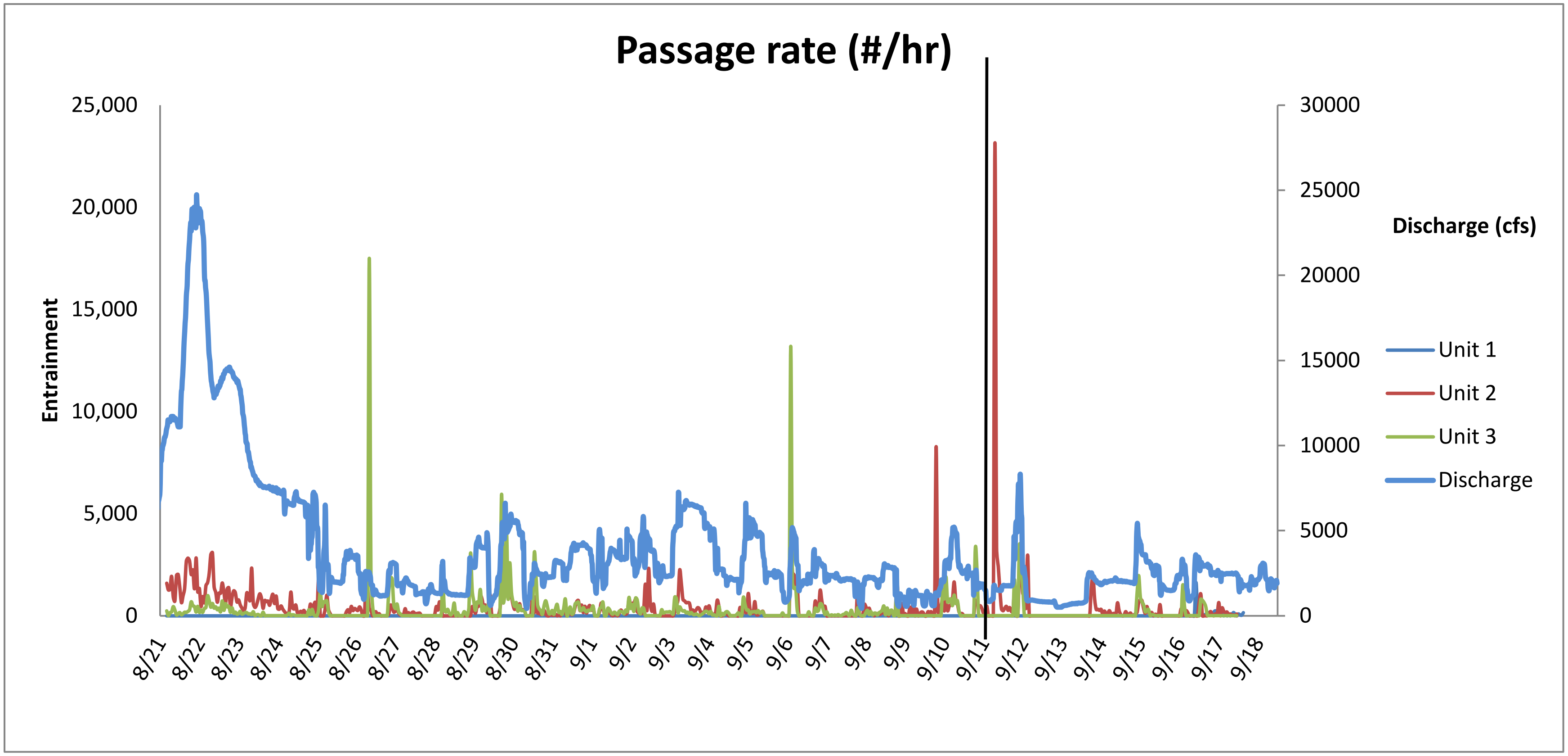

FIGURE 13. **ENTRAINMENT RATES (HERRING/HOUR) AND MOHAWK RIVER DISCHARGE (USGS GAGE 01357500 IN COHOES, NY) AT THE SCHOOL STREET STATION COHOES, NY. THE BLACK LINE DENOTES WHEN THE BYPASS FLOW SCENARIO 1 TRANSITIONED INTO SCENARIO 2 (9/11/14 AT 10:30).**

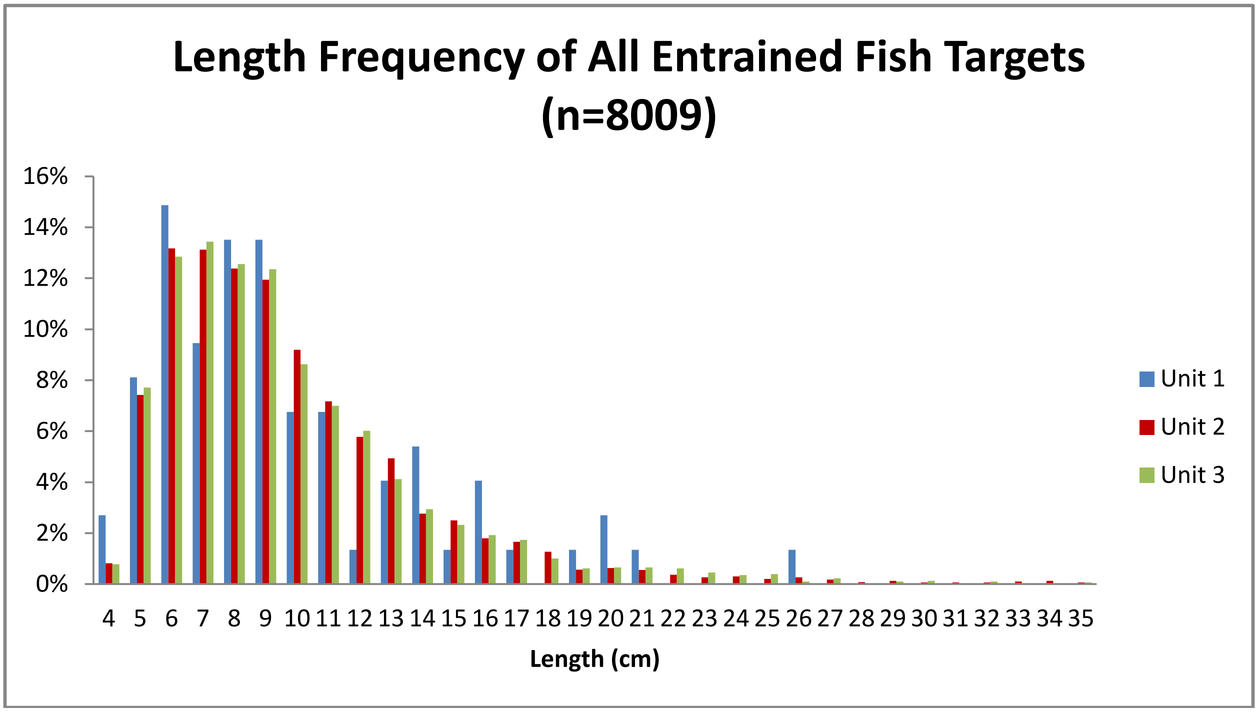

FIGURE 14. **LENGTH FREQUENCY OF ENTRAINED FISHES AT THE SCHOOL STREET PROJECT COHOES, NY**

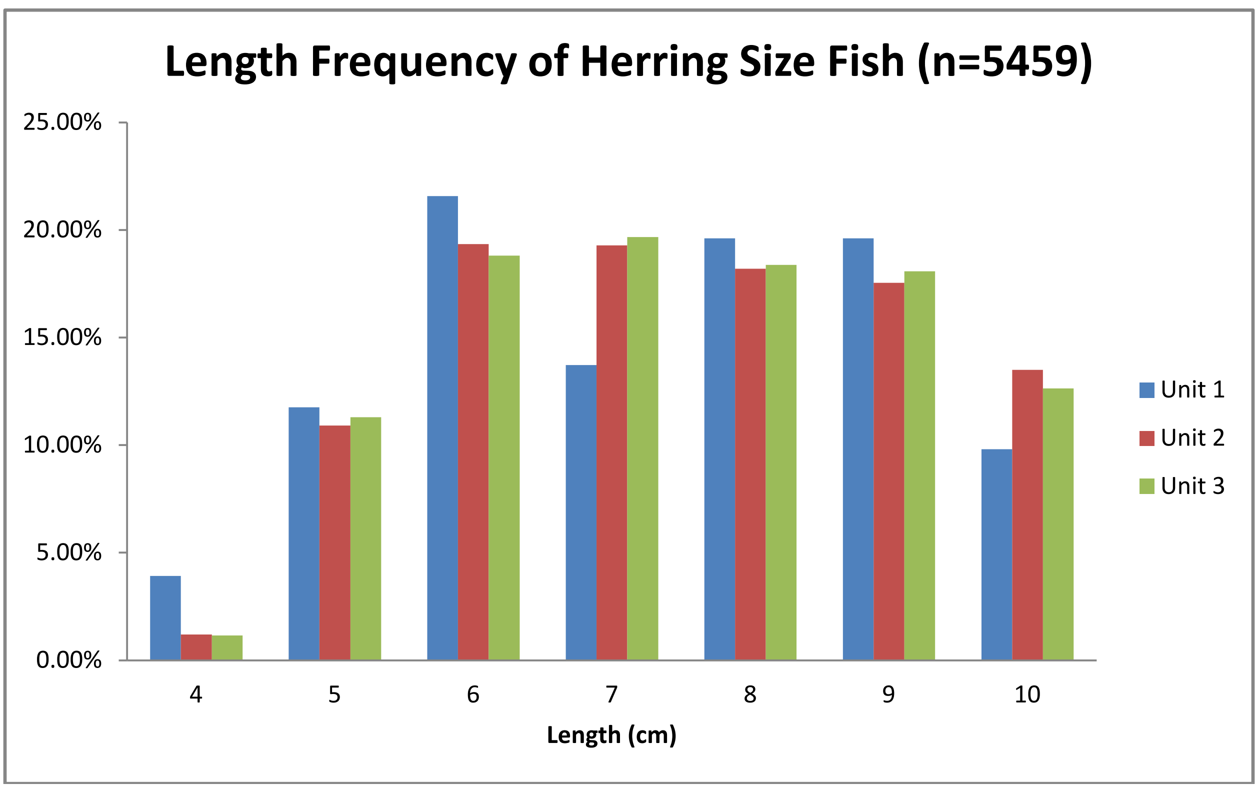

FIGURE 15. **LENGTH FREQUENCY OF ENTRAINED HERRING AT THE SCHOOL STREET PROJECT COHOES, NY**

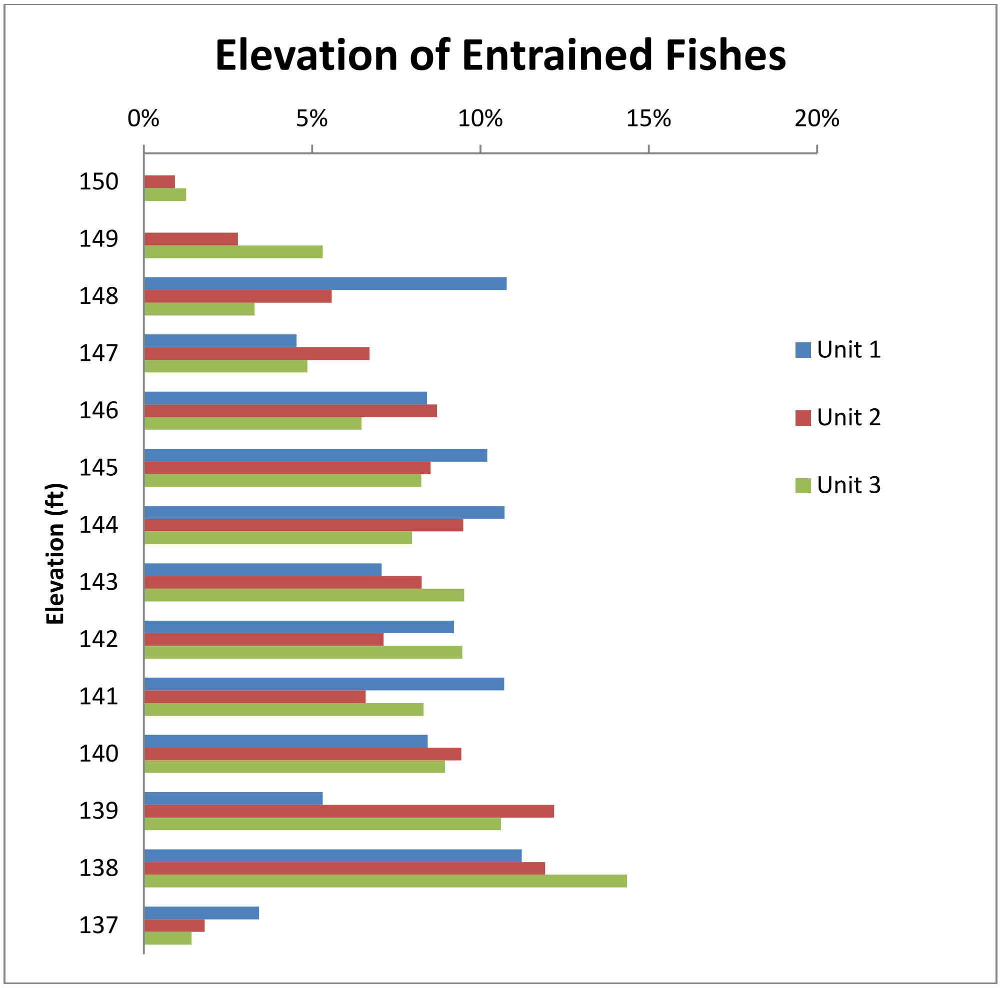

FIGURE 16. ELEVATION OF ENTRAINED FISHES AT THE SCHOOL STREET PROJECT COHOES, NY. ALL FISHES WERE ASSIGNED TO THE NEAREST 1 FT ELEVATION.

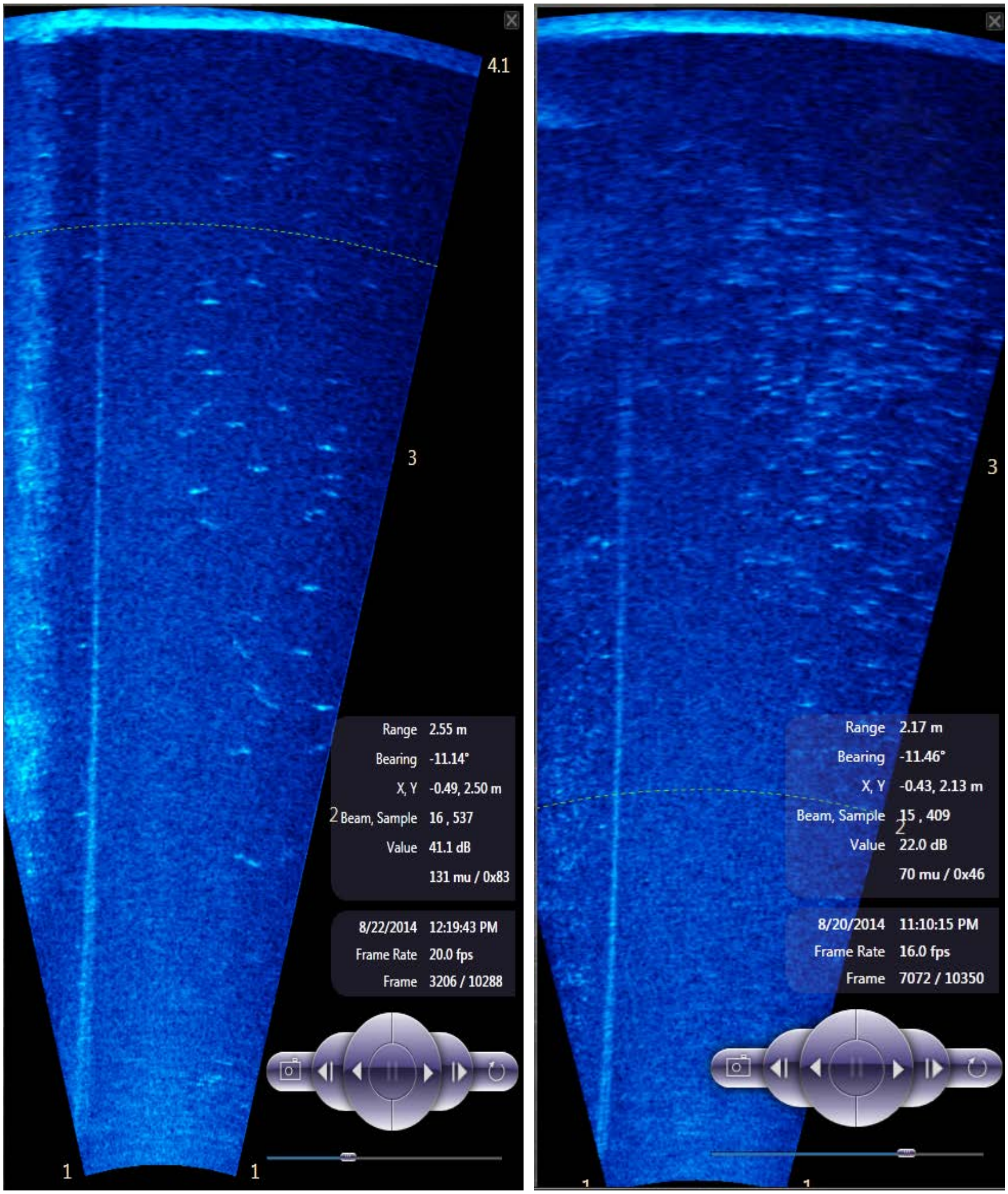

FIGURE 17. EXAMPLES OF IMAGES HERRING WITHIN THE DOWNSTREAM FISH BYPASS AT THE SCHOOL STREET PROJECT COHOES, NY. NOTE THE DIFFERENCE IN HERRING DENSITY BETWEEN THE TWO IMAGES.

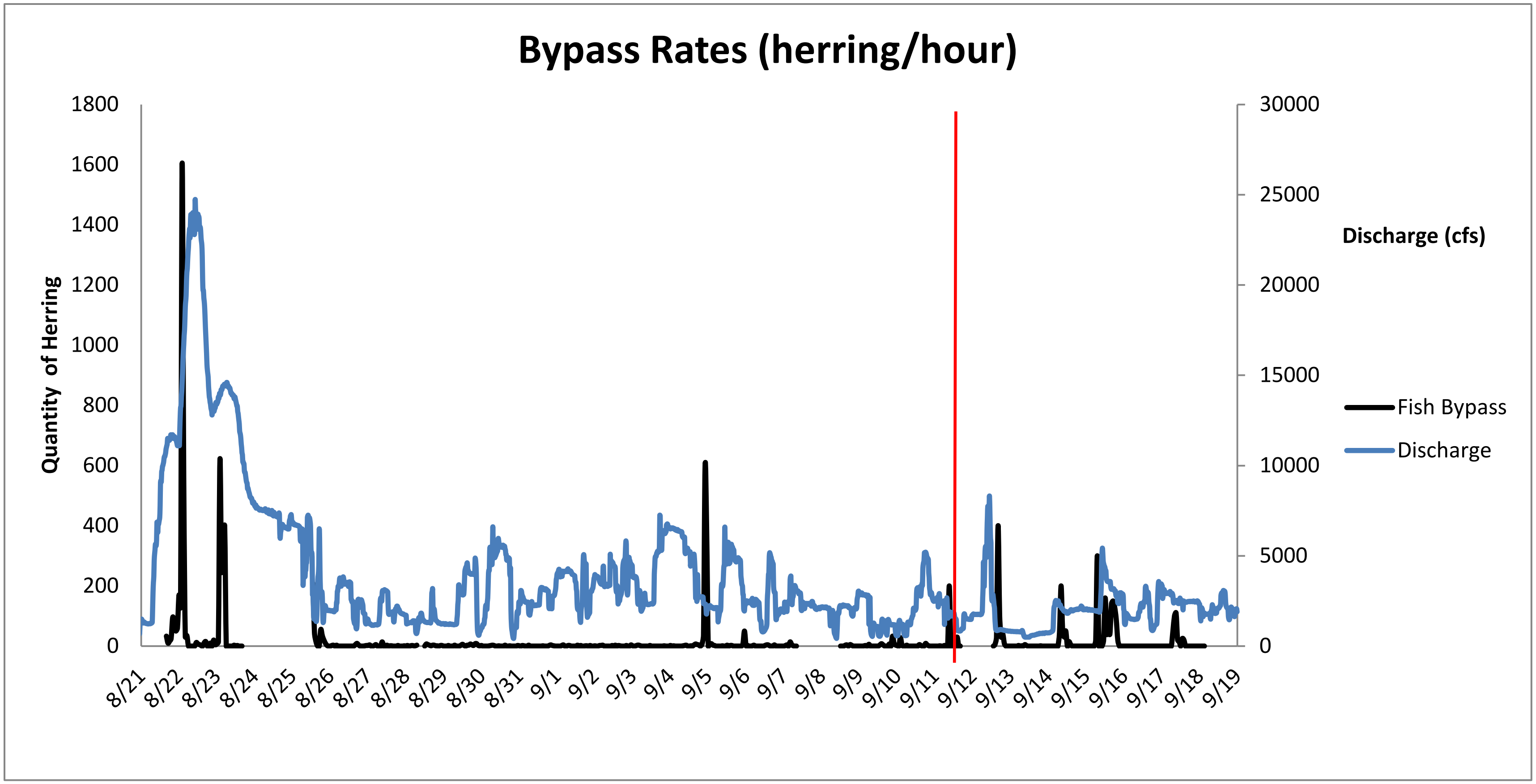

FIGURE 18. BYPASS RATES (HERRING/HOUR) AND MOHAWK RIVER DISCHARGE (USGS GAGE 01357500 IN COHOES, NY) AT THE SCHOOL STREET STATION COHOES, NY. THE RED LINE DENOTES WHEN THE BYPASS FLOW SCENARIO 1 TRANSITIONED INTO SCENARIO 2 (9/11/14 AT 10:30).

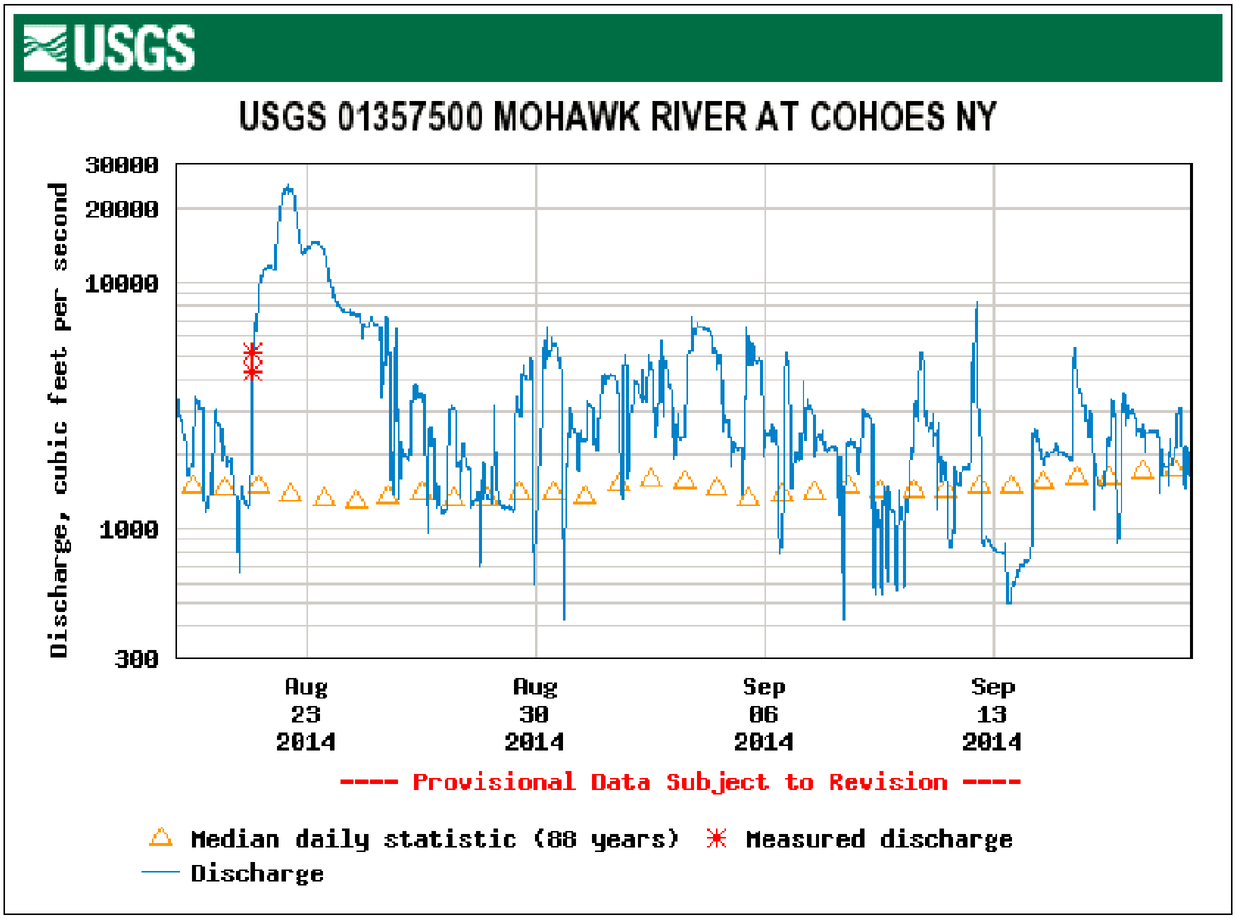

FIGURE 19 **DISCHARGE OF THE MOHAWK RIVER AS MEASURED AT THE USGS GAGE (01357500) IN COHOES, NY.**

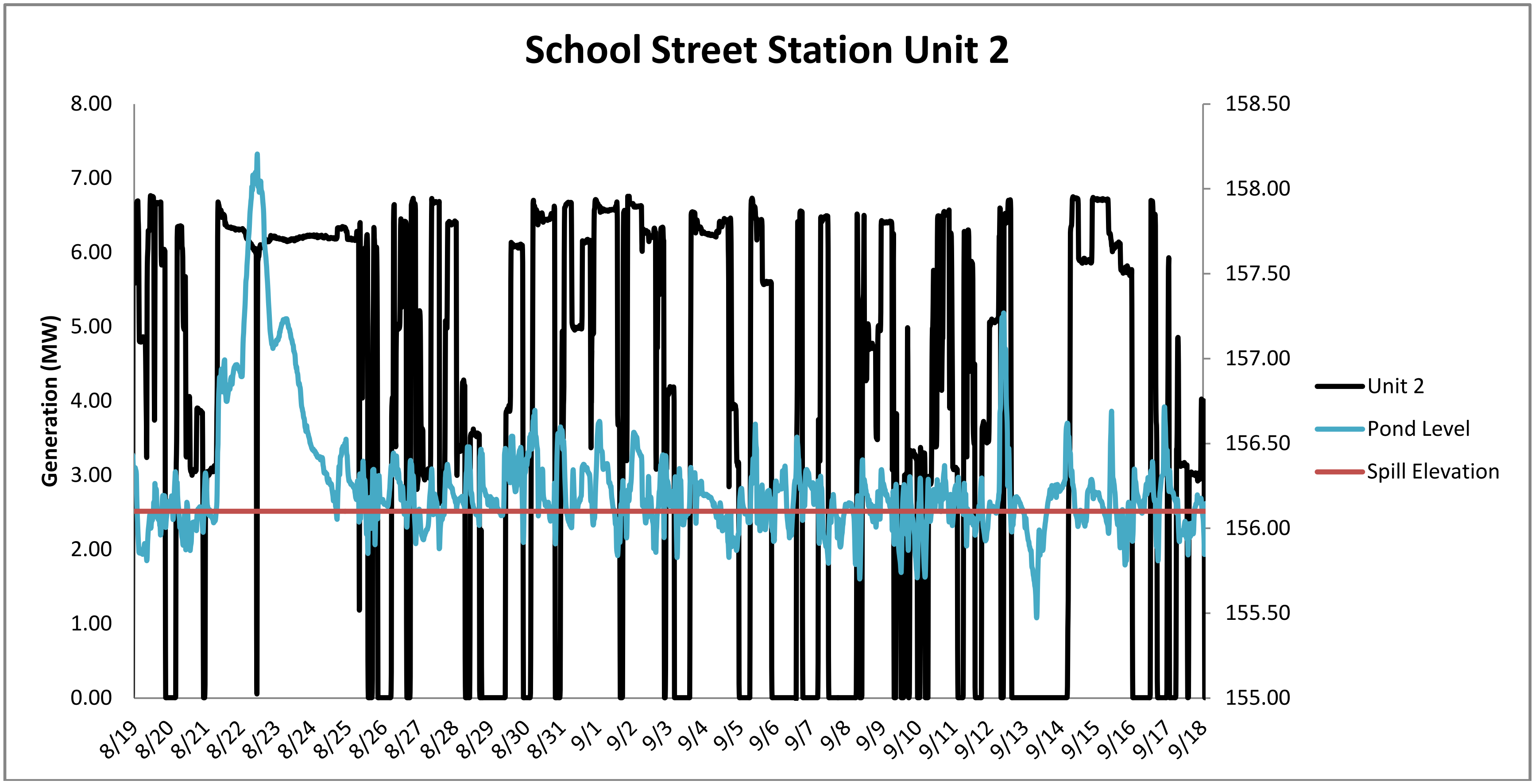

FIGURE 20 **UNIT 2 GENERATION AT THE SCHOOL STREET STATION COHOES, NY.**

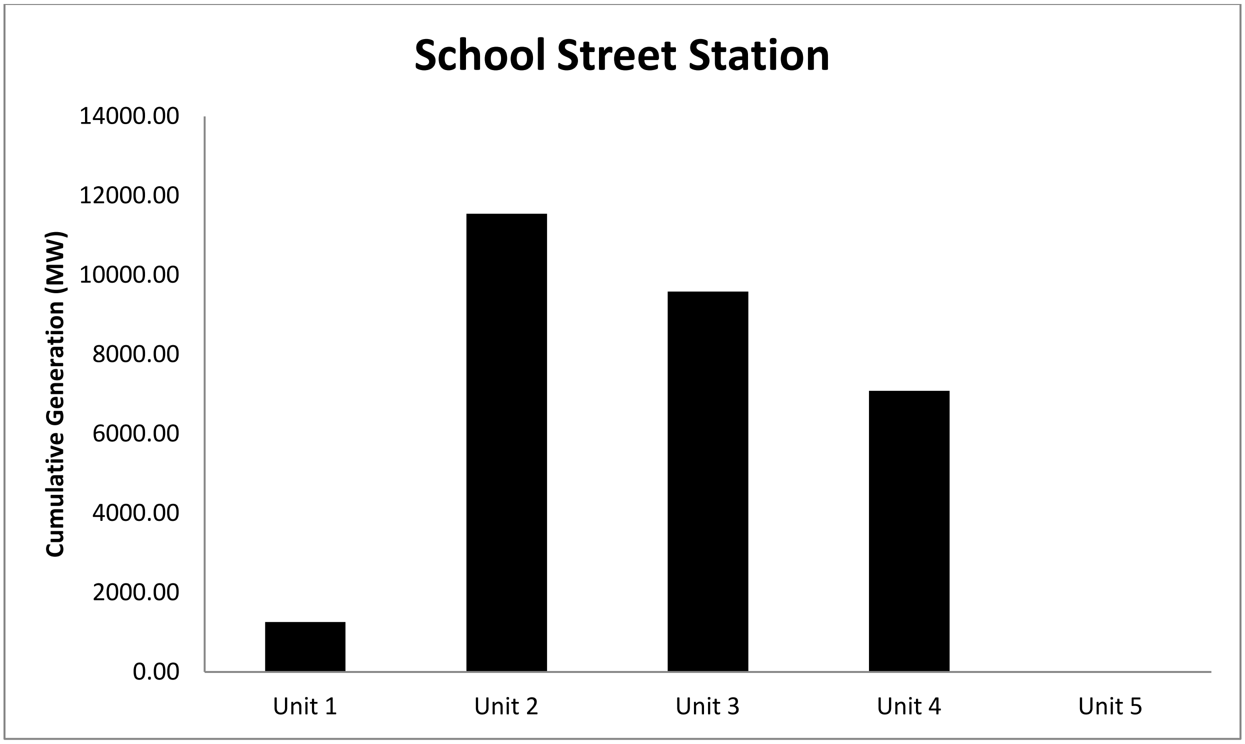

FIGURE 21 CUMULATIVE GENERATION DURING THE STUDY PERIOD EXTENDING FROM AUGUST 19 THROUGH SEPTEMBER 18, 2014 AT THE SCHOOL STREET STATION COHOES, NY. NOTE THAT UNITS 1-4 ARE EQUALLY SIZED AND GENERATION IS DIRECTLY PROPORTIONAL TO OPERATION DURATION (I.E. UNIT 2PRODUCED THE MOST ELECTRICITY DURING THE STUDY PERIOD BECAUSE IT OPERATED THE MOST FREQUENTLY).

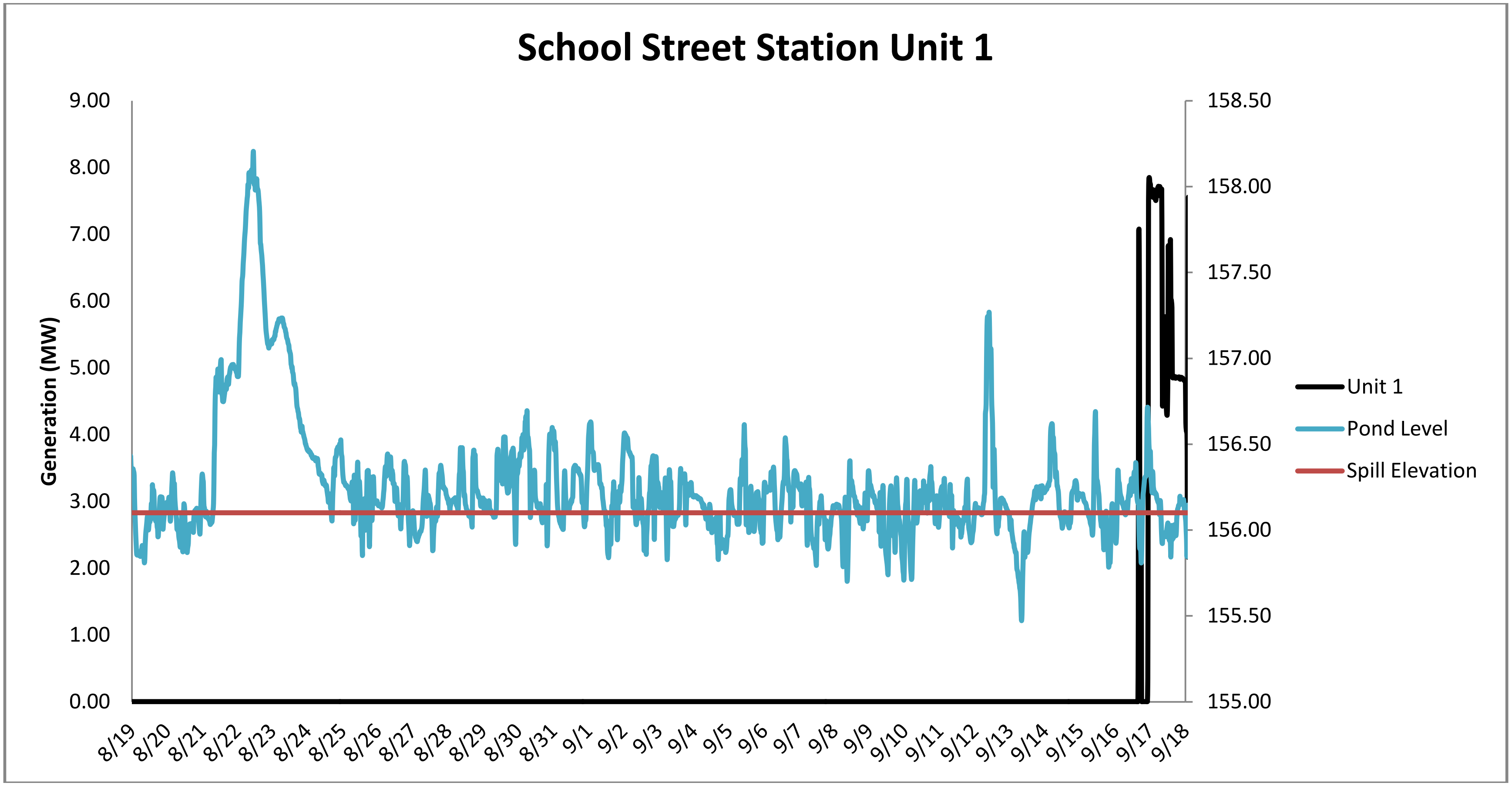

FIGURE 22. UNIT 1 GENERATION AT THE SCHOOL STREET STATION COHOES, NY.

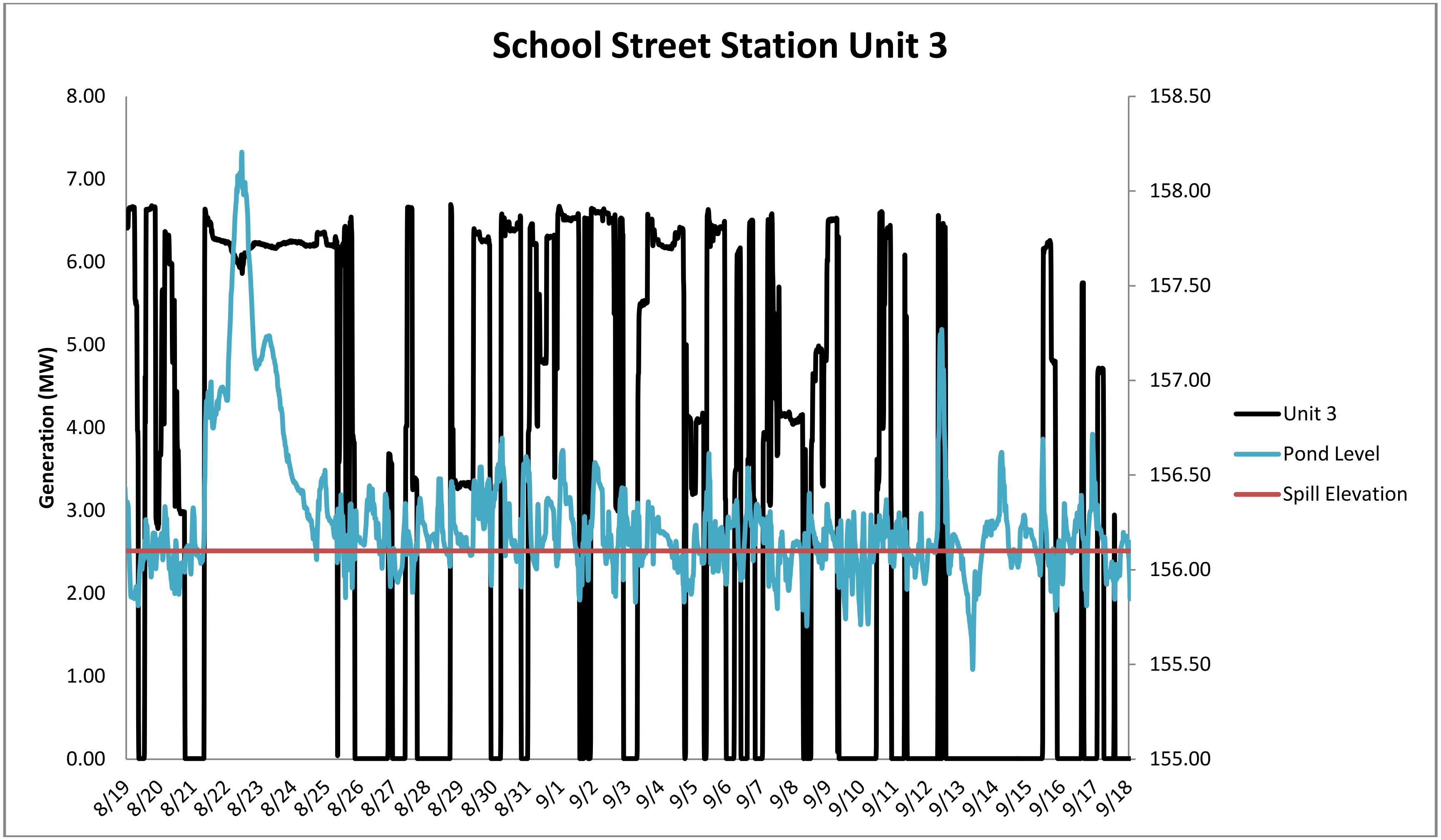

FIGURE 23. **UNIT 3 GENERATION AT THE SCHOOL STREET STATION COHOES, NY.**

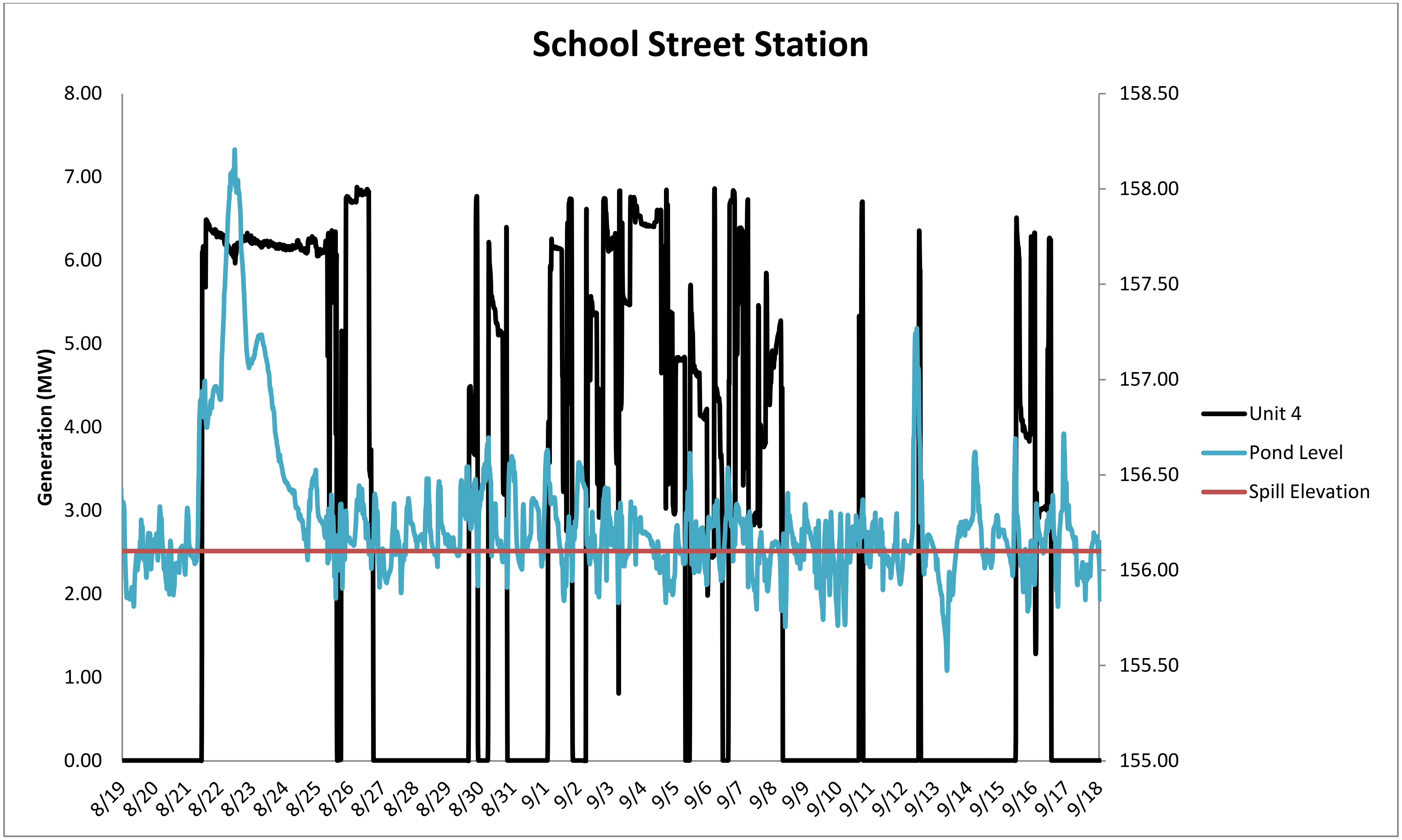

FIGURE 24. UNIT 4 GENERATION AT THE SCHOOL STREET STATION COHOES, NY.

JUVENILE BLUEBACK HERRING DOWNSTREAM PASSAGE EFFICIENCY REPORT

SCHOOL STREET PROJECT
FERC NO. 2539

Prepared for:

Brookfield Renewable Energy Group
Queensbury, New York

Prepared by:

Kleinschmidt

Essex, Connecticut
www.KleinschmidtGroup.com

April 2016

JUVENILE BLUEBACK HERRING DOWNSTREAM PASSAGE EFFICIENCY REPORT

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JUVENILE BLUEBACK HERRING
DOWNSTREAM PASSAGE EFFICIENCY STUDY

SCHOOL STREET PROJECT
FERC NO. 2539

1.0 INTRODUCTION

The School Street Hydroelectric Project (Project) (FERC No. 2539) is owned and operated by Brookfield Renewable Energy Group (Brookfield). The Project is located on the Mohawk River, 2.5 river miles upstream of its confluence with the Hudson River in Cohoes, New York. The Project was issued a new FERC License on February 15, 2007. Downstream fish passage for anadromous and catadromous fish, as well as resident fish, was required as part of the new license. In September 2007, a Final Plan was developed to investigate the phase I fishway effectiveness. The Final Plan included requirements for testing downstream passage survival for resident fish, American eels, juvenile and adult blueback herring; passage efficiency of juvenile and adult blueback herring; an inspection of the conveyance structures; and a hydraulic survey to document flow field and approach velocities in front of the angled bar rack and fishway entrances.

To date, Brookfield has met their obligations to investigate the phase I fishway effectiveness as described in the Final Plan (Kleinschmidt 2007) and Phase I Fishway Effectiveness Testing Study Plan (Study Plan) (Kleinschmidt 2011), with one exception; the evaluation of downstream bypass efficiency of juvenile blueback herring (herring or juvenile herring). The following report details the 2015 downstream passage efficiency study, including compliance background, the materials and methods used in the evaluation, the results, a discussion of the results and conclusions.

2.0 OBJECTIVES

The goal of this study is to investigate the efficiency of downstream passage of herring by providing a quantitative estimate of the proportion of juvenile blueback herring that use the fishway (bypassed) versus the proportion that pass through the turbines (entrained). Passage efficiency was to be evaluated and compared over two bypass flow regimes, 2% and 5% of station capacity.

3.0 PROJECT DESCRIPTION

The Project consists of:

1) A stone masonry gravity dam extending 1,278 ft across the Mohawk River, 16 ft in height;
2) A reservoir with a surface area of approximately 100 acres at a normal maximum water surface elevation of 156.1 ft, and a gross storage capacity of 788 acre-feet;
3) A power canal extending approximately 4,400 ft from the dam to the powerhouse, approximately 150 ft wide and 14 ft deep;
4) An upper gatehouse structure that currently includes nine slide gates and three steel tainter gates to control the diversion of flow into the canal;
5) A lower gatehouse with five steel head gates to control flow into the five penstocks; and
6) A powerhouse measuring 170 ft long by 78 ft wide, housing five generating units with vertical shaft Francis turbines rated at 92 ft of head, with a total maximum capacity of 38.8 megawatts (MW).

4.0 FISHWAY DESCRIPTION

The fishway conveyance structure is located near the downstream end of the angled bar rack. It has two intake portals and includes a multi-level gate with top and bottom entrances (Figures 1 and 2). Attraction flow to the fishway entrances can vary between two to five percent of the Project’s total hydraulic capacity. Conveyance pipes from both entrances converge in a fish separation chamber part-way along the fish conveyance structure (Figure 3). The chamber reduces the volume of the bypass flow and guides fish along a wire floor screen, directing them into a fish return weir pool. The excess attraction water flows through the screen and is discharged downstream of the Project. A gate valve at the downstream end of the fish separation chamber provides hydraulic control within the fish conveyance structure. An adjustable weir is located at the inlet to the fish return weir pool (Figure 4). The movable weir provides fine-tune adjustment to the depth of water cascading over the weir as well as the bypass discharge flow (design flow 25 cfs). Once in the fish return weir pool, fish are guided to the entrance of the final return pipe, and are deposited into the tailwater of the Project.

5.0 BACKGROUND

The Final Plan described the evaluation of downstream passage of herring at the Project and recommended the use of passive study techniques. In the summer of 2010, Brookfield conducted a proof of concept study (Feasibility Study) to investigate the feasibility of using DIDSON (Dual-Frequency Identification Sonar) and split-beam hydroacoustic technologies to investigate bypass efficiency. The Feasibility Study demonstrated that DIDSON and split-beam hydroacoustic technologies could be used to effectively compare the quantity of herring passage through the downstream bypass versus the quantity entrained. As such, Brookfield mobilized to conduct the full scale evaluation during the *fall* outmigration in September and October of 2010. Unfortunately, the effort did not meet the objective of evaluating passage efficiency due to high water, low test fish availability, and site specific conditions. Significant resources were dedicated to this effort with no results.

In 2011, Brookfield consulted with the New York State Department of Environmental Conservation (NYSDEC) and United States Fish and Wildlife Service (USFWS) to develop an alternative approach to investigate downstream bypass efficiency. Brookfield proposed to employ Passive Integrated Transponder (PIT) technologies to evaluate downstream passage at the Project. The proposed methodology was detailed in the *Phase I Fishway Effectiveness Testing Study Plan* (Kleinschmidt 2011) and distributed to the NYSDEC and USFWS for comment and approval. The agencies concurred with Brookfield's revised approach and the study was conducted in the late summer and early fall of 2012 when out-migrating herring became available. The study team found that the small size and fragile nature of the herring in combination with high ambient water temperature made it difficult to effectively tag. Due to high tagging and handling mortality, the effort was abandoned.

In January 2013, Brookfield met with the NYSDEC and USFWS to explore alternatives for a successful evaluation in 2013. It was agreed that hydroacoustic methods should be reemployed to meet compliance objectives relative to downstream passage efficiency at the Project. As such, Brookfield developed a hydroacoustic-based study designed to investigate the efficiency of downstream passage of herring by providing a quantitative estimate of the proportion of juvenile blueback herring that uses the fishway (bypassed) versus the proportion that passes through the turbines (entrained) at two bypass flow regimes, 2% and 5% of station capacity. The study was detailed in a Study Plan titled *Juvenile Blueback Herring Downstream Passage Efficiency Evaluation Study Plan* (Study Plan) (Kleinschmidt 2012, Appendix A). The Study Plan was distributed to the NYSDEC and USFWS for comment and approval. The agencies concurred with Brookfield's approach and the study was conducted in August and September 2013. Meaningful results were not achieved in 2013 due to very low numbers of out-migrating juvenile herring. The study was repeated again in 2014 and yielded quality data and results but was considered ineffectual by resource agencies due to mechanical issues preventing the operation of Unit 1, the priority unit located closest to the downstream fish bypass entrance (Kleinschmidt 2015). To satisfy the agencies, an additional year of study was needed, which was conducted in August-September 2015.

6.0 METHODS

The methods detailed in this section were developed in consultation with the NYSDEC and the USFWS. Brookfield employed hydroacoustic technologies to monitor juvenile herring passage through the downstream fish bypass and through the Project units. Acoustic camera technologies were employed to monitor the downstream bypass between August 18, and September 22, 2015, whereas split-beam hydroacoustic technologies were employed in the intake area of three of the five units at the Project between August 20, and September 24, 2015.

6.1 FISHWAY MONITORING

Herring passage through the downstream bypass was monitored using an ARIS 3000 acoustic camera (ARIS) manufactured by Sound Metrics Inc. The ARIS is the latest model of acoustic camera developed by Sound Metrics, providing higher resolution images than those of the DIDSON used in previous studies. The fishway was operated at two attraction flow scenarios during the study; 2% (120 cfs) from August 18 to September 18 (09:45); and 5% (330 cfs) of the station's design capacity of 6,600 cfs from September 18 (09:45) to September 22, 2015. A weir extension board was installed to reduce the area in which outmigrating herring could pass over the weir (Figure 5). This arrangement ensured that the ARIS would provide complete monitoring coverage of the passable area. The ARIS employs a relatively wide field of view (29° horizontal) and was mounted to the weir extension and oriented such that fish could be monitored as they approached the weir as well as provide a record of passage as they cascaded over it (Figure 5). The ARIS employed a concentrator lens to reduce the vertical beam angle from 14° to 8° and was tilted downward slightly (~2°) to minimize interference with the water surface as well as to detect the top of the submerged weir board to provide a physical reference point by which to evaluate passage over the weir (Figure 6). The fish return weir and cascading flows created a physical barrier to upstream movement and served as a *point of no return* where fish were obligated to continue downstream and bypass the Project.

The ARIS camera was operated at high frequency (3.0 MHz) to provide the greatest possible image resolution and automated to record data continuously throughout the monitoring period. The focal length was set to automatically alternate between two focal zones; 2 and 3.5 meters, at 15-minute intervals so as to not bias data collection efforts to near-field only. All targets were imaged; however, just like an optical camera, image clarity was greatest at those targets that occurred within the focal zone. The ARIS was operated from a dedicated field laptop and data were archived on external hard drives. The ARIS monitoring system employed an internet connection, which allowed the investigators to access the system remotely via a *Go To MY PC* account. The ARIS system was checked daily throughout the course of the study to ensure proper operation, monitor data storage capacity, and to check for the presence of herring within the fish separation chamber.

In addition to the ARIS, a video monitoring system was employed in the fish separation chamber to verify targets detected by the ARIS. The system employed a Delta Vision Series Camera manufactured by Ocean Systems. Video data were recorded on a dedicated DVR System by Everfocus. The video camera was deployed at the downstream end of the fish separation chamber and oriented such that the field of view covered the entire passable area over the weir (Figure 7). Peak bypass events were reviewed to verify the identity of acoustic targets.

6.2 INTAKE MONITORING

The School Street Station is typically operated such that Unit 1 is the first-on last-off, with Units 2 through 5 going online sequentially, as station inflow allows. In general, inflow to the Project during the juvenile herring out-migration period is seasonally low with the majority of

generation produced from Units 1, 2 and 3. As such, Brookfield targeted these units for monitoring. Each of the turbine intakes was monitored using a DT-X split-beam system manufactured by BioSonics, which employed 200 kHz transducers with a ~6.8° beam.
A transducer was installed at each of the three intake bays at Units 1, 2 and 3 (Figure 8). The transducers were mounted on 2-inch diameter vertical aluminum pipes, attached to the front of the grating covering each bay and positioned in a downward-looking orientation (Figure 9). The transducers were deployed as shallow as possible (~2.0 ft) to maximize the effective sampling area of the conical beam such that each transducer sampled approximately 10% of the penstock opening (Figure 10). The split-beam monitoring system was controlled by a dedicated field computer, which also stored the data. The automated system employed a sampling scheme in which each unit was monitored independently for 20 minutes of each hour of the day (i.e., 20 min at Unit 1, 20 min at Unit 2, and 20 min at Unit 3 for a combined total of 60 min of data per hour). The sampling scheme was employed to reduce the volume of data generated, while maintaining an adequate sample size in which to make hourly comparisons between downstream passage rates via the bypass and Project entrainment rate. Data were collected at a ping rate of 18 pings per second and pulse duration of 0.2 milliseconds with an intensity threshold of -80 dB. The split-beam monitoring system employed an internet connection which allowed the investigators to access the system remotely via a *Go To MY PC* account. The split-beam system was checked regularly (every few days) throughout the course of the study to ensure proper operation, monitor data storage capacity, and to check for the presence of herring moving through the Project intakes.

6.3 DATA ANALYSES

Data collected within the fishway and at the intakes were intended to be used to develop estimates of passage (i.e. bypassed and entrainment) over time, such that an estimate of Project passage efficiency (PPE) could be calculated as follows:

$$PPE = \sum (bypassed/(bypassed + entrained)) * 100$$

The calculation of the PPE reflects the sum of passage over distinct intervals of time in which direct comparisons between the bypass and entrainment could be made and does not provide a comprehensive estimate of the seasonal passage. The PPE proportion was calculated during periods in which both the split-beam (intake) and the acoustic camera (fish bypass) data were valid and only during period of Project operation.

6.3.1 ACOUSTIC CAMERA AND VIDEO DATA

ARIS data were processed with ARIS Fish software by Sound Metrics Inc. Video data were processed using the EverFocus HD Reader software. The data were sub-sampled such that fifteen minutes of each hour of data recorded during period of Project operation were analyzed. ARIS data were further processed by alternating between the two focal lengths sampled. In other words, 15 minutes of Hour 1, in which the focal length was 2 m, were processed, followed by 15 minutes of Hour 2, in which the focal length was 3.5 m, and then back to processing 15 minutes of Hour 3 in which focal length was 2 m; and so on. Fish were differentiated from debris based on size, shape and type of motion as indicted in the study plan.

6.3.2 SPLIT-BEAM DATA

Split-beam data were processed in Myriax Echoview software. After applying an intensity threshold of -54 dB, the data were analyzed with an α,β-tracking algorithm, which identifies the series of echoes that were returned by an individual fish over successive pings. The tracking results were reviewed on the echogram and exported as a database containing time, target strength and 3-D positional information for each fish detected. This database was further filtered to remove all fish (or other targets) with a mean target strength of -54 dB or less, which translates into fish approximately 3.8 cm in length or smaller (Warner et al., 2002). The overall estimate of entrainment included those targets that ranged between 3.8 cm and 10.0 cm, only. This size range was based on the results of the 2012 evaluation at which time length data were collected on 103 individuals and ranged from 4.5 to 7.5 cm. The selected range (i.e. between 3.8 cm and 10.0 cm) accounts for seasonal variability in juvenile herring length.

Fish counts were expanded for the non-sampled area of the intake cross-section as follows. An expansion factor was calculated for each individual fish as a function of its effective beam width at the range it was observed. This effective beam width depends on the acoustic beam pattern and the size of the target. Thus, for a given transducer, at any given range, a large fish can be detected over a wider portion of the intake cross-section than a smaller fish. The expansion factor compensates for this differential detection probability. For each fish *i* the expansion factor x_i was calculated as:

$$x_i = \frac{w}{b_i}$$

where w is width (m) of the turbine intake, and b_i is the effective width (m) of the sonar beam for fish *i* at the range at which it is observed. For example, if for a given time period, one fish is observed at a range where its effective beam width is half the width of the intake, its expansion factor is 2. Thus, it is estimated that 2 fish passed (1 observed in the portion of the intake that was effectively covered by the sonar beam, 1 unobserved in the portion that was not covered). The expansion factors are summed over all fish observed in a given time period to estimate the total number of fish *F* that passed through the intake:

$$F = \sum_i x_i$$

The fish counts were further expanded to account for sampling 1/3 of each hour by multiplying the counts by 3. The fish passage rates were calculated by dividing the fish counts expanded for the area not sampled and time by the percentage of the time in each hour when the units operated.

Echogram examples of the split-beam data collected in the turbine intakes are shown in Figure 11 and Figure 12. Each echogram plots echoes over time (x-axis) and range (y-axis), with range increasing from top to bottom. The strong signal at the bottom of each echogram is the echo reflected by the intake floor. In Figure 11, the colors in the top two echograms relate to target strength; the warmer the color the stronger the echo. The strong echo of the intake floor is shown in red. The colors in the bottom two echograms relate to the angle at which the target was detected. Targets that move downstream (as do all targets shown in Figure 11) leave echo traces that change (over time) from cool to warm colors; whereas targets that move upstream generate traces that progress through the color spectrum in the opposite direction (example shown in Figure 12). Traces that show no change in angle color are echoes reflected by a stationary object such as the intake floor. Note that the echo traces in the echogram from Unit 1 (Figure 11, left) are short because the targets move quickly through the beam due to the high speed of the current. When a turbine is idle, as in the case of Unit 3 (Figure 11, right), the speed of the current is low and fish or other targets remain in the beam for a longer time and therefore generate longer echo traces. The diffuse clouds of echoes seen at the top of the echograms from Unit 1 are noise from entrained air. The short solid traces towards the bottom half of the Unit 1 echograms and most of the long solid traces in the Unit 3 echograms are fish.

Echogram examples of split-beam data collected in the intake of Unit 2, under high noise conditions, are shown in Figure 12. The target strength echogram (Figure 12, left), angle echogram (Figure 12, middle), and the so-called “single target” echogram (Figure 12, right), which displays the filtered data that is used by the fish tracking algorithm, are depicted. Note that for Unit 2, the angles are reversed; a change in angle color from warm to cold indicate downstream movement. Four tracked fish are outlined in color on the “single target” echogram (Figure 12, right). The angle echogram indicates that the three fish near bottom are travelling downstream (Figure 12, middle), while the fish that is closer to the surface is swimming upstream.

Units 1-3 were monitored for 20 minute each of every hour throughout the study period. Total entrainment for each unit was estimated by multiplying the 20 minute entrainment rate by three to estimate entrainment over the entire hour. Units 4 and 5 were not monitored and did not operate during the study period. All estimates were weighted based on unit operation in any given hour. For example, if Unit 2 was operational for only 30 minutes within an hour then the entrainment estimate for that hour was reduced by 50%.

7.0 RESULTS

The Project intakes (Units 1-3) were monitored between August 20, and September 24, 2015 (35 days) and the downstream fishway was monitored between August 18, and September 22, 2015 (35 days). During this period, two bypass test flow scenarios were investigated; 120 cfs and 330 cfs. Entrainment magnitude, bypass magnitude and bypass efficiency (PPE) were calculated during periods when direct comparisons between the bypass and entrainment could be made (i.e., during station operation and valid data collection at both monitoring locations). This equated to

15.4% of the study period. The estimated entrainment magnitude during the 120 cfs scenario (29 day period) was 28,167 herring. The entrainment magnitude during the 330 cfs scenario (6 day period) was 1,123 herring. No passage of herring through the downstream bypass was documented during the study period and as such the calculated passage efficiency for both flow scenarios was zero.

7.1 SPLIT-BEAM

The mean rate of entrainment at Units 1-3, during both flow scenarios, was 149 herring per hour. However, entrainment was sporadic with low rates of entrainment interspersed by peak events, which rose as high as 2,460 herring per hour at Unit 2 on September 14, 2015 (Figure 13). Peak events were short in duration (generally, less than 1 hour). River discharge and entrainment rate seem to be positively correlated with increased entrainment following increased discharge; however, this is more likely the result of operations occurring during periods of increasing discharge. Figure 14 illustrates the correlation between ascending flows and generation. Entrained fishes ranging from 4 cm to 34 cm in length were detected by the spilt-beam monitoring system (Figure 15). Most (58.1%) were within the target length range of juvenile herring (i.e., 3.8 – 10.0 cm) (Figure 16). The water surface elevation of the canal was operated at or near elevation 154.5 ft and the bottom of the intake structure was at 137 ft, a depth of approximately 17.5 ft. The elevations at which fishes were entrained varied between 150 and 137 ft but was most prevalent at elevations between 141 and 138 ft (Figure 17).

7.2 ARIS ACOUSTIC CAMERA

No fish were observed in the bypass reach during the period of analysis, which included those times when the Project was in operation (154.75 hrs). The ARIS acoustic camera operated continuously throughout the study period but was occasionally ineffective due to a drop in canal surface water elevation, which dewatered the camera, and during a 14-hour period on September 13, 2015 in which data files were corrupted. A total of 2,321 minutes (38.7 hrs) of ARIS data were reviewed.

7.3 River Flow and Operations

River flow at the Project ranged from a low of approximately 288 cfs on September 9, to a high of approximately 4,390 cfs on August 22, 2015 as measured at the USGS gage number 01357500 Mohawk River at Cohoes, NY (Figure 18). Flow in the Mohawk River was low during the study period with an average discharge of 1,156 cfs and a median of 957 cfs, well below the median daily statistic, which ranges from 1,320 cfs to 1,810 cfs as calculated from 89 years of record.

Generation at Units 1-3 during the study period was sporadic, and occurred during approximately 18.4% of the study period (Figure 19). Of the three units that generated, Unit 1 operated most frequently with peaks in generation of 7.26 MW, 7.49, and 7.45 MW on August 22, September 9, and September 14, 2015, respectively (Figure 19). Generation at Unit 2 occurred at four discrete and brief intervals (< a day) on August 22, September 1, 14 and 16, 2015 with a maximum generation of 6.36 MW on the September 14, 2015 (Figure 19). Unit 3 operation occurred only in August on the 20 and 21, 2015 with a maximum generation of 6.15 MW on August 21, 2015 (Figure 19).

The impoundment surface water elevation (WSEL) ranged between 155.79 ft on September 22, and 156.6 ft on August 21, 2015 (Figure 20). The spill elevation at the dam is 156.1 ft and spill did occur during the study period with a maximum depth of 0.64 ft (Figure 20). Spill events were generally small in magnitude, often less than 0.35 ft.

8.0 DISCUSSION AND CONCLUSIONS

The objective of this study was to investigate the efficiency of downstream passage of herring by providing a quantitative estimate of the proportion of juvenile blueback herring that uses the fishway (bypassed) versus the proportion that passes through the turbines (entrained). In order to achieve this objective, passage rate data must be available for both passage routes and at the same time. Further, entrainment passage is only applicable during those periods in which the Project was operating. In 2015 the Project operated infrequently due to low river flow conditions, approximately 18.4% of the study period. Further, fluctuating WSEL in the canal occasionally dewatered the ARIS camera rendering it ineffective and further reducing the amount of valid data by which to make a direct comparison. As such, the period in which direct comparisons could be made was significantly reduced when compared the expected (15.4% of the study period).

The study effort was further confounded by the lack of herring in the system during the study period. No fishes, shad or otherwise, were observed in the fish separation chamber. This is atypical when compared to previous studies conducted at the Project in which at least some level of passage or fish holding within the separation has been observed. ARIS data were only analyzed during periods of Project generation because only data collected during generation could be used to meet the objectives of this study. It is possible that some level of passage via the downstream bypass occurred during periods of no generation. However, prior study efforts at the Project have shown that herring that enter the separation chamber mill around for extended periods of time exhibiting schooling behavior with small groups of herring breaking off and passing over the weir. Given these prior observations, it is likely that if any significant number of herring entered the separation chamber, the analysis would have documented their presence.

The split-beam sonar at the Project intake detected herring and an estimate of entrainment was achieved in 2015. However, the magnitude of entrainment was much less in 2015 than during the 2014 study effort. In 2015, an estimated 29,290 herring were entrained compared to 436,388 in 2014 (Kleinschmidt 2015). This is likely the result of fewer herring in the system during the 2015 study period. Given this result, a reduction in bypassed herring is to be expected, but it is unclear why no herring were observed in the bypass.

Video data were collected within the fish separation chamber to help confirm acoustic targets identified by the ARIS camera. The camera was operated continuously throughout the entire study period and was effective during daylight hours. The subsequent review of video data was in agreement with that of the ARIS and no herring or fishes of any species were observed. During installation and removal of the ARIS camera, the separation chamber was dewatered, and in contrast with previous years of investigation, no fish were observed in the chamber nor schooling in the canal in the vicinity of the angled bar rack and bypass intakes. Further, evidence that the downstream run magnitude was much less during the 2015 study period when compared to other years of investigation, particularly in 2014.

9.0 LITERATURE CITED

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Kleinschmidt. 2014. Juvenile Blueback Herring Downstream Passage Efficiency Report School Street Project FERC No. 2539. Prepared Brookfield Renewable Power.

Kleinschmidt. 2013. Juvenile Blueback Herring Downstream Passage Efficiency Evaluation Study Plan School Street Project FERC No. 2539. Prepared Brookfield Renewable Power.

Kleinschmidt. 2011. Phase I Fishway Effectiveness Testing Supplemental Study Plan School Street Project FERC No. 2539. Prepared Brookfield Renewable Power.

Kleinschmidt. 2007. Phase I Fishway Effectiveness Testing Plan Addressing Settlement Agreement Section 3.7, and 401 Water Quality Certification Condition 13, FERC Project No. 2539. Prepared for Erie Boulevard Hydropower, L.P.

Warner, D.M., L.G. Rudstam, and R.A. Klumb. 2002. In situ target strength of alewives in freshwater. Transactions of the American Fisheries Society 131:212–223.

\\kleinschmidtusa.com\Condor\Jobs\826\162\Docs\Report\Report School Street Project 2015.docx

Appendix B

Figures

FIGURE 1 **ONE OF TWO FISHWAY INTAKES (CENTER DISTANCE) AND THE DEBRIS/ICE SLUICE INTAKE (ADJACENT TO FISHWAY INTAKE TO THE RIGHT) AT THE SCHOOL STREET PROJECT COHOES, NY.**

FIGURE 2 **THE MULTI LEVEL GATE STRUCTURE WITHIN THE FISHWAY INTAKE STRUCTURE AT THE SCHOOL STREET PROJECT COHOES, NY.**

FIGURE 3 FISHWAY SEPARATION CHAMBER AT THE SCHOOL STREET PROJECT COHOES, NY.

FIGURE 4 FISHWAY SEPARATION CHAMBER, HIGHLIGHTING THE ADJUSTABLE WEIR AT THE SCHOOL STREET STATION COHOES, NY.

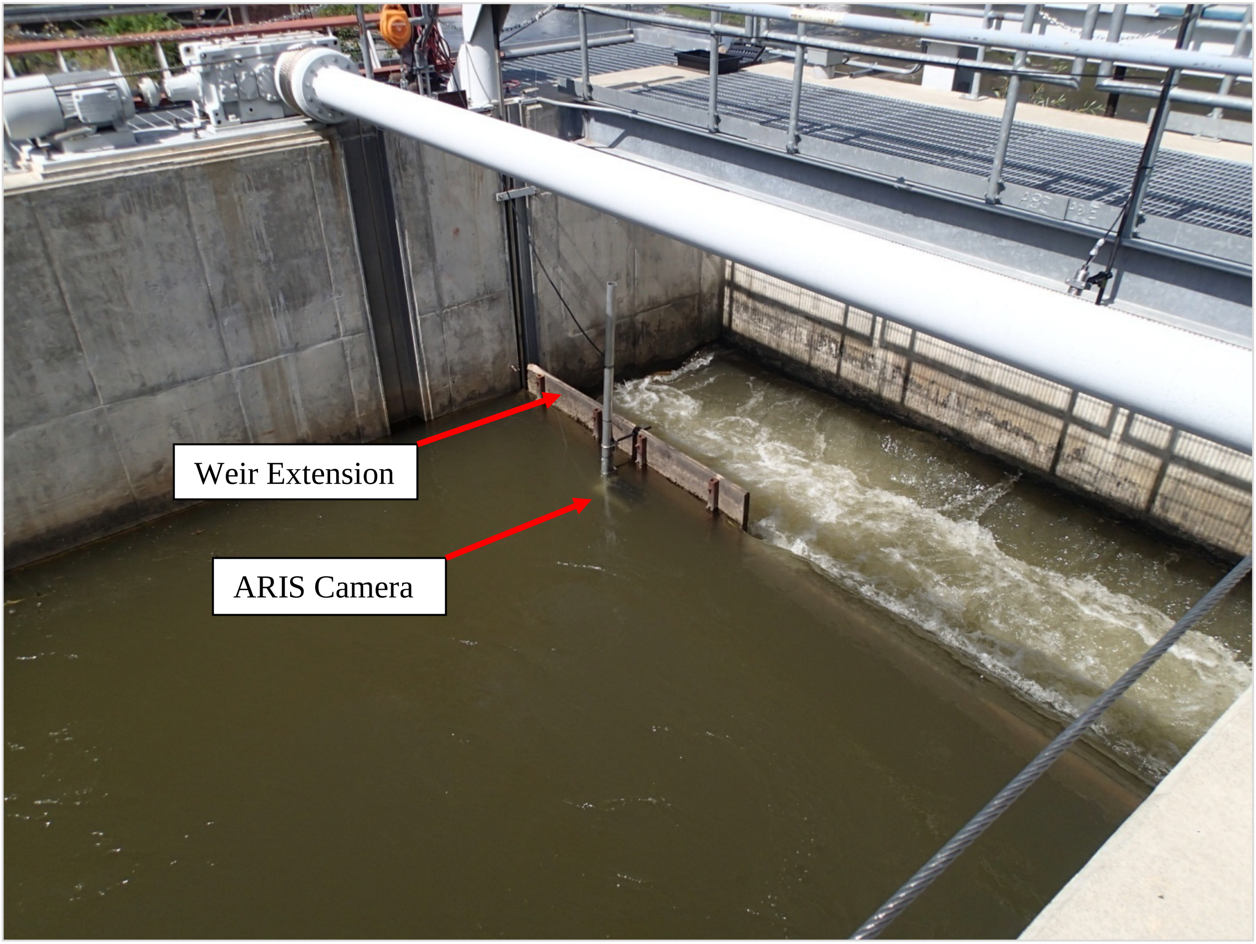


FIGURE 5 **MONITORING EQUIPMENT DEPLOYED IN THE FISH SEPARATION CHAMBER AT THE SCHOOL STREET PROJECT COHOES, NY.**

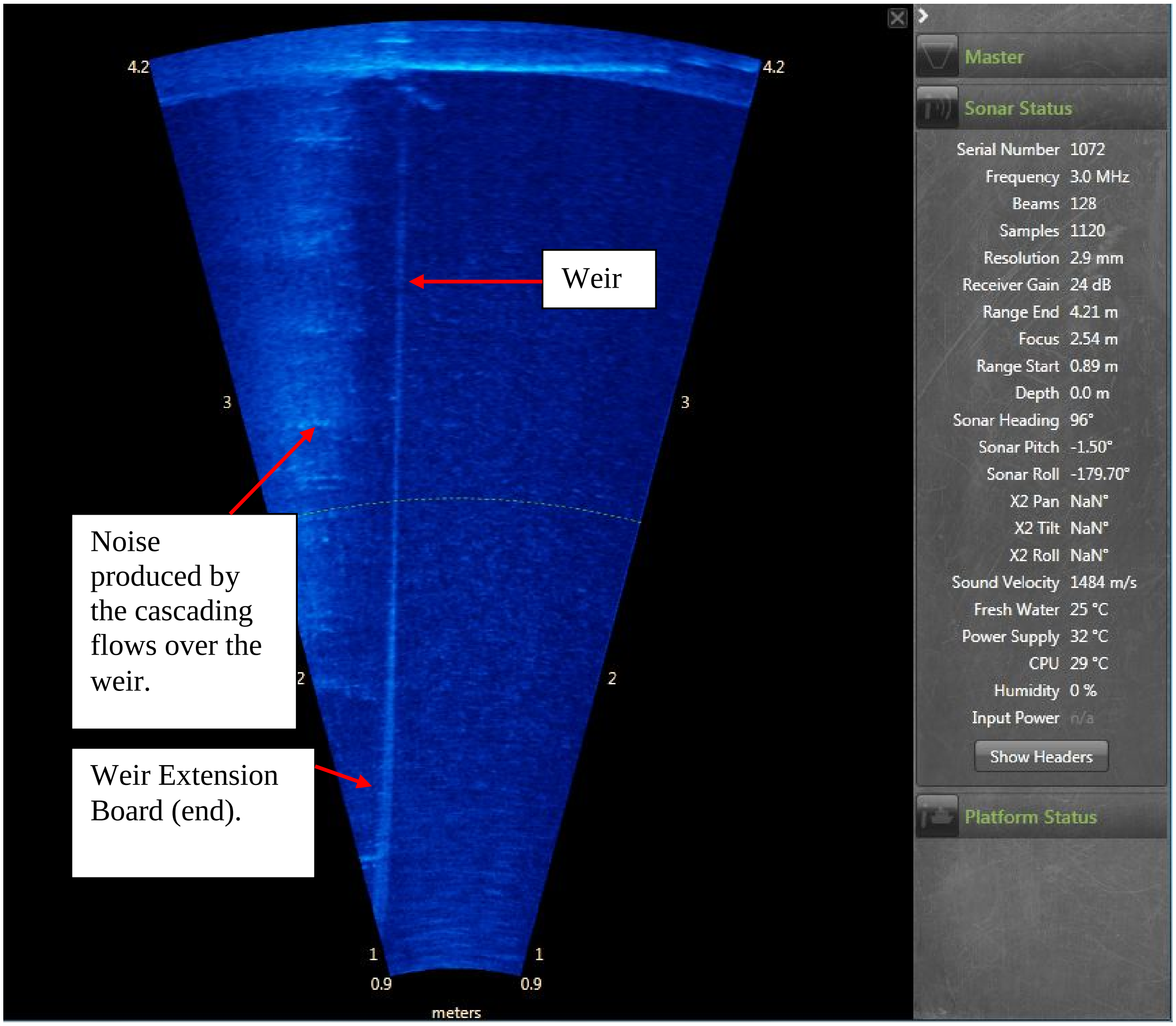


FIGURE 6 **EXAMPLE FIELD OF VIEW PRODUCED BY THE ARIS AS MOUNTED IN THE FISH SEPARATION CHAMBER AT THE SCHOOL STREET PROJECT COHOES, NY.**

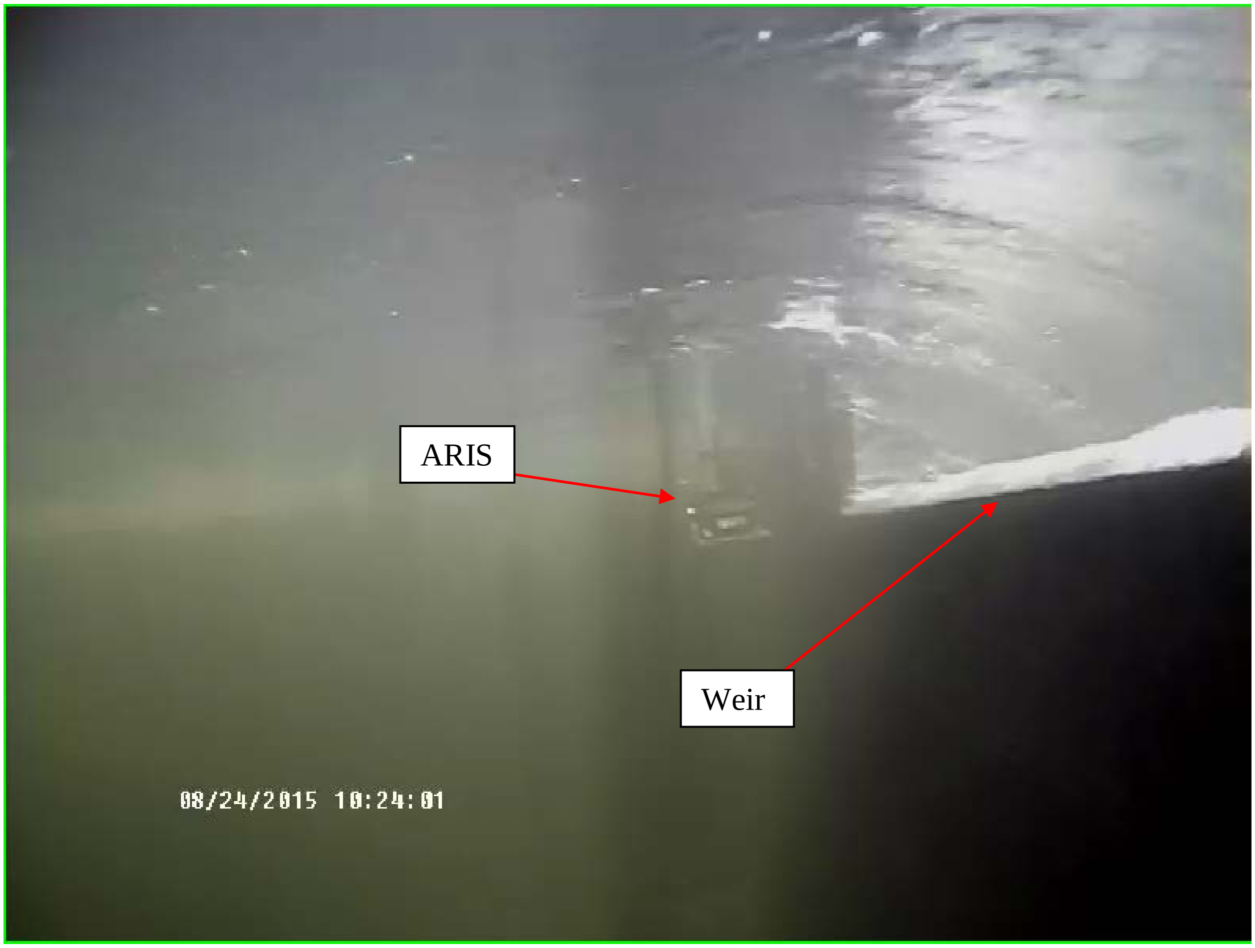


FIGURE 7 EXAMPLE FIELD OF VIEW PRODUCED BY THE VIDEO AS MOUNTED IN THE FISH SEPARATION CHAMBER AT THE SCHOOL STREET PROJECT COHOES, NY.

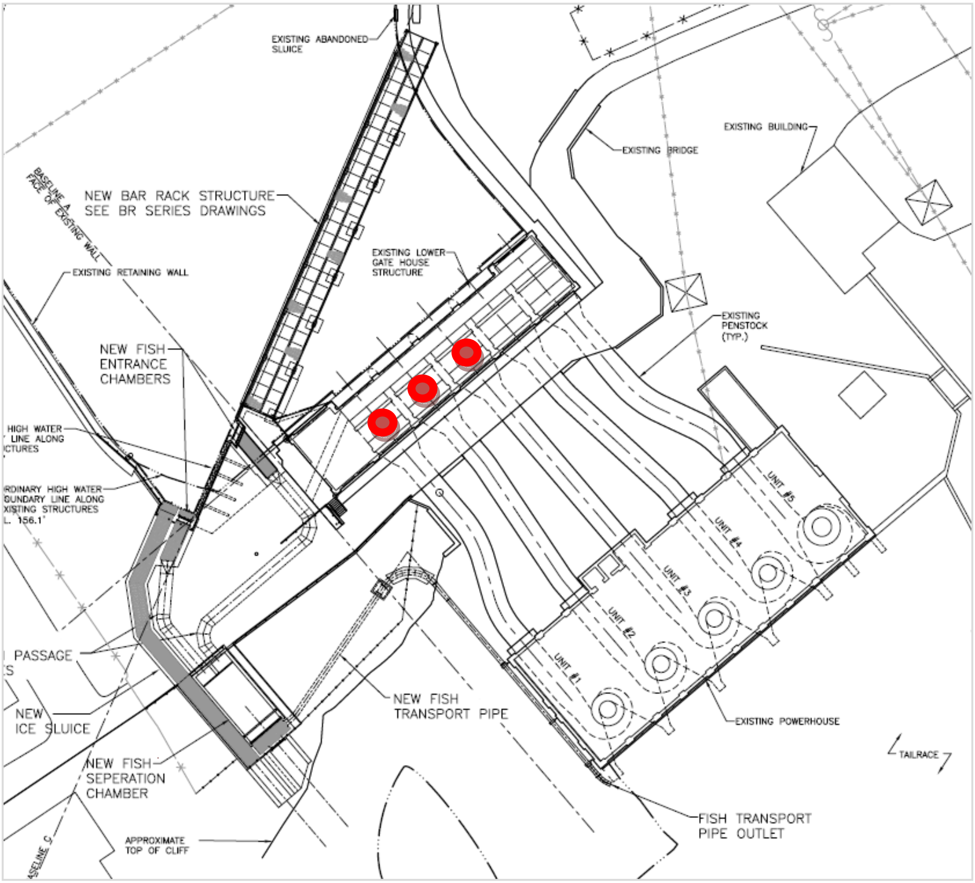
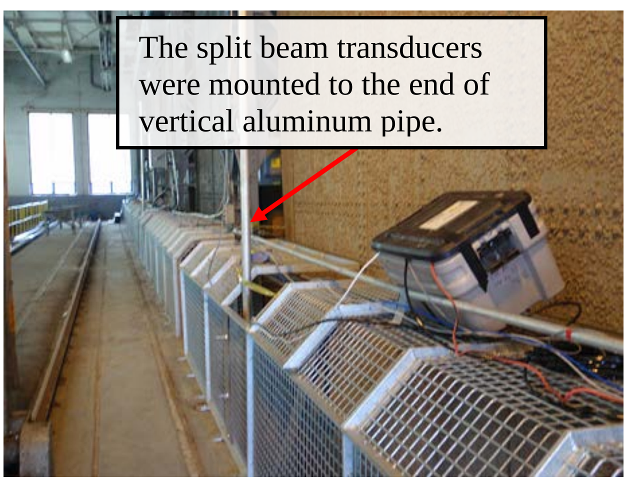


FIGURE 8 **THE LOCATION OF THE THREE SPLIT-BEAM TRANSDUCERS USED TO MONITOR ENTRAINMENT AT THE SCHOOL STREET STATION COHOES, NY.**



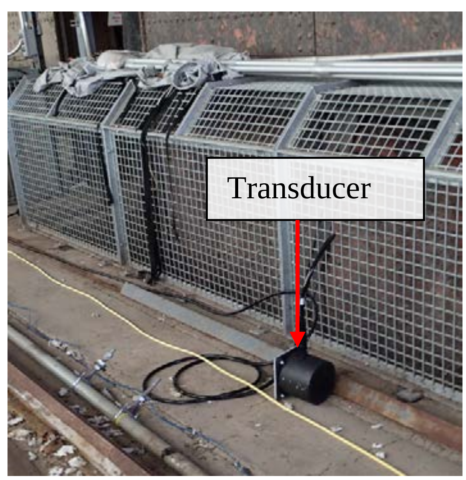


FIGURE 9 **PLACEMENT OF SPLIT-BEAM SYSTEMS IN THE INTAKE BAYS AT THE SCHOOL STREET PROJECT COHOES, NY.**

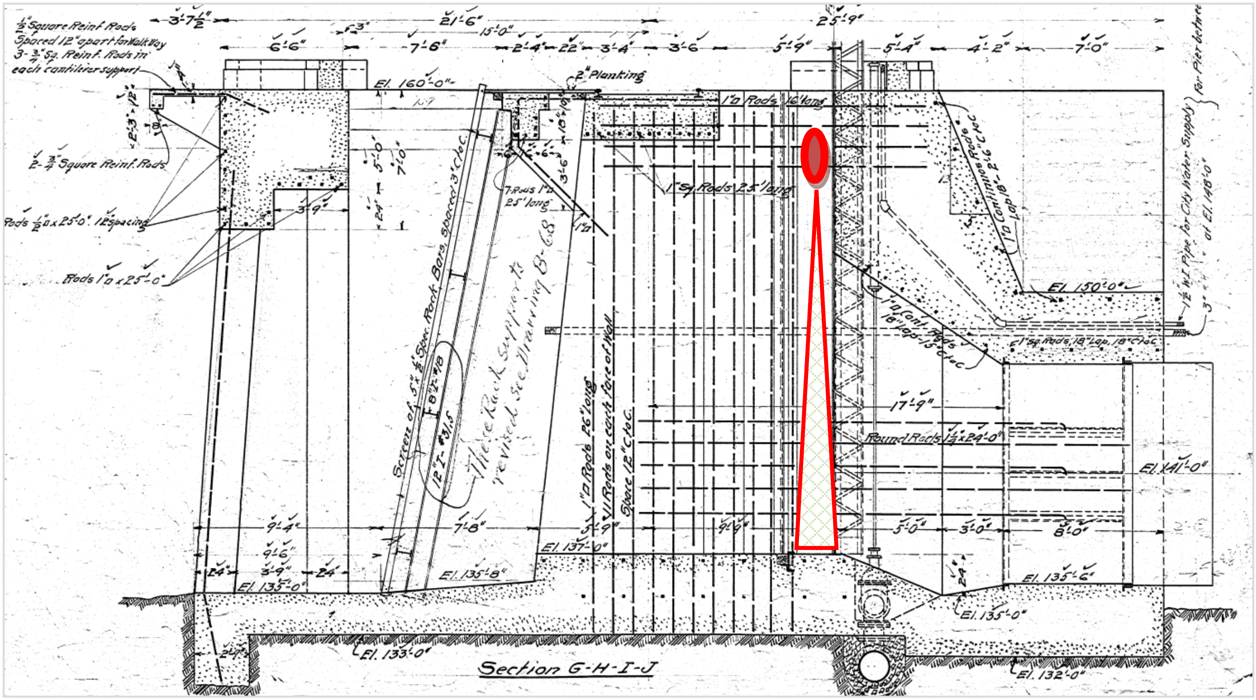


FIGURE 10 **SIDE VIEW DESIGN DETAIL OF UNIT 4 (SAME AS UNITS 1-3) AT THE SCHOOL STREET STATION COHOES, NY. THE FIGURE DEPICTS THE LOCATION OF THE SPLIT-BEAM TRANSDUCER AND ASSOCIATED ACOUSTIC BEAM (ESTIMATED SAMPLE AREA ~10% OF THE INTAKE AREA) (NOT TO SCALE). THE MEAN HIGH SURFACE WATER ELEVATION IS 156.1'.**

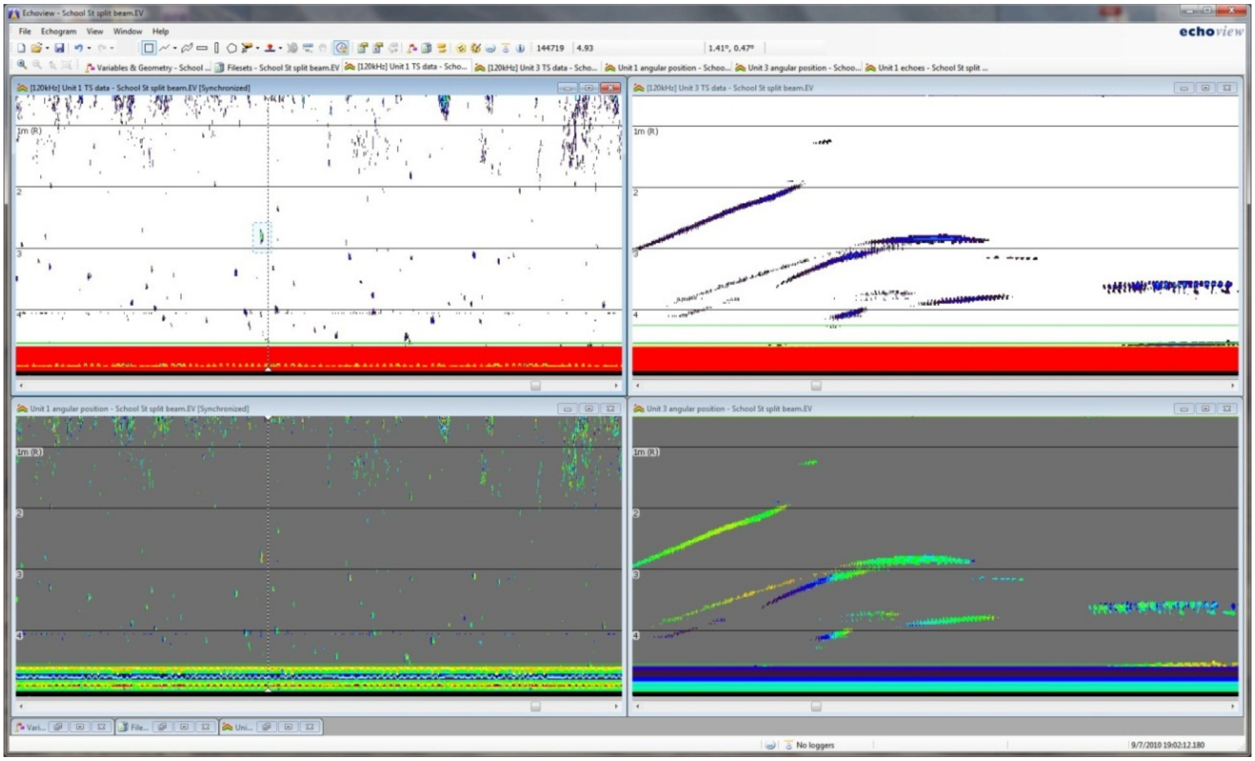


FIGURE 11 EXAMPLE ECHOGRAMS FROM UNIT 1 (LEFT) WHEN IT WAS OPERATING AND UNIT 3 (RIGHT) WHEN IT WAS IDLE.

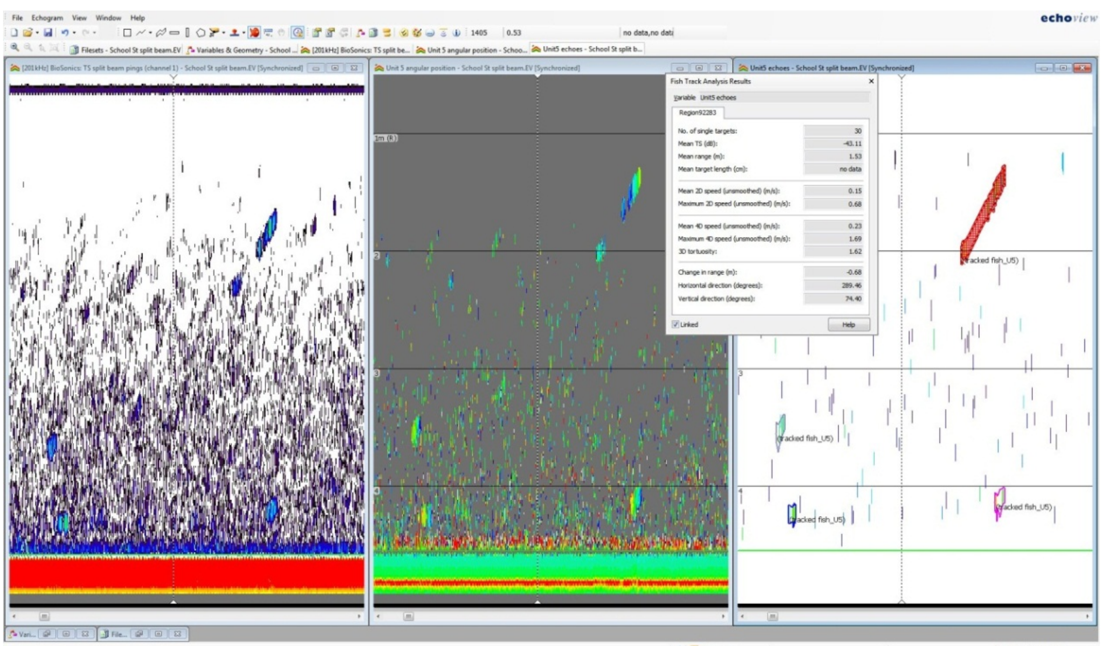


FIGURE 12 EXAMPLE ECHOGRAMS, COLLECTED UNDER HIGH NOISE CONDITIONS WHEN THE UNIT WAS OPERATING.

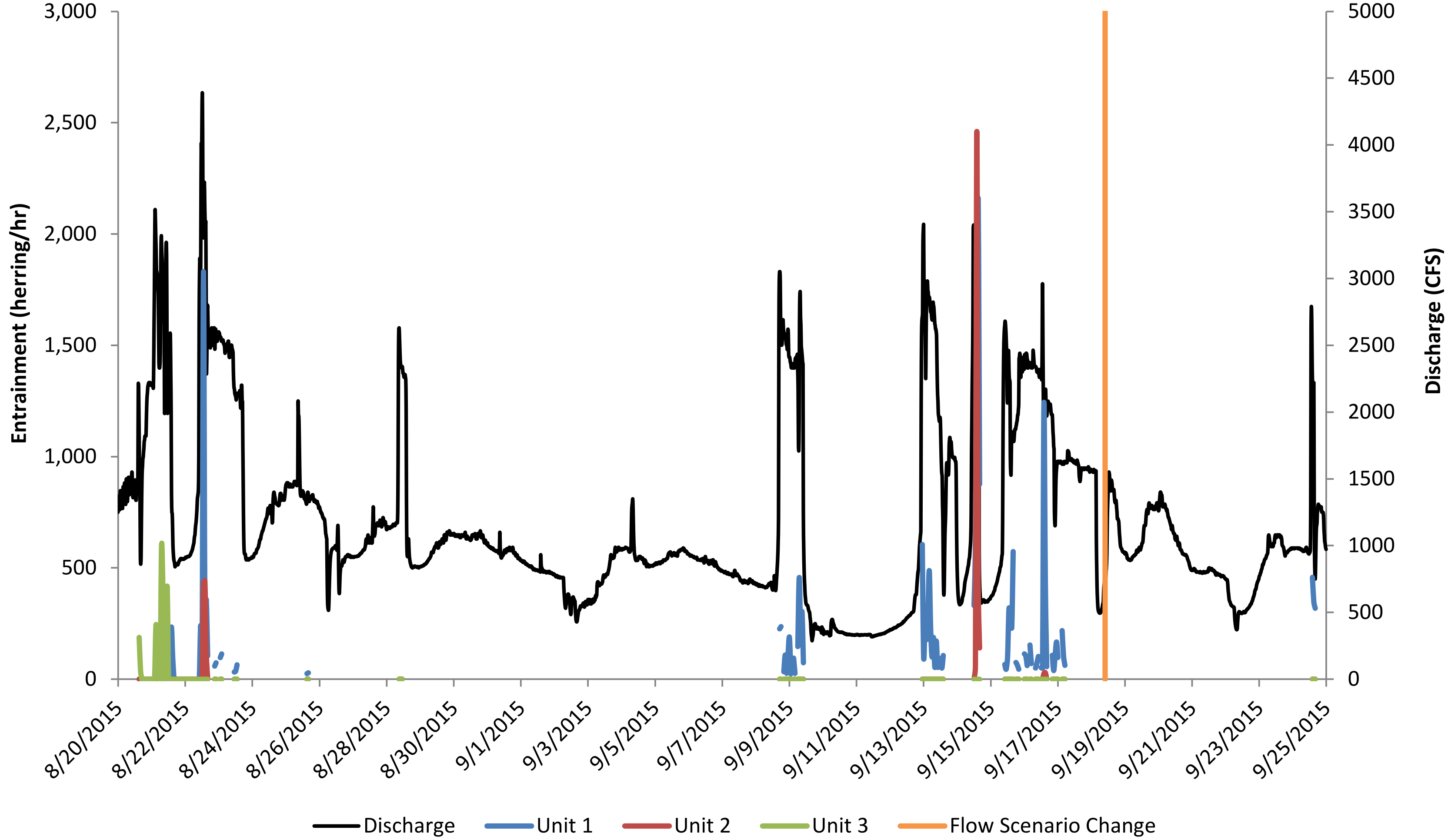


FIGURE 13. ENTRAINMENT RATES (HERRING/HOUR) AND MOHAWK RIVER DISCHARGE (USGS GAGE 01357500 IN COHOES, NY) AT THE SCHOOL STREET STATION COHOES, NY. THE ORANGE LINE DENOTES WHEN THE BYPASS FLOW SCENARIO 1 TRANSITIONED INTO SCENARIO 2 (9/18/15 AT 9:45).

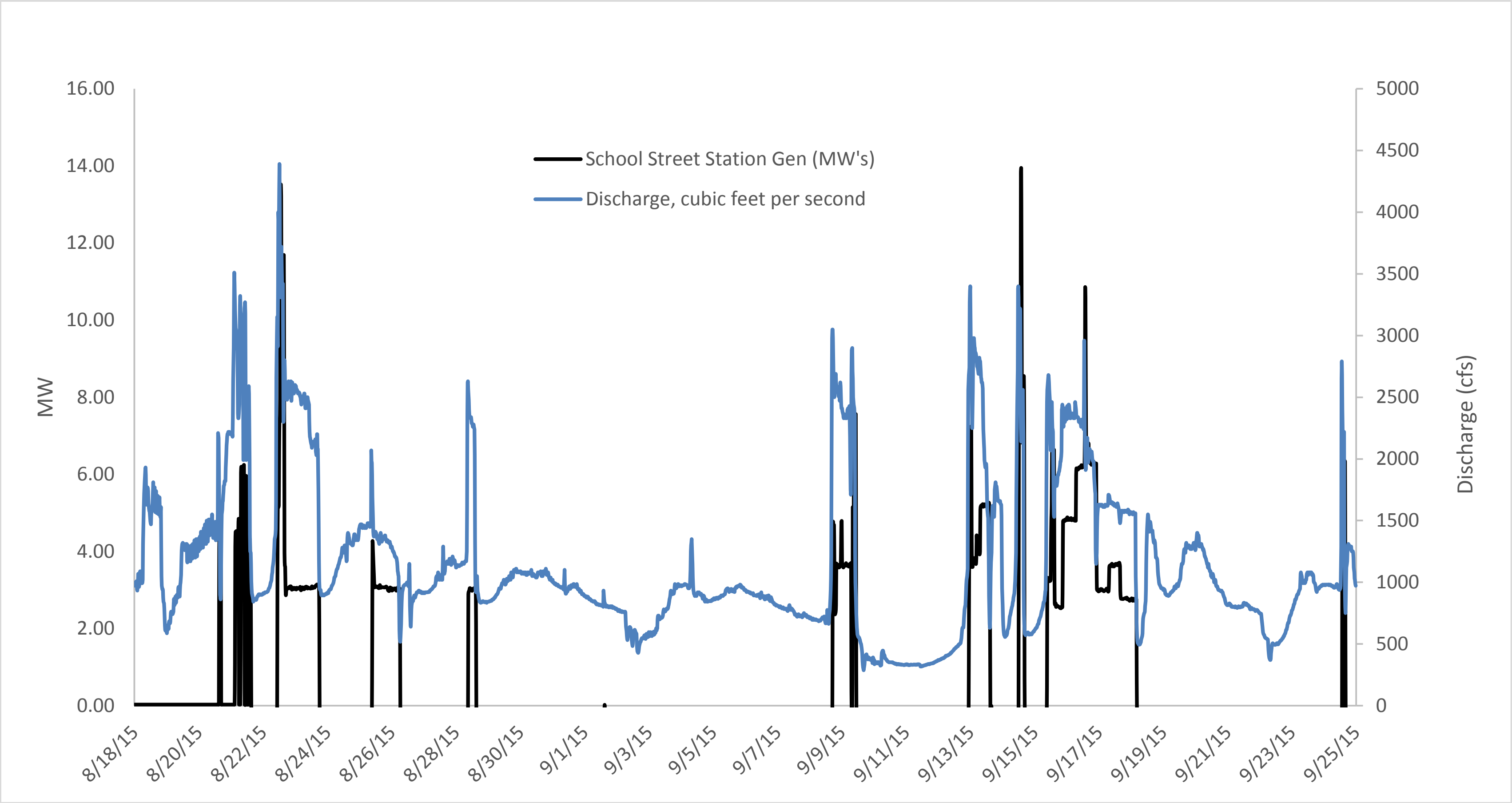


FIGURE 14. GENERATION AND MOHAWK RIVER DISCHARGE (USGS GAGE 01357500 IN COHOES, NY) AT THE SCHOOL STREET STATION COHOES, NY THROUGHOUT THE 2015 MONITORING PERIOD.

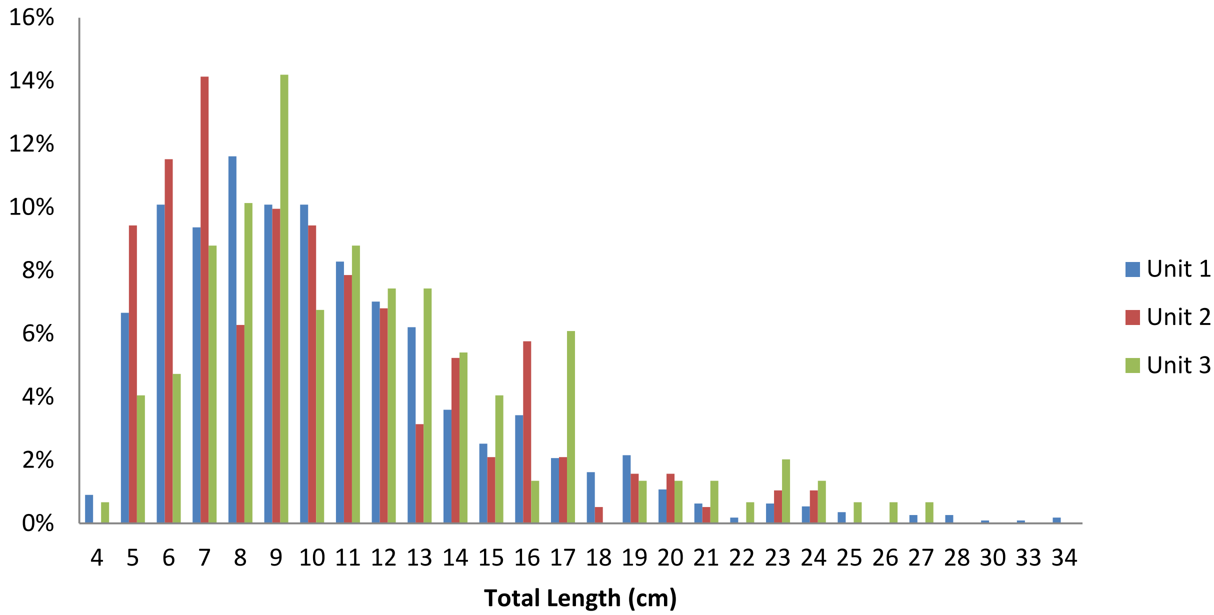


FIGURE 15. LENGTH FREQUENCY OF ENTRAINED FISHES (N=1450) AT THE SCHOOL STREET PROJECT COHOES, NY

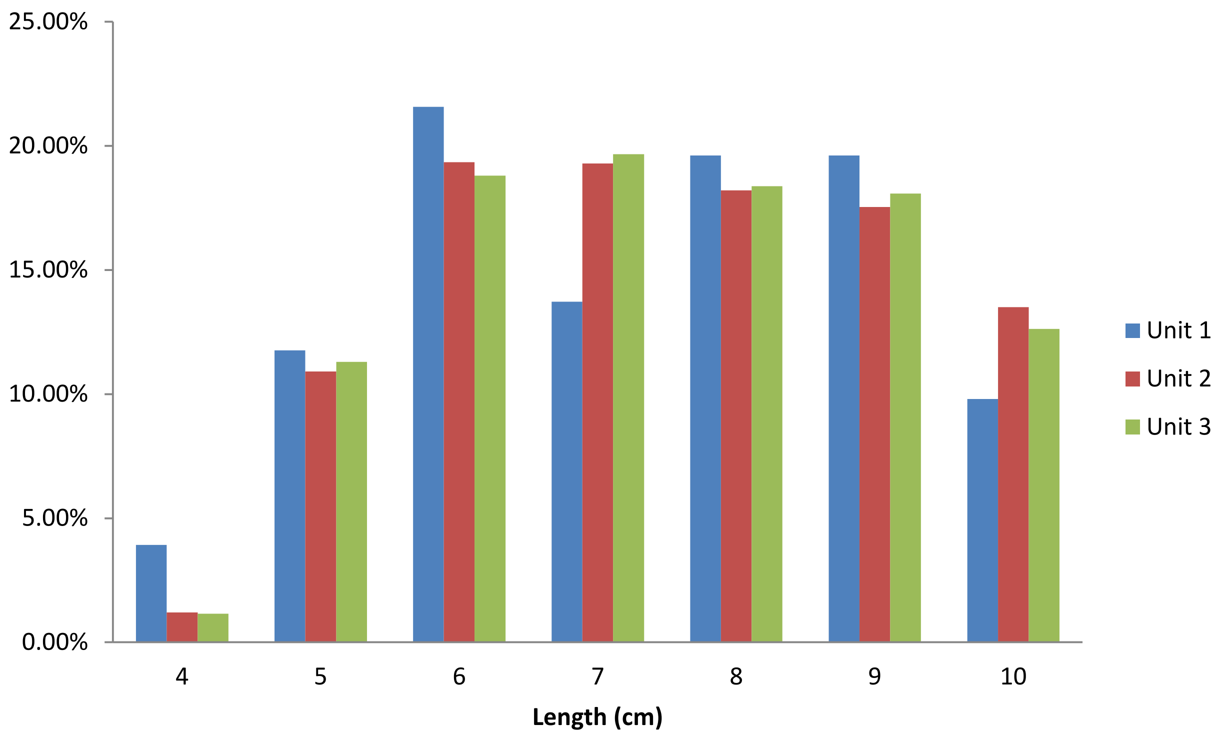


FIGURE 16. LENGTH FREQUENCY OF ENTRAINED HERRING SIZED FISHES (N=842) AT THE SCHOOL STREET PROJECT COHOES, NY

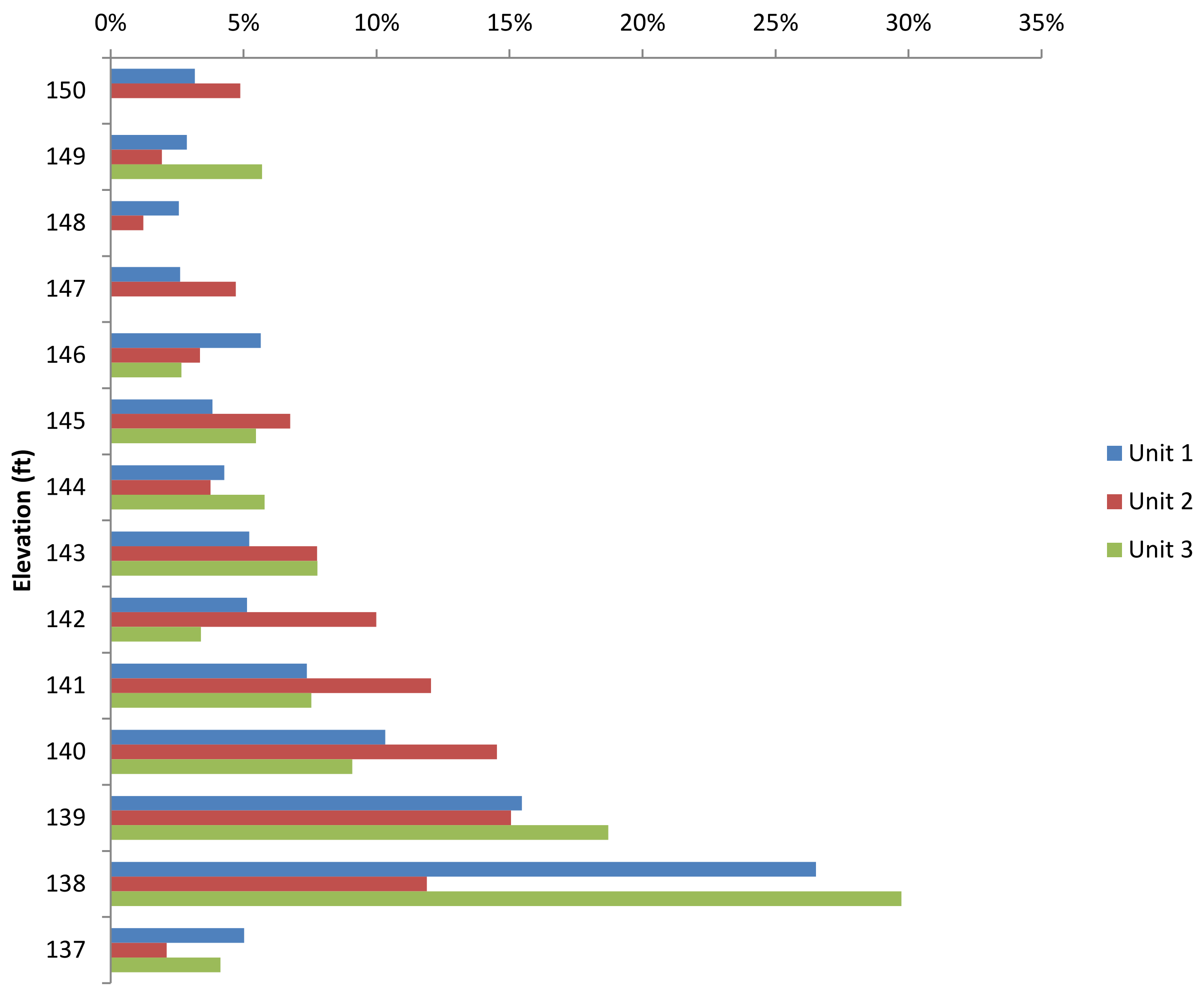


FIGURE 17. ELEVATION OF ENTRAINED FISHES AT THE SCHOOL STREET PROJECT COHOES, NY. ALL FISHES WERE ASSIGNED TO THE NEAREST 1 FT ELEVATION.

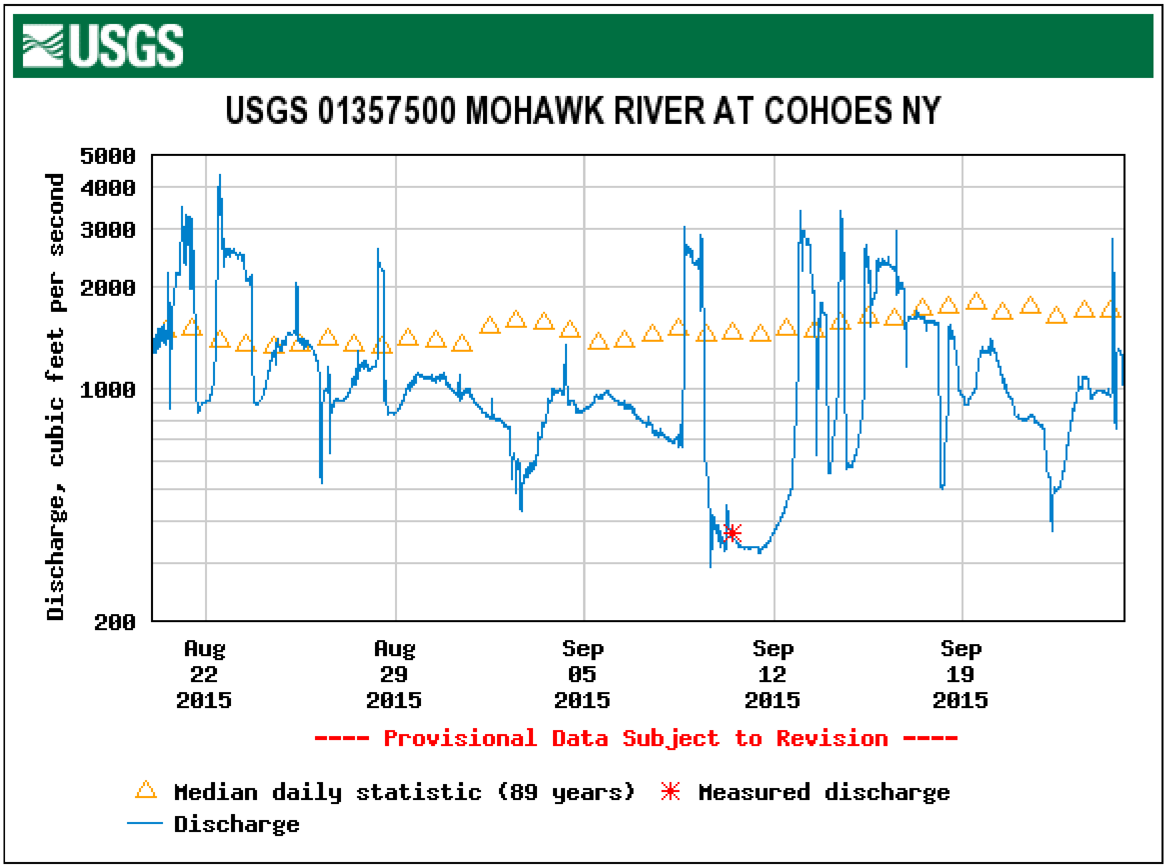


FIGURE 18 DISCHARGE OF THE MOHAWK RIVER AS MEASURED AT THE USGS GAGE (01357500) IN COHOES, NY.

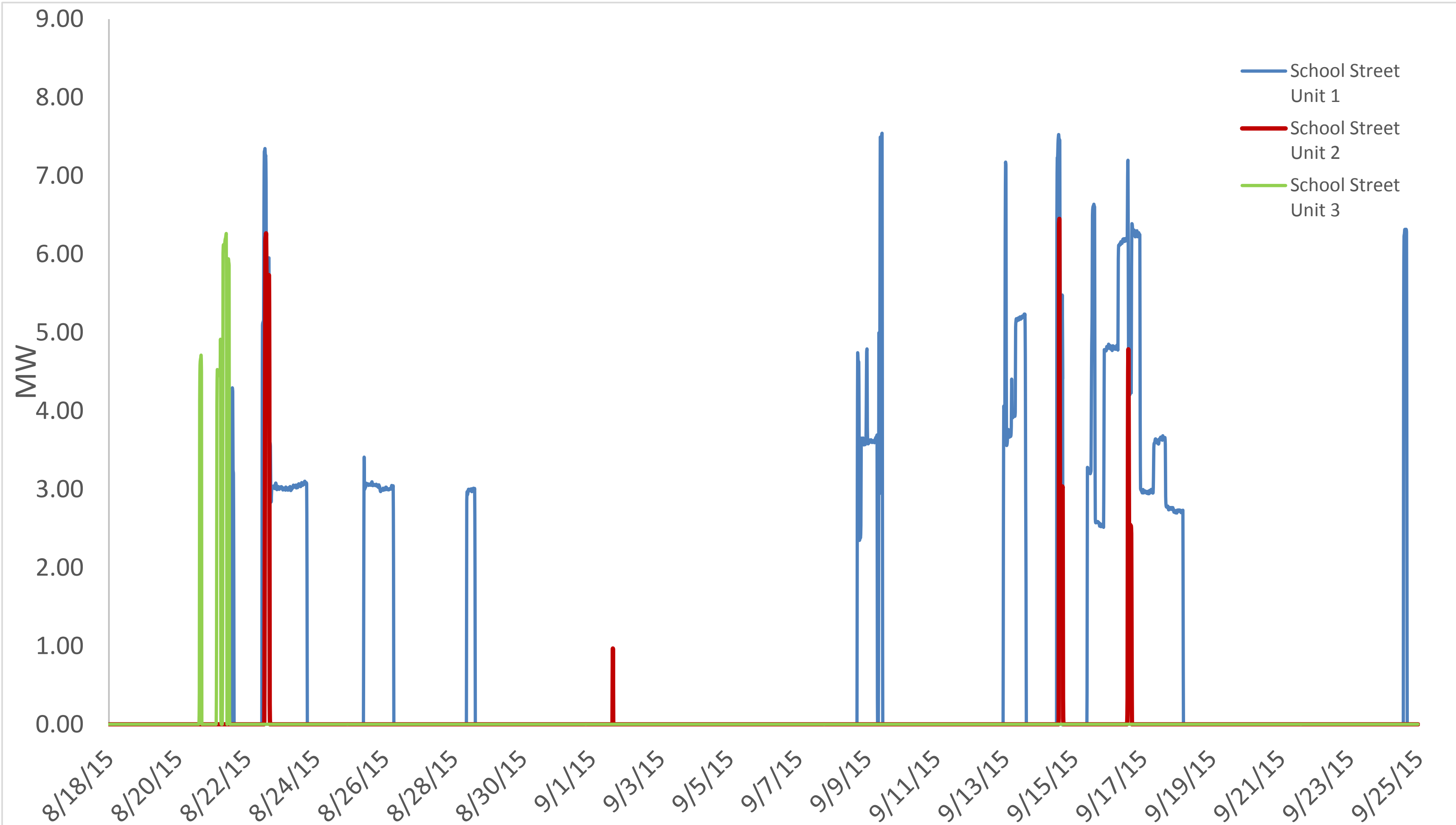


FIGURE 19 GENERATION AT THE SCHOOL STREET STATION COHOES, NY THROUGHOUT THE 2015 MONITORING PERIOD.

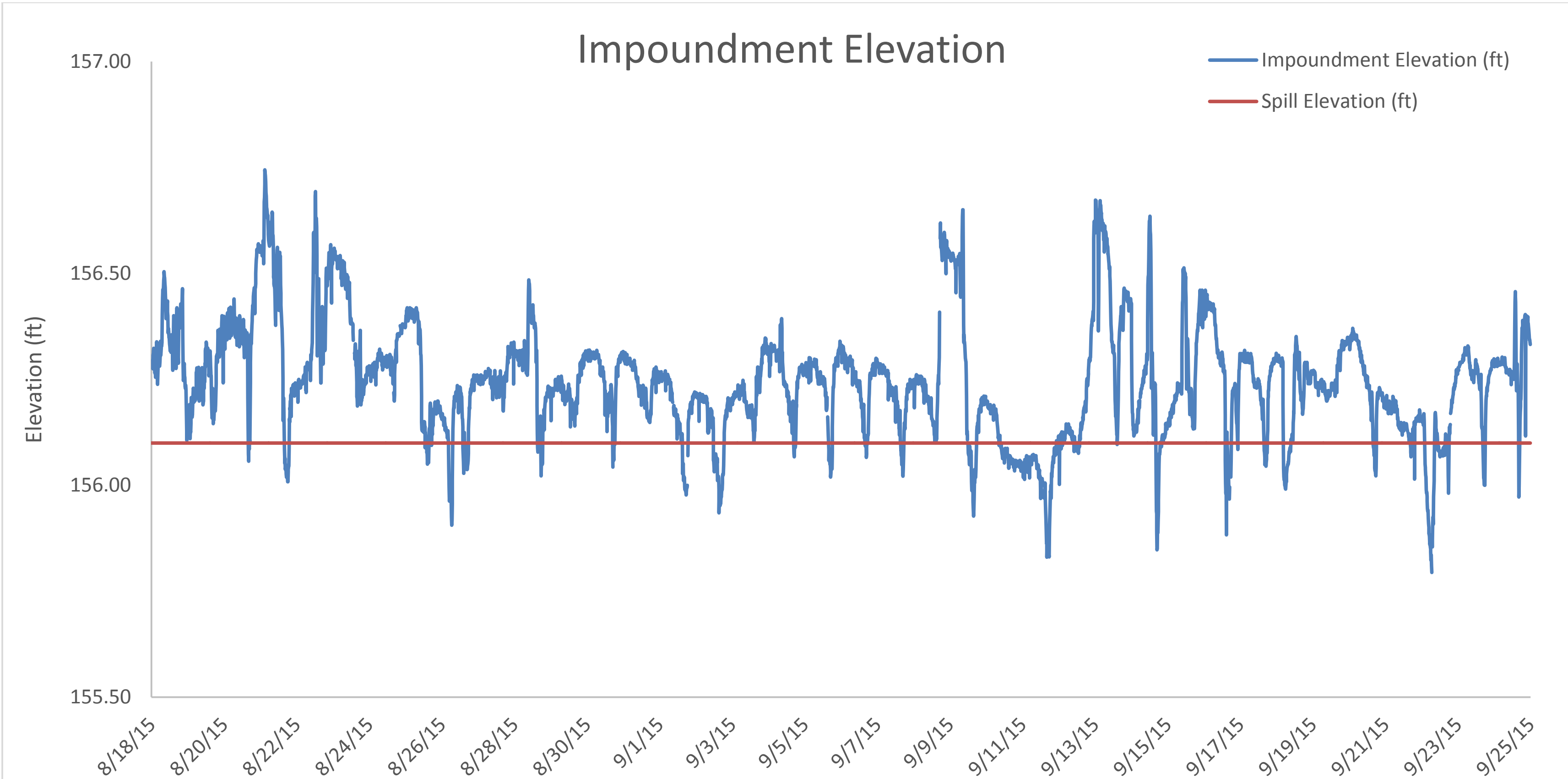


FIGURE 20 IMPOUNDMENT WATER SURFACE ELEVATION AT THE SCHOOL STREET PROJECT COHOES, NY THROUGHOUT THE 2015 MONITORING PERIOD.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
3817 Luker Road
Cortland, NY 13045

July 20, 2016

Ian Borlang, Compliance Manager
Atlantic Operations
Brookfield Renewable Energy Group
399 Big Bay Rd.
Queensbury, NY 12804

RE: School Street Hydroelectric Project (FERC #2539)
Juvenile Blueback Herring Bypass Efficiency Testing Report

Dear Mr. Borlang:

The U.S. Fish and Wildlife Service (Service) has reviewed Brookfield's May 6, 2016, *Juvenile Blueback Herring Downstream Passage Efficiency Report* (Report) for the School Street Hydroelectric Project (Project), located on the Mohawk River in Albany and Schenectady Counties, New York. The results of the Report were discussed at a site visit held on June 16, 2016. The site visit was attended by representatives of the Service, the New York State Department of Environmental Conservation (NYSDEC), Brookfield, and Kleinschmidt.

<u>Background</u>

The 2014 juvenile blueback herring (*Alosa aestivalis*) testing showed a very small percentage of the fish utilizing the fishway. However, that test was conducted without Unit 1 operable. The fishway was designed to utilize the Unit 1 intake flow as an attraction flow to the adjacent fishway. The general consensus was that the ineffectiveness of the fishway was likely due to the lack of attraction flow.

Brookfield repeated the testing in 2015 with Unit 1 operational throughout the testing period. As discussed in the Report, no juvenile blueback herring were detected using the fishway. Based on 2 years of testing, it can be safely concluded that the downstream fish passage facility is not effectively passing juvenile blueback herring. Previous testing had shown fair to good effectiveness at passing adult blueback herring, American eel (*Anguilla rostrata*), and a variety of warmwater fish species.

Rationale for Repeating the Testing in 2015

At the June site visit, Brookfield indicated that the Service and the NYSDEC had not accepted the 2014 test results because Unit 1 was not operational, as required in the license. However, a review of the license indicated that Brookfield was only required to operate the units sequentially, starting with "…the **available** turbine nearest to the fish conveyance structure…. [Emphasis added]" Therefore, Brookfield asked the Service and the NYSDEC to accept the 2014 study as fully meeting the license requirements.

At the time we reviewed the 2014 testing results, we indicated that the study demonstrated that the fishway was not effective at passing juvenile blueback herring. However, since the consensus was that this ineffectiveness was likely due to the failure of Unit 1 to be operational, we recommended that Brookfield conduct another year of testing (with Unit 1 operational) to demonstrate that the fishway is effective. If Brookfield opted to not undertake another year of testing, then we would be forced to conclude that the fishway was ineffective at passing juvenile blueback herring and begin the process of determining alternative ways to protect the outmigrating juvenile blueback herring. Brookfield opted to undertake an additional year of testing with Unit 1 operational. With this, the Service now agrees that Brookfield has adequately tested the fishway effectiveness for outmigrating juvenile blueback herring. No additional testing is necessary.

Options to Improve Project Effectiveness for Juvenile Blueback Herring

Since the fishway is not effective at passing outmigrating juvenile blueback herring, we must explore options to modify the fishway to make it more effective or find an alternative means of protecting and passing the juvenile blueback herring. Although both years of testing demonstrated lower entrainment with higher flows [330 cubic feet per second (cfs) vs. 120 cfs] through the fishway, the passage effectiveness was not significantly improved. It is not likely that the fishway can be modified to substantially improve its effectiveness at passing juvenile blueback herring.

The license for the Project included the proposed installation of a "fish-friendly" turbine that could potentially be used as the primary means of fish passage, pending the results of effectiveness testing. Although Brookfield has cancelled that proposal for economic reasons, the Service would still consider a "fish-friendly" turbine to be a potentially viable alternative for downstream passage of juvenile blueback herring.

Another alternative that could be considered is project shutdown during peak outmigration season. The downstream New York State Dam (FERC #7481) utilizes a hydroacoustic system to determine the density of outmigrating juvenile blueback herring. The fish bypass flow is adjusted based on this density; when a certain density is reached, operations are curtailed in a stepwise fashion until the station is completely shut down and all flows are passing through the fishway or over the dam. A similar approach might be feasible at School Street.

Summary

Brookfield has adequately addressed the license requirements to test the effectiveness of the fishway. The fishway is not effective at passing outmigrating juvenile blueback herring. The Service recommends that Brookfield explore options to improve fishway effectiveness and/or to reduce juvenile blueback herring entrainment mortality. After Brookfield has prepared an analysis of alternatives, we recommend that a meeting be held with the Service and the NYSDEC to discuss the appropriate remedies. Since these remedies would not be available for the 2016 outmigration period which will soon commence, we recommend that Brookfield maintain the higher attraction flow of 330 cfs during the juvenile blueback herring outmigration period (August through October).

* * * * *

We appreciate the opportunity to review the Report. If you have any questions or desire additional information, please contact Steve Patch at 607-753-9334.

Sincerely,

Patricia Cole

for David A. Stilwell
Field Supervisor

cc: NYSDEC, Albany, NY (M. Woythal)
NYSDEC, Stamford, NY (C. VanMaaren)

Kleinschmidt

Mr. Ian Borlang, Compliance Manager
Atlantic Operations
Brookfield Renewable Energy Group
399 Big Bay Rd.
Queensbury, NY 12804

Dear Ian

Kleinschmidt has reviewed the response of the US Fish and Wildlife Service (Service) regarding compliance requirements to address Section 3.7 of the Settlement Agreement and 401 Water Quality Certification Condition 13 relative to downstream fish passage effectiveness of juvenile blueback herring (JBBH) at the School Street Project (FERC No. 2539). In their letter dated July 20, 2016 (*School Street Hydroelectric Project (FERC #2539) Juvenile Blueback Herring Bypass Efficiency Testing Report*), the Service recognized that "*testing showed a very small percentage of fish utilizing the fishway*". This result was based on two years of evaluation conducted in 2014 and 2015 that has ultimately lead to the Service's conclusion that the downstream fish bypass is not effective at passing JBBH; however, the Service affirmed that "*Brookfield has adequately addressed the license requirements to test the effectiveness of the Fishway*". The Service recommends that Brookfield explore options to improve fishway effectiveness and/or to reduce JBBH entrainment mortality. In an email by Mark Woythal, dated August 24, 2016, the New York State Department of Environmental Conservation (NYSDEC) concurred with the Service's comments and recommendation.

The Service identified two option to improve JBBH fish passage effectiveness and/or entrainment survival including the installation and adequate testing of a "fish friendly" turbine or Project shutdown during the peak outmigration season.

Kleinschmidt believes that there are other options by which the Service's fish passage objectives may be met at the School Street Project. We have prepared a brief synopsis of options for Brookfield's consideration.

<u>Option 1. Desktop Turbine Entrainment Survival Analysis</u>

The Service recommends exploring options to improve fishway effectiveness **and/or to reduce juvenile blueback herring entrainment mortality**. To the best of our knowledge, no site-specific studies or analyses of turbine passage (entrainment) survival of JBBH has been conducted empirically at the School Street Project and therefore no baseline is currently available by which to measure a hypothetical reduction in entrainment mortality. Conducting a field study at School Street would potentially be expensive and time-consuming.

A desktop analysis, which relies on extrapolating data from other studies with comparable station and operational parameters, can be completed to estimate turbine entrainment survival more economically. It is our experience that turbine entrainment survival of juvenile Alosines (Shad &

River Herring) can potentially be high, and a desktop assessment would be useful to put turbine passage survival in perspective. For example, recent empirical studies (2015) conducted at the Turners Falls Project located on the Connecticut River estimated immediate survival of juvenile shad exposed to turbine passage at 95%. We suspect that a desktop analysis at the School Street Project would reveal a similar survival estimate.

The Service recommends that Brookfield evaluate a seasonal shutdown to mitigate station impacts on JBBH passage. A shutdown would necessitate passage via the fishway and/or over the dam, through the bypass reach and ultimately over Cohoes Falls. These options are likely to be less effective than turbine passage due to high levels of mortality, resulting from fish falling onto hard surfaces and passing over the falls. In 2011, Brookfield evaluated survival of JBBH passing through the downstream fishway, which resulted in a survival estimate of 43.3%. Passage survival over the dam and through the bypass reach is unknown but is expected to be lower than turbine passage survival. For example, studies conducted (2015) at the Turners Falls Dam revealed that juvenile American Shad (a similar species to JBBH) passage survival over the dam (through the bascule gates) was lower (ranging from 47.7 to 75.6%) than survival through the turbines (95%). We would expect the difference in passage survival over the dam at School Street to be potentially lower when compared to entrainment survival given the presence of Cohoes Falls within the bypass reach. This approach is not without its challenges; the data are likely to demonstrate that turbine passage is the safest route; resource agencies do not like to accept turbine passage as an effective option. Further, dam passage survival has never been evaluated at School Street so without empirical testing it may be difficult to convince the resource agencies that it is not an effective means of passage. Mark–Recapture methods could be used to evaluate dam/bypass reach passage survival if a site-specific field study were to be elected.

The cost of a desktop entrainment survival assessment is estimated at approximately $15,000. Should survival need to be field-evaluated through the bypass reach, additional study costs of approximately $100,000 – $125,000 are expected.

Option 2. Canal Exclusion

JBBH are part of a select group of fishes referred to as hearing specialists. They have specialized structures coupling their inner ear to the swim bladder, which make them particularly sensitive to ultrasound (up to 180 kHz). Ultrasound can potentially be used as a deterrent to exclude JBBH. Such a technology may be deployable at the canal gatehouse to divert JBBH from entering the School Street power canal; passing over the dam through the minimum flow gate or through a notch in the dam. Although fish would then experience what we believe to be high mortality at Cohoes Falls, at least it would satisfy the agencies by diverting fish from turbine passage.

Such technology is currently being employed at the New York Power Authority's (NYPA) Crescent Project. This approach would simulate the Project shutdown approach recommended by the Service in which the herring would be obligated to pass the Project via passage over the dam and through the bypass reach. The ultrasound array would only need to be operated during the outmigration period. However, the downstream fish bypass would still need to remain in operation for other fishes, such as resident species and American Eel, which are not susceptible to the influence of ultrasound. Prior studies conducted at School Street in 2010 showed a very high bypass survival of American Eel (100%) and resident species (93.6%) and we do not anticipate any further action related to these species.

The cost of an ultrasound deterrent system is still being evaluated. I will pass along an estimate as soon as we receive the required information from the manufacturer. It is likely that resource agencies would request effectiveness testing of such a system, which is estimated at a cost of approximately $100,000.

I am available to discuss these option in detail and would be happy to make a presentation to Brookfield and address any questions or concerns you may have.

Sincerely,

KLEINSCHMIDT ASSOCIATES

Bryan Apell

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
3817 Luker Road
Cortland, NY 13045

March 3, 2017

Ian Borlang, Compliance Manager
North Atlantic Operations
Brookfield Renewable Energy Group
399 Big Bay Rd.
Queensbury, NY 12804

RE: School Street Hydroelectric Project (FERC #2539)
Downstream Fish Passage Effectiveness for Juvenile Blueback Herring

Dear Mr. Borlang:

The U.S. Fish and Wildlife Service (Service) has reviewed Brookfield's January 30, 2017, response to our comments on the effectiveness testing for juvenile blueback herring (*Alosa aestivalis*) of the School Street Hydroelectric Project (Project) downstream passage facility. The Project is located on the Mohawk River in Albany and Saratoga Counties, New York.

The School Street fishway was ineffective at passing juvenile blueback herring. The Service recommended that Brookfield explore options to improve the downstream passage effectiveness and hold a meeting with the Service and the New York State Department of Environmental Conservation (NYSDEC) to discuss these options. Brookfield's letter discussed four options: 1) a fish-friendly turbine; 2) project shutdown during peak outmigration season; 3) desktop turbine entrainment survival analysis; and 4) canal exclusion. The first two options were recommended by the Service.

Brookfield rejected option 1 due to cost. Options 2 and 4 were technically feasible but had issues that might preclude them from being effective options. Brookfield recommended option 3, a desktop turbine entrainment survival analysis.

The Service understands Brookfield's concerns with options 1, 2, and 4. However, we do not see the merits of option 3. A desktop study would be qualitative in nature. Many entrainment studies have been conducted around the United States, and in particular, in New York. The results have generally been very site-specific, with similar turbines or projects on the same river showing markedly different results. In some instances, two similar turbines located on the same dam produced different results. As such, the confidence limits around any quantitative desktop analysis would be large. Therefore, the Service considers these desktop analyses to be more qualitative in nature, providing a general idea of fish species and numbers that may be entrained

June 19, 2017

VIA E-MAIL

Mr. Ian Borlang
Brookfield Renewable Power
399B Big Bay Road
Queensbury, NY 12804

School Street Meeting Summary

Attendees:
Jesus Morales (USFWS)
Ian Borlang (Brookfield)
Bob Garrett (Brookfield)
Bryan Apell (Kleinschmidt Associates)

Brookfield held an onsite meeting (6/14/17) at the School Street Project to discuss downstream passage of juvenile blueback herring (JBBH) at the Project. Invitations were sent to state and federal agency staff including Steve Patch (USFWS), Jesus Morales (USFWS) and Mark Woythal, (NYSDEC). Steve Patch and Mark Woythal did not attend.

The meeting began at 0900, and after greetings and introductions, the group began a tour of the facility. It was Jesus's first trip to the project and Bryan began with a brief description of the downstream passage facilities and an account of the compliance studies that had been conducted. Jesus asked what studies had been conducted specifically for JBBH and what methodologies had been used. Bryan explained that hydroacoustic technologies had been used during several study efforts to evaluate passage efficiency by directly comparing the rate of entrainment of JBBH to the rate of passage through the downstream bypass. Jesus asked if any tagging studies had been done and Ian replied that it had been attempted but abandoned because it was deemed infeasible. The group agreed that it is very difficult to tag JBBH and is not a good application for route selection studies.

The tour continued and the group explained the downstream passage facilities, including the angled bar rack guidance system leading to the multi-level, dual bypass entrances. Jesus inquired about the original proposal to use a fish-friendly unit at the site. Ian explained that given the current energy market, that it was not a viable option at the time. Jesus said he understood that the investment was too great given the price of energy. The tour continued to the fish separation chamber and Bryan explained how it worked and how the weir had been modified from its original design to increase the depth of water at the crest. At this point, Jesus, commented that he agreed with the new proposal to conduct a desktop study to evaluate turbine passage survival at the station. He commented that empirical studies are very difficult to conduct with JBBH given their fragile nature. Jesus requested that the evaluation consider project operation during the migration season and include a flow allocation analysis with flow duration curves. He was

Kleinschmidt Associates PA, PC

July 24, 2017

VIA E-MAIL

Mr. Ian Borlang
Brookfield Renewable Power
399B Big Bay Road
Queensbury, NY 12804

July 5, 2017 Meeting Summary, Downstream Passage Survival of Juvenile Blueback Herring at the School Street Project.

Attendees (via telephone):
Jesus Morales (USFWS)
Steven Patch (USFWS)
Mark Woythal (NYSDEC)
Chris Van Maaren (NYSDEC)
Ian Borlang (Brookfield)
Bob Garrett (Brookfield)
Bryan Apell (Kleinschmidt Associates)

Brookfield held a meeting (7/5/17) via telephone to discuss a conclusion to the compliance requirement of evaluating downstream passage survival of juvenile blueback herring (JBBH) at the School Street Project.

The meeting began at 1400. Ian opened by welcoming everyone and thanking them for their participation. Ian indicated that the objective of the meeting/discussion was to conclude the outstanding compliance issue of downstream passage of JBBH at the Project. Ian invited Steve to begin the discussion. Steve indicated that he had met with Jesus prior to the current meeting to discuss his recommendations following the site visit held on June 14, 2017. Steve asked Jesus to summarize the options that he came up with. Jesus indicated that he did not come up with the options but agreed with Option 3, which included an analysis of turbine passage survival. Ian commented that the options to move forward were developed by Brookfield and Kleinschmidt and submitted in a memo to the group for review. Everyone indicated that they did receive and were aware of the document. Jesus went on to advocate for conducting a desktop turbine entrainment survival evaluation. He indicated that such a desktop study in conjunction with an analysis of the Project passage survival based on flow allocation and operational parameters could be used to develop a survival model incorporating a sensitivity analysis that could inform the group on the most suitable route of passage for JBBH at the Project. He indicated that turbine passage may be the most suitable route of passage, but if not, he recommended that Brookfield evaluate the feasibility of using a surface boom and deflector to guide emigrating JBBH to a sluice located immediately upstream of the gatehouse where they could be discharged into the Project bypass reach.

There was discussion about survivability of passage over the dam and through the bypass reach and over Cohoes Falls. Mark questioned the assumption that survival would be low through the

DESKTOP EVALUATION OF ENTRAINMENT AND DOWNSTREAM PASSAGE SURVIVAL OF JUVENILE BLUEBACK HERRING

SCHOOL STREET PROJECT
FERC No. 2539

Prepared for:

Brookfield Renewable
Queensbury, NY

Prepared by:

Kleinschmidt

Essex, Connecticut
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January 2018

DESKTOP EVALUATION OF ENTRAINMENT AND DOWNSTREAM PASSAGE SURVIVAL OF JUVENILE BLUEBACK HERRING

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1.0 EXECUTIVE SUMMARY

The School Street Hydroelectric Project (Project) was issued a new Federal Regulatory Commission (FERC) license on February 15, 2007. In compliance with the new license, Brookfield Renewable (Brookfield) developed and executed a plan to investigate passage of diadromous and resident fishes at the Project. Brookfield has met their obligation for compliance studies; however, empirical studies conducted at the Project have shown that most emigrating juvenile Blueback Herring (JBBH) pass via entrainment through the turbines rather than using the downstream fish bypass. This finding has resulted in the conclusion, by the presiding resource agencies, that downstream passage of JBBH is ineffective. This desktop study endeavors to evaluate the most suitable route of passage for emigrating JBBH by assessing survival through the multiple passage options available at the Project.

An individual based model employing Monte-Carlo simulation was used to determine the best overall route of passage at the Project. The model relies on empirical data collected at other similar study sites. The model results suggest that regardless of the flow scenario (Section 5.2), the best overall route of passage based on survival rate estimates is entrainment passage. The model inputs originate from empirically collected data on JBBH (or similar surrogate species) and represent the best estimates of real world scenarios at the Project. However, there are multiple model parameters that can be manipulated that will affect the estimated passage survival. The attached excel spreadsheet contains the model simulation for each of the twelve scenarios and has been provided should reviewers wish to conduct other scenarios.

The blade strike analysis estimated the highest survival rates in all scenarios simulated, ranging from 0.88 at a 90% weekday exceedance flow and a 2% fish bypass flow, to 0.97 at all the 10% exceedance flow scenarios. The blade strike analysis determined that Unit 1 has the highest probability of blade strike (0.206) as compared to the other four units (Table 6). Blade strike survival estimates may increase if unit generation priority was shifted from 1-2-3-4-5 to 2-3-4-5-1 (i.e., Unit 1 last on first off). The model also estimated a cascade survival rate of 63% (i.e., 63% survival rate for passage over Cohoes Falls) based on a range of survival estimates of a surrogate species (American Shad) passing over Turners Falls Dam.

An ancillary entrainment stressor survival rate was factored in with blade strike survival resulting in the overall estimates of entrainment survival rates. Entrainment survival rates were always higher than the cascade survival rates and the fish bypass survival rates, making it the best option for passage of JBBH through the Project.

1.0 INTRODUCTION

The School Street Hydroelectric Project (Project) (FERC No.2539) is owned and operated by Brookfield Renewable (Brookfield). The Federal Energy Regulatory Commission (FERC) issued a new license to the Project on February 15, 2007 that required downstream fish passage for diadromous and resident fishes. In September 2007, a Final Plan was developed to investigate the Phase I fishway effectiveness and included requirements for testing downstream passage survival of resident fish, American Eels, juvenile and adult Blueback Herring, passage efficiency of juvenile and adult Blueback Herring, an inspection of the conveyance structures, and a hydraulic survey to document flow field and approach velocities in front of the angled bar rack and fishway entrances.

To date, Brookfield has completed their investigation of the Phase I Fishway Effectiveness as described in the Final Plan and Phase I Fishway Effectiveness Testing Study Plan and met their compliance obligations as stipulated in the settlement agreement. The presiding resource agencies, U.S. Fish and Wildlife Service (USFWS) and New York State Department of Environmental Conservation (NYSDEC), indicated their concurrence in a letter dated July 20, 2016, but ultimately concluded that the downstream bypass was ineffective at safely passing juvenile Blueback Herring (JBBH) at the Project.

As requested by the agencies in their letter, Brookfield evaluated several options to improve passage survival and presented them in a letter dated January 30, 2017. A consensus was reached through subsequent consultations with the agencies on June 14, and July 5, 2017. It was agreed that a desktop evaluation should be conducted to investigate passage survival at the Project. The evaluation investigated passage survival of the various passage options available to emigrating JBBH to determine a final course of action to improve overall project passage survival. Prior empirical studies have shown that passage survival of JBBH migrating through the downstream fish bypass to be poor (43.3% survival). As such, two other options under consideration are: 1) turbine passage (entrainment) or 2) immediately upstream of the canal gatehouse to convey

JBBH into the bypass reach through an existing gate. The following report details the methodology, results and conclusions to the desktop entrainment analysis.

2.0 OBJECTIVES

The objective of this desktop study is to better understand Project passage survival of JBBH and determine the most suitable route of passage at the Project.

3.0 PROJECT DESCRIPTION

The Project is located on the Mohawk River, 2.5 river miles upstream of its confluence with the Hudson River in Cohoes, New York (Figure 1). The project is composed of the following infrastructure:

1. A stone masonry gravity dam extending 1,280 ft across the Mohawk River, 16 ft in height, completed in 1865;
2. A reservoir with a surface area of approximately 100 acres at a normal maximum water surface elevation of 156.1 ft, and a gross storage capacity of 788 acre-ft;
3. A power canal extending approximately 4,400 ft from the dam to the powerhouse, 150-ft wide and 14-ft deep;
4. An upper gatehouse structure that currently includes nine slide gates and three steel tainter gates to control the diversion of flow into the canal;
5. A lower gatehouse with five steel headgates to control flow into the five penstocks; and
6. A powerhouse measuring 170-ft long by 78-ft wide, housing five generating units with vertical shaft Francis turbines rated at 92 ft of head, with a total maximum capacity of 38.8 megawatts.

The fishway consists of an angled bar rack with one-inch clear spacing and a fish conveyance system. The angled bar rack is located in the power canal just upstream of the lower gatehouse. The rack guides fish to the entrance of a fish conveyance system that transports fish around the powerhouse and discharges to the Project tailwater. The rack structure is angled approximately 45 degrees from the upstream face of the existing lower gatehouse. The lower portion of the rack includes a solid, two-foot high, concrete, eel diversion berm to guide emigrating American Eel toward the bypass entrance at the downstream end of the rack.

The fishway conveyance structure is located near the downstream end of the angled bar rack. It has two intake portals and includes a multi-level gate with top and bottom entrances. Attraction flow to the fishway entrances can vary from two to five percent of the Project's total hydraulic capacity. Conveyance pipes from both entrances converge in a fish separation chamber part-way along the fish conveyance structure. The chamber reduces the volume of the bypass flow by guiding fish along a wire floor screen and directing them into a fish return weir pool. The excess attraction water flows through the floor screen and is discharged downstream of the Project. A gate valve at the downstream end of the fish separation chambers provides hydraulic control within the fish conveyance structure. An adjustable weir is located at the entrance to the fish return weir pool. The weir provides fine-tune adjustment to the depth of water cascading over the weir, as well as the overall bypass flow (design flow 24 cfs). Once in the fish return weir pool, fish are guided to the entrance of the return pipe and are deposited into the tailwater of the Project.

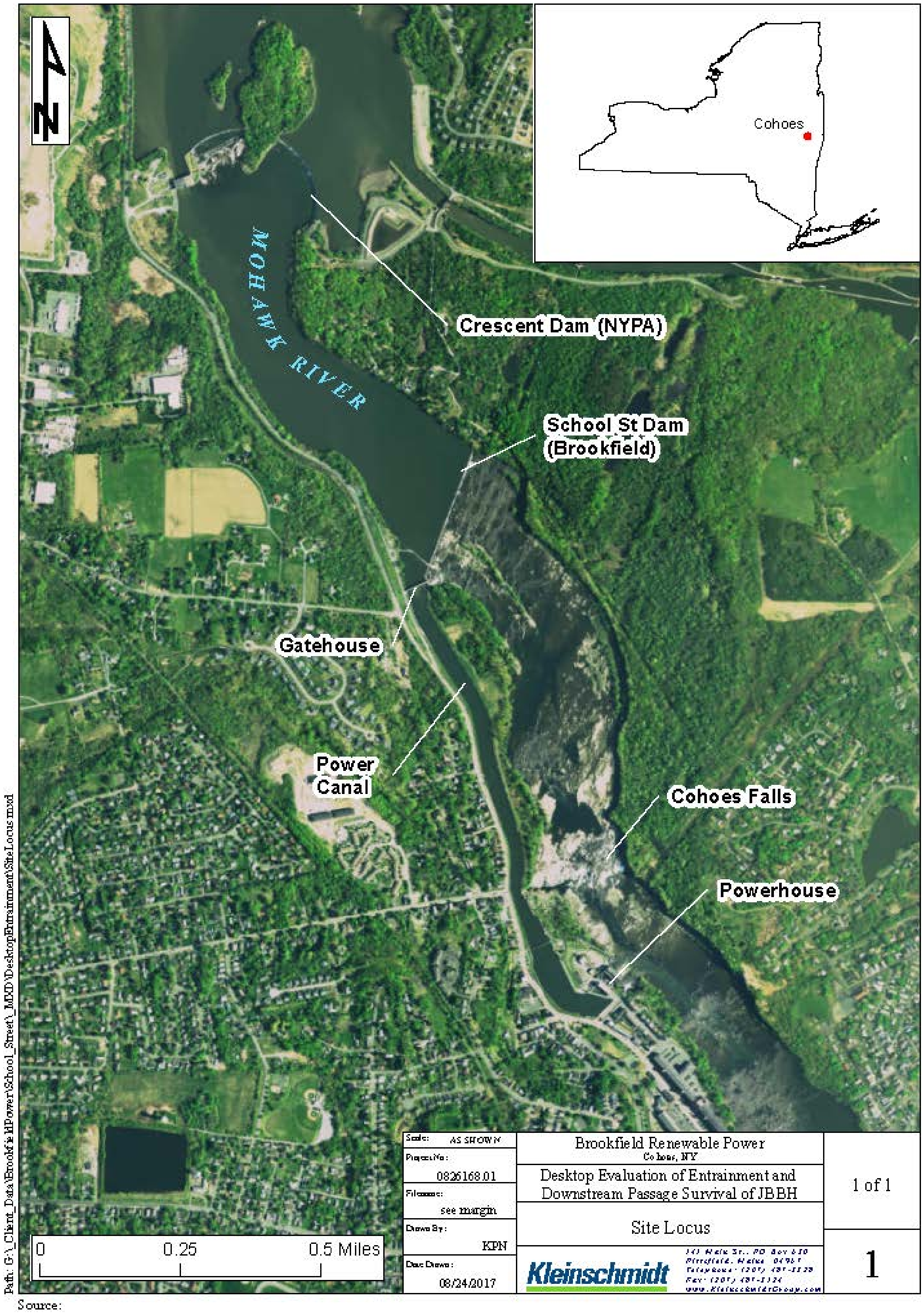

FIGURE 1 PROJECT LOCATION

4.0 BACKGROUND

This study attempts to understand migratory survival rates of JBBH as they migrate through the Project. The methodology employed to achieve the study objective includes the use of an individual based simulation model. With this model, we can simulate the fate of individual fish during a migratory event through the project via chance encounters with infrastructure and natural sources of mortality (e.g., passage over Cohoes Falls). These migratory events consist of 1,000 fish with lengths drawn from a simulated random normal distribution based on the mean and standard deviation of fish collected (n = 213) at the Project in previous studies. There are three routes of passage available to emigrating JBBH, each of which contains stressors that may affect survival. The three routes available for passage consist of: 1) through the downstream fish bypass; 2) through the powerhouse turbines (i.e., entrainment); and 3) over the dam via spill. Associated sources of mortality include: 1) mechanical stresses within the downstream fish bypass facilities; 2) blade strike, pressure and shear-induced stresses from turbine passage; and 3) physical stresses encountered from passage over the dam, through the bypass reach and over Cohoes Falls. This study estimates theoretical turbine and dam passage survival of JBBH as well as investigates how flow affects passage routing.

To understand the survivability of JBBH as they pass through the Project, Brookfield has constructed an individual based model, where route selection and interactions with infrastructure are governed with a Monte-Carlo simulation model (Model). Each simulated fish is exposed to a suite of project stressors and route decisions. These decisions include choice of migratory route with associated stressors due to physical interactions, entrainment and/or blade strike. The fish are sampled from simulated populations and interactions with each structure are governed by random trials. The Model assumes all fish are emigrating and all fish will interact with the facility in the same way for each possible route of passage. As fish approach the Project, there is a set of interactions that each individual experiences for any possible passage route. The Model will simulate the mortality of fish as they pass through the Project. Figure 2 illustrates the possible routes of passage in a conceptual model.

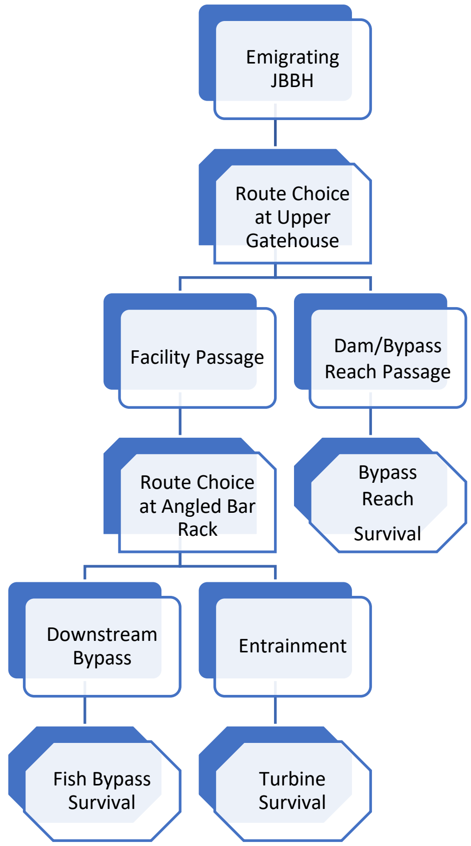

FIGURE 2 DOWNSTREAM PASSAGE CONCEPTUAL MODEL AT THE SCHOOL STREET PROJECT, COHOES, NY

5.0 METHODS

5.1 TURBINE PARAMETERS DATA

The blade strike models derived by Franke et al. (1997) require accurate measurements of a suite of turbine parameters. The generating units at the Project are Francis turbines, with four of the five units of similar design, while the fifth unit is larger. Required inputs for the blade strike model include: nameplate turbine capacity (horsepower, hp), rated turbine head (ft), estimated maximum discharge (cfs), discharge at maximum efficiency (cfs), percent discharge at maximum efficiency, number of wicket gates, runner speed (rotations per minute, rpm), runner diameter (in), runner diameter at the inlet/centerline/discharge (in), runner inlet height (in), number of blades, turbine efficiency (nameplate). These parameters (Table 1) were collected and used to develop and calibrate an initial blade strike model for entrained JBBH.

TABLE 1 SCHOOL STREET UNIT PARAMETERS

PARAMETER	UNIT 1	UNIT 2	UNIT 3	UNIT 4	UNIT 5
Nameplate Capacity (hp)	10,700	10,700	10,700	10,700	14,000
Rated Turbine Head (ft)	92	92	92	92	96
Max. Discharge (cfs)	1,256	1,053	1,104	962	1,890
Efficient Discharge (cfs)	1,150	870	850	800	1,400
Percent Discharge at Max. Efficiency	92%	83%	77%	83%	74%
Number of Wicket Gates	20	20	20	20	16
Runner Speed (rpm)	180	180	180	180	150
Runner Diameter at Inlet/Centerline (in)	34	34	34	34	62
Runner Diameter at Discharge (in)	84.34	84.81	84.81	84.92	107.20
Runner Inlet Height (in)	29.5	29.5	29.5	29.5	38
Number of Blades	15	15	15	15	11
Turbine Efficiency	82%	84%	83%	87%	84%

5.2 OPERATIONS DATA AND DEVELOPMENT OF FLOW SCENARIOS

Operations and river flow (USGS Gage 01357500 Mohawk River at Cohoes, NY) data were evaluated over a 10-year period at the Project. Flow data were used to develop seasonal flow duration curves that coincide with the JBBH migratory period (mid-August – October) in the Mohawk River. These curves were used to inform on the flow scenarios for each model. In addition to the regular minimum flow requirement (Monday – Friday) in the bypass reach, the Project must release aesthetic flows on the weekend and federal holidays; as well as a fish bypass flow of 2 to 5% of total inflow (6,600 cfs). Therefore, the following 12 flow scenarios were evaluated:

1) 10% Weekday, 2% Bypass
2) 50% Weekday, 2% Bypass
3) 90% Weekday, 2% Bypass

4) 10% Weekday, 5% Bypass
5) 50% Weekday, 5% Bypass
6) 90% Weekday, 5% Bypass
7) 10% Weekend, 2% Bypass
8) 50% Weekend, 2% Bypass
9) 90% Weekend, 2% Bypass
10) 10% Weekend, 5% Bypass
11) 50% Weekend, 5% Bypass
12) 90% Weekend, 5% Bypass

5.3 Model Development and Implementation

The model was constructed in Microsoft Excel for ease of use and sharing among stakeholders. A Monte-Carlo style draw simulates the fate of modeled fish for each of the possible routes and associated stressors. The project stressors include impacts from passage over the dam and through the bypass reach, blade strike, and stressors experienced in the downstream fish bypass.

5.3.1 Route Selection at the Gatehouse

At the Upper Gatehouse and low head dam (Figure 2), JBBH may enter the canal to pass through the facility or use the bypass reach to pass downstream of the Project. At this location, we assumed that JBBH follow flow proportionately. Choice in route (R_1) was controlled through a Monte-Carlo style draw (x_1) from a uniform random number generator in Excel (RAND) with Equation 1:

$$R_1 = \begin{cases} x_1 \leq Q_1 = 1 \\ x_1 > Q_1 = 0 \end{cases} \qquad \textbf{1}$$

Where R_1 is the first choice of route and indicates if fish chooses the facility (represented as 1) or bypass reach (represented as 0), x_1 is the first random number draw (designated by RAND), and Q_1 is the proportion of flow through the facility. This equation indicates that if the random number draw x_1 is less than or equal to the proportion of flow through the facility, then the fish will choose the facility. If the fish chooses the facility, then it will be exposed to another choice of route at the angled bar rack (entrainment or through fish bypass). A fish that does not enter the canal would be exposed to mortality stressors at the dam and over Cohoes Falls.

5.3.2 ROUTE SELECTION AT THE ANGLED BAR RACK

Route selection at the angled bar rack was estimated based on prior passage effectiveness studies (Kleinschmidt 2014) that monitored the proportion of JBBH emigrating through the turbines versus those emigrating through the downstream fish bypass. The passage rate estimates were monitored simultaneously using split-beam hydroacoustics and sound imaging camera technology (ARIS/DIDSON). In a similar fashion to route selection at the gatehouse, route selection at the angled bar rack was simulated with:

$$R_2 = \begin{cases} x_2 \leq Q_2 = 1 \\ x_2 > Q_2 = 0 \end{cases} \qquad \textbf{2}$$

Where R_2 is the choice in route and indicates if a fish chooses entrainment (represented as 1) or fish bypass (represented as 0), x_2 is a random number draw, and Q_2 is the proportion of flow through the units. During the 2% bypass flow, Q_2 is 0.9317, while during the 5% bypass flow Q_2 drops to 0.862.

5.3.3 TURBINE PASSAGE SURVIVAL

Those fish entrained through the units face turbine mortality stressors, including blade strike, shear and pressure changes. Blade strike models developed by Franke et al. (1997) are an industry standard and predict the survival rate of fish that pass through hydroelectric turbines. These models consider fish size, turbine specifications, and station hydraulics to estimate the theoretical blade strike and survival of specific sized fish for a particular turbine configuration. Direct effects of turbine passage can be predicted as a probability because the variables (such as turbine diameter, number of blades, etc.) and their ranges can be precisely defined. These models allow the user to manipulate parameters such as fish size or turbine characteristics to determine the relative effect on turbine passage survival. This predictive model is based on the work of Von Raben (Bell 1981). Franke et al. (1997) refined the Von Raben model to consider the effect of tangential projection of the fish length on blade strike probability because most turbine passage mortality at low head dams (<100 ft) is caused by fish striking a turbine blade or some other turbine component.

For Francis turbines, the probability of strike was calculated with the following procedure. The first step calculated the angle tangential of absolute flow upstream of the runner (a_t) with Equation 3:

$$\tan(90 - a_t) = \frac{2\pi E_{\omega d} * \eta}{Q_{\omega d}} \frac{B}{D_1} + \frac{\pi * 0.707^2}{2Q_{wd}} \frac{B}{D_1} \left(\frac{D_2}{D_1}\right)^2 - 4 * 0.707 * \tan\beta \frac{B}{D_1} \left(\frac{D_2}{D_1}\right)^2 \qquad \textbf{3}$$

where $E_{\omega d}$ is the energy coefficient, η is the turbine efficiency and $Q_{\omega d}$ is the discharge coefficient. The energy coefficient $E_{\omega d}$ is given with Equation 4:

$$E_{\omega d} = \frac{gH}{(\omega D)} \qquad \textbf{4}$$

where g is the acceleration due to gravity (ft/s^2), H is the turbine net head (ft), ω is the rotational speed of the runner ($RPM * 2\pi/60$), and D is the diameter of the runner (ft). The turbine efficiency ($Q_{\omega d}$) is given with Equation 5:

$$Q_{\omega d} = \frac{Q}{\omega D^3} \qquad \textbf{5}$$

where D^3 is the diameter (ft) of the runner cubed. The relative flow angle (β) is given with Equation 6:

$$\tan\beta = \frac{0.707 * \frac{\pi}{8}}{\xi * Q_{opt} \left(\frac{D_1}{D_2}\right)^3} \qquad \textbf{6}$$

where Q_{opt} is the turbine discharge at best efficiency (ft^3/s) and ξ is the ratio between discharge (Q) with no exit swirl and Q_{opt}. A value of 1.1 for ξ was used as suggested by Franke et al. (1997). Finally, the probability of mortality from blade strike M^t is given with Equation 7:

$$M^t = \lambda \frac{NL}{D} \left[\frac{\sin a_t \frac{B}{D_1}}{2Q_{wd}} + \frac{\cos a_t}{\pi} \right] \qquad \textbf{6}$$

Where λ is a strike mortality correlation factor, N is the number of buckets, and L is the length of the fish (ft). A correlation factor (λ) was utilized in the Advanced Hydro Turbine (Franke et al. 1997) model to adjust the predictive model results to correspond with documented empirical results. This correlation factor was originally introduced by Von Raben (cited by Bell 1981) because the contact of a fish with a turbine component does not always result in injury or mortality (Bell 1981; Cada 1998). Therefore, Von Raben introduced the correlation factor to adjust the predicted turbine strike results to more closely match empirical results. This factor also extends the applicability of these predictive equations to all injury mechanisms related to the variable NL/D (see above for definition of parameters). As stated in Franke et al. (1997) "*such mechanisms could include mechanical mechanisms leading edge strike and gap grinding as well as fluid induced mechanisms related to flow through gaps or other flow phenomena associated with blades.*" Based on a substantial number of test results obtained from studies conducted with salmonids on the west coast, Franke et al. (1997) recommends that the correlation factor be set between 0.1 to 0.2, and we used 0.2 as a conservative estimate.

Following the computation of the probability of a blade strike M_t, a blade strike simulation was conducted for those fish entrained with a draw (x_3) from a uniform random distribution (RAND). Blade strike survival is given with Equation 7:

$$S_t = \begin{cases} x_3 \leq 1 - M_t = 1 \\ x_3 > 1 - M_t = 0 \end{cases} \qquad \mathbf{7}$$

Where S_t is a survival counter where 1 is survival and 0 is mortality, x_3 is a draw from a uniform random distribution, and M_t is the probability of a blade strike. The overall rate of turbine survival for a single simulation is the sum of S_t for those fish entrained, divided by the total number of fish entrained ($\sum R_2$). Confidence intervals were estimated from the output of many (minimum of 100) simulations. However, there are other sources of turbine related mortality that are not evaluated by the blade strike models, namely shear stress and pressure.

The overall entrainment survival rate is affected by stressors not quantified with blade strike models. Shear stress and pressure induced mortality can have an effect on populations, especially for small fish with a low probability of being struck by a turbine blade. Numerical models assessing the physiological condition of fish affected by shear and pressure changes have not been created; therefore, Kleinschmidt back-calculated these ancillary entrainment stressors with information from other studies. The EPRI entrainment database (EPRI 1997) includes a suite of entrainment studies conducted throughout the United States for a range of species, turbine types, and head. Kleinschmidt compiled information from studies with similar species (clupeids) and turbine parameters (Francis units) over a range of dam heads and developed a logistic regression model assessing the overall entrainment survival rate. The response variable is the probability of survival, while predictors included head (ft), runner diameter (ft), number of blades (N) and runner speed (rpm).

With the overall entrainment survival rate known (E), Kleinschmidt also simulated ancillary entrainment survival S_a. We assumed that the probability of being struck and killed by a turbine blade (M_t) and that the probability of mortality through other ancillary stressors were independent and calculated the ancillary entrainment survival S_a with equation 8:

$$S_a = \begin{cases} x_4 \leq \dfrac{E}{1 - M_t} = 1 \\ x_4 > \dfrac{E}{1 - M_t} = 0 \end{cases} \tag{8}$$

Where S_a is a survival counter where a fish survives (1) if the random draw (x_4) is less than or equal to the ancillary survival rate $\frac{E}{1-M_t}$.

5.3.4 Downstream Fish Bypass Survival

When the choice of route at the angled bar rack indicates movement into the downstream bypass $(R_2 = 0)$, fish are exposed to mortality stressors at the downstream bypass. Brookfield has previously conducted (Kleinschmidt 2012) survival testing of JBBH at the downstream bypass, and found that survival was 43.3%. Bypass survival (S_b) was simulated with draws from a uniform random distribution (x_4) with Equation 9:

$$S_b = \begin{cases} x_4 \leq K = 1 \\ x_4 > K = 0 \end{cases} \tag{9}$$

Where S_b indicates bypass survival (1) or mortality (0), x_4 is a draw from a uniform random distribution and K is the derived bypass survival rate as calculated from empirical survival data. The formula states that if the random draw x_4 is less than or equal to the survival rate K, then the fish has survived passage through the downstream bypass. The overall rate of survival for a single simulation is the sum of S_b for those fish that pass via downstream bypass, divided by the total number of fish bypassed.

5.3.5 BYPASS REACH PASSAGE SURVIVAL

When the choice of route at the dam indicates movement into the downstream bypass ($R_1 = 0$), fish are exposed to mortality stressors at the dam, within the bypass reach, and at Cohoes Falls. Natural waterfalls/cascade survival rates (F) were sourced from literature and expert opinion. Cohoes Falls survival (S_f) was simulated with draws from a uniform random distribution (x_5) with Equation 10:

$$S_f = \begin{cases} x_5 \leq F = 1 \\ x_5 > F = 0 \end{cases} \qquad \textbf{10}$$

Where S_f indicates survival (1) or mortality (0) over Cohoes Falls, x_5 is a draw from a uniform random distribution, and F is natural falls survival rate. The formula states that if the random draw x_5 is less than or equal to the survival rate F, then the fish has survived passage through the Cohoes Falls. The overall rate of survival for a single simulation is the sum of S_f for those fish that pass via Cohoes Falls, divided by the total number of fish that choose this route.

5.4 LITERATURE REVIEW

A literature based review was compiled in order to address "additional sources of mortality" associated with fish passage at the dam and over the falls (Appendix A). The review focused on mortality associated with fish passage at spillways and/or during free fall experiments with the emphasis on JBBH and other small juvenile fish.

6.0 RESULTS

6.1 OPERATIONS DATA AND FLOW SCENARIOS

Ten years (2008 - 2017) of river flow (cfs) data (15-minute time interval) were compiled from the USGS gage at Cohoes Falls on the Mohawk River. Only data for the JBBH migratory period (mid-August through October) were used to generate a flow duration curves (Figure 3).

Exceedance percentages (10%, 50% and 90%) and the associated flow values were extracted from these curves to aid with the development of flow scenarios. Flow scenarios (Table 1 and Table 2) were developed using the School Street pond fluctuation (ft) and flow (cfs) requirements by month in priority order (Figure 4). In total, twelve scenarios were developed using a 10%, 50% and 90% exceedance flow (weekday and weekend flows) as well as applying a 2% bypass flow and a 5% bypass flow, respectively. The values within the unit columns in Tables 1 and 2 represent the efficient discharge (cfs) for each unit. Units are operated in order of preference 1-2-3-4-5. The remaining flow (cfs) is the amount of water spilled over the dam in any given scenario.

When inflow is less than Project capacity, the proportion of flow through the Project is a function of minimum flow releases and generation. Upon reaching Project capacity, the proportion of flow through the project is given with $1 - Q_{min}/Q$, where Q_{min} is the minimum flow requirement (245 cfs weekday, 500 cfs weekend) and Q is the actual river flow. When the river flow is greater than the Project capacity (6,600 cfs at maximum efficiency), the dynamics change and the proportion of flow through the project is given with: 6,600/Q, where Q is the river flow. Figure 4 depicts inflow dynamics as a function of river flow for the weekend and weekday. Note that there is no difference between weekend and weekday proportions when inflow is greater than Project capacity.

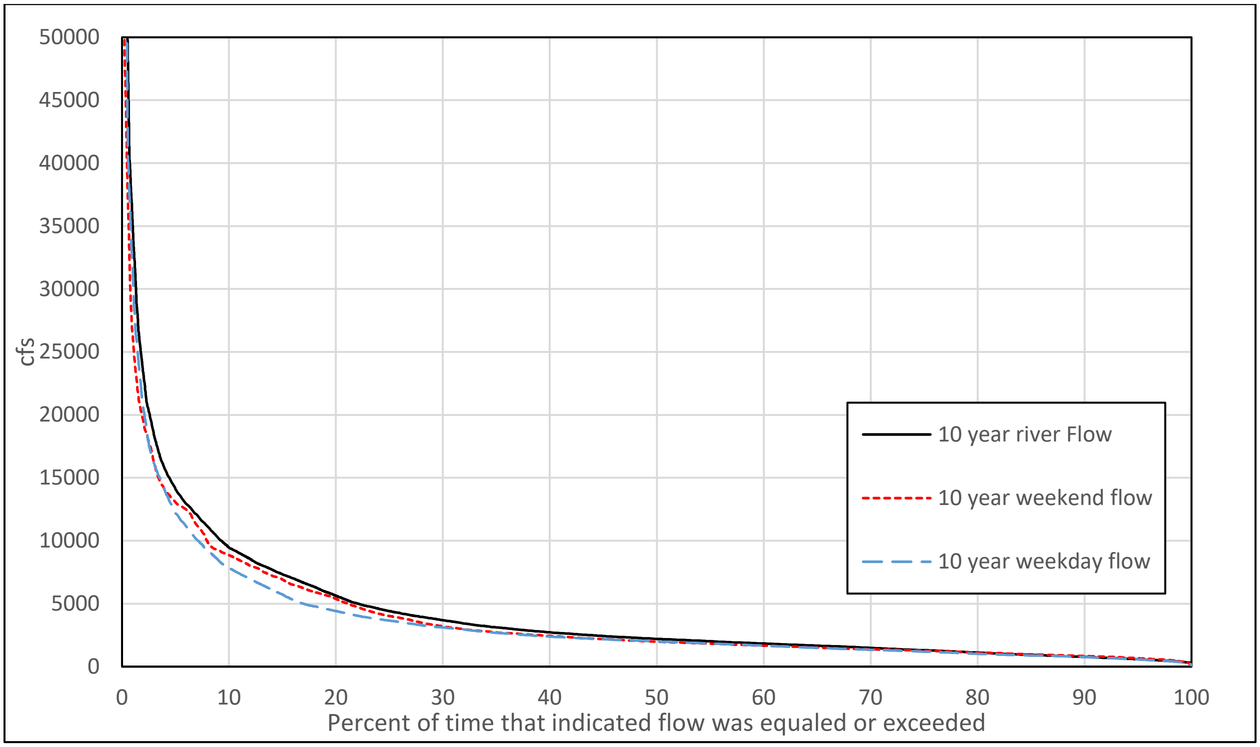

FIGURE 3 FLOW DURATION CURVES FOR TOTAL RIVER FLOW, WEEKEND FLOW AND WEEKDAY FLOW FOR JBBH MIGRATORY PERIOD (AUG.15-NOV.1) OVER 10-YEAR PERIOD FROM THE USGS GAGE AT COHOES FALLS

TABLE 2 RIVER FLOW EXCEEDANCES AND CORRESPONDING FLOW (CFS) REQUIREMENTS (2% FISH BYPASS) IN PRIORITY ORDER FOR JBBH MIGRATORY PERIOD (AUG.15-NOV.1)

EXCEEDANCE	SCENARIO	RIVER FLOW (CFS)	HABITAT FLOW SOUTH GATE (CFS)	HABITAT FLOW NORTH GATE (CFS)	FISH BYPASS (2%)	AESTHETIC	UNIT 1	UNIT 2	UNIT 3	UNIT 4	UNIT 5	REMAINING CFS
10%	Weekday	7870	-200	-45	-132		1256	1053	1104	962	1890	1228
50%	Weekday	2000	-200	-45	-132		1256	367				
90%	Weekday	758	-200	-45	-132		381					
10%	Weekend	8860	-200	-45	-132	-255	1256	1053	1104	962	1890	1963
50%	Weekend	1970	-200	-45	-132	-255	1256	82				
90%	Weekend	842	-200	-45	-132	-255	210					

TABLE 3 RIVER FLOW EXCEEDANCES AND CORRESPONDING FLOW (CFS) REQUIREMENTS (5% FISH BYPASS) IN PRIORITY ORDER FOR JBBH MIGRATORY PERIOD (AUG.15-NOV.1)

EXCEEDANCE	SCENARIO	RIVER FLOW (CFS)	HABITAT FLOW SOUTH GATE (CFS)	HABITAT FLOW NORTH GATE (CFS)	FISH BYPASS (5%)	AESTHETIC	UNIT 1	UNIT 2	UNIT 3	UNIT 4	UNIT 5	REMAINING CFS
10%	Weekday	7870	-200	-45	-330		1256	1053	1104	962	1890	1030
50%	Weekday	2000	-200	-45	-330		1256	169				
90%	Weekday	758	-200	-45	-330		183					
10%	Weekend	8860	-200	-45	-330	-255	1256	1053	1104	962	1890	1765
50%	Weekend	1970	-200	-45	-330	-255	1140					
90%	Weekend	842	-200	-45	-330	-255	12					

Pond/Flow (cfs) Requirements by Month - In Priority Order

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Priority
Pond	> -0.5 feet												1
Habitat - South	90			200								90	2
Habitat - North	30			45								30	3
Fish Bypass				2-5% of hydraulic capacity									4
Aesthetic					Additional 255 during weekend daytime and federal holidays								5
Generation	Generation takes lowest priority - operate units in order of preference 1-2-3-4-5												6

FIGURE 4 **SCHOOL STREET POND/FLOW (CFS) REQUIREMENTS BY MONTH IN PRIORITY ORDER**

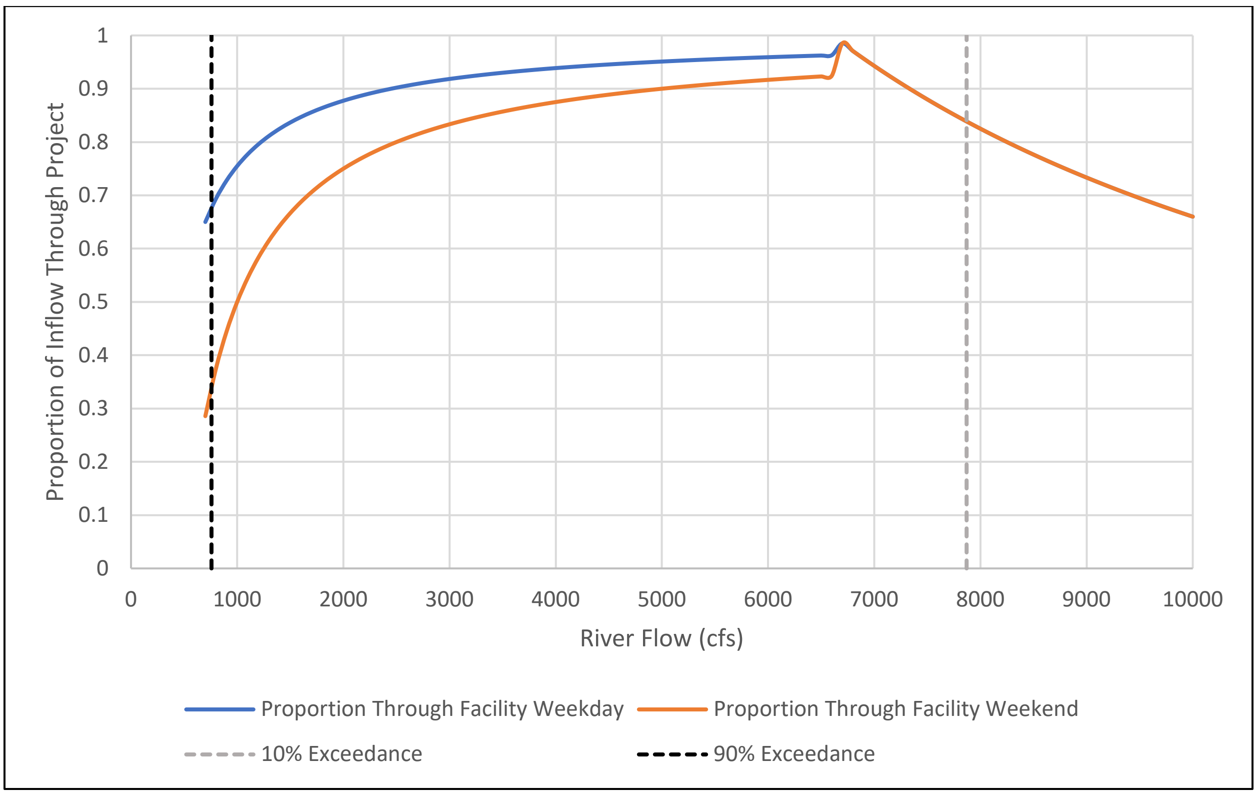

FIGURE 5 **THE INFLOW DYNAMICS AT THE SCHOOL STREET PROJECT. NOTE DYNAMICS CHANGE CONSIDERABLY WHEN INFLOW IS GREATER THAN THE MOST EFFICIENT PROJECT CAPACITY (6,600 CFS).**

6.2 TURBINE PASSAGE SURVIVAL

Turbine passage survival was estimated using empirical data from multiple turbine passage survival studies. Studies testing the survival of clupeids were used to generate a database of survival estimates. A logistic regression assessed survival rate as a function of rated head (Figure 6). Rated turbine head at School Street is 92 ft for Units 1 through 4 and 96 ft for Unit 5. Based on these values for rated head, the expectation of entrainment survival rates estimated from Figure 6 is approximately 0.75 with 95% CI of (0.71,0.78).

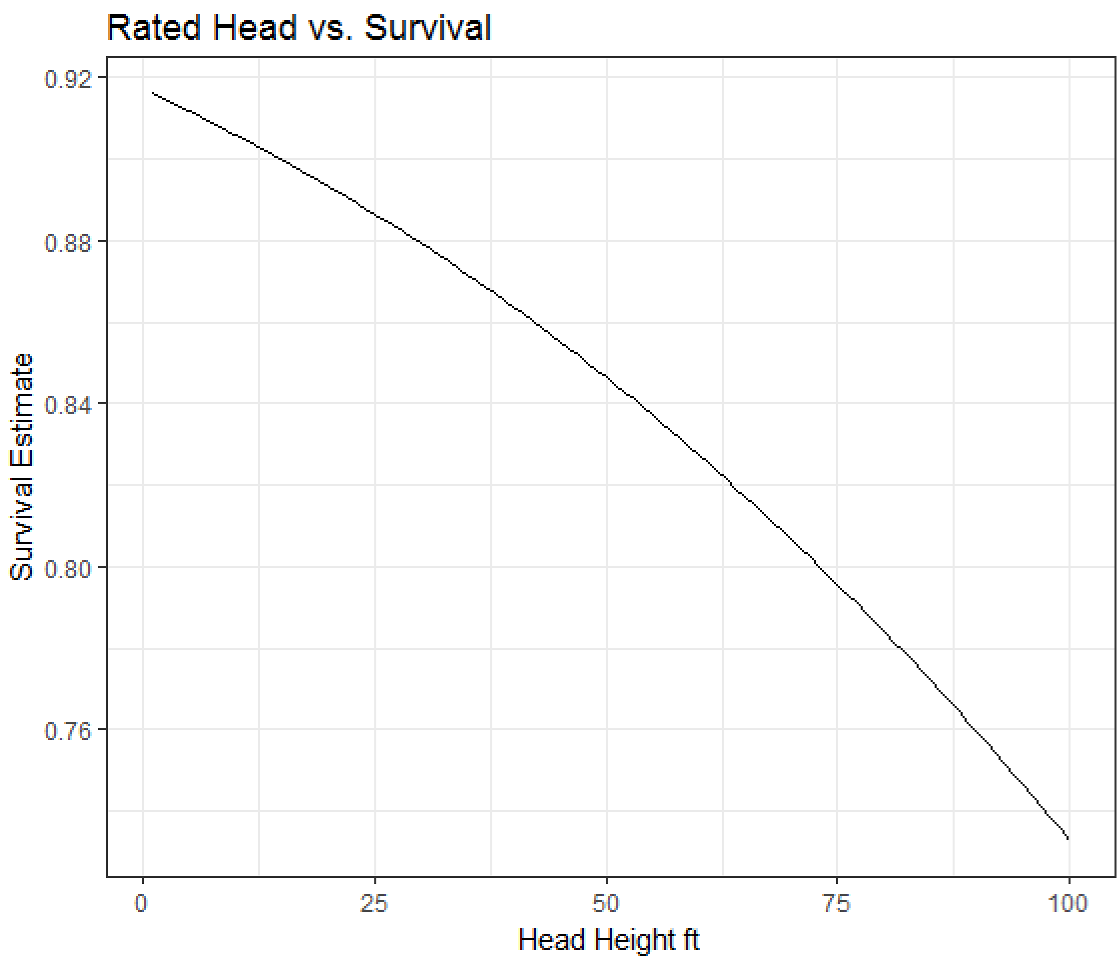

FIGURE 6 EMPIRICAL SURVIVAL ESTIMATES OF CLUPEIDS AT VARIOUS RATED HEAD HEIGHTS

6.3 DOWNSTREAM FISH BYPASS SURVIVAL

A 2011 School Street report prepared by Kleinschmidt entitled *Phase 1 Fishway effectiveness testing Juvenile Blueback Herring and Adult American Eel Survival evaluation*, FERC No.2539 was used to provide an estimate of downstream fish bypass survival. In this study, 213 herring were recaptured (100%) and evaluated as alive or dead; yielding a passage survival of 43.3%.

6.4 Bypass Reach Passage Survival

Estimates for bypass reach survival were collected from a recent (2015) study at Turners Falls Dam assessing the tag-recapture survival estimates for juvenile American Shad when passed over bascule gates at a height of 35 ft. American Shad were used as a surrogate species for JBBH in this case. Many other studies of survival over a dam or from freefall in the literature contained estimates based on salmonids; which are known to be a more robust fish than JBBH and can withstand more extreme conditions due to their life history characteristics (Bradford 1995, Savoy and Crecco 2004). An estimate for bypass reach survival of 63% was used in this study based on a range of survival from 47.7% to 75% for juvenile American Shad cascading over a 35-ft high dam (FirstLight 2015).

6.5 Model Simulation Results and Overall Survival

Table 4 represents the Monte-Carlo simulation results for all scenarios and includes several outputs: mean length (mm), facility passage, number of fish entrained, number of fish bypassed, bypass reach survival rate, blade strike survival, ancillary entrainment stressor survival, entrainment survival rate, cascade survival rate and overall migration survival rate. Each model run simulated a length distribution for a population of 1000 JBBH using the mean and standard deviation from 243 fish previously collected at the School Street Project. For each simulation, the mean and standard deviation of the lengths of 1000 simulated fish was approximately 69 mm and 6.54 mm, respectively.

Facility passage is dependent on proportion of flow going through the Project; the model assumes that fish follow the flow, and therefore, facility passage is a function of flow. Facility passage is highest during Scenario 2 (50% weekday, 2% bypass) with 877 fish passed and Scenario 5 (50% weekday, 5% bypass) with 878 fish passed (Table 3). The actual river flow during these scenarios is 2000 cfs. Once flow is prioritized based on Figure 4, 200 cfs is diverted to habitat south, 45 cfs to habitat north, and either 132 or 330 cfs to the fish bypass (2% or 5%). Another 1256 cfs is directed to Unit 1 and the remaining flow passes through Unit 2 (376 and 169 cfs, respectively) with the proportion of water spilling over the dam at approximately 12%

(Table 4). This means that approximately 88% of the flow is passing through the facility and the model confirms this with 87.8% (878/1000) of fish passing through the facility.

The model output contains a more detailed breakdown of entrainment (Attachment A), providing each unit a fish entrainment estimate based on the proportion of flow prioritized to each consecutive unit. For example, in a 90% exceedance scenario, there is only enough water to generate with Unit 1; therefore, all fish are entrained through Unit 1 (Table 4).

Blade strike survival remained high in all scenarios with the highest strike survival of 0.97 during Scenario 1 (10% weekday, 2% bypass), Scenario 4 (10% weekday, 5% bypass), Scenario 7 (10% weekend, 2% bypass) and Scenario 10 (10% weekend, 5% bypass) (Table 3). During these scenarios, river flow was 7870 cfs (Scenarios 1 and 4) and 8860 cfs (Scenarios 7 and 10). All units are being used for generation during these scenarios. The lowest blade strike survival (0.88) is during Scenario 9 (90% weekend, 2% bypass). During this scenario, there is only enough water to generate with Unit 1, given the priority protocol (Figure 4). An explanation for the lower blade strike survival in these scenarios can be attributed to Unit 1 having a higher probability of blade strike than all the other units (Table 5).

Ancillary entrainment stressor survival was an unknown in this analysis; therefore, it was calculated from the blade strike survival and the expected entrainment survival for a given rated head (EPRI entrainment database). In all scenarios, ancillary entrainment stressor survival ranged from 0.77 to 0.85. Entrainment survival rates were interpolated from Figure 5 using the appropriate head height of 92 ft and an estimated survival of approximately 0.75. Cascade survival rate, as discussed in the section above, was estimated at 63% from the Turners Falls study estimate of survival of juvenile American Shad spilled over the bascule gates.

We determined the overall migration survival by summing the number of fish that survived through each passage route, divided by the number of fish simulated (1000). Table 3 shows the highest migration survival rates at Scenario 2 (50% weekday, 2% bypass), Scenario 11 (50% weekend, 2% bypass) and Scenario 12 (90% weekend, 5% bypass) of 0.79and 0.78, respectively.

TABLE 4 MONTE CARLO SIMULATION RESULTS FOR 12 PROPOSED SCENARIOS (BASED OFF 50 AGGREGATED SIMULATION RESULTS PER SCENARIO). SURVIVAL ESTIMATES AND RANGE (+/- THREE STANDARD DEVIATIONS)

Scenario	Mean Length (mm)	Facility Passage	Number Entrained	Number Bypassed	Bypass Survival Rate	Blade Strike Survival	Ancillary Entrainment Stressor Survival	Entrainment Survival Rate	Cascade Survival Rate	Migration Survival Rate
10% Weekday 2% Bypass	69.29 (68.8-69.8)	811.7 (778.9-844.5)	756.38 (721.1-791.6)	55.32 (38.9-71.7)	0.43 (0.25-0.61)	0.97 (0.95-0.99)	0.77 (0.73-0.82)	0.75 (0.70-0.80)	0.63 (0.53-0.72)	0.73 (0.69-0.76)
50% Weekday 2% Bypass	69.3 (68.7-69.9)	876.92 (845.2-908.6)	815.92 (777.7-854.1)	61 (36.5-85.5)	0.44 (0.23-0.64)	0.91 (0.88-0.94)	0.83 (0.78-0.87)	0.75 (0.69-0.81)	0.64 (0.51-0.78)	0.79 (0.73-0.82)
90% Weekday 2% Bypass	69.33 (68.6-70)	675.9 (625.9-725.9)	630.06 (582.7-677.4)	45.84 (24.9-66.7)	0.43 (0.21-0.64)	0.89 (0.85-0.93)	0.85 (0.79-0.9)	0.75 (0.68-0.83)	0.63 (0.54-0.71)	0.76 (0.71-0.81)
10% Weekday 5% Bypass	69.35 (68.8-69.9)	841.24 (811.1-871.3)	724.8 (684.3-765.3)	116.44 (82.5-150.4)	0.43 (0.3-0.57)	0.97 (0.95-0.99)	0.77 (0.73-0.82)	0.75 (0.7-0.79)	0.62 (0.51-0.73)	0.71 (0.67-0.75)
50% Weekday 5% Bypass	69.32 (68.6-70)	878.52 (845.16-911.9)	755.18 (712.9-797.4)	123.34 (89.4-157.3)	0.44 (0.3-0.58)	0.90 (0.86-0.93)	0.83 (0.79-0.88)	0.75 (0.68-0.81)	0.63 (0.52-0.73)	0.76 (0.72-0.8)
90% Weekday 5% Bypass	69.33 (68.8-69.9)	673.12 (631.1-715.1)	579.1 (534.1-624.1)	94.0 (67.5-120.5)	0.44 (0.28-0.6)	0.89 (0.85-0.92)	0.85 (0.81-0.89)	0.75 (0.69-0.82)	0.63 (0.55-0.70)	0.74 (0.70-0.79)
10% Weekend 2% Bypass	69.37 (68.6-70.1)	721.7 (676.6-766.8)	672.6 (625.1-720.1)	49.1 (27.8-70.4)	0.44 (0.24-0.64)	0.97 (0.95-0.98)	0.77 (0.73-0.81)	0.75 (0.7-0.8)	0.63 (0.54-0.73)	0.72 (0.68-0.76)
50% Weekend 2% Bypass	69.34 (68.7-69.9)	746.16 (705.4-786.9)	698 (651.8-744.2)	48.16 (28.9-67.3)	0.44 (0.23-0.64)	0.89 (0.86-0.93)	0.84 (0.8-0.88)	0.75 (0.69-0.81)	0.63 (0.55-0.71)	0.77 (0.73-0.81)
90% Weekend 2% Bypass	69.33 (68.7-69.9)	404.9 (356.8-452.9)	376.96 (331.9-422.0)	27.94 (13.2-42.7)	0.43 (0.15-0.7)	0.88 (0.84-0.93)	0.84 (0.8-0.89)	0.74 (0.67-0.82)	0.63 (0.56-0.69)	0.70 (0.66-0.75)
10% Weekend 5% Bypass	69.35 (68.8-69.9)	743.78 (702.3-785.3)	641.7 (604.5-678.9)	102.08 (75.9-128.2)	0.42 (0.3-0.55)	0.97 (0.95-0.98)	0.78 (0.72-0.84)	0.75 (0.69-0.82)	0.63 (0.54-0.73)	0.70 (0.66-0.75)
50% Weekend 5% Bypass	69.33 (68.7-70)	811.56 (772.2-850.9)	757.36 (715.2-799.5)	54.2 (32.2-77.2)	0.42 (0.21-0.62)	0.89 (0.86-0.92)	0.85 (0.81-0.88)	0.75 (0.7-0.81)	0.64 (0.55-0.73)	0.78 (0.74-0.82)
90% Weekend 5% Bypass	69.3 (68.6-70.1)	812.8 (765.4-860.2)	756.58 (708.8-804.4)	56.22 (35.4-77.1)	0.42 (0.24-0.6)	0.89 (0.85-0.92)	0.85 (0.8-0.89)	0.75 (0.69-0.81)	0.63 (0.51-0.75)	0.78 (0.74-0.82)

TABLE 5 APPORTIONED FLOW AT EACH SCENARIO

Scenario	River Flow (cfs)	Habitat South (cfs)	Habitat North (cfs)	Fish Bypass (cfs)	Aesthetic (cfs)	Proportion Through Units					Proportion Spilled
						Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	
10% Weekday 2% Bypass	7870	-200	-45	-132	-	0.2004	0.1681	0.1762	0.1535	0.3017	0.1872
50% Weekday 2% Bypass	2000	-200	-45	-132	-	0.7739	0.2261	-	-	-	0.1225
90% Weekday 2% Bypass	758	-200	-45	-132	-	1	-	-	-	-	0.3232
10% Weekday 5% Bypass	7870	-200	-45	-330	-	0.2005	0.1681	0.1762	0.1536	0.3017	0.162
50% Weekday 5% Bypass	2000	-200	-45	-330	-	0.8814	0.1186	-	-	-	0.1225
90% Weekday 5% Bypass	758	-200	-45	-330	-	1	-	-	-	-	0.3232
10% Weekend 2% Bypass	8860	-200	-45	-132	-255	0.2005	0.1681	0.1762	0.1536	0.3017	0.2780
50% Weekend 2% Bypass	1970	-200	-45	-132	-255	0.9387	0.0613	-	-	-	0.2538
90% Weekend 2% Bypass	842	-200	-45	-132	-255	1	-	-	-	-	0.5938
10% Weekend 5% Bypass	8860	-200	-45	-330	-255	0.2005	0.1681	0.1762	0.1536	0.3017	0.2556
50% Weekend 5% Bypass	1970	-200	-45	-330	-255	1	-	-	-	-	0.2538
90% Weekend 5% Bypass	842	-200	-45	-330	-255	1	-	-	-	-	0.5938

TABLE 6 PROBABILITY OF STRIKE FOR EACH UNIT

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
Probability of Strike	0.206	0.031	0.008	0.031	0.009

7.0 CONCLUSIONS AND RECOMMENDATIONS

Overall, the individual based model employing Monte-Carlo simulation proved insightful and was useful in determining the best overall route of passage at the School Street Project based on empirical passage survival rates. The model concluded that regardless of the scenario, the best overall route of passage based on survival rate estimates is passage through the units (entrainment). The attached excel spreadsheet contains model simulation worksheets for each of the 12 scenarios simulated. The model inputs used in the simulations were realistic as they were based on empirically collected JBBH data (or surrogate species) and represent the best estimates of real world scenarios at the Project. However, there are multiple model parameters that can be manipulated that will affect the estimated migration survival rate.

Given the current model inputs and the simulated results, the best overall route of passage based on survival rates is passage of JBBH is entrainment through the turbines. Generally, the blade strike survival rates were high. However, the results suggest that unit priorities may be adjusted to 2-3-4-5-1 rather than 1-2-3-4-5 to minimize entrainment mortality due to blade strike because Unit 1 has the highest probability of blade strike of the five units at the Project (Table 5). Even when a relatively high ancillary entrainment stressor survival rate is factored in, the estimates of entrainment survival rates are higher than the cascade (i.e., Cohoes Falls) survival rates and the fish bypass survival rates, making it the best option for passage of JBBH through the Project. The bypass reach survival rate (63%) is likely a conservative estimate, as we only accounted for mortality associated with fish cascading over Cohoes Falls. In reality, fish are faced with additional mortality stressors when passing the Project via the bypass reach including spill over the dam, and predation within the relatively shallow waters of the bypass reach. These stressors are likely to reduce survival through the bypass reach but to what degree remains unknown.

8.0 LITERATURE CITED

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APPENDIX A:

LITERATURE REVIEW

LITERATURE REVIEW

Kleinschmidt compiled several studies investigating the survival of JBBH and other species via passage over spillways and free fall experiments. This section is a summary of some of those studies.

In 1972, a compendium on the survival of fish passing through spillways and conduits was published. Studies in the mid 1950's conducted by the Washington Department of Fisheries (WADF) began to quantify the success of fish subjected to free fall. Terminal velocity values were established for a range of fish sizes. Smaller fish (less than 7 inches) reached a terminal velocity of approximately 52 feet per second (fps). Free fall experiments confirmed that small fish suffered little mortality when dropped from heights as great as 300 ft. It was concluded that larger fish that exceed a striking velocity of 50 fps can experience considerable damage to the eyes, gills and internal organs, which are injuries generally associated with pressure change, resulting from mechanical forces due to the difference in movement of fish in relation to velocity (Bell et al. 1972).

More recently, a 2002 review compiled results from several studies investigating downstream fish passage mortality including a section regarding passage through spillways (Larinier and Travade 2002). The review determined similar conclusions as the 1972 WADF; citing multiple experiments when fish exceed a critical free fall velocity of 15-16 m/s (49-52 fps) and become more susceptible to damage on impact (Larinier and Travade 2002). Fish with a length of less than 13 cm, whose velocity remains below this critical threshold during free fall suffer no harm when dropped from any height. Passage through spillways was concluded to be the safest downstream route choice for small fish (less than 13 cm) because they never reach a terminal velocity that exceeds the critical velocity (Larinier and Travade 2002). Empirical data from multiple experiments confirms this conclusion with many studies reporting very high survival rates for smaller juvenile fish (mostly salmonids) passing through spillways (Table A-1).

In 1992, a report was prepared for New York Power Authority to assess the survival of JBBH in powerhouse/turbine passage and spillage over the dam at Crescent Hydroelectric Project. The Crescent Project is located just upstream of the School Street Hydroelectric Project on the Mohawk River. For this study, 125 JBBH were tagged and passed through the powerhouse while the turbine was operating at its full rated capacity. An additional 110 JBBH were tagged and spilled over the dam with another 110 control fish tagged and released into the pool below the dam. Upon release of test fish, a flashboard was removed on the dam creating approximately 40 cfs (at full pond elevation) passing through and plunging into a spill pool at the base of the dam. The vertical distance the fish fell from crest of the dam to the pool was approximately 12 ft. The results of the spillage experiment revealed very high immediate survival (≤1 hr = 100%), and a 48-hour survival rate of 88.3%. These studies were later published in a 1996 paper by Mathur et al., concluding that spillway passage cannot be assumed better or worse than turbine passage, as both survival measurements are very high in multiple studies. Each hydro facility is different and sources of mortality via spillage is site dependent in regard to depth of plunge pool, substrate, hydraulic characteristics, volume of spillage and obstruction of flow path. This study concluded that turbine passage mortality was a result of number of running blades, blade speed and clearance between blades relative to fish size resulting in blade strike, structural collision, or grinding in narrow gaps. Little to no mortality has been attributable to factors such as cavitation or pressure changes (Mathur et al, 1996).

A more recent study in 2015 evaluated the direct injury and relative survival of juvenile American Shad at the Turners Falls Hydroelectric Project (Kleinschmidt 2016). One portion of the study was to determine the survival probability (1 and 48 h) for shad passing over the Bascule Gates at three different discharge rates of 1,500, 2,500 and 5,000 cfs. Survival rates over the Bascule Gates ranged from 47.7-75.6% and visible injury rates ranged from 29.6-44.3% on recaptured fish passed over the gates. The high rates of injury and low rates of survival over the Bascule Gates were ascribed to site-specific factors in this case. There are boulders and concrete sills just below Turners Falls Dam that may have been the source of mortality and injury to fish during spill.

Several studies report very high survival rates for juvenile fish passing through spillways. The majority of studies that report any mortalities attributes them to site-specific factors including shearing effects, grazing against surfaces during spill, turbulence at the base of the dam, and physical shock or damage from collisions with aprons or baffles (Larinier and Travade 2002, Ruggles and Murray 1983).

TABLE A-1 COMPILED SURVIVAL ESTIMATES FROM VARIOUS JUVENILE FISH AT DIFFERENT HEIGHT DAMS

PROJECT	SPECIES	VERTICAL DISTANCE	SURVIVAL ESTIMATES
Washington Dept. Fisheries	Juvenile Salmonids	300 ft	>90%
Crescent Dam	Juvenile Blueback Herring	16 ft	1hr = 100% 48hr = 88.3%
Turners Falls	Juvenile American Shad	35 ft	47.7 – 75.6%
Snake River – Monumental Dam	Juvenile Salmonids	100 ft	90%
Bonneville Dam	Juvenile Salmonids	85 ft	96-100%
McNary Dam	Juvenile Salmonids	88 ft	98%
John Day Dam	Juvenile Salmonids	105 ft	98%
Glines Dam	Juvenile Salmonids	196 ft	92%

DESKTOP EVALUATION OF ENTRAINMENT AND DOWNSTREAM PASSAGE SURVIVAL OF JUVENILE BLUEBACK HERRING

STUDY PLAN

SCHOOL STREET PROJECT
FERC NO. 2539

Prepared for:

Brookfield Renewable Power
Queensbury, NY

Prepared by:

Kleinschmidt

Essex, Connecticut
www.KleinschmidtGroup.com

August 2017

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

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October 13, 2017

Robert Garrett, Compliance Specialist
Brookfield Renewable Energy Group
North Atlantic Operations
399 Big Bay Road
Queensbury, NY 12804

RE: School Street Hydroelectric Project (FERC #2539)
Review of Study Plan for Desktop Evaluation of Entrainment and Downstream Passage Survival of Juvenile Blueback Herring

Dear Mr. Garrett,

Thank you for opportunity to review Brookfield Renewable Energy Group's (Brookfield) August 2017, 2017, *Study Plan for Desktop Evaluation of Entrainment and Downstream Passage Survival of Juvenile Blueback Herring* (Study Plan) for the School Street Project. The project is located on the Mohawk River at Cohoes, New York in both Albany and Saratoga Counties.

The results of this Study Plan will aid in determining what type of alternative to the existing downstream fish passage structure could be implemented to increase the effectiveness of downstream-migrating juvenile blueback herring *(Alosa aestivalis).* The New York State Department of Environmental Conservation (DEC) has the following general comments regarding the Study Plan.

DEC appreciates the collaborative efforts between Brookfield and the resource agencies; particularly the United States Fish and Wildlife Service's (USFWS) Fishway Engineer, Jesus Morales, and your consultant, Kleinschmidt Associates in the development of the Study Plan. Following our review of both the Study Plan and the comment letter provided by the USFWS to Brookfield on September 28, 2017, the DEC can concur with the methods presented.

We do have a concern that should be addressed, at a minimum, in the final report. The report states that "associated sources of mortality" during entrainment include, but are not limited to pressure and shear-induced stresses during turbine passage. The empirically-calibrated blade strike models do not include this source of entrainment mortality. The Study Plan, on page 10, indicates that "most turbine passage mortality at low head dams (<100 ft) is caused by fish striking a turbine blade or some other turbine component". This generalized statement should be discussed in much more detail. "Associated sources of mortality" need to be accounted for using literature-based citations which justify the omission of this source of fish loss or injury (specifically juvenile blueback herring) from the final estimate of entrainment mortality.

This results of the desktop evaluation should provide enough information to negotiate an acceptable alternative to the existing ineffective downstream passage facility, designed particularly for juvenile blueback herring. We appreciate the opportunity to review the Study Plan. If you have any follow-up questions, or would like to schedule a short follow-up call to discuss our concern with associated sources of mortality, please feel free to contact me at your nearest convenience.

Sincerely,

Mark S. Woythal

Mark Woythal
Instream Flow Unit Leader

cc: (via email only)
Chris VanMarren; DEC- Stanford
Steve Patch; USFWS- Cortland
Jesus Morales; USFWS- Hadley, MA

DESKTOP EVALUATION OF ENTRAINMENT AND DOWNSTREAM PASSAGE SURVIVAL OF JUVENILE BLUEBACK HERRING

STUDY PLAN

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DESKTOP EVALUATION OF ENTRAINMENT AND DOWNSTREAM PASSAGE SURVIVAL OF JUVENILE BLUEBACK HERRING

STUDY PLAN

1.0 INTRODUCTION

The School Street Hydroelectric Project (Project) (FERC No. 2539) is owned and operated by Brookfield Renewable (Brookfield). The Federal Energy Regulatory Commission (FERC) issued a new License to the Project on February 15, 2007, in which downstream fish passage for anadromous and catadromous fish, as well as resident fish, was required. In September 2007, a Final Plan was developed to investigate the Phase I fishway effectiveness and included requirements for testing downstream passage survival of resident fish, American Eels, juvenile and adult Blueback Herring; passage efficiency of juvenile and adult Blueback Herring; an inspection of the conveyance structures; and a hydraulic survey to document flow field and approach velocities in front of the angled bar rack and fishway entrances.

To date, Brookfield has completed their investigation of the Phase I Fishway Effectiveness as described in the Final Plan and Phase I Fishway Effectiveness Testing Study Plan and met their compliance obligations as stipulated in the settlement agreement. The presiding resource agencies, U.S. Fish & Wildlife Service (USFWS) and New York State Department of Environmental Conservation (NYSDEC), indicated their concurrence in a letter dated July 20, 2016, but ultimately concluded that the downstream bypass was ineffective at safely passing juvenile Blueback Herring (JBBH) at the Project.

As requested by the agencies in their letter, Brookfield evaluated several options to improve passage survival and presented them in a letter dated January 30, 2017. A consensus was reached through subsequent consultations with the agencies on June 14, and July 5, 2017. It was agreed that a desktop evaluation should be conducted to investigate passage survival at the Project. The evaluation would investigate passage survival of the various passage options available to emigrating JBBH and determine a final course of action to improve overall project passage survival. Prior empirical studies have shown that passage survival of JBBH migrating through the downstream fish bypass to be poor (43.3% survival), As such, two other options are under consideration 1) turbine passage (entrainment) or 2) spill passage at the dam with the aid of a fish guidance structure (e.g. surface boom and deflector) located immediately upstream of the canal gatehouse to convey JBBH into the bypass reach through an existing gate. The following Study Plan details the methodology to be used to conduct the desktop evaluation.

2.0 OBJECTIVE

The objective of this desktop study is to better understand Project passage survival of JBBH to determine the most suitable route of passage of at the Project.

3.0 SITE AND PROJECT OPERATIONAL DESCRIPTION

The Project is located on the Mohawk River, 2.5 river miles upstream of its confluence with the Hudson River in Cohoes, New York (Figure 1). It is composed of the following components:

1. A stone masonry gravity dam extending 1,280 ft across the Mohawk River, 16 ft in height, completed in 1865;
2. A reservoir with a surface area of approximately 100 acres at a normal maximum water surface elevation of 156.1 ft, and a gross storage capacity of 788 acre-ft;
3. A power canal extending approximately 4,400 ft from the dam to the powerhouse, 150 ft wide and 14 ft deep;
4. An upper gatehouse structure that currently includes nine slide gates and three steel tainter gates to control the diversion of flow into the canal;
5. A lower gatehouse with five steel headgates to control flow into the five penstocks; and
6. A powerhouse measuring 170 ft long by 78 ft wide, housing five generating units with vertical shaft Francis turbines rated at 92 ft of head, with a total maximum capacity of 38.8 megawatts.

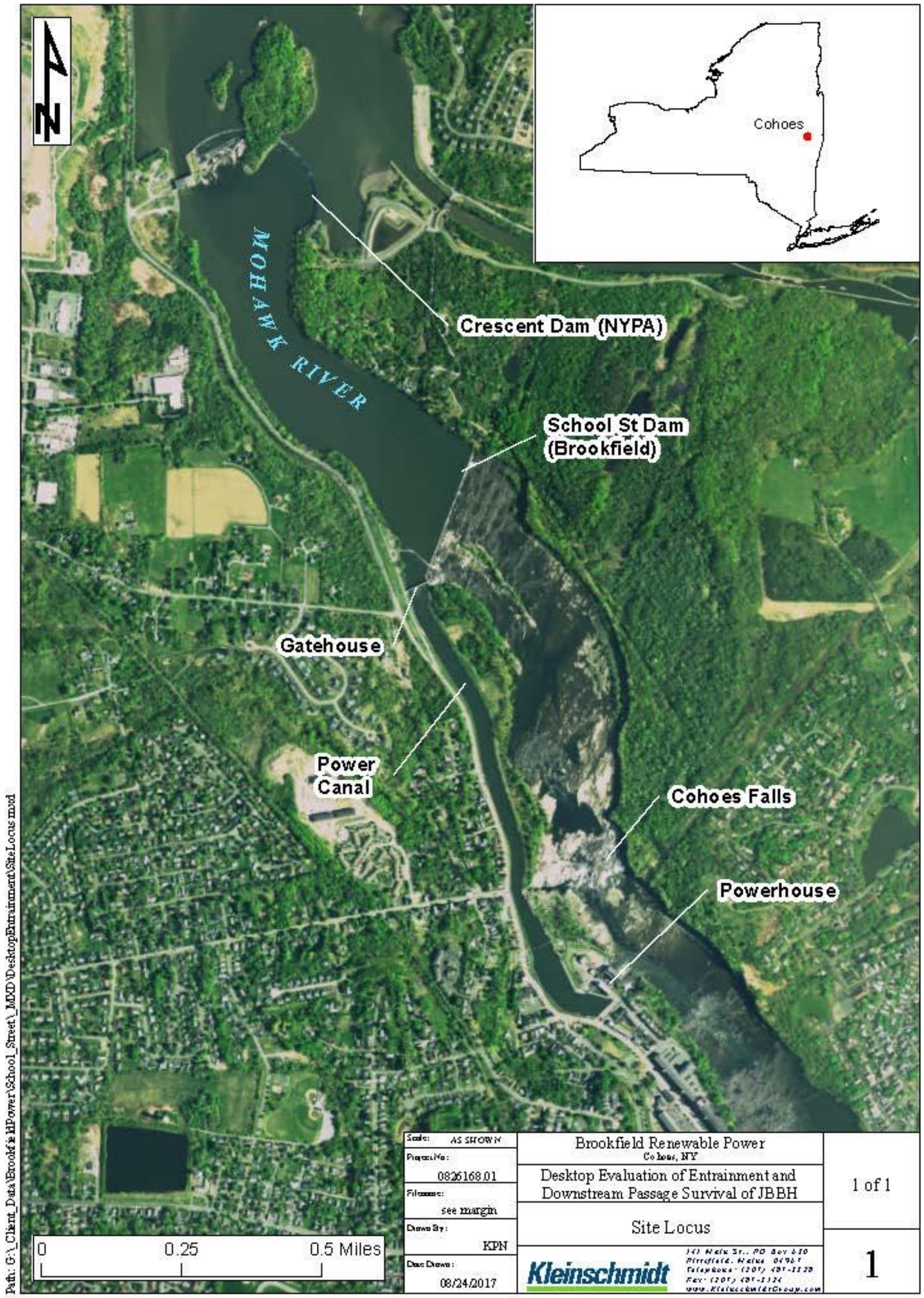

FIGURE 1 PROJECT LOCATION

The fishway consists of an angled bar rack with one-inch clear spacing and a fish conveyance system. The angled bar rack is located in the power canal just upstream of the lower gatehouse. The rack guides fish to the entrance of a fish conveyance system that transports fish around the powerhouse and discharges to the Project tailwater. The rack structure is angled approximately 45 degrees from the upstream face of the existing lower gatehouse. The lower portion of the rack includes a solid, two-foot high, concrete, eel diversion berm to guide emigrating American Eel toward the bypass entrance at the downstream end of the rack.

The fishway conveyance structure is located near the downstream end of the angled bar rack. It has two intake portals and includes a multi-level gate with top and bottom entrances. Attraction flow to the fishway entrances can vary from two to five percent of the Project’s total hydraulic capacity. Conveyance pipes from both entrances converge in a fish separation chamber part-way along the fish conveyance structure. The chamber reduces the volume of the bypass flow by guiding fish along a wire floor screen and directing them into a fish return weir pool. The excess attraction water flows through the floor screen and is discharged downstream of the Project. A gate valve at the downstream end of the fish separation chambers provides hydraulic control within the fish conveyance structure. An adjustable weir is located at the entrance to the fish return weir pool. The weir provides fine-tune adjustment to the depth of water cascading over the weir, as well as the overall bypass flow (design flow 24 cfs). Once in the fish return weir pool, fish are guided to the entrance of the return pipe and are deposited into the tailwater of the Project.

4.0 STUDY APPROCAH

This study endeavors to better understand the total project survival of JBBH through simulation. There are three routes of passage available to emigrating JBBH, each of which contains stressors that may affect survival. The three routes available for passage consist of: 1) through the downstream fish bypass; 2) through the powerhouse turbines (i.e., entrainment); and 3) over the dam via spill. Associated sources of mortality include: 1) mechanical stresses within the downstream fish bypass facilities; 2) blade strike, pressure and shear-induced stresses from turbine passage; and 3) physical stresses encountered from passage over the dam, through the bypass reach and over Cohoes Falls. This study will estimate theoretical turbine and dam passage survival of JBBH as well as investigate how flow and the addition of a fish guidance structure at the upper gatehouse may affects passage routing.

To understand the survivability of JBBH as they pass through the Project, Brookfield proposes to construct an individual based model, where route selection and interactions with infrastructure are governed with a Monte-Carlo simulation model (Model). Each simulated fish is exposed to a suite of project stressors and route decisions. These decisions include choice of migratory route with associated stressors due to physical interactions, entrainment and/or blade strike. The fish are sampled from simulated populations and interactions with each structure are governed by random trials. The Model assumes all fish are emigrating and all fish will interact with the facility in the same way. As fish approach the Project, there is a set of interactions that each individual experiences for any possible passage route. The Model will simulate the mortality of fish as they pass through the Project. Figure 2 illustrates the possible routes of passage in a conceptual model.

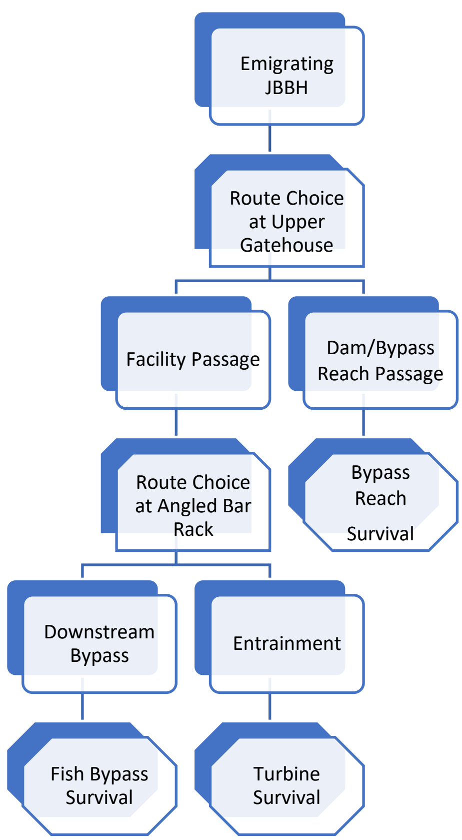

FIGURE 2 DOWNSTREAM PASSAGE CONCEPTUAL MODEL AT THE SCHOOL STREET PROJECT, COHOES, NY.

As emigrating JBBH approach the Project, they can choose to migrate through the facility or pass over the dam and through the bypass reach. The choice of route is made at the dam and/or upper gatehouse. However, juveniles tend to follow flow and for the purposes of the analysis JBBH will be assumed to follow the flow proportionally unless otherwise specified. For example, if 90% of the flow is routed through the canal, then 90% of the fish will follow the canal route. However, if a fish guidance structure were employed upstream of the upper gatehouse this assumption would no longer be valid as the partial barrier is likely to affect route selection. As such this evaluation scenario will rely on information available in the literature to bound the estimate (e.g. best case and worst case passage guidance effectiveness scenario).

Once in the power canal, JBBH can either pass through the angled bar rack and become entrained or enter the downstream fish bypass to avoid turbine passage. At this location, we cannot assume that route selection is proportional to flow due to the partial barrier afforded by the full depth angled bar rack. As such, Brookfield proposes to rely on route selection proportions estimated during a prior fish bypass effectiveness evaluation (Kleinschmidt 2014) to simulate the ratio of fish that undergo turbine passage versus passage via the downstream fish bypass.

Impingement and canal mortality are assumed to be negligible and will not be assessed. Brookfield will assess the rates of mortality for those fish that use the downstream fish bypass, those that are entrained, and those that pass over the dam and through the bypass reach. Prior studies (Kleinschmidt 2012) will inform survival through the downstream bypass, while empirically calibrated blade strike models (Franke et al. 1997) will inform entrainment survival. Survival over the dam and through the bypass reach, which includes passage over Cohoes Falls is unknown; therefore, a sensitivity analysis will be performed that incorporates published survival rates from similar studies identified with a literature review and expert opinion.

Both choice of migratory route and survival will be simulated with a Monte-Carlo random number trial. The RAND function in Excel will be used to assign a random number between 0 and 1 for each individual fish, where all values between 0 and 1 are equally likely to be assigned. Therefore, one would expect 50% of the trials to be equal to 0.50 or less. If the random number generated is greater than or equal to a test statistic, than the fish has experienced an event (route choice or death). For example, if the survival rate of a fish passing through the downstream bypass sluice is 80%, and the random number trial generated 0.90, the fish did not survive the trial. Any number between 0 and 0.8 means that the fish survived the trial because 80% of the expected random number trials occur between 0 and 0.8.

An individual based model where fate is controlled through Monte-Carlo random number trials is the preferred method for this project because survival is route-dependent and this model will allow us to estimate uncertainty. If all fish were exposed to each individual stressor at the Project, then the through-project survival would be the product of each independent probability. However, a fish that passes the Project via Cohoes Falls will not be exposed to turbine passage stressors. Therefore, through-project survival for that fish does not depend on the turbine survival rate. 'Individual' in the term 'individual based model' refers to a single fish. Each simulated fish will choose one of the routes (Figure 2). These simple rule-based interactions and random number trials will govern the fate of each fish and produce emergent properties of interest (i.e., through-project survival) by simulating a large population of emigrating JBBH, many times, with simple rules deduced from empirical studies to allow a facility-specific downstream passage rate with error estimated to be determined.

5.0 METHODOLOGY

The following methodology will be employed to meet the objective of this study.

5.1 TURBINE PARAMETERS DATA

The blade strike models derived by Franke et al. (1997) require precise measurements of a suite of turbine parameters. The generating units at the Project are Francis turbines, with four of the five units of identical design, while the fifth unit is larger. The blade strike model requires: nameplate turbine capacity (hp), rated turbine head (ft), estimated maximum discharge (cfs), discharge at maximum efficiency (cfs), percent discharge at maximum efficiency, number of wicket gates, runner speed (rpm), runner diameter (in), runner diameter at the inlet/centerline (in), runner inlet height (in), number of blades, turbine efficiency (nameplate). These parameters will be collected and used to develop and calibrate an initial blade strike model for entrained JBBH.

5.2 OPERATIONS DATA AND DEVELOPMENT OF FLOW SCENARIOS

Operations and river flow (USGS Gage 01357500 Mohawk River at Cohoes, NY) data will be evaluated over a 10-year period at the Project. Flow over the dam and through the bypass reach will be calculated by subtracting the station discharge (cfs) from the USGS gage located in the Project tailwater. Computed bypass flow data will be used to develop seasonal flow duration curves for each source of flow (turbine, downstream bypass and bypass reach) that coincide with the JBBH migratory period (mid-August – October). These curves will inform on the flow scenarios inputs into the Model scenarios. In addition to the regular minimum flow requirement (Monday – Friday), the Project must release aesthetic flows on the weekend and federal holidays; therefore, the following six flow scenarios will be evaluated, at a minimum: 1) weekday low flow (90% exceedance), 2) weekend low flow (90% exceedance), 3) weekday high flow (10% exceedance), 4) weekend high flow (10% exceedance), 5) weekday median flow (50% exceedance) and 6) weekend median flow (50% exceedance).

5.3 LITERATURE REVIEW AND EXPERT CONSULTATION

A literature review and consultation with experts will be conducted in regards to the ability of fish to survive passage over a cascade. This investigation will inform the estimate of survival through the bypass reach and over Cohoes Falls. As an example, aerial stocking programs are an effective way to release fish in remote lakes. Western states have been using this method successfully and survival estimates may be useful as surrogate data for the present study. If necessary, consultation with the fisheries professionals leading these programs will be conducted to obtain information on the release height and survival rate of stocked fish. A literature review will be conducted on survival studies of fish released upstream of dams and large cascades. Expert opinion may be sought, if necessary, to develop a sensitivity analysis that uses the limits of published survival rates and expert opinion.

A literature review will also be conducted to inform on the expected effectiveness of a partial depth guidance structure to guide JBBH to the bypass reach and exclude them from the canal. Effectiveness estimates will be used to bound the expected performance of such a device at School Street to estimate project passage survival under such a scenario. The evaluation will consider an upper and lower bound for passage effectiveness, which will ultimately inform on the proportion route selection of JBBH and thus overall passage survival.

5.4 Model Development and Implementation

The model will be constructed in Microsoft Excel for ease of use and shared among stakeholders. A Monte-Carlo style draw will simulate the fate of modeled fish for each of the possible routes and associated stressors. The project stressors include impacts from passage over the dam and through the bypass reach, blade strike, and stressors experienced in the downstream fish bypass.

5.4.1 Route Selection at the Gatehouse

At the low head dam and Gatehouse (Figure 2), JBBH may enter the canal to pass through the facility or use the bypass reach to pass downstream of the Project. At this location, JBBH will be assumed to follow flow proportionately. Choice in route (R_1) will be controlled through a Monte-Carlo style draw (x_1) from a uniform random number generator in Excel (RAND) with Equation **Error! Reference source not found.**:

$$R_1 = \begin{cases} x_1 \leq Q_1 = 1 \\ x_1 > Q_1 = 0 \end{cases} \qquad \mathbf{1}$$

Where R_1 is the first choice of route and indicates if fish chooses the 1 (facility) or 0 (bypass reach), x_1 is the first random number draw (RAND), and Q_1 is the proportion of flow through the facility. This equation indicates that if the random number draw x_1 is less than or equal to the proportion of flow through the facility, then the fish will choose the facility. If the fish chooses the facility, then it will be exposed to another choice of route at the angled bar rack (entrainment or through fish bypass). A fish that does not enter the canal would be exposed to mortality stressors at the dam and over Cohoes Falls.

5.4.2 Route Selection at Gatehouse with Aid of a Fish Guidance Structure

The approach to this analysis will be identical as described above in section 5.4.1 except a coefficient will be derived based on guidance effectiveness proportions available in the literature to reapportion the route selection variable (R1) based on flow. The fish guidance structure will affect equation 1 via a coefficient applied to Q that will range between 0 and 1. The presence of a fish guidance structure will reduce the impact of flow through the gatehouse in guiding fish through the project. We will experiment with interaction effects as part of the sensitivity analysis, with the assumption that the fish guidance structure may have reduced behavioral modification capacity at higher flow.

5.4.3 ROUTE SELECTION AT THE ANGLED BAR RACK

Route selection at this location will be estimated based on prior passage effectiveness studies (Kleinschmidt 2014) that monitored the proportion of JBBH emigrating through the turbines versus those emigrating through the downstream fish bypass. The passage rate estimates were monitored simultaneously using split-beam hydroacoustics and sound imaging camera technology (ARIS/DIDSON).

5.4.4 TURBINE PASSAGE SURVIVAL

Blade strike models developed by Frank et al. (1997) predict the survival rate of fish that pass through hydroelectric turbines. These models consider fish size, turbine specifications, and station hydraulics to estimate the theoretical blade strike and survival of specific sized fish for a particular turbine configuration. Direct effects of turbine passage can be predicted as a probability because the variables (such as turbine diameter, number of blades, etc.) and their ranges can be precisely defined. These models allow the user to manipulate parameters such as fish size or turbine characteristics to determine the relative effect on turbine passage survival. This predictive model is based on the work of Von Raben (Bell 1981). Franke et al. (1997) refined the Von Raben model to consider the effect of tangential projection of the fish length on blade strike probability because most turbine passage mortality at low head dams (<100 ft) is caused by fish striking a turbine blade or some other turbine component.

For Francis turbines, the probability of strike will be calculated with the following procedure. The first step calculates the angle tangential of absolute flow upstream of the runner (a_t) with Equation 2:

$$\tan(90 - a_t) = \frac{2\pi E_{\omega d} * \eta}{Q_{\omega d}} \frac{B}{D_1} + \frac{\pi * 0.707^2}{2Q_{wd}} \frac{B}{D_1} \left(\frac{D_2}{D_1}\right)^2 - 4 * 0.707 * \tan\beta \frac{B}{D_1} \left(\frac{D_2}{D_1}\right)^2 \qquad \mathbf{2}$$

where $E_{\omega d}$ is the energy coefficient, η is the turbine efficiency and $Q_{\omega d}$ is the discharge coefficient. The energy coefficient $E_{\omega d}$ is given with Equation 3:

$$E_{\omega d} = \frac{gH}{(\omega D)} \tag{3}$$

where g is the acceleration due to gravity (ft/s^2), H is the turbine net head (ft), ω is the rotational speed of the runner ($RPM * 2\pi/60$), and D is the diameter of the runner (ft). The turbine efficiency ($Q_{\omega d}$) is given with Equation 4:

$$Q_{\omega d} = \frac{Q}{\omega D^3} \tag{4}$$

where D^3 is the diameter (ft) of the runner cubed. The relative flow angle (β) is given with Equation 5:

$$\tan\beta = \frac{0.707 * \frac{\pi}{8}}{\xi * Q_{opt}\left(\frac{D_1}{D_2}\right)^3} \tag{5}$$

where Q_{opt} is the turbine discharge at best efficiency (ft^3/s) and ξ is the ratio between discharge (Q) with no exit swirl and Q_{opt}. A value of 1.1 for ξ will be used as suggested by Franke et al. (1997). Finally, the probability of mortality from blade strike M^t is given with Equation 6:

$$M^t = \lambda \frac{NL}{D}\left[\frac{\sin a_t \frac{B}{D_1}}{2Q_{wd}} + \frac{\cos a_t}{\pi}\right] \tag{6}$$

Where λ is a strike mortality correlation factor, N is the number of buckets and L is the length of the fish (ft).

A correlation factor (λ) is utilized in the Advanced Hydro Turbine model to adjust the predictive model results to correspond with documented empirical results. This correlation factor was originally introduced by Von Raben (cited by Bell 1981) because the contact of a fish with a turbine component does not always result in injury or mortality (Bell 1981; Cada 1998). Therefore, Von Raben introduced the correlation factor to adjust the predicted turbine strike results to more closely match empirical results. This factor also extends the applicability of these predictive equations to all injury mechanisms related to the variable NL/D (see above for definition of parameters). As stated in Franke et al. (1997) "*such mechanisms could include mechanical mechanisms leading edge strike and gap grinding as well as fluid induced mechanisms related to flow through gaps or other flow phenomena associated with blades*." Based on a substantial number of test results obtained from studies conducted with salmonids on the west coast, Franke et al. (1997) recommends that the correlation factor be set between 0.1 to 0.2. This study will use a correlation factor derived from empirical studies. A logistic regression model will be constructed using a dataset compiled from the EPRI entrainment database (EPRI 1997) from studies with similar turbine types. The response variable is the probability of survival, while predictors include head (ft), runner diameter (ft), number of blades (N) and runner speed (rpm). The blade strike survival $(1 - M^t)$ will be compared against the predicted logistic regression survival, and λ will be the difference between two.

Following the computation of the probability of a blade strike, a blade strike simulation will be conducted for those fish entrained with a draw (x_3) from a uniform random distribution (RAND). Blade strike survival is given with Equation 7:

$$S^t = \begin{cases} x_3 \leq 1 - M^t = 1 \\ x_3 > 1 - M^t = 0 \end{cases} \quad \textbf{7}$$

Where S^t is a survival counter where 1 is survival and 0 is mortality, x_3 is a draw from a uniform random distribution and M^t is the probability of a blade strike. The overall rate of survival for a single simulation is the sum of S^t for those fish entrained, divided by the total number of fish entrained (E). Confidence intervals are estimated from the output of many (minimum of 100) simulations.

5.4.5 DOWNSTREAM FISH BYPASS SURVIVAL

When the choice of route at the angled bar rack indicates movement into the downstream bypass $(R_2 = 0)$, fish are exposed to mortality stressors at the downstream bypass. Brookfield has previously conducted (Kleinschmidt 2012) survival testing of JBBH at the downstream bypass, and found that survival was 43.3%. Bypass survival (S^b) is simulated with draws from a uniform random distribution (x_4) with Equation 8:

$$S^b = \begin{cases} x_4 \leq K = 1 \\ x_4 > K = 0 \end{cases} \quad \textbf{8}$$

Where S^b indicates bypass survival (1) or mortality (0), x_4 is a draw from a uniform random distribution and K is the derived bypass survival rate as calculated from empirical survival data. The formula states that if the random draw x_4 is less than or equal to the survival rate K, then the fish has survived passage through the downstream bypass. The overall rate of survival for a single simulation is the sum of S^b for those fish that pass via downstream bypass, divided by the total number of fish bypassed. Confidence intervals are estimated from the output of many (minimum of 100) simulations.

5.4.6 BYPASS REACH PASSAGE SURVIVAL

When the choice of route at the dam (Equation **Error! Reference source not found.**) indicates movement into the downstream bypass ($R_1 = 0$), fish are exposed to mortality stressors at the dam, within the bypass reach, and at Cohoes Falls. Natural waterfalls/cascade survival rates (F) will be sourced from literature and expert opinion. Cohoes Falls survival (S^f) is simulated with draws from a uniform random distribution (x_5) with Equation 9:

$$S^f = \begin{cases} x_5 \leq F = 1 \\ x_5 > F = 0 \end{cases} \qquad \mathbf{9}$$

Where S^f indicates survival (1) or mortality (0) over Cohoes Falls, x_5 is a draw from a uniform random distribution and F is natural falls survival rate. The formula states that if the random draw x_5 is less than or equal to the survival rate F, then the fish has survived passage through the Cohoes Falls. The overall rate of survival for a single simulation is the sum of S^f for those fish that pass via Cohoes Falls, divided by the total number of fish that choose this route. Confidence intervals are estimated from the output of many (minimum of 100) simulations.

5.5 PREPARE DRAFT AND FINAL REPORTS

A draft report will be prepared that includes the following sections: an executive summary, introduction, project description, methods, results, discussion and literature cited. The project description will include information on project history, location, project area, project facilities and operation at School Street. The methods and results sections of the report will include information on the size of JBBH simulated, site characterization relative to turbine passage survival, and a Route-specific survival estimates and an overall through-project survival estimate. Specifically, the turbine survival assessment will include information pertaining to database development and acceptability criteria, information extracted from empirical studies, and survival estimates using predictive models for turbine survival by size classes.

6.0 WORKS CITED

Bell, M.C. 1981. Updated compendium on the success of passage of small fish through turbines. Prepared for U. S. Army Corps of Engineers, North Pacific Division, Portland, OR.

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Kleinschmidt. 2012. Phase 1 Fishway Effectiveness Testing Juvenile Blueback Herring and Adult American Eel Survival Evaluation Report for School Street Project FERC No. 2539. Prepared for Brookfield Renewable Power.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Fish and Wildlife, Bureau of Habitat, Region 4
65561 State Highway 10, Suite 1, Stamford, NY 12167-9503
P: (607) 652-2645 I F: (607) 652-2342
www.dec.ny.gov

6/12/18

Daniel Maguire, PE
Compliance Specialist
Brookfield Renewable
184 Elm St.
Potsdam, NT 13676

RE: School Street Hydroelectric Project (FERC #2539)
Review of Desktop Evaluation of Entrainment and Downstream Passage Survival
Of Juvenile Blueback Herring

Dear Mr. Maguire,

The NYS Department of Environmental Conservation has reviewed Brookfield's February 26, 2018, *Desktop Evaluation of Entrainment and Downstream Passage Survival of Juvenile Blueback Herring* at the School Street Project on the Mohawk River. The NYSDEC does not concur with the Evaluation's conclusion that turbine passage is clearly the preferred route for downstream fish passage at this site.

The NYSDEC concurs with the March 29, 2018 letter from the USFWS concerning this desktop evaluation. In this letter the Service draws out concerns with the data and comparative literature used to make the assessment. The NYSDEC agrees that the assessment does not accurately make the case that the best option for downstream passage for juvenile blueback herring is through the turbines.

Likewise, the NYSDEC supports the Service's suggested proposal to continue to operate the fishway as it has been since license issuance with an attraction flow of 132 cfs. Additionally, for the juvenile blueback herring passage period, defined as August through October, Brookfield should install a fish guidance system.

Please coordinate with the NYSDEC and the Service to schedule a meeting to further discuss this study and to develop the best option for downstream passage of juvenile blueback herring.

Sincerely,

Chris VanMaaren
NYSDEC Region 4 Habitat/Fisheries Manager

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

FEDERAL ENERGY REGULATORY COMMISSION
Washington, D. C. 20426

OFFICE OF ENERGY PROJECTS

Project No. 2539-045 – New York
School Street Hydroelectric Project
Erie Boulevard Hydropower, L.P.

March 20, 2020

VIA FERC Service

Daniel Maguire, PE
Compliance Manager
184 Elm Street
Potsdam, NY 13676

Subject: Fishway Effectiveness Evaluation Report, Article 401

Dear Mr. Maguire:

This acknowledges receipt of your January 10, 2020 filing containing your response to our November 14, 2019 request for additional information regarding your 2019 final Fishway Effectiveness Evaluation Report. Your report was required by Ordering Paragraph (B) of the Order Modifying and Approving Fishway Effectiveness Testing Plan Pursuant to Article 401.[1] The report was to include any recommended changes in project operation or structures needed to enhance fish migration based on monitoring results.

According to your report, the best overall route of passage for juvenile blueback herring (JBBH), based on survival rate estimates, is turbine passage. You state that a bypass system is cost prohibitive and would not improve fish passage survival rates greater than turbine passage. The U.S. Fish and Wildlife Service (FWS) commented that an evaluation of the reasons for mortality in the fish bypass pipe or improvements to pipe survivability should be explored. Article 401 and the approved testing plan required that if you did not adopt a recommendation, your filing with the Commission must include your reasons for rejecting the recommendation, based on project specific information.

In your filing, you discuss the issues with possible improvements to the fish passage pipe noting that any enhancements, such as creating a smooth pipe by slip-lining, would entail significant costs with no guarantee that it would be successful. Installation would be required with additional costs in order to determine its effectiveness. The estimated costs of such an improvement was determined by your consultant to be in the

[1] 121 FERC ¶ 62,126 (issued November 20, 2007)

range of $750 K to $1.5 M. Further, this also has the possible effect of jeopardizing the existing passage for adult blueback herring, American eel, and resident species. Finally, you state that this type of installation would be a new and untested application of materials with unknown costs. Your filing explored the installation of a new trashrack system designed to direct juvenile JBBH towards the bypass. A new system would entail significant costs and incur additional maintenance and operational costs associated with debris due to smaller trashrack openings. In addition, modifications to the discharge pipe as well as effectiveness studies also would be necessary.

In your desktop study of JBBH survival through the project versus passage over Cohoes Falls, it was determined that survival through the units (75%) was greater than over the falls (63%). You note that peak migration often occurs during high flow events whereby most emigrating JBBH follow spill towards and over the falls. This was evident in several years of study in which the majority of emigrating JBBH did not enter the power canal.

The agencies did not agree with this conclusion by letters dated March 29, 2018 and June 20, 2018. Further, in its September 5, 2019 letter, the FWS agreed that testing was complete and that no additional testing was needed; however, they determined that the existing fishway was not effective at passing JBBH downstream and that an alternative means of passing JBBH is required. The FWS notes that while JBBH may be a non-native species introduced to the river by means of the NYS canal and lock system, they are managed as a key component of the ecosystem by the New York Department of Environmental Conservation (New York DEC). In addition, you note that the existing bypass system is successful in passing resident fish, American eel and Adult BBH, and that any modifications may have unintended consequences for these species while not assuring successful downstream passage of JBBH. According to your report, you believe that you have met the requirements of Article 401 and the obligations set forth in the approved fish bypass effectiveness plan.

We agree that the installation and testing of the downstream passage facility at the project meets the aforementioned requirements and further testing or exploration of additional alternatives is not recommended. The potential cost and unknown benefits of alternative measures outweigh the benefits of any possible additional passage. We agree that the present configuration of the existing downstream facility, passage through the units and over Cohoes Falls, provide an adequate means for successfully passing JBBH downstream of the project. The location and configuration of the School Street Project, with respect to its power canal and the 65-foot Cohoes Falls, provides additional complications for providing downstream passage. These factors and that the fact that JBBH are a non-native species, the uncertainty of any significantly improved efficiency with a slip-lined pipe, plus the substantial cost associated with the reconfigured downstream passage facilities advance our conclusion.

Thank you for your report and cooperation. Your report meets the requirements of license Article 401. If you have any questions, please contact Mr. Joseph Enrico at (212) 273-5917 or email at *joseph.enrico@ferc.gov* .

Sincerely,

Thomas J. Lovullo
Chief, Aquatic Resources Branch
Div. of Hydropower
Administration and Compliance

Brookfield
Renewable

MEMORANDUM

To: Danny Maguire and Jason Zehr, Brookfield
From: Bryan Apell, Kleinschmidt Associates
Date of memo: May 22, 2020

Re: 05/19/2020 School Street Downstream JBBH Passage Improvement Alternatives Meeting Minutes

Project #: 0826181.01

Introduction

The Federal Energy Regulatory Commission (FERC) issued a new license to the School Street Hydroelectric Project (Project) (FERC No. 2539) owned and operated by Brookfield Renewable (Brookfield) on February 15, 2007 that required downstream fish passage for diadromous and resident fishes. In September 2007, a Final Plan was developed to investigate the fishway effectiveness and included requirements for testing downstream passage survival of resident fish, American Eel, juvenile and adult Blueback Herring, and passage efficiency of juvenile and adult Blueback Herring.

Brookfield completed its Fishway Effectiveness evaluation as described in the Final Plan and fulfilled its compliance obligations. The resource agencies, U.S. Fish and Wildlife Service (USFWS) and New York State Department of Environmental Conservation (NYSDEC), concurred that the Fishway Effectiveness evaluation was completed via letter dated July 20, 2016. However, they concluded that the downstream bypass was ineffective at safely passing juvenile Blueback Herring (JBBH) at the Project.

Brookfield has maintained an open dialog regarding downstream passage of JBBH with the resources agencies and several potential solutions have been discussed. The USFWS, in a letter dated September 5, 2019, requested Brookfield evaluate downstream passage alternatives to improve the effectiveness at the Project. Kleinschmidt Associates was retained to assess potential improvement alternatives and associated estimate the costs. On March 3, 2020, FERC issued a letter acknowledging that Brookfield has met its obligations as set forth in 2007 Final Plan. A meeting was hosted by Brookfield via Teams on May 19, 2020, to present potential options for improvement to downstream massage and associated discussions. The following meeting minutes summarizes the meeting discussions. A copy of the presentation is in Attachment A.

Meeting Attendees

Steve Patch and Jesus Morales from USFWS,
Nicole Cain and Chris Van Maaren of NYDEC,
Jason Zehr, Danny Maguire, Michael Sutton and Owen Hooper of Brookfield
Bryan Apell (Senior Fisheries Ecologist), Keith Martin (Senior Fish Passage Engineer) and Karen Bishop of Kleinschmidt Associates

Brookfield
Renewable

<u>5/19/2020 Meeting (Teams) Summary:</u>

Bryan Apell began the call, at approximately 10:00, with a summary of the downstream passage studies that had been conducted at the Project including evaluations of adult American Eel, adult and juvenile Blueback Herring and resident fishes. The subject of the call was to discuss alternatives to improve passage success of JBBH. Six alternatives were presented and discussed as listed below:

1. JBBH Density monitoring (hydroacoustic) coupled with decreased generation
2. Turbine Passage with a change of unit sequencing
3. Empirical studies of survival through the bypass reach
4. Fish guidance boom and plunge pool discharging to the bypass reach
5. Hydroacoustic barrier and plunge pool discharging to the bypass reach
6. Punch plate overlay on existing bar rack with improvement to discharge pipe

The Kleinschmidt team described each alternative including the benefits and short comes of each and their associated estimated cost. During the discussion of Alternative 1, monitoring JBBH density, Steve Patch asked how Kleinschmidt came up with the $1M price. Bryan Apell explained there would be an initial cost of ~ $300k for deployment, in addition to the loss of revenue annually that was estimated at ~$426K which could be highly variable. While discussing Alternative 2, Turbine passage, Bryan asked how the USFWS came up with the 90% survival rate over the dam and if the 70-foot drop over Cohoes Falls was considered. Steve Patch responded by saying this was calculated assuming there would be a plunge pool constructed. There were no direct comments on Alternative 3, the Bypass Reach Survival Study, but there seemed to be agreement that this alternative to better understand passage survival at the Project would be difficult to accomplish and potentially dangerous given the site-specific conditions and the presence of Cohoes Falls in the Project bypass reach.

Keith Martin discussed the Alternatives 4 through 6. While discussing Alternative 4, the Guidance Boom, Jesus Morales asked if this would be put in seasonally. Keith Martin stated that it would function seasonally but could possibly stay in year-round depending on ice and debris loads. Alternative 5, is a similar approach as the guidance boom, but uses ultrasonic sound to create a guidance barrier rather than a boom. Jesus Morales asked about the variability of success using acoustic method and if a literature review was done. Keith Martin stated this method was considered because it was being used upstream at the Crescent Project but was not sure if any of that data was publicly available. He stated that the Crescent Project had success with some sizes of fish, then added more arrays and after which the agencies deemed it adequate. Nicole Cain stated that Crescent Project and Fisheries Ferry data is available on the FERC E-Library. Keith Martin added an additional comment stating that both the Guidance Boom and Ultrasonic barriers are basically equivalent in price ($2.5M to $3M) with the range in cost due to unknowns.

There was discussion regarding Alternative 6, the bar rack and pipe modifications. Jesus Morales asked if there was any analysis done on the reduction of velocity and changes of depths pertaining to this specific system. Keith Martin responded by saying the change of velocity was not specifically calculated but that the change in depth was self-evident. He stated any pipe less than 12-inch diameter will have a full pipe flow. Full pipe flow implies pressurized flow, but attempts would be made to match the hydraulic grade line so as to minimize any pressure changes. Keith Martin also added that this method would reduce turbulence. Jesus Morales asked if the pipe would clog with debris. Keith Martin said a rack would need to be created at the bypass entrance to reduce debris from entering the pipe. Jesus Morales then asked if there was an acceleration weir, in which Keith Martin stated no, and the use of one would require closing off the lower bypass entrances which were designed for eel passage.

Jesus Morales asked if there was any video monitoring of the JBBH approaching the rack and what their behavior was. Bryan Apell answered no, there is no video data but observations of JBBH at School Street have been made over the years. JBBH have been seen on the downstream side of the angled bar rack after passing through. They have also been observed and recorded via video and acoustic camera in the fish bypass separation chamber where they school just upstream of the weir before relenting, eventually going backwards into the bypass discharge pool and pipe. Jesus Morales commented that on other projects, JBBH have been seen avoiding rapid accelerations of water and suggested a uniform acceleration weir be placed in.

This transitioned into the next section of discussion of suggesting potential alternatives. Jesus Morales expressed concerns about the “ski jump” at the bottom of the bypass discharge pipe, stating he believed it could be creating hydraulic hammering on the fish and may be a source of injury. Keith Martin responded that the slip lining of the pipe was designed to address those concerns by keeping the pipe full and have a coherent water flow. He also stated that the bend is primarily used to direct the fish around a corner and deliver them to the tailrace. Keith Martin noted that this curved section of pipe was built to be modified if necessary.

Bryan Apell and Nicole Cain then discussed how these modifications were for JBBH, but that other species use these passages as well, including; adult American Eel, Lamprey, adult Herring and resident fishes. She asked if any of these changes would reduce the use of the downstream bypass for these other species, in which Bryan Apell responded with a yes, these modifications could have an impact.

Steve Patch brought up the FERC letter dated March 20, 2020, which states that Brookfield has met their obligations for providing downstream passage. Danny Maguire stated that although Brookfield has met the obligations, Brookfield would like to continue to work with the agencies (USFWS, NYDEC) to improve downstream passage for JBBH but ultimately the plan needs to make sense financially and environmentally. Danny Maguire stated he did not want to reduce the successes already accomplished with the passage of the other migratory species and resident species.

Steve Patch then asked about attracting more JBBH into the downstream bypass and not focusing on just survivability. Jesus Morales mentions the acceleration weir again, in which Keith Martin responded that it could only function if it was controlled seasonally and that it would require closing the lower level outlets. Bryan Apell pointed out this would impact the eel migrations, which coincide with JBBH emigrations.

Nicole Cain asked if we could rank the methods based on cost, impact on operations, and the least negative impact on the current successes while also increasing JBBH migration. Bryan Apell suggested that the Guidance Boom would be the best biological solution but at significant cost with many construction unknowns. Danny Maguire asked, if Brookfield decided on the boom method, if the 1-inch racks could be removed or reduce the amount of time the rack would be deployed. Jesus Morales brought up that eels would not be redirected by the Guidance Boom due to migrating close to the riverbed floor and that removing the 1-inch racks would likely cause entrainment of the eels.

Danny Maguire states that Brookfield's preferred alternative was for turbine passage and offered that operational changes such as unit sequencing may improve survival. The current unit sequencing entices American Eels and other species to the downstream bypass but altering the sequence such that Unit 2 was first on last off rather than Unit 1 because the desktop entrainment analysis showed that the characteristics of Unit 2 resulted in the highest probability of survival. Steve Patch suggested the units change sequencing when a high density of JBBH are seen and proposed communications with the other hydroelectric dams around School Street. Changing the unit sequencing during the day and night to attempt to accommodate both American Eels and JBBH was also suggested.

Steve Patch stated that currently no structural changes seem to make sense biologically or financially and that operational changes seem to be the best option. He requested that Bryan Apell and Danny Maguire develop a unit sequencing methodology that would work best for both American Eels and JBBH.

The meeting (Team Call) adjourned at Noon.

Memorandum

To: Jason Zehr, Compliance Specialist, Brookfield

From: Bryan Apell, Project Manager, Kleinschmidt

Date: November 20, 2020

Re: Fish Passage Options

In response to the U.S. Fish and Wildlife Service (USFWS or Service) comments in its letter dated May 27, 2020 (Attachment 1) regarding the fish passage compliance compilation for the School Street Hydroelectric Project (FERC No. 2539), Brookfield has revised the document to incorporate the recommendations by the USFWS and explored alternative sequencing of unit operation to provide the safest route of passage through the station for Juvenile Blue Back Herring (JBBH) by preferentially operating the most fish friendly unit during the JBBH downstream migration periods (Item No. 1). This memorandum also contemplates the operational modifications to the fishway for eels as JBBH have competing seasonal and temporal interests (Item No. 1). Lastly, the Service's fishway engineer also made some suggestions for modifications to the fishway that may improve JBBH attraction and improve passage survival. These measures include the construction of a uniform acceleration weir (UAW) and the elimination of the "ski jump" at the end of the pipe (Item No. 2).

Background

The 2007 license issued to the School Street Hydroelectric Project by the Federal Energy Regulatory Commission (FERC) required effectiveness testing of the fishway for a variety of fish species, including adult Blueback Herring (ABBH), JBBH, American Eel, and non-anadromous resident species. Testing began in 2009, and the average survival rates for each species were 82% (ABBH), 43.3% (JBBH), 100% (American Eel) and 93% (resident fishes). JBBH passage survival estimates through the downstream bypass were low. Further, difficulties including lack of test specimens, high control mortalities, and early migration due to high flow events prohibited reliable route of passage results. In January 2018, Brookfield submitted a report entitled *Desktop Evaluation of Entrainment and Downstream Passage Survival of Juvenile Blueback Herring,* to evaluate survival of JBBH passing through the turbines as compared to passing over the falls.

The report concluded that the best overall route of passage based on survival rates is passage of JBBH through the turbines, a conclusion that the resource agencies did not concur with. However, the analysis also revealed that the potential for mortality due to blade strike probability varied amongst the 5 units. Units are currently operated in order of preference in the following sequence: Unit 1-2-3-4-5, where Unit 1 is brought online first and last to be shut down. The preferential sequencing of units at the Station is based on proximity to the downstream bypass. Unit 1 is operated as "first on last off" to provide flow characteristics that are believed to entice fishes to the bypass entrance. However, empirical studies at the Station have shown that JBBH are much more likely to be entrained than use the bypass and the current unit operation sequence is less protective of JBBH and other alternatives.

Item No. 1

The desktop entrainment evaluation concluded that Unit 3 is most protective of JBBH as it exhibits the lowest probability of strike (0.008), while Unit 1 exhibits the highest probability of strike (0.206). The preferred unit sequencing based on probability of strike (lowest to highest) should be Unit 3-5-2-4-1. However, Unit 5 has a higher hydraulic capacity when compared to the other units and is often unfeasible to run during the relatively low flow period that coincides with the seasonal JBBH emigration. As such, to balance project operational limitations with JBBH passage survival a unit sequencing of Unit 3-2-4-5-1 is proposed. This approach prioritizes the unit with the lowest probability of strike and therefore the highest survival (Unit 3) to be *fist on last off* and the unit with the highest probability of strike and lowest survival (Unit 1) to be *last on first off*. This proposed operational modification would reduce the likelihood of blade strikes by preferentially operating a safer unit that will be more protective of entrained JBBH emigrating downstream through the Project.

Table 1. Probability of blade strike by unit at the School Street Project based on results of desktop entrainment evaluation

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
Probability of Strike	0.206	0.031	0.008	0.031	0.009

Emigration of young-of-year JBBH past the School Street Project typically occurs during early fall (September and October). This timeframe coincides with the pre-spawning adult eel (silver phase) downstream migration toward marine spawning grounds. There was concern that modifications to unit sequencing would affect the hydraulics near the fish bypass entrances that could reduce attraction and ultimately the effectiveness of the downstream fishway for eels. As the average test survival rate for downstream eel through the Project was 100%, it is unlikely that the unit sequencing would change the survival rate. In addition, the full-depth, 1-inch spacing on the trash racks in combination with the concrete eel weir along the bottom of the racks serve as a physical exclusion barrier known to be effective for most downstream migrating silver phase eel at hydroelectric facilities[1]. As such, emigrating eel are not likely to be at risk of entrainment but may exhibit a longer degree of delay when locating the downstream bypass, although to what degree, if any, is unknown.

Changes in daily operation have been suggested as a potential option to maximize the effectiveness of the downstream bypass for both species. In addition to the shared seasonality of emigration by these two species, they share daily temporal trends in which peak migration generally occurs in the late afternoon and evenings. Studies conducted at the Turners Falls Hydroelectric Facility, located on the Connecticut River in Massachusetts, showed that juvenile American Shad (related Clupeid to the JBBH) exhibited peak migration in the evenings between

[1] Amaral, S., T. Melong, P. Mathisen, D. Giza, and P. Jacobson. 2014. Evaluation of Bar Rack Spacing and Approach Velocity for Preventing Entrainment of Silver American Eels at Hydropower Projects. American Fisheries Society 144th Annual Meeting. August 2014.

15:00 and 23:00 hr[2]. Other work conducted on the Connecticut River at the Holyoke Hydroelectric Station showed similar evening and nighttime migrations of silver phase eel. Given the similarities in seasonal and daily migration patterns for both species, daily operational changes are unlikely to improve passage survival of both species. However, prioritization of Unit 3 seasonally between August 15 through October should promote survival of entrained JBBH. This approach may have some impact on the duration of delay experienced by migrating eel but given the current protective structures employed at the Project is not expected to affect survival of eel.

Item No. 2

A uniform acceleration weir (UAW) is a surface entrance specifically designed to accelerate water at a more constant rate by incorporating a general funnel shape which slopes up from the bottom and in from the sides. UAWs are designed for a specific flow and as such, the head across the funnel shape must be finely controlled.

At the School Street downstream passage facility, the two sets of surface entrances and low-level orifices discharge into a common conduit, such that they are not hydraulically isolated from each other. Flow at each entrance is adjusted to carefully balancing invert/open area to achieve the same head differential/loss at each weir/orifice. Incorporating a properly designed UAW at one or more of the surface entrances would likely preclude the operation of other entrances at the detriment to eel passage which relies on the lower level orifices to access downstream passage and is therefore not recommended.

The 'ski jump' at the end of the discharge pipe (see attached Sheet FB-17) is a curved elbow meant to direct the fish laterally into the tailrace rather than discharge fish onto a rocky ledge which lies parallel with the powerhouse wall on which the discharge pipe is attached. The sloped discharge pipe has a vertical elbow at the end to allow for a horizontal discharge. The lateral elbow is downstream of the vertical elbow. These two elbows are connected by a bolted flange which could be rotated, although we don't expect that rotating the discharge elbow would improve the discharge characteristics. Two modifications which might improve the discharge are a cone reducer and a compound curve.

The intent of a cone reducer would be to decrease the existing 24" pipe diameter down to about 10" and thereby increase the depth of flow in the pipe, resulting in a more coherent discharge of water exiting the pipe rather than a spray (more laminar, less separation). This change in diameter would need to be a gentle transition such as a 20-foot-long slender cone to prevent a hydraulic jump inside the pipe.

The intent of a compound curve is to redirect water in a single three-dimensional curve rather than change direction twice through two elbows oriented in two distinct planes. This could reduce 'sloshing' which may contribute to the spray-like shape of the discharge. This would require removing the two elbows and replacing the lower pipe section and supports. If pipe diameter is

[2] Kleinschmidt. 2016. Evaluation of Downstream Passage of Juvenile American Shad. Prepared for FirstLight Power Resource Services.

small enough, the pipe could be rolled into a smooth curve, rather than fabricate a curve from welded pie-shaped wedges, further reducing turbulence.

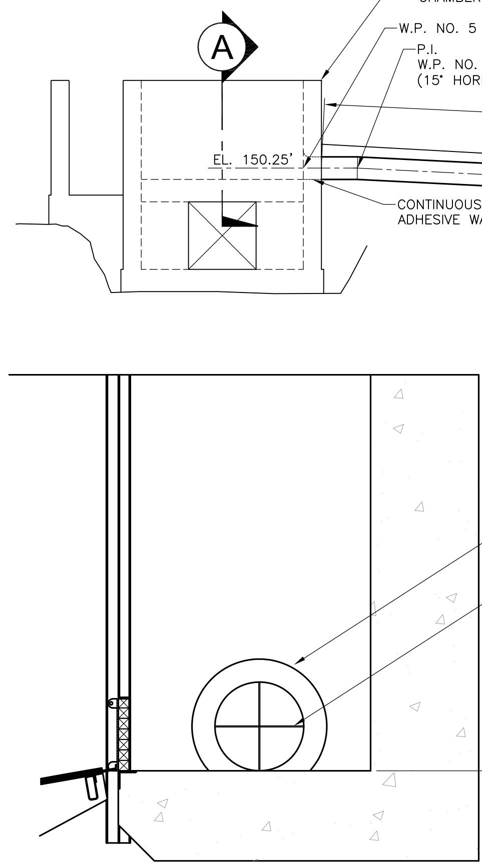
Replacing the lower section of the discharge pipe as described could cost on the order of $100,000 to $200,000. The largest share of this cost and its uncertainty is the result of the difficulty in accessing the work area. This would require a temporary staging area at the base of the cliff, and either barge-mounted equipment, or large cranes reaching over the cliff, or a combination of both. The degree to which these potential engineered changes may improve passage survival is unknown.

Please feel free to contact me if you have any questions or wish to discuss this further.

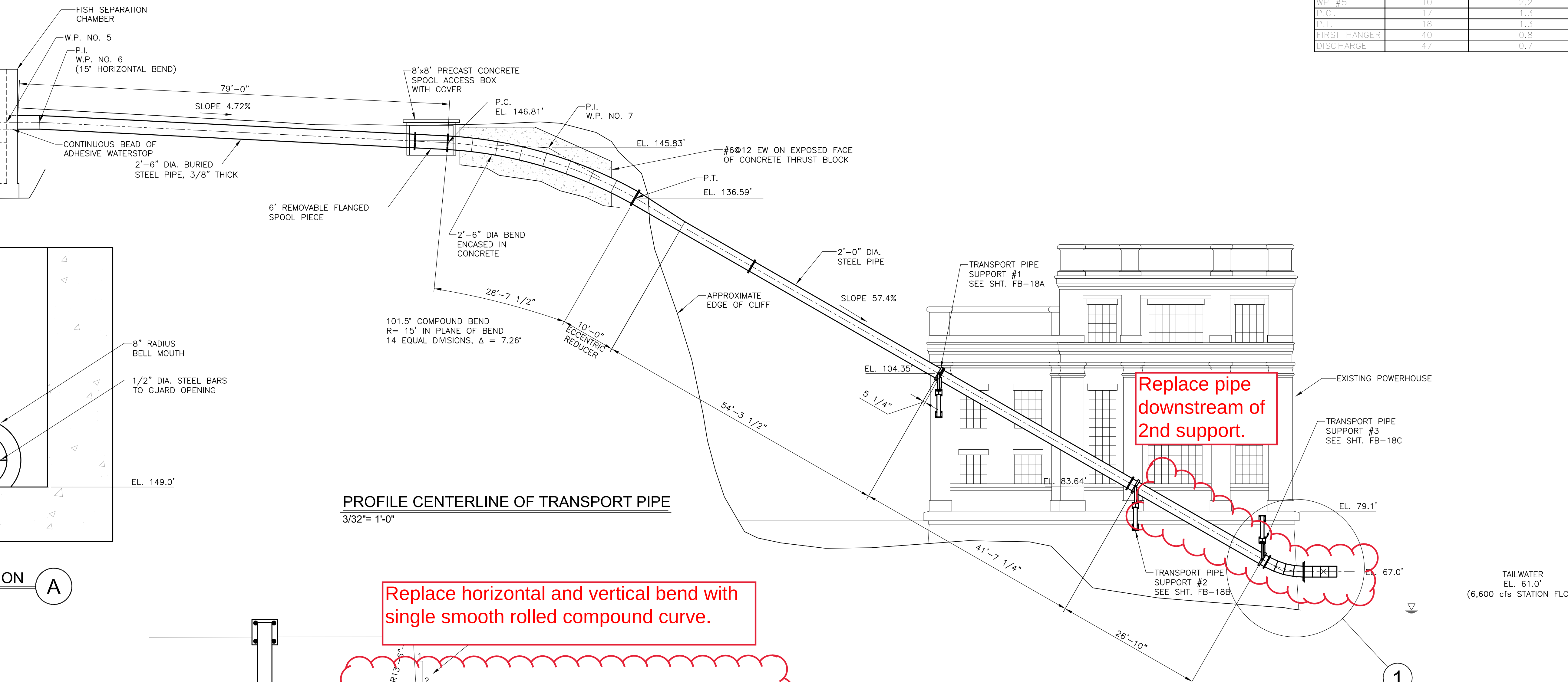
Thank you,

Bryan Apell
Senior Project Manager
Fisheries and Aquatic Ecologist

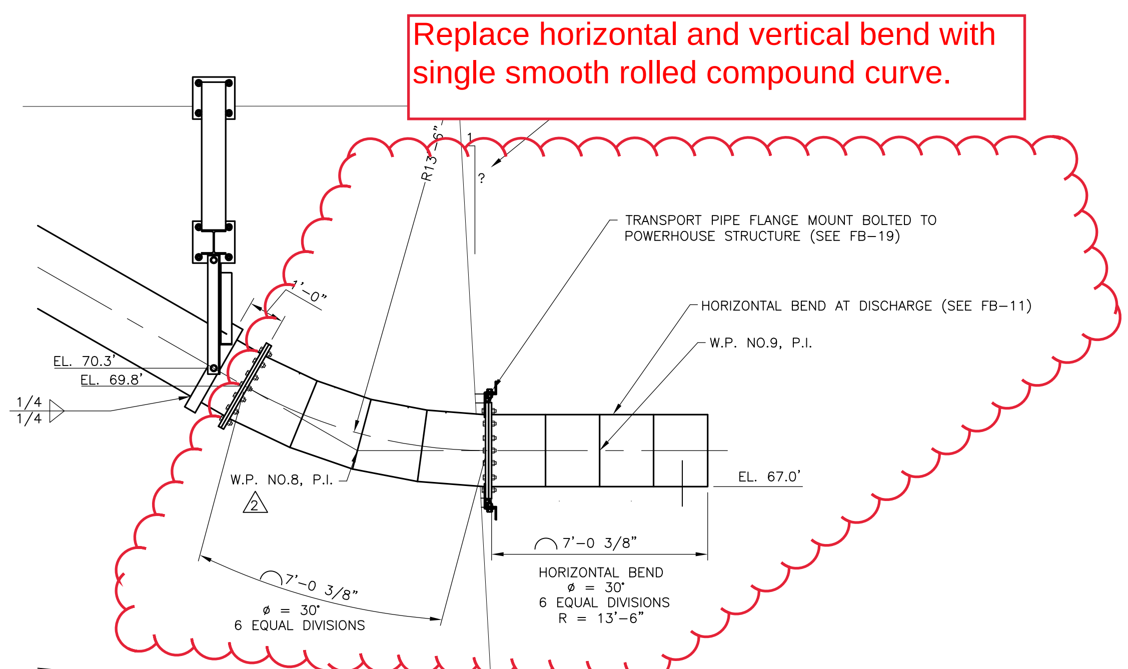
LOCATION	VELOCITY (fps)	DEPTH OF FLOW (ft)
WP #5	10	2.2
P.C.	17	1.3
P.T.	18	1.3
FIRST HANGER	40	0.8
DISCHARGE	47	0.7



SECTION A
3/8"= 1'-0"



PROFILE CENTERLINE OF TRANSPORT PIPE
3/32"= 1'-0"



DETAIL 1
3/8"= 1'-0"

NOTES:
1. SEE FB-11 FOR PLAN VIEW
2. SEE FB-6 FOR NAPPE PROFILE
3. SEE FB-16 FOR WORK POINT LOCATION TABLE

RECORD DRAWING NOTE:
CONCRETE HEADWALL PLACED AT THE DOWNSTREAM END OF THE 2'-0" DIA. FISH BYPASS PIPE ELBOW. DETAILS UNKNOWN.

RECORD DRAWING
THIS DRAWING REPRESENTS THE BEST INFORMATION AVAILABLE TO THE ENGINEER UPON COMPLETION OF THE WORK.
KLEINSCHMIDT ASSOCIATES
CONSULTING ENGINEERS
DATE: 7/7/10 BY: Leslie L Cower, P.E.

No.	Revision	Date
4	REVISED SUPPORT #1	12-15-08
3	REVISED PIPE SUPPORTS	8-15-08
2	GENERAL REVISIONS	5-30-08
	AGENCY REVIEW	4-25-08
	AGENCY REVIEW	4-11-08
1	GENERAL REVISIONS	4-1-08
0	RELEASED FOR CONSTRUCTION	2-15-08
A	ISSUED FOR CLIENT REVIEW	1-25-08
	RECORD DRAWING	7-7-10

Scale: AS SHOWN
Project No: 826-082
AutoCad Release: 2007
Filename: 826-082 SHT FB17.dwg
Design By: KAM
Drawn By: RDL
Checked By: LLC
Date Revised: 12-15-08

ERIE BOULEVARD HYDROPOWER L.P.
BROOKFIELD POWER NEW YORK

SCHOOL STREET SETTLEMENT UPGRADES
COHOES, NY

FISH TRANSPORT PIPE
PROFILE AND DETAILS

Kleinschmidt
Energy & Water Resource Consultants
141 Main Street P.O. Box 650
Pittsfield, Maine 04967
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Fax: (207) 487-3124
www.KleinschmidtUSA.com

FB-17

J:\826\082\Drawings\Record Drawings 7-7-10\826-082 SHT FB17.dwg

United States Department of the Interior

FISH AND WILDLIFE SERVICE
3817 Luker Road
Cortland, New York 13045

December 16, 2020

Jason Zehr, Compliance Specialist
Brookfield Renewable Energy Group
399 Big Bay Rd.
Queensbury, NY 12804

RE: School Street Hydroelectric Project (FERC #2539)
Unit Sequencing for Fish Passage

Dear Mr. Zehr:

The U.S. Fish and Wildlife Service (Service) has reviewed Brookfield's November 23, 2020, correspondence regarding the proposed alteration to unit sequencing at the School Street Project, located on the Mohawk River in Albany and Saratoga Counties, New York. The alterations to the unit sequencing are intended to improve downstream passage effectiveness for juvenile Blueback Herring (*Alosa aestivalis*). The Service concurs with the proposed sequencing.

Brookfield also provided us with an updated version of the *School Street Fish Passage Compliance Compilation* (Compilation). The Compilation adequately addresses the concerns previously expressed by the Service.

Brookfield also examined potential modifications to the fish passage pipe recommended by the Service. Brookfield determined that these modifications would be logistically difficult, expensive, and unlikely to substantially improve fish passage. We have consulted with our Fish Passage Engineering Division and they concur that the modifications are not needed.

We appreciate the opportunity to review Brookfield's correspondence. If you have any questions or desire additional information, please contact Steve Patch at 607-753-9334 or stephen_patch@fws.gov.

Sincerely,

David A. Stilwell
Field Supervisor

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