

Exhibit 33

May 12, 2016

VIA ELECTRONIC FILING

Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

**Re: Conowingo Hydroelectric Project, FERC Project No. 405
Offer of Settlement and Explanatory Statement**

Dear Secretary Bose:

Pursuant to Rule 602 of the Rules of Practice and Procedure of the Federal Energy Regulatory Commission (“FERC” or “Commission”),¹ Exelon Generation Company, LLC (“Exelon”) hereby files its Offer of Settlement and Explanatory Statement for the relicensing of the Conowingo Hydroelectric Project (“Conowingo”).

As set forth in the Explanatory Statement, the Offer of Settlement settles all remaining issues between Exelon and the U.S. Department of the Interior regarding the appropriate terms of the fishway prescription for Conowingo, satisfies all Federal statutory and regulatory requirements, and is in the public interest.² Further, the Offer of Settlement is supported by substantial evidence in the record, as required under Section 313(b) of the Federal Power Act.³

By copy of this letter, all participants are hereby notified, in accordance with Rule 602(f),⁴ that comments on the Offer of Settlement must be filed on or before June 1, 2016. Reply comments must be filed on or before June 13, 2016.

Please do not hesitate to contact the undersigned if you have questions or require additional information regarding this matter.

¹ 18 C.F.R. § 385.602 (2015).

² See *Policy Statement on Hydropower Licensing Settlements*, Docket No. PL06-5-000, PP 3-5 (2006).

³ 16 U.S.C. 8251(b) (2015).

⁴ 18 C.F.R. § 385.602(f) (2015).

Respectfully submitted,

/s/ Jay Ryan

Jay Ryan

Marcia Hook

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The Warner

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Counsel to Exelon Generation Company, LLC

cc: Emily Carter (FERC)
Official Service List for Docket No. P-405

**UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION**

Exelon Generation Company, LLC)
)
) **Docket No. P-405-106**

**CONOWINGO HYDROELECTRIC PROJECT RELICENSING
OFFER OF SETTLEMENT AND EXPLANATORY STATEMENT**

Pursuant to Rule 602 of the Rules of Practice and Procedure of the Federal Energy Regulatory Commission (“FERC” or “Commission”),¹ Exelon Generation Company, LLC (“Exelon”), owner and operator of the Conowingo Hydroelectric Project (“Conowingo” or “Project”) hereby submits this Offer of Settlement and Explanatory Statement addressing the Settlement Agreement (“Settlement Agreement”) executed between Exelon and the U.S. Department of the Interior, Fish and Wildlife Service (“Interior”). A copy of the Settlement Agreement is provided as Attachment 1.

The Settlement Agreement resolves issues between Exelon and Interior regarding the appropriate terms of the fishway prescription for Conowingo, satisfies all Federal statutory and regulatory requirements, and is in the public interest. Moreover, the Settlement Agreement is supported by substantial evidence, including 32 relicensing studies and the Final Environmental Impact Statement issued in the above-captioned docket. Accordingly, Exelon respectfully requests that the Commission: (1) approve the Offer of Settlement; and (2) issue a new 50-year license for Conowingo that incorporates, without modification or expansion, the terms and conditions of the Settlement Agreement.

¹ 18 C.F.R. § 385.602 (2015).

OFFER OF SETTLEMENT

I. BACKGROUND

Exelon formally initiated the relicensing process for Conowingo with the filing of a Notice of Intent and Pre-Application Document (“PAD”) on March 12, 2009.² In the PAD, Exelon indicated that it would use the Integrated Licensing Process (“ILP”) to relicense Conowingo. Since that time, Exelon has engaged in extensive stakeholder outreach with state and Federal resource agencies, non-governmental organizations, local municipalities, recreational users, and other individuals with an interest in the Project. As part of the ILP, Exelon conducted 32 resource studies for Conowingo. Information gained from these studies and stakeholder input informed the Final License Application (“FLA”) for Conowingo and the terms and conditions of the Settlement Agreement.³

Throughout the relicensing process, Exelon and Interior actively engaged in discussions regarding a number of fish passage issues. The Settlement Agreement contained in this Offer of Settlement represents the formal resolution of all issues between Exelon and Interior pertaining to the fishway prescription for Conowingo.

The terms of the Settlement Agreement will provide measurable and immediate benefits to the American eel, river herring, and American shad populations of the Susquehanna River, and will ensure that any future impediments to fish passage will be addressed through the implementation of additional mitigation and enhancement measures. The terms of the Settlement Agreement also carefully balance resource issues with the need to maintain a low-cost and reliable source of clean power. Consequently,

² Pre-Application Document for the Conowingo Hydroelectric Project, Docket No. P-405 (filed Mar. 12, 2009).

³ Exelon Generation Company, LLC’s Final License Application for the Conowingo Hydroelectric Project and Request for Waiver of the Requirement to Include a Draft Biological Assessment, Docket No. P-405-106 (filed Aug. 30, 2012).

Exelon believes that the public interest will best be served if the Commission approves the Offer of Settlement as filed.

II. EXPLANATORY STATEMENT

A. LICENSING COMMITMENTS

The Settlement Agreement provides for the settlement of all pending issues between Exelon and Interior pertaining to the fishway prescription for Conowingo. By the terms of the Settlement Agreement, Exelon and Interior agree that Interior will file a modified prescription for fishways in a form identical to the modified prescription provided as Exhibit A to the Settlement Agreement (“Modified Prescription”).⁴

1. Fish Passage Facilities

Exelon currently operates two fish lifts at Conowingo. The West Fish Lift, adjacent to the right dam abutment, was completed in 1972 and originally operated as part of a trap and transport facility. The East Fish Lift, located near the mid-point of the Conowingo Dam, was constructed in 1991 to allow for direct passage of fish to Conowingo Pond and interim trap and transport operations until upstream fish passage facilities were constructed at the remaining upstream dams. The trap and transport program was terminated once construction of the fish passage facility at York Haven was completed in 2000. The West Fish Lift currently operates for specific experiments conducted for resource agencies (*e.g.*, induced spawning, transport to specific tributaries). The East Fish Lift operates solely as a tailwater to headpond fish lift.

⁴ Pursuant to the terms of the Settlement Agreement, Exelon has reserved its right to file comments on the Decision Document supporting Interior’s Modified Prescription.

Under the Modified Prescription, Exelon will implement substantial improvements to the existing fish passage facilities within three years of license issuance (“Initial Construction Items”). The Initial Construction Items include:

- Modifying the East Fish Lift to provide 900 cubic feet per second (“cfs”) of attraction flow.
- Replacing the current 3,300-gallon hopper at the East Fish Lift with two 6,500-gallon hoppers.
- Reducing cycle time at each hopper at the East Fish Lift to be able to lift fish four times per hour.
- Completing modifications to the East Fish Lift structure to allow for trapping and sorting fish at the East Fish Lift facility and transporting them to the western side of the dam to a truck for transport upstream.
- Modifying the West Fish Lift to facilitate trap and transport.
- Constructing and maintaining structures, implementing measures, and/or operating the Project to provide American shad and river herring a zone of passage to the fish passage facilities.
- Evaluating potential trapping locations for American eel on the east side of Conowingo Dam including Octoraro Creek starting in May of the first calendar year after license issuance or immediately if license issuance occurs during the upstream American eel migration period.

In addition to these Initial Construction Items, Exelon will commence trap and transport of American shad and river herring from Conowingo to above the York Haven Hydroelectric Project beginning the first fish passage season after license issuance.⁵ Exelon also has committed to trap and transport American eels at the west side of Conowingo Dam.

Five years after issuance of the new license, Exelon will commence a three-year “Initial Efficiency Test” of fish passage at the Project. The Initial Efficiency Test will

⁵ Exelon has agreed to annually trap and transport up to 80 percent of the run, up to a maximum of 100,000 fish for each species.

measure the passage efficiency of the improved facilities. If the facilities achieve an 85 percent upstream passage efficiency for adult American shad,⁶ Exelon will continue to operate the facilities without further modification. Exelon will then conduct two-year “Periodic Efficiency Tests” every five years to ensure that the Project maintains an upstream passage efficiency of 85 percent for adult American shad throughout the term of the new license.

If the Project does not achieve an upstream passage efficiency of 85 percent after the Initial Efficiency Test or any Periodic Efficiency Test, Exelon will be required to implement measures to improve passage efficiency at the Project. Exelon and Interior have agreed on a tiered list of potential measures, which are designed to address fish passage impediments associated with attraction flow and capacity limitations. The degree of the shortfall from the 85 percent passage efficiency target determines the scope of the additional mitigation and enhancement measures that will be required.⁷ As set forth in the Modified Prescription, these additional mitigation measures range from the implementation of preferential turbine operating schemes to the construction of a new West Fish Lift.

In the first fish passage season after Exelon implements any measure or measures to improve passage effectiveness, Exelon will commence a three-year Post-Modification Efficiency Test. The Post-Modification Efficiency Test will measure the passage efficiency of the improved facilities. If the Project achieves an upstream passage efficiency of 85 percent for American shad, Exelon will continue to operate the facilities

⁶ Pursuant to section 12.7.2.1 of the Modified Prescription, Exelon receives credit toward achieving the upstream passage target efficiency of 85 percent as a result of its trap and truck operations.

⁷ For example, if Conowingo achieves an Adjusted Efficiency of 65 percent and Interior determines that the shortfall stems from an issue with attraction efficiency, Exelon will implement one of the improvements in Section 12.6.2.2 (“Improving Attraction Efficiency - Tier II (*Adjusted Efficiency* 55%-69%)”).

without modification and will return to conducting two-year Periodic Efficiency Tests every five years. Again, if any Periodic Efficiency Test demonstrates that the Project is not achieving an 85 percent passage efficiency, Exelon will implement a measure or measure(s) from the tiered list of options, to be followed by a Post-Modification Efficiency Test. This cycle of testing and modifying, as necessary, will continue throughout the term of the license.

As a result of the agreed-upon tiered structure of future mitigation measures, the cost of the measures contained in the Modified Prescription range from \$155 to \$339 million.

2. Fishway Operation and Maintenance Plan

In addition to the improvements described above, Exelon will develop and implement a Fishway Operation and Maintenance Plan (“FOMP”) that will provide extensive information about the operations of Conowingo’s fish passage facilities.

The FOMP will be submitted to Interior, FERC, and the resource agencies (State of Maryland and Commonwealth of Pennsylvania, Susquehanna River Basin Commission, and National Marine Fisheries Service) for review and approval, and will include the following information:

- Schedules for routine maintenance, pre-season testing, and the procedures for routine fishway operations, including seasonal and daily periods of operation, and associated dam and powerhouse operational measures needed for proper fishway operation;
- Details of how the Project shall be operated during the migration season to provide for adequate fish passage conditions, including:
 - pre-season preparation and testing;
 - sequence of turbine start-up and operation under various flow regimes to enhance fishway operation and effectiveness;

- debris management at the fishway entrance, guidance channels, and the exit;
- plant operations to provide near- and far-field attraction flows required for the fishway zone of passage in the tailrace;
- Trap and transport logistics plan and design plans for west and east fish lift modifications needed for trap and transport, including provisions for planning trap and transport logistics so as to avoid, to the extent possible, trapping a population unrepresentative of the migrating population as a whole.
- Trap and transport logistics plan for American eel;
- Standard operating procedures for monitoring and enumerating fish passage by species, including the American eel passage facilities;
- Standard operating procedures for collecting biological samples from target species to assess restoration efforts;
- Standard operating procedures for monitoring and reporting operations that affect fish passage;
- Standard operating procedures in case of emergencies and Project outages to first, avoid, and second, minimize, potential negative impacts on fishway operations and the effectiveness of upstream and downstream passage for target species; and
- Plans for post season maintenance, protection, and winterizing the fish lifts and eel passage facilities.

By December 31 of each year, Exelon will submit an annual report to Interior, FERC, and the resource agencies detailing the implementation of the FOMP and operational data for both fishways and the Project. This data will allow the parties to examine correlations between particular operational patterns and successful or unsuccessful fishway operation, and to confirm, once an operational regime with known effectiveness is settled upon, that the Project continues to operate under that regime.

In addition to the annual report, Exelon will record data for daily flows, water quality, project operations, fishway operations, and fish passage in a database during the

fish passage season. Interior will be provided open access to the database. Data will be entered into the database no later than one week after collection.

3. Fishway Effectiveness Monitoring Plan

In addition to the Initial Efficiency Test and Periodic Efficiency Tests described above, the Modified Prescription includes downstream American eel effectiveness monitoring, upstream American eel effectiveness testing, and downstream adult and juvenile American shad and river herring effectiveness testing. The plans for all the studies described in the Modified Prescription will be contained in the Fishway Effectiveness Monitoring Plan (“FEMP”)—a document Exelon will develop in consultation with Interior, and which is subject to approval by Interior and FERC.

In any year that Exelon is conducting a study, it will submit a yearly interim study report to Interior and FERC following the conclusion of the study year. The interim and final reports for upstream passage studies will be submitted to Interior by December 31st of each study year. The interim and final reports for downstream passage studies will be submitted to Interior by August 1 following each study year. The final study report will include results for each life stage and type of study conducted with a determination of Exelon’s success or failure in achieving the passage efficiency criteria set forth in the Modified Prescription. In conjunction with submitting the final study report(s), Exelon also will provide Interior electronic copies of all data collected from the studies.

Further, Exelon agrees to meet with Interior and the Susquehanna River Anadromous Fish Restoration Cooperative (“SRAFRC”) to discuss the FEMP and FOMP. This meeting will occur no later than January 31 each year unless Exelon and Interior agree on a different date. At this annual meeting Exelon will discuss with Interior and SRAFRC the fish passage results from the previous year, review regulatory

requirements for fish lift and eel passage operations, and discuss any upcoming modification or testing Exelon proposes for the upcoming fish passage season.

Exelon has agreed to operate the Project to achieve a downstream survival efficiency of at least 80 percent of the adult and 95 percent of the juvenile American shad and river herring moving downstream past the Project. Exelon also has agreed to operate the Project to achieve a downstream survival efficiency criterion of at least 85 percent of the adult American eel moving downstream past the Project. If the results of the downstream studies indicate that the Project is not achieving these efficiency criteria, Interior may exercise its reservation of authority to address the issue.

B. EXELON'S PRE-LICENSING COMMITMENTS

Exelon and Interior also have agreed to five other provisions—Sections 3.1 through 3.5 of the Settlement Agreement—that memorialize Exelon's commitment to undertake certain activities prior to the issuance of a new license⁸ to ensure that the Initial Construction Items will timely commence upon license issuance.

Specifically, Section 3.1 of the Settlement Agreement provides that, by December 31, 2017, Exelon will develop a detailed logistics plan and operating protocol for trap and transport of American shad and river herring from the East Fish Lift and the West Fish Lift at Conowingo. The logistics plan will address near-term operations, as well as the logistics necessary to support the transport of up to 100,000 American shad and 100,000 river herring. Under Section 3.2, Exelon commits to develop detailed computational fluid dynamics models of the zones of passage to the East Fish Lift and West Fish Lift to assess the ability of fish to reach both lifts. Exelon will develop these models by

⁸ Given the schedule for completing ongoing work associated with Exelon's application for a water quality certification from the Maryland Department of the Environment, Exelon anticipates that FERC could issue a new license for Conowingo in 2018.

December 31, 2017. Section 3.3 of the Settlement Agreement requires that Exelon develop its initial FOMP by September 30, 2017. Exelon also commits, in Section 3.4, to finalize design plans for the Initial Construction Items by December 31, 2018. Finally, in Section 3.5 of the Settlement Agreement, Exelon has committed to implement a 900 cfs attraction flow at the East Fish Lift by 2021 if a new license is not issued by December 31, 2018. Exelon will file with FERC copies of all final plans provided to Interior as a result of these pre-licensing settlement commitments.⁹

III. REQUEST FOR A 50-YEAR LICENSE TERM

In recognition of the substantial investment Exelon has committed to make during the term of the new license, Interior and Exelon support the issuance of a new license for the Project for a term of 50 years.¹⁰

It is well-established that the Commission will grant a fifty-year license “for projects with proposed extensive redevelopment, new construction, new capacity, or mitigative and enhancement measures.”¹¹ Under the Settlement Agreement with Interior, Exelon has proposed that extensive mitigative and enhancement measures be incorporated into the new license for Conowingo. These measures, discussed above, will have a total nominal cost ranging from \$155 to \$339 million over the term of the license depending on which measures are required and when those measures are implemented. Given the substantial investment that Exelon has committed to make during the new license term, the proposed license conditions represent extensive mitigative and enhancement measures that warrant a 50-year license term.

⁹ Exelon and Interior do not believe it is necessary to amend Exelon’s current license to incorporate these pre-licensing commitments. *See* 18 C.F.R. § 4.200.

¹⁰ Section 2.0 of the Settlement Agreement states that “The Parties agree that FERC should grant Exelon a New License for a term of 50 years because of the substantial investment Exelon will make during the new license.”

¹¹ *Mead Corporation*, 72 FERC ¶ 61,027, at p. 61,077 (1995).

IV. CONCLUSION

This Offer of Settlement represents the successful culmination of years of negotiations between Exelon and Interior. The provisions of the Settlement Agreement were carefully crafted to ensure that Exelon would meet or exceed its regulatory obligations under the Federal Power Act, while providing additional substantial benefits to the Susquehanna River. The result is an Offer of Settlement that will help preserve and restore Susquehanna River resources. Accordingly, implementation of the measures contained in the Settlement Agreement is in the public interest.

For the foregoing reasons, Exelon respectfully requests that the Commission determine that the Offer of Settlement is in the public interest, accept the Offer of Settlement without modification or condition, and incorporate the provisions contained in the Modified Prescription into a new 50-year license for Conowingo.

Respectfully submitted,

/s/ Jay Ryan

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Counsel for Exelon Generation Company, LLC

Dated: May 12, 2016

Attachment 1

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Exelon Generation Co., LLC
Project No. 405

CONOWINGO HYDROELECTRIC PROJECT
SETTLEMENT AGREEMENT

April 21, 2016

This agreement (the “Settlement Agreement”), effective as of the date of the last signature affixed hereto (the “Effective Date”), is made and entered into by and between Exelon Generation Company, LLC (“Exelon” or “Licensee”) and the United States Department of the Interior (“Department”) Fish & Wildlife Service (“USFWS”) (each, a “Party” and collectively, the “Parties”). This Settlement Agreement relates to the Conowingo Hydroelectric Project (“Project”), which is the subject of an ongoing relicensing proceeding before the Federal Energy Regulatory Commission (“FERC” or “Commission”) for a new license (“New License”).

1.0 GENERAL TERMS

1.1 Term of the Settlement Agreement

This Settlement Agreement shall remain in effect, in accordance with its terms, throughout the term of the New License, including any annual licenses thereafter.

1.2 Purpose and Goals

The purpose of this Settlement Agreement is to resolve among the Parties their disagreements over the appropriate terms of a Prescription for Fishways, and other related matters, to be included in the New License for the Project (“Prescription”) pursuant to section 18 of the Federal Power Act (16 U.S.C. § 811), and to document certain other agreements between the Parties concerning fish passage at the Project not appropriate for inclusion in the Prescription.

The goal of this Settlement Agreement is to establish mutually acceptable terms concerning passage of fish past the Project.

1.3 Parties to Support Regulatory Approvals

The Parties agree to support the issuance of a New License by FERC that is consistent with the terms of this Settlement Agreement. For those issues addressed herein, the Parties agree not to propose or otherwise communicate any comments, certification, or license conditions inconsistent with, or additive to, the terms of this Settlement Agreement to FERC or any other Federal or state resource agency with jurisdiction over fish passage at the Project. Notwithstanding the above, this Settlement Agreement shall not be interpreted to restrict: (i) Parties' participation in, or comments on, issues not addressed herein; (ii) Parties' participation in any future relicensing proceeding related to the Project; and (iii) Licensee's ability to file comments on sections of the Department's Decision Document and Modified Prescription ("Modified Prescription"), including the design populations for American shad and river herring, other than the Fish Passage Requirements in Attachment A.

1.4 Successors and Assigns

This Settlement Agreement shall be binding upon and shall inure to the benefit of the Parties hereto and their respective successors and assigns.

1.5 Agency Appropriations

Nothing in this Settlement Agreement shall be construed as: (i) obligating any Federal, state, or local government to expend in any fiscal year any sum in excess of appropriations made by Congress, state legislatures, or local governing body, or administratively allocated for the purpose of this Settlement Agreement for the fiscal year; or (ii) involving the Department or its Bureaus in any contract or obligation for the future expenditure of money in excess of such appropriations or allocations.

1.6 Establishes No Precedents

This Settlement Agreement is made with the express understanding that it constitutes a negotiated resolution of issues specific to the Project. Accordingly, nothing in this Settlement Agreement will be construed as a legal precedent that may be cited by the Parties to FERC or any court or administrative hearing process with regard to any other proceeding. This Section 1.6 shall survive any termination of this Settlement Agreement. Any Party withdrawing from this Settlement Agreement pursuant to Section 1.10 will continue to be bound by this Section 1.6.

1.7 Filing of Settlement Agreement

The Parties agree that within 21 days of the Effective Date, the Licensee shall file this Settlement Agreement with the Commission pursuant to 18 C.F.R. § 85.602.

1.8 Withdrawal of Trial-Type Hearing request

Within 7 days of the Effective Date, Exelon shall withdraw its Request for Trial-Type Hearing, filed with the Department September 11, 2015.

1.9 Filing of Modified Prescription

Within 30 days of the Effective Date, the Department shall file a modified prescription for fishways, as provided by 43 C.F.R. § 45.72, containing the operative terms agreed to herein and attached hereto as Exhibit A (“Modified Prescription”).

1.10 Withdrawal Rights

No Party may withdraw from this Settlement Agreement without the prior written consent of the other Parties, which consent may be withheld in another Party’s sole discretion; provided, however, a Party may unilaterally withdraw from this Settlement Agreement if: (i) FERC issues a New License and the New License contains conditions which are materially inconsistent with the terms of this Settlement Agreement as

reflected in Attachment A, FERC issues a New License and the New License contains fish passage conditions that are materially additive to the terms of the Settlement Agreement, or MDE issues a water quality certification that contains fish passage conditions that are materially additive to, or materially inconsistent with, the terms of the Settlement Agreement; and (ii) the New License is not thereafter satisfactorily modified as a result of the filing of a request for rehearing as provided in Section 1.11 or the water quality certification issued by MDE is not thereafter satisfactorily modified after administrative and judicial appeals are pursued by Licensee. A Party withdrawing from this Settlement Agreement shall provide twenty (20) days' prior written notice, which notice shall include a written explanation of the reasons for withdrawing from this Settlement Agreement. In the event that a Party withdraws from this Settlement Agreement pursuant to this Section 1.10, this Settlement Agreement shall thereafter be null and void, and any Party may take the position that this Settlement Agreement is not available to support FERC's public interest determination.

1.11 Rehearing and Judicial Review

The Parties agree not to file a request with FERC for rehearing of the New License concerning matters addressed in this Settlement Agreement unless: (i) the New License contains conditions which are materially inconsistent with the terms of this Settlement Agreement; or (ii) the New License contains fish passage conditions that are materially additive to the terms of the Settlement Agreement. Notwithstanding the above, Exelon shall maintain its right to seek rehearing of the New License if the New License term is less than 50 years. In the event a Party decides to file a request for rehearing in accordance with the terms of this provision, it will provide the other Parties

written notice of its intention to file a request for rehearing at the earliest practicable time. Any Party, following the issuance of a FERC Order on Rehearing, may elect to file a petition for judicial review with respect to the matters covered by this provision.

1.12 Counterparts

This Settlement Agreement may be executed in any number of counterparts, all of which taken together shall constitute one and the same instrument.

2.0 AGREEMENT ON THE TERM OF THE NEW LICENSE

The Parties agree that FERC should grant Exelon a New License for a term of 50 years because of the substantial investment Exelon will make during the New License.

3.0 MISCELLANEOUS PROVISIONS

3.1 Trap and Transport Logistics Plan and Operating Protocol

By December 31, 2017, Exelon will develop a detailed logistics plan and operating protocol for trap and transport of American shad from both the East Fish Lift and the West Fish Lift at Conowingo. The logistics plan will address near-term operations, as well as the logistics necessary to support the transport of up to 100,000 American shad and 100,000 river herring.

3.2 Computational Fluid Dynamics

By December 31, 2017, Exelon will develop, in consultation with the USFWS, detailed computational fluid dynamics models of the zones of passage to the East Fish Lift and West Fish Lift.

3.3 Fish Passage Operation and Maintenance Plan

Exelon will develop and submit to the USFWS its initial Fishway Operation and Maintenance Plan by September 30, 2017.

3.4 Design Plans

By December 31, 2018, Exelon will finalize design plans for the Initial Construction Items, as that term is defined in section 12.6.1 of the Modified Prescription.

3.5 Letter to FERC

Within 10 days of the Effective Date, the USFWS shall file with FERC in Docket P-405-116 a letter: (i) informing FERC that issues regarding attraction flows at the East Fish Lift have been addressed by the Settlement Agreement; and (ii) withdrawing its January 21, 2016 request that Exelon modify the East Fish Lift to support a 900 cubic feet per second (“cfs”) attraction flow prior to the issuance of the New License. However, if the New License is not issued by the end of 2018, Exelon agrees to provide a 900 cfs attraction flow by 2021.

ACKNOWLEDGED AND AGREED TO:

DEPARTMENT OF THE INTERIOR

By: 

Name: Wendi Weber

Title: Regional Director, Region 5

Date: April 1, 2016

EXELON GENERATION COMPANY, LLC

By: Victoria K. Hall

Name: Vicky Will

Title: Vice President, Operations Support

Date: April 21, 2016

ATTACHMENT A

MODIFIED PRESCRIPTION FISH PASSAGE REQUIREMENTS AND RELATED LICENSEE COMMITMENTS

12. Modified Prescription for Fishways

12.1 Design Criteria

12.1.1 Design Populations

12.1.1.1 American Shad

The goal for this fishway prescription is to ultimately be able to pass up to 5 million American shad annually in order to maintain self-sustaining populations of 2 million American shad annually migrating to and reproducing in the Susquehanna River upstream of York Haven Dam and in suitable tributaries.

12.1.1.2 River Herring

The goal for this fishway prescription is to ultimately be able to pass up to 12 million river herring annually in order to maintain self-sustaining populations of 5 million river herring annually migrating to and reproducing in the Susquehanna River upstream of York Haven Dam and in suitable tributaries.

12.1.1.3 American Eel

The Licensee shall construct, operate, and maintain fishway(s) at Conowingo Dam sufficient to pass upstream migrating eels that arrive to the Project into the mainstem of the Susquehanna River upstream of York Haven Dam.

12.1.2 Design Capacity

Capacity is determined by a given weight of fish transferred over a given period of time. Capacity calculations take into consideration all species of fish using a fish passage facility; e.g., fish lift(s), and their corresponding weights, and proportional availability.

12.1.2.1 Initial Capacity

Considering that American shad passage efficiency has been measured to be as low as 25 percent (Exelon 2012d, p. 26), and the Project has passed an average of 1.1 million gizzard shad per season from 2012 - 2014 (SRAFRC 2013a, p. 7; Normandeau Associates 2013, p. 3; Normandeau Associates 2014b, p. 3), the Service estimates that as many as 4.4 million gizzard shad could potentially be in the tailrace annually attempting to move upstream. Based on the

estimated biomass of gizzard shad attempting to pass upstream at the current time (4.4 million gizzard shad = 5.3 million pounds of fish) as well as allowing additional capacity for growth of American shad and river herring populations, the Service estimates a fish lift biomass capacity of at least 7 million pounds of fish per season needs to be provided immediately after license issuance. Two 6,500-gallon hoppers sharing the same holding pool, with a cycle time of 15 minutes, provides capacity to move 7 million pounds of fish in a single season (assuming a peak day run of 5 percent of the seasonal run, a peak hour run of 15 percent of the peak day and hopper minimum water volume of 0.1 cubic feet per pound of fish). Based on projected numbers of a successful American shad restoration using the population model, a fish lift capacity of 7 million pounds of fish should provide safe passage at the Conowingo Project for approximately half of a fifty (50) year license term (assuming that the gizzard shad population does not grow larger than 4.4 million fish). For details on calculating fish lift capacity, refer to Appendix A.

12.1.2.2 Final Potential Capacity

The Service anticipates that restored populations of American shad and river herring may require passage capacity for up to 5 million American shad and 12 million river herring as well as other species at the Project. American shad and river herring would require 26 million pounds of hopper capacity in addition to the potential 5 million pounds that may be required by riverine species. However, the fishway prescription does not require construction of sufficient capacity to pass this number immediately; rather, capacity is added only as populations grow enough to impede efficiency in the event that fishway capacity becomes a bottleneck to future population growth. This fishway prescription incorporates a fish passage efficiency target and measures to assess fish passage efficiency throughout the term of the license in order to test for future conditions that would require corrective actions contained in this prescription. This fishway prescription includes measures providing for an ultimate fishway capacity of up to 18 million pounds per season (four 6,500-gallon hoppers with separate holding pools). The Department recognizes the potential lack of capacity for this current fishway prescription during the later years of American shad and river herring restoration, and may exercise its reservation of authority to address this issue at a later date if fishway capacity appears to be a limiting factor to population restoration, as reflected in declining upstream fish passage efficiency due to lack of fishway capacity.

12.1.3 Design Flows

The Licensee shall design new fishway(s) to ensure operation under river flows in the range of 6,330 cfs to 143,000 cfs. However, the Licensee shall not be required to operate the fishway(s) at flows greater than 113,000 cfs unless data available at the time demonstrates that operation of fishways at flows greater than 113,000 cfs is necessary to achieve the target efficiency. Furthermore, the fishways shall be designed with sufficient freeboard (or other protection) to minimize damage from river flows of up to the 50-year return interval.

12.2 Efficiency Criteria

The Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC 2010, 2013) and the Service (USFWS 2015b) have established upstream and downstream passage efficiency criteria for the Susquehanna River basin that are the basis for this Prescription for Fishways. The Service defines upstream fish passage efficiency as the proportion of the fish in the Project tailwaters that successfully move through the fishway and continue upstream migrations, calculated as a percentage. Downstream fish passage efficiency is the proportion of the fish that approach the upstream side of the Project and survive unharmed as they pass the Project and continue downstream migrations. Definitions for fish passage terms used in this document are provided in Section 14. Where no numeric efficiency criteria were set, the Service's goal is to minimize Project impacts to migratory fish populations, with a goal of 100 percent passage and the understanding that no project is likely to fully achieve that goal despite application of the best available technology. Where the Service has information or modeling indicating that restoration may be achieved with less than 100 percent passage, the Service has been able to adopt numeric targets that will achieve restoration, and measures to reach those targets.

12.2.1 Criteria for Upstream American Shad Passage Efficiency¹

The Licensee shall operate the Project to achieve the upstream passage efficiency criterion of passing 85 percent of all adult American shad that enter the Project tailwaters ("Target

¹ FWS has agreed to meet with the Licensee in 2043 if the upstream hydroelectric projects are not meeting their target passage efficiencies consistently by then, to discuss the passage efficiency criterion for American shad at the Conowingo project based on then available data. The Service may consider adjusting the passage efficiency criterion at that time.

Efficiency”). The tailwaters of the project are defined as extending to the downstream tip of Rowland Island.

The Licensee can receive additional credit toward achieving the upstream passage efficiency criterion for adult American shad by trapping at Conowingo and transporting American shad to upstream of York Haven Dam and thus avoiding upstream passage impediments at the intervening hydroelectric projects on the Susquehanna River (see Section 12.7.2.1).

12.2.2 Criteria for Downstream American Shad Passage Efficiency

The Licensee shall operate the Project to achieve the downstream survival efficiency criterion of at least 80 percent of the adult American shad moving downstream past the Project.

The Licensee shall operate the Project to achieve the downstream survival efficiency criterion of at least 95 percent of the juvenile American shad moving downstream past the Project.

12.2.3 Criteria for Upstream River Herring Passage Efficiency

In accordance with sections 12.5 and 12.6, the Licensee shall operate the Project to minimize the impact of the Project on upstream migration for adult river herring that approach the Project tailwaters.

Numerical criteria for upstream river herring passage efficiency may be developed in the future when additional information about Susquehanna River herring populations becomes available. Any needed change in fishway requirements resulting from such new targets is not provided for in this Prescription, and would be the subject of independent administrative processes.

12.2.4 Criteria for Downstream River Herring Passage Efficiency

The Licensee shall operate the Project to achieve the downstream survival efficiency criterion of at least 80 percent of the adult river herring moving downstream past the Project.

The Licensee shall operate the Project to achieve the downstream survival efficiency criterion of at least 95 percent of the juvenile river herring moving downstream past the Project.

12.2.5 Criteria for Upstream American Eel Passage Efficiency

The Licensee shall operate the Project to minimize the impact of the Project on upstream migration for juvenile American eel that approach the Project tailwaters.

Numerical criteria for upstream American eel passage efficiency may be developed in the future when additional information about the Susquehanna River American eel population becomes available. Any needed change in fishway requirements resulting from such new targets is not provided for in this Prescription, and would be the subject of independent administrative processes.

12.2.6 Criteria for Downstream American Eel Passage Efficiency

The Licensee shall operate the Project to achieve the downstream survival efficiency criterion of at least 85 percent of the adult (i.e., silver) American eel moving downstream past the Project.

12.3 Seasonal Implementation of Fish Passage

The Licensee shall operate a fishway for upstream passage of anadromous fish daily during the American shad and river herring upstream *Migration Period* (Table 9). The Licensee shall operate the fish lift(s) daily during the upstream *Migration Period*, and begin releasing attraction flows at least one hour prior to the start of daily lift operations. The fish lift(s) will operate at the following times during the *Migration Period*: (1) in March, from 7 a.m. to 7 p.m.; (2) in April, from 6:30 a.m. to 7.30 p.m.; and (3) in May and June from 6:00 a.m. to 8:00 p.m.

The Licensee shall provide attraction flow and operate fish passage facilities for continuous upstream American eel passage (i.e. 24 hours per day) during the entire upstream *Migration Period* (Table 9).

The Licensee shall ensure prior to the start of the *Migration Periods* that all mechanical elements of the fishway(s) are working properly. The Licensee shall repair, maintain, and test fishway(s) as necessary in advance of the migration period, in accordance with the *Fishway Operation and Maintenance Plan* (FOMP) so as to begin operations when required. The Licensee shall

maintain and operate fishways to maximize fish passage effectiveness throughout the upstream and downstream *Migration Periods* (Table 9).

Table 9. Upstream and downstream *Migration Periods* for species covered in this Modified Prescription for Fishways.

Species	Upstream Migration Period¹	Downstream Migration Period¹
American shad	Starting when river temperature reaches 50 ° F, until river temperatures rise above 72 ° F for four consecutive days, but ending no earlier than June 1, and no later than June 15 ²	July 1 through November 15 (juv.) May 1 through July 1, as long as river temperature is above 65 ° F ² (adult)
Alewife and blueback herring	Starting when river temperature reaches 48 ° F for three consecutive days and no earlier than March 1, until river temperatures rise above 72 ° F for four consecutive days, but ending no earlier than June 1, and no later than June 15 ^{2,3,4}	June 15 through October 14 (juv.) April 15 through July 1 (adult)
American eel	May 1 through September 15 ⁵	September 15–February 15, whenever river temperature is above 37 ° F for 4 consecutive days ^{2,6}

¹ Subject to notice and comment, any of these migration periods may be changed during the term of the license by the Department, based on new information, and in consultation with the other fishery agencies and the Licensee. At any time during the new license term, Licensee may submit new information to the Department in support of a request to change the migration periods. In the event the Department seeks to require downstream passage by means other than through the units, the downstream migration periods automatically will be reviewed jointly by the Department, other fishery agencies, and the Licensee.

² Water temperatures shall be monitored once daily at 11 a.m. at Monitoring Station 643 (Shure's Landing) or some other location agreed upon by the Licensee and the Service.

³ This migration period is based on alewife migration timing from other tributaries to the Chesapeake Bay (Sutherland 2000, p. 9; Eyler et al. 2002, p. 59; Slacum et al. 2003, p. 13).

⁴ The Service recognizes that, because of factors outside of the Licensee's control, safety considerations may preclude the Licensee's personnel from performing duties necessary to commence fish passage measures at Conowingo by the commencement date. When such conditions arise, the Licensee shall notify the Service and the Service and the Licensee shall consult regarding the anticipated schedule for commencing such measures.

⁵ This initial operational period is based on preliminary data on American eel migration at Conowingo Dam (Minkinen and Park 2014, Figure 4).

⁶ This initial operational period is based on preliminary data on American eel migration timing from other tributaries to the Chesapeake Bay (Eyler 2014, pp. 44-46). Results from the "Downstream American Eel Effectiveness Monitoring" (Section 12.7.5) shall be used to further refine this migration period.

12.4 Fishway Operation and Maintenance Plan

The Licensee shall develop and submit a Fishway Operation and Maintenance Plan (FOMP) to the Service, FERC, and resource agencies (states of Maryland and Pennsylvania, Susquehanna River Basin Commission, and National Marine Fisheries Service) for review and approval by the Service. The Licensee shall keep the FOMP updated on an annual basis, to reflect any changes in fishway operation and maintenance planned for the year. If the Service requests a modification of the FOMP, the Licensee shall respond to the requested modification within 30 days of the request by filing a written response with the Service and serving a copy of the response on FERC and the resource agencies.² Any modifications to the FOMP by the Licensee shall require approval by the Service and, if necessary, FERC prior to implementation.

The FOMP shall include:

- Schedules for routine maintenance, pre-season testing, and the procedures for routine fishway operations, including seasonal and daily periods of operation, and associated dam and powerhouse operational measures needed for proper fishway operation;
- Details of how the Project shall be operated during the migration season to provide for adequate fish passage conditions, including:
 - pre-season preparation and testing;

² Requested modifications to the FOMP will not include changes to turbine operations. Any modifications to turbine operations shall be implemented only pursuant to Section 12.5.4.

- sequence of turbine start-up and operation under various flow regimes to enhance fishway operation and effectiveness;
- debris management at the fishway entrance, guidance channels, and the exit;
- plant operations to provide near- and far-field attraction flows required for the fishway zone of passage in the tailrace;
- Trap and transport logistics plan and design plans for west and east fish lift modifications needed for trap and transport, including provisions for planning trap and transport logistics so as to avoid, to the extent possible, trapping a population unrepresentative of the migrating population as a whole.
- Trap and transport logistics plan for American eel;³
- Standard operating procedures for monitoring and enumerating fish passage by species, including the American eel passage facilities;
- Standard operating procedures for collecting biological samples from target species to assess restoration efforts;
- Standard operating procedures for monitoring and reporting operations that affect fish passage;
- Standard operating procedures in case of emergencies and Project outages to first, avoid, and second, minimize, potential negative impacts on fishway operations and the effectiveness of upstream and downstream passage for target species; and
- Plans for post-season maintenance, protection, and winterizing the fish lifts and eel passage facilities.

The Licensee shall provide written documentation to the Service, FERC, and resource agencies that all fishway operational personnel have reviewed and understand the FOMP and it shall be signed by the operations manager of the Project. Copies of the approved FOMP and any modifications shall be provided to the Service, FERC, and resource agencies on an annual basis.

By December 31 of each year, the Licensee shall provide an annual report to the Service, FERC, and resource agencies detailing: the implementation of the FOMP, including any deviations from

³ The Licensee can incorporate by reference American eel plans and logistics developed pursuant to the Eel Passage Advisory Group.

the FOMP and a process to prevent those deviations in the future; any proposed modifications to the FOMP, or in the case of emergencies or project outages, the steps taken by the Licensee to minimize adverse effects on fisheries including any proposed modifications to those steps to further enhance their effectiveness in the future; and operational data for both fishways and the Project to allow the Parties to examine correlations between particular operational patterns and successful or unsuccessful fishway operation, and to confirm, once an operational regime with known effectiveness is settled upon, that the Project continues to operate under that regime. The Service understands that details of operation constitute confidential business information, and agrees to protect them from disclosure as such to the extent it is able to do so by law.

The annual report shall also include:

- Description of routine maintenance as well as repairs made to the fishways or eel passage facilities during the previous fish passage season;
- Average daily flows at the Marietta gauging station;
- Daily water temperature and dissolved oxygen readings⁴ in the fish lift and tailwater areas;
- Hourly individual turbine unit operations and discharge, hourly total discharge from the powerhouse, hourly discharge over the spillway, and hourly passage counts of all fish species at each hopper;
- Daily counts of American eel collected at each facility;
- Thirty-minute recordings of total flow discharging from behind the hopper, total flow discharging from the attraction water supply diffuser, water surface elevation immediately upstream from the entrance gates, water surface elevation at the tailwaters, elevation to the crest of the entrance weir gates, and any irregularities such as the identification of a visible boil in the zone over the floor diffusers;
- Number of fish by species trapped and transported, including date, time, and location of release;

⁴ The Licensee shall provide dissolved oxygen readings, commencing each year when the Project's NPDES permit requires annual data collection to begin, through the end of the upstream migration period.

- Weekly collection of a subsample of biological information from passing adult American shad and river herring consisting of sex ratio, spawning condition, length, weight, and age.

In addition to the annual report, the data for daily flows, water quality, project operations, fishway operations and fish passage as described above shall be recorded in a database during the fish passage season and the Service shall be provided open access to that database. Data shall be entered into the database no later than one week after collection.

These data shall be used to assess impacts of river conditions and hydropower operations on successful fish passage through the lifts, with the goal of achieving a better diagnosis of potential fish passage issues at the Project. The operational data will not provide the Service with an independent basis to require modifications and improvements beyond those that may be implemented through the process described below.

By January 31 of each year, the Licensee shall meet with the Service and the Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRFC) to discuss the FOMP (and FEMP – See Section 12.7.1). This meeting shall occur no later than January 31 of each year unless the Licensee and the resource agencies agree on a different date. At this annual meeting the Licensee shall discuss with the Service and SRAFRFC the fish passage results from the previous year, review regulatory requirements for fish lift and eel passage operations, and discuss any upcoming modification or testing the Licensee shall conduct during the upcoming season.

12.5 Sequencing of Upstream Fish Passage Construction and Implementation

Timely construction, operation, and maintenance of fishways is necessary to ensure their effectiveness and to achieve restoration goals. Therefore, the Licensee shall (1) notify, and (2) obtain approval from the Service and FERC for any extension of time to comply with conditions the Department prescribes.

12.5.1 Trap and Transport of American Shad and River Herring

The Licensee has agreed to and will trap and transport American shad and river herring to areas upstream of York Haven Dam annually. The number of American shad and river herring trapped

and transported annually will be up to 80 percent of the number of each species captured in the fish lifts up to a maximum of 100,000 of each species annually. Trap and transport operations shall continue until the Licensee can achieve a measured 85 percent upstream passage efficiency for American shad at the Project without reliance on the trap and truck credit provided for in Section 12.7.2.1.

12.5.2 Initial Construction

Unless otherwise stated, the Licensee shall implement the items defined in Section 12.6.1 “*Initial Construction Items*” within 3 years following license issuance. Construction shall be conducted in a way as to allow for trap and transport operations as well as volitional passage at the EFL to continue uninterrupted during this time period.

12.5.3 Operation in the First Passage Season after License Issuance

Within 1 year of license issuance, trap and transport operations from the EFL and WFL shall begin. A total of 80 percent of the run, up to 100,000 American shad and 100,000 river herring per year shall be trapped and transported to the mainstem Susquehanna River upstream of York Haven.

12.5.4 Efficiency Testing and Triggering of Subsequent Modifications

In the 5th year after license issuance, the Licensee shall begin the “*Initial Efficiency Test*” of fish passage at the Project. The Licensee shall conduct the *Initial Efficiency Test* as defined in Section 12.7.2 in order to evaluate passage performance relative to upstream efficiency criteria for American shad and river herring as described in Section 12.2. In the 5th year after license issuance, the Licensee shall also assess mortality of American shad during the trap and transport process.

If at the end of the *Initial Efficiency Test*, the combined results of the three-year study (the combination of measured efficiency of the *Initial Efficiency Test* and the *Trap and Transport Credit* resulting in an *Adjusted Efficiency*) meet the *Target Efficiency* of 85 percent for upstream passage of American shad, the Licensee shall operate the Project using the FOMP implemented during the *Initial Efficiency Test*. The Licensee shall then conduct a two-year “*Periodic*

Efficiency Test” as defined in Section 12.7.2 in every 5th year thereafter to ensure that the upstream-prescribed efficiency criterion continues to be met through the term of the license.⁵

If at the end of the *Initial Efficiency Test* or after any *Periodic Efficiency Test* thereafter during the license term, or after any subsequent “*Post-Modification Efficiency Test*” as defined in Section 12.7.2, the study results indicate that the Licensee is not meeting the required *Adjusted Efficiency*, the Licensee shall conduct an evaluation of the radio telemetry data and any other data available to the Service and/or the Licensee to determine if the passage inadequacy is related to fishway attraction or fish lift capacity. Concurrent with the submission of the final report from an efficiency study, the Licensee shall propose a course of action most likely to achieve the *Target Efficiency*. Both the Service and the Licensee have agreed on a tiered list of options and the types of either attraction or capacity problems which the tiers may address. If the reason for not achieving the *Target Efficiency* is insufficient fishway attraction, then the Licensee shall follow the actions in Section 12.6.2. If the reason for not achieving the *Target Efficiency* is lack of fish lift capacity, then the Licensee shall follow the actions in Section 12.6.3. In the event that both fishway attraction and fish lift capacity are limiting factors to achieving the *Target Efficiency*, the Licensee shall address items listed under both sections 12.6.2 and 12.6.3, but only to the extent both attraction and capacity measures are necessary to achieve the required *Target Efficiency*. The list of measures in sections 12.6.2 and 12.6.3 is not exclusive and does not preclude either party from identifying and proposing other measures commensurate with the required level of improvement and corresponding tier. The Service shall react to the Licensee’s proposal for improving fish passage efficiency within 90 days of receipt. It may:

- A. Say nothing, in which case the Licensee shall proceed with its proposed course of action;
- B. Agree affirmatively with the Licensee’s proposed course of action, in which case the Licensee shall proceed;
- C. Propose a different option, not on the tiered list of options, which the Licensee shall proceed with if it agrees;
- D. Require, instead, that the Licensee implement an option or options from the appropriate (or lower numbered) tier to address each problem. The Service will choose that option(s)

⁵ At the Licensee’s election, and with Service concurrence, the Periodic Efficiency Test may be extended an additional 1 year. Only after the efficiency tests are completed will the Licensee be required to propose, as may be necessary, a course of action to achieve the Target Efficiency.

it deems most likely to achieve the *Target Efficiency*. The Service may select an option from a higher-numbered tier only if all options from an appropriate or lower-numbered tier have been implemented. If two or more options appear equally likely to achieve the efficiency criterion, the Service will present the Licensee with the choice, and the Licensee may proceed with whichever it prefers. The Service shall explain, in writing, its reasons for finding that its choice(s) is more likely than the Licensee's to lead to the desired passage efficiency. The Licensee shall then proceed with the selected course of action.

12.5.5 General construction requirements.

All functional (i.e., 30 percent, 60 percent, and 90 percent) and final design plans, operation and maintenance plans, construction schedules, and hydraulic model studies for the new fishways or modifications to existing fishways described herein shall be developed in consultation with the Service and submitted to the Service and FERC for approval. The planning and design process for structures shall generally include CFD modeling prior to construction and post-construction shakedown and testing to confirm modeling.

12.6 Fish Passage Facilities

12.6.1 Initial Construction Items

East Fish Lift Modifications – The Licensee shall modify the EFL facility to provide 900 cfs attraction flow to the EFL. Modifications to the EFL facility will include replacing spillway gates A & B, replacing the crowder system, addressing structural vibration issues, replacing diffuser gates A and B, replacing the control system, and upgrading the electrical system to allow for a 15 minute lift cycle.

Replace the current 3,300-gallon hopper with two 6,500-gallon hoppers at the EFL

The Licensee shall remove the current hopper and install two 6,500-gallon hoppers within the existing superstructure of the EFL. One hopper will replace the current 3,300-gallon hopper and the second hopper will be located immediately upstream from the current location of the existing

EFL hopper (see Figure 10). Access to both hoppers will be provided by the current entrance gates (A, B, and C) and the hoppers will share the same holding pool.

Trap and Transport Facilities at the EFL

The Licensee shall reduce cycle time at each hopper at the EFL to be able to lift fish four times per hour and complete modifications to the EFL structure to allow for trapping and sorting fish at the EFL facility and transporting them to the western side of the dam to a truck for transport upstream. Modifications to the EFL shall include two new sorting tanks; a loading tank; and a hy-rail truck and forklift, or functionally similar equipment, to facilitate movement of American shad from sorting tanks at the EFL to the west shore. These improvements shall be accomplished without losing a season of the passage provided by the EFL.

Trap and Transport Facilities at the WFL

WFL modifications shall be made to facilitate trap and transport including: decreasing lift cycle time by replacing the crowder linkage system and raising the elevation of the sorting tank(s), and providing a mechanism to allow for direct sluicing of fish into tanks mounted on the transport vehicle. These initial improvements shall be accomplished without losing a season of the passage provided by the EFL or trap and transport from the WFL.

Provide a Zone of Passage (ZOP) to the Fish Passage Facilities

The Licensee shall construct and maintain structures, to provide American shad and river herring a ZOP (i.e., route of passage) as described in this section.

In advance of any ZOP development and/or construction, the Service and Licensee will review CFD modeling results from the tailrace. The Licensee shall run the model under a predetermined number of structures arrangements (e.g., different angles, different spacing between the weirs, different weir slopes). In consultation with the Service, the Licensee shall choose to construct the configuration of structures that provides the most conducive hydraulic conditions for fish passage of river herring. The area to be considered for potential ZOP improvements includes approximately 2,500 feet on the west bank and 3,500 feet on the east side of Rowland Island. Based on CFD modeling results that analyze discharge velocities and turbulence, the Licensee

shall provide stone weirs, and/or other suitable alternatives or measures that provide a contiguous zone of passage (ZOP) from the southern tip of Rowland Island to one or both of the lifts. The Licensee shall install up to ten stone weirs, with the option of considering other configurations for structures, so long as the total cost does not exceed the cost estimated for up to ten weirs.⁶ Model results will guide the placement and formation of these structures to provide for the hydraulic conditions necessary for the weakest swimmers (river herring) to reach the lifts. Specifically, the ZOP must be designed to maintain instantaneous velocities below 3 feet per second, separated only by brief regions of higher velocity that river herring may traverse in seconds at burst speeds up to 6 feet per second, over the full range of operational flows for the EFL, and in all generation scenarios.

After ZOP construction is completed, the Licensee shall assess the ZOP for upstream migrating river herring under the full range of the current fish passage design flows (i.e., up to 113,000 cfs of river flow).

Eel Passage – Eastern Location – The Licensee shall, consistent with the Eel Passage Plan established by Muddy Run license, evaluate potential trapping locations for American eel on the east side of Conowingo Dam including Octoraro Creek starting in May of the first calendar year after license issuance or immediately if license issuance occurs during the upstream American eel migration period. The plan and schedule for implementation of temporary and permanent eel passage facilities and other design criteria shall follow requirements established by the Muddy Run license and be approved by the Service and FERC following consultation with the Licensee and the respective resource agencies. The Licensee shall operate any temporary or permanent eel passage facility continuously (24 hours per day, 7 days per week) during the American eel Upstream Migration Period and shall submit proposed stocking locations for collected American eels to the Service and resource agencies for review and approval by the Service prior to beginning such measures.

Eel Passage – Western Location

⁶ The estimated cost of ten weirs plus a contingency of 30% is no more than \$2.3 million in 2016 dollars.

The Licensee shall conduct a trap and transport operation for American eels at the west side of Conowingo Dam beginning immediately after license issuance. The eel passage facility shall be designed to provide volitional passage for American eels no later than 2031, and will be sited taking into consideration the potential for a new West Fish Lift.⁷

Design criteria shall follow the components described in the Muddy Run license. The Licensee shall conduct trap and transport of American eels until 2030, and will implement volitional American eel passage starting in the 2031 season. The Licensee shall operate the eel passage facility continuously (24 hours per day, 7 days per week) during the American eel upstream Migration Period. The Licensee shall submit proposed stocking locations for collected American eels to the Service and resource agencies for review and approval by the Service prior to beginning trap and transport of American eels.

12.6.2 Improving Attraction Efficiency

Included is a list of physical and operational modifications to the Project intended to address observed deficiencies in fishway attraction efficiency. The tiered process for improving attraction efficiency is based on passage efficiency during the most recent efficiency test. The items included in the different tiers were developed to be commensurate with the degree of shortfall from the *Target Efficiency*. If, based on the *Adjusted Efficiency* of the current test, all appropriate options from the corresponding tier, including any option proposed by the Licensee and approved by the Service, have been exhausted, the items from the next highest numbered tier may be required, regardless of the current project passage efficiency. More than one item from a tier may be completed at one time depending on the degree of the *Adjusted Efficiency* shortfall.

12.6.2.1 Improving Attraction Efficiency – Tier I (*Adjusted Efficiency* 70%-85%)

In the year following any failure by the Licensee to reach the *Target Efficiency* due to inadequate fishway attraction, the Licensee shall implement one or more of the modifications to Project

⁷ Consistent with the Eel Passage Plan established by the Muddy Run license, construction of the volitional passage facility will eliminate the Licensee's obligation to participate in the trap and transport program once the volitional upstream eel passage facility is operational. However, if the upstream eel trap and transport and periodic evaluation program continues beyond 2030, the Licensee will continue to provide access to the Conowingo eel collection facilities for as long as the program continues. The Licensee, however, shall bear no cost responsibility for the trap and transport and periodic evaluation program until 2046, at which time cost responsibility shall be shared among all participants in the program.

operations and facilities described in this section.

Correct any Technical Operational Problems and/or Implement Internal Modifications

The Licensee shall correct any technical operational problems that may have been detected during the fish passage season and/or implement internal modifications to the West and/or East fish lift (e.g., energy dissipation, hydraulic attraction).

Implementation of preferential turbine operating schemes

The Licensee shall develop a turbine operation scheme that can range from simply first on/last off to modification of specific Francis and Kaplan unit operation to ensure that fish are able to successfully locate and access the fish lift entrances.

12.6.2.2 Improving Attraction Efficiency – Tier II (*Adjusted Efficiency 55%-69%*)

Within 2 years following any failure to meet the *Target Efficiency* due to inadequate attraction to the fishway, the Licensee may implement either one of the modifications to the Project facilities described in this section to reach upstream passage efficiency.⁸

Relocate EFL Entrances A & B

If the CFD modeling results indicate modifications to Entrances A & B will improve guidance to and accessibility of the lift entrances, then the Licensee shall extend the entrance channel at entrance A with two 45-degree turns in the fish passage facility channel, so as to discharge into the area behind the catwalk piers and upstream from the Kaplan turbine discharge/boil. The attraction flow should be effective along the catwalk and through the space between the piers (Figure 10, USFWS 2013h). The Licensee shall also modify the existing entrance B so that the centerline of the discharge plume will be at a 45-degree angle to the river flow.

Construct a new Entrance D with a separate crowder and holding pool

⁸ The Service may require relocation of Entrances A&B and, if the *Adjusted Efficiency* continues to be between 55%-69%, Entrance D at a later point, but then, per Tier III (and consistent with the “not before” dates), may only require the AWS, not the WFL. Alternatively, the Service may require the relocation of Entrance A&B, and in subsequent cycles proceed to choose the WFL (again, consistent with the “not before” dates) if (a) the *Adjusted Efficiency* is below 55% and Entrance D has not been constructed or (b) the *Adjusted Efficiency* is between 55%-69% and the Service determines that Entrance D is not likely to achieve the efficiency criterion.

The Licensee shall build a new additional entrance, Entrance D, with a separate crowder and holding pool (Figure 10). The hopper will be accessed from the new entrance and through a proposed collection gallery that will span the full length of the Kaplan turbine section of the powerhouse. Entrance D and the collection gallery are intended to provide access to the EFL from the Francis turbine section of the powerhouse. The new collection gallery will be located against and along the powerhouse wall. This improvement will not be required by the Service to be operational before year 15 of the license.

12.6.2.3 Improving Attraction Efficiency -Tier III (*Adjusted Efficiency less than 55%*)

Following any failure by the Licensee to reach upstream passage efficiency due to inadequate fishway attraction, the Licensee may implement one or more of the modifications to Project operations and facilities described in this section.

Construct an Auxiliary Water Supply at the EFL

The Licensee shall construct a new AWS stilling basin and system so the energy from up to 4,300 cfs can be dissipated and incorporated into effective attraction flows emanating from the multiple fish lift entrances. This improvement will not be required by the Service to be operational before year 25 of the license.

WFL Construction

Licensee shall construct a new WFL (as described below, in parts 1-5) in the west corner of the powerhouse tailrace. The Licensee shall operate the new WFL as a tailwater to headpond fish lift with a collection facility for fish sampling that, at the Licensee's option, could be used as a fish trap and transport facility. This improvement will not be required by the Service for reasons of attraction efficiency to be operational before year 25 of the license, and only if neither Entrance D nor the EFL AWS stilling basin and system have been constructed. If the Service requires construction of the WFL for reasons of attraction efficiency, it has agreed not to subsequently require the EFL AWS stilling basin and system under this Prescription.

WFL Construction – Part 1

The Licensee shall construct a facility that provides the capability of enumerating fish passage by

species, allows for the collection of and holding of fish for biological sampling, and that can also be used for trapping and transporting American shad and available river herring per year, with the potential for captured fish to be transported upstream of the York Haven Dam.

WFL Construction – Part 2

The Licensee shall install two 6,500-gallon hoppers, with separate crowders, in the new WFL, capable of operating simultaneously.

WFL Construction – Part 3

The Licensee shall construct the WFL to have the ability to provide up to 5 percent of hydraulic capacity of the Project (or up to 4,300 cfs) for attraction flow to the fishway entrance(s). During the design phase and during preconstruction, the Licensee shall conduct computational fluid dynamics (CFD) modeling and other supporting analysis to develop appropriate fish lift entrance attraction flows, velocities, and hydraulic conditions. The Licensee shall operate the WFL to provide attraction flow of at least 2,600 cfs (3 percent of hydraulic capacity of the Project) during the Upstream Migration Period for American shad and river herring. With the goal of improving fish passage efficiency at the WFL following initial start-up of the new WFL, the Service may require the lift operator to modify operation of the fish lift, the allocation of flows through its Auxiliary Water System (AWS), and/or the total amount of flow being supplied to the WFL (up to a maximum of 4,300 cfs or 5 percent of the Project hydraulic capacity).

WFL Construction – Part 4

The Licensee shall design and construct an AWS that meets Service criteria for energy dissipation of the attraction flow while maintaining water quality standards.

WFL Construction – Part 5

The Licensee shall conduct an assessment of the ZOP downstream of the WFL to ensure that it continues to be passable over the range of flows in which the WFL is operational.

12.6.3 Improving Fish Lift Capacity

Included is a list of physical and operational modifications to the Project intended to address

possible deficiencies in fish lift capacity. The tiered process for improving capacity is based on passage efficiency during the most recent efficiency test. The items included in the different tiers were developed to be commensurate with the degree of missing the required 85 percent passage efficiency criterion. If, based on the *Adjusted Efficiency* of the current test, all options from the corresponding tier have been exhausted; the items from the next highest numbered tier may be required, regardless of the current project passage efficiency. Implementation of modifications in the capacity tiers is independent of the implementation of similar items used to improve attraction efficiency in section 12.6.2. Both attraction and capacity improvements can be required simultaneously if deemed appropriate from the most recent study results, but only to the extent both improvements are needed to meet the *Target Efficiency*.

12.6.3.1 Improving Fish Lift Capacity - Tier I (Adjusted Efficiency 70% – 85%)

Within 2 years following any failure by the Licensee to reach upstream passage efficiency due to inadequate fishway capacity, the Licensee shall implement the modification to Project facilities described in this section.

Construct a new Entrance D with a separate crowder and holding pool

The Licensee shall build a new additional entrance, Entrance D, with a separate crowder and holding pool (Figure 10). The new hopper will be accessed from the new entrance and through a proposed collection gallery that will span the full length of the Kaplan turbine section of the powerhouse. Entrance D and the collection gallery are intended to provide access to the EFL from the Francis turbine section of the powerhouse. The new collection gallery will be located against and along the powerhouse wall. This improvement will not be required by the Service under this Prescription to be operational before year 15 of the license.

12.6.3.2 Improving Fish Lift Capacity - Tier II (Adjusted Efficiency less than 70%)

Within 3 years following any failure by the Licensee to reach upstream passage efficiency due to inadequate fishway capacity, the Licensee shall implement the modifications to Project facilities described in this section.

WFL Construction

The Licensee shall construct a new WFL (as described in section 12.6.2.3) in the west corner of the powerhouse tailrace. The Licensee will operate the new WFL as a tailwater to headpond fish lift with a collection facility for fish sampling that, at the Licensee's option, could be used as a fish trap and transport facility. This improvement will not be required by the Service under this Prescription to be operational for reasons of capacity before year 25 of the license.

12.7 Fish Passage Effectiveness Monitoring

Efficiency testing of both upstream and downstream fish passage, and determining mortality rates of American shad when using trap and transport are critical to evaluating the success of fish passage structures and operations, diagnosing problems, and determining both when modifications are needed and what modifications are likely to be effective. These measures are essential to ensuring the effectiveness of fishways over the term of the license, particularly in cases where the increasing size of fish populations as a result of improved upstream passage may also lower upstream fish passage efficiencies due to migrating fish crowding and exceeding daily or annual lift capacity, thus keeping some fish from successfully passing the project and limiting net effectiveness.

12.7.1 Fishway Effectiveness Monitoring Plan

The Licensee shall develop a Fishway Effectiveness Monitoring Plan (FEMP) in consultation and with the approval of the Service, and will submit the FEMP to the FERC for approval within 6 months of license issuance. The FEMP will contain the plans for the studies described in Sections 12.7.2 through 12.7.5. If the Service requests a modification of the FEMP, the Licensee shall file a written response with the Service within 30 days and send a copy of the response to FERC and resource agencies. Any modifications to the FEMP by the Licensee will require approval by the Service and, if necessary, FERC prior to implementation.

The Licensee shall submit yearly interim study reports to the Service and FERC following the conclusion of each study year. The interim and final reports for upstream passage studies will be submitted to the Service by December 31st of each study year. The interim and final reports for downstream passage studies will be submitted to the Service by August 1 following each study year. The final study report will include results for each life stage and type of study conducted

with a determination of the Licensee's success or failure in achieving the passage efficiency criteria established in Section 12.2. In conjunction with submitting the final study report(s), the Licensee shall also provide electronic copies of all data collected from studies to the Service.

The Licensee shall meet with the Service and the Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC) to discuss the FEMP and FOMP. This meeting will occur no later than January 31 each year unless the Licensee and the Service agree on a different date. At this annual meeting the Licensee shall discuss with the Service and SRAFRC the fish passage results from the previous year, review regulatory requirements for fish lift and eel passage operations, and discuss any upcoming modification or testing the Licensee proposes for the upcoming fish passage season.

12.7.2 Initial Efficiency Test, Post-Modification Efficiency Tests, and Periodic Efficiency Tests for Upstream Passage of American Shad and River Herring

The *Initial Efficiency Test* and any *Post-Modification Efficiency Tests* will consist of a three-year fish tagging and monitoring study of American shad and river herring using radio telemetry, or other best tracking technology. The *Periodic Efficiency Tests* will consist of a two-year American shad tagging study using the same techniques unless the Licensee elects, with Service concurrence, to conduct an additional one year of study. The *Initial Efficiency Test* will begin in the 5th passage season after license issuance. The *Post-Modification Efficiency Test* will begin in the first fish passage season immediately following any required modification implemented from the tiers. The *Periodic Efficiency Test* will be conducted on every 5th year after a previous study determines that the *Adjusted Efficiency* of the project is achieving 85 percent passage efficiency for American shad. Early Periodic Efficiency Tests may be delayed by up to two years to coincide with the schedule for tests at Muddy Run agreed upon in the 2015 Settlement Agreement between the Service and the Licensee.

These studies will use sufficient numbers of test fish to account for drop-back and other fish loss. These fish will be collected from a downstream location, and be representative of the migrating population as a whole. Specific details of the telemetry studies such as sample sizes, collection of and release location of tagged American shad and river herring, arrangement of telemetry

receivers, and appropriate statistical analyses shall be developed by the Licensee in conjunction with the Service and other resource agencies. The Licensee shall submit final study plans to the Service and FERC for review and approval prior to initiating any study.

12.7.2.1 Trap and Transport Credit for American Shad

The Licensee will receive additional credit toward the upstream passage efficiency criterion for adult American shad that are trapped and transported upstream of York Haven Dam. The Service will recognize the benefits to the species by giving credit towards the calculation of whether the efficiency criterion for upstream shad passage is met, due to the value to restoration of avoiding the passage of impediments at the upstream hydroelectric projects.

Details of the credit toward the efficiency criterion are provided in Appendix B. Part of the calculation of the credit toward efficiency criterion requires an estimate of the mortality associated with trap and transport operations. In the 4th year after license issuance, the Licensee shall work with the Service and other resource agencies to develop a one-year study to estimate the mortality of fish which are trapped and transported to areas upstream of York Haven Dam. Such a study will include assessment of immediate mortality (mortality occurring during transport) as well as delayed mortality (mortality occurring during some time period after release). The results of the study will be used to modify, as necessary, the mortality input utilized in the trap and truck credit. The Service's proposed methodology for this study is included in Appendix C; however the Licensee and the Service have not agreed upon a final methodology and final study design is expected to take place post-licensing.

12.7.3 Upstream American Eel Effectiveness Testing

Unless the Service and the Licensee agree that no effective technology is available to enable such testing, the Licensee shall conduct an upstream efficiency study on juvenile American eel at the WFL facility in the year immediately following license issuance. The study will determine the American eel upstream passage efficiency of the eelway throughout the upstream migration season. The study will consist of two components, including determining attraction efficiency to the facility and passage efficiency of the facility once an eel enters the structure. Efficiency studies will be repeated following any modifications to the operation or physical structure to

evaluate the relative success of the modifications. The Licensee shall provide an annual report on the efficiency study to the Service by December 31 of the study year.

12.7.4 Downstream Adult and Juvenile American Shad and River Herring Effectiveness Testing

The Licensee shall conduct downstream passage effectiveness studies of American shad and river herring in 2027 in coordination with the Service. As part of the Conowingo FEMP for downstream passage, the Licensee will evaluate both juvenile and adult life stages using a study protocol developed cooperatively with the Service to include a Conowingo Pond route of passage study. A route of passage study will be conducted to determine the routes chosen by downstream migrating fish through the Project under various generation conditions to determine if there are preferred routes of passage at the dam. The route of passage study will be conducted for 2 years to account for inter-annual variation in flow conditions. The Licensee will have the option to extend the route of passage study for an additional year.

In addition to the route of passage study, a one year separate and discrete passage study for both adult and juvenile American shad and river herring shall be conducted to estimate survival through the Kaplan and Francis turbines under best gate efficiency. This study will commence in 2027. The effects of barotrauma during turbine passage will be included as part of the turbine survival studies for all life stages when possible. Results of the studies will be used to determine through-Project survival (i.e. via spill, Francis turbines, Kaplan turbines, etc.), and immediate and latent mortality for each route to achieve the passage criteria.

In the event the Licensee is unable to achieve the efficiency criteria for survival based on the results of the downstream studies, the Department may exercise its reservation of authority to address the issue.

12.7.5 Downstream American Eel Effectiveness Monitoring

The Licensee shall conduct or participate in two separate studies on downstream migrating American eel in the Susquehanna River. The studies can be done concurrently or separately, and will be conducted in conjunction with the American eel downstream studies undertaken by the

Licensee of the Muddy Run Hydroelectric Project. The Licensee shall initiate studies when the Service determines that sufficient numbers of downstream migrants can be collected in the upper watershed to conduct a valid study.

First, the Licensee shall participate in a basin-wide study coordinated by the Service to determine timing of downstream migration of American eels in the Susquehanna River (see USFWS 2014d). To complete this study, the Licensee shall contribute \$75,000 to the Service to collect and tag fish for use in the basin-wide study. Radio telemetry monitoring will be conducted by the Licensee year-round for 3 consecutive years.⁹

In addition to the basin-wide migration timing study, the Licensee will conduct a study at Conowingo Dam to determine migratory delay, route of downstream passage (i.e. via spill, Francis turbines, Kaplan turbines, etc.), and immediate and latent mortality for each route. If a sufficient number of tagged fish encounter the Project, a route of passage study can be done concurrently with the basin-wide downstream migration study using the same tagged eels assuming appropriate tag technology is available to assess latent mortality of those fish during the study.

In the event the Licensee is unable to achieve the efficiency criterion for survival based on the results of the downstream studies, the Department may exercise its reservation of authority to address the issue.

12.8 Fishway Inspections

The Licensee shall provide Service personnel and other Service-designated representatives, timely access to the fish passage facilities at the Project and to pertinent Project operational records for the purpose of inspecting the fishways to determine compliance with the Fishway Prescription.

⁹ Mobile tracking and data analysis for this study will be the responsibility of the Service. Annually, the Service will share with the Licensee all data collected as part of the basin-wide study.

13. Pre-License Actions Agreed to by the Licensee

13.1. Items to be completed in 2016 - 2017

The License Applicant has agreed to develop and finalize a detailed logistics plan and operating protocol for trap and transport of American shad and river herring from both the EFL and WFL. The Logistics plan will address near-term operations, as well as logistics necessary to support the collection and transport of up to 80 percent of the American shad and river herring passing the project with a maximum transport of 100,000 American shad and 100,000 river herring annually. This plan will be completed by December 31, 2017.

The License Applicant has agreed to develop detailed computational fluid dynamics (CFD) models of the zones of passage, in consultation with the Service, to the EFL and WFL to assess the ability of fish to reach them.

The License Applicant has agreed to develop its initial FOMP (as described in Section 12.4) and submit to the Service by September 30, 2017.

13.2. Items to be completed in 2017 - 2018

The License Applicant has agreed to finalize design plans for initial fishway improvement and improvements to facilitate the trap and transport program.

14. Definition of Technical Terms

Adjusted Efficiency– The calculated fish passage efficiency that accounts for the biological benefit of fish trapped and transported from the project to areas upstream of other mainstem dams. This calculated efficiency gives credit towards efficiency targets for the number of fish that are trapped and transported.

Alosines – collective term for American shad, blueback herring and alewife

Anadromous – migratory fish that spawn in freshwater rivers but spend most of their life in the ocean

Attraction Efficiency – The proportion of the migrating population that successfully passes a designated downstream point at the Project (i.e. the downstream end of Rowland Island), and successfully enters the fish lift

Barotrauma – trauma due to changes in barometric pressure such as the expansion and rupture of a fish’s swim bladder

Biomass – pounds of fish

Catadromous – migratory fish that spawn in the ocean but spend most of their life in freshwater

Diadromous – includes both anadromous and catadromous migratory fish

Downstream Fish Passage Efficiency – the percentage of the fish that approach the upstream side of the Project and survive unharmed as they pass the Project and continue downstream migrations

Effective Passage – the combination of fish passage facilities and project operations that provide conditions where fish can approach and move past a barrier with little or no impact to their migration. Effectiveness may include both qualitative and quantitative components; however, a different term, efficiency, is typically reserved for quantitative evaluations of effectiveness.

Entrainment – fish passage via a particular structure, usually referring to directing fish passage through turbines or into downstream fish passage facilities

Fecund – more fertile, having more eggs

Fish Ladder – an engineered ramp-like structure, typically constructed of concrete and/or metal, used to provide upstream fish passage

Fish Lift – an elevator-like structure with a hopper used to convey fish from the tailwaters to the headpond of high dams

Fish Passage Facility – the physical structure of the fishway used to convey fish upstream; with the term being synonymous with “fish lift” at this Project

Fishway – shall have the definition provided in P.L. 102-486, § 1701(b) (1992)

Headpond – the body of water located on the upstream side of the dam

Hopper – the structural part of the fish lift used to hold fish as they are transported from the tailwaters to the head pond

Impingement – to trap fish against a structure, usually referring to intake screens

Nature-Like Fishway – a ramp-like structure, typically constructed of natural materials (rocks, logs), used to provide upstream fish passage

Panmictic – of one spawning population with no genetic differentiation between geographic areas

Peaking – a hydro-electric facility that rarely spills water has the ability to store water and release on demand for power generation, typically having the ability to significantly impact flows downstream of the project

Repeat Spawning – ability to spawn over multiple years

Run-of-River – a hydro-electric facility that has limited (if any) ability to store water, with water typically flowing over the crest of the dam at all times

Safe Passage – the movement of fish through the zone of passage that does not result in any unacceptable stress, incremental injury, or death of the fish.

Self-Sustaining - Ability to maintain migratory fish populations at the level of their restoration goal without supplementation from trap and transport or hatchery products.

Tailrace – the area downstream of the dam that is in the hydraulic influence of Project operations

Tailwaters – the area downstream of Conowingo Dam located between the dam and the downstream end of Rowland Island

Timely Passage – the successful movement through the zone of passage that proceeds without a delay that would impact the natural behavior patterns or life history requirements of a fish

Trap and Transport – fish that are collected at a downstream project and loaded in a tank truck and transported and released into some location upstream of that project

Upstream Fish Passage Efficiency – the percentage of the fish present in the Project tailwaters that successfully move through the fish lift and continue upstream migrations; e.g. the proportion of fish that start at point B (downstream end of Rowland Island in the case of Conowingo Dam) and passes point E in Figure 5

Volitional Passage – a fish passage facility that allows fish to swim unimpeded from the tailwaters to the headpond; fish lifts are not considered volitional passage because the fish rely on the operation of the lifts in order to pass upstream into the headpond

Zone of Passage (ZOP) – The contiguous area of sufficient lateral, longitudinal, and vertical extent in which adequate hydraulic and environmental conditions are maintained to provide a route of passage through a stream reach influenced by a dam (or stream barrier); e.g. the area between point A and point E in Figure 5.

Appendix A. Calculation of Fishway Capacity for a 6,500-Gallon Hopper

Biological Parameters		
	$\lambda_m = 0.052$ (season/day)	Season-to-Day run compression coefficient; empirically determined designed parameter
	$\beta = 0.15$ (day/hr)	Hour-to-Day run compression coefficient; empirically determined design parameter
	T=15 min	Lift cycle time (recommended)
Hopper Size		
	$Vol_H = 868.9 \text{ ft}^3$	Estimate of proposed hopper volume (6,500 gallons)
	$V_{fH} = 0.1$ (ft^3/lbf)	Volume required per fish-pound; USFWS criterion; for lift times greater than 15 minutes, a 30 percent increase in V_{fH} is recommended
Allowable peak biological loadings		
$Flb_h = (Vol_H / v_{fH} * T)$	$Flb_h = 34,756$ lbf/hr	Allowable loading of fish in pounds per peak hour
$Flb_d = Flb_h / \beta$	$Flb_d = 231,706$ lbf/day	Allowable loading of fish in pounds during the peak day
$Flb_s = Flb_d / \lambda_m$	$Flb_s = 4,455,897$ lbf/season	Allowable loading of fish in pounds during an entire season

Appendix B. Calculating Trap and Transport Credit

Credit Towards an Overall Efficiency Criterion (85 percent of the fish entering the Conowingo Tailrace)

For a given number of shad trapped and transported we can estimate the number that would need to pass Conowingo Dam via the fish lift to result in the same number of spawners upstream of York Haven Dam. This number is termed “lift equivalents” (L_e) and is calculated as:

$$[1] \quad L_e = (\sum_{i=1}^n TT_i) \cdot (1 - TT_m) / D$$

Where TT_i refers to the number trapped and transported each year during a single or multi-year study to measure passage efficiency, and TT_m is the mortality associated with trapping and transporting shad. Harris and Hightower (2011) estimated mortality of trapped and transported shad in the Roanoke River to be 15 percent. However, SRAFRFC (1997) gave estimates of mortality for holding shad prior to trap and transport, mortality during the transport, and delayed mortality following release. When all these factors are considered, the overall mortality associated with trap and transport operations was 6 percent, which was used in this model. The denominator (D) in equation [1] will be calculated using the maximum efficiency of each of the two upstream dams with the highest passage efficiency over the three year study and the average of these efficiencies. For example, if the highest efficiencies of Holtwood, Safe Harbor, and York Haven Dams over the three year study were 0.60, 0.78, and 0.50, respectively, then the denominator would be calculated as $D = 0.60 \cdot 0.78 \cdot \left(\frac{0.60+0.78}{2}\right) = 0.3229$. It was assumed that other than the mortality associated with trap and transport operations, no other negative impacts on their fitness occurred compared to shad that would migrate via multiple fish passage facilities to areas upstream of York Haven Dam.

The L_e can be added to the observed number that were lifted past Conowingo Dam during the study period to arrive at an adjusted total number that are passed via the fish lift (L_a).

$$[2] \quad L_a = L_e + \sum_{i=1}^n L_i$$

where L_i is the observed number lifted in each year.

During a radio telemetry study at Conowingo Dam, an estimate of passage efficiency will be made and given the total number of shad actually passed (lifted and released into Conowingo Pond + trapped and transported upstream), an estimate of the total number of shad downstream of Conowingo Dam during all years of the study can be made.

$$[3] \quad N = (\sum_{i=1}^n P_i) / E_o$$

where P_i is the total number passed each year and E_o is the estimated passage efficiency during the study. Equation [3] also assumes that no mortality is suffered while attempting to pass Conowingo Dam.

The variance of N can be estimated by the delta method using the estimated variance of E_o .

$$[4] \quad Var(N) = [Var(E_o) / E_o^4] \cdot (\sum_{i=1}^n P_i)^2$$

The adjusted passage efficiency is then the adjusted number that are lifted during the study divided by the total number of shad downstream of Conowingo Dam during all years of the study.

$$[5] \quad E_a = L_a / N$$

The associated variance from the delta method is:

$$[6] \quad Var(E_a) = [Var(N) / N^4] \cdot L_a^2$$

The 95 percent confidence interval for E_a can be approximated as:

$$[7] \quad 95\% \text{ C.I.} \approx 1.96 \cdot \sqrt{Var(E_a)}$$

If the upper 95% confidence limit is greater than or equal to the efficiency criterion, then the criterion is considered to be met.

Appendix C. Trap and Transport Mortality Study

To assess the mortality associated with trap and transport (T&T) of American shad collected at Conowingo Dam and transported to areas upstream of York Haven Dam, a study design similar to that of Millard et al. (2005) will be employed. This study will have both a treatment (T&T shad) and a control group (shad not T&T). The purpose of having both a treatment and a control group is to evaluate both the immediate and delayed mortality associated with T&T operations while controlling for mortality associated with handling stress while carrying out the study.

Control groups will consist of shad that are caught in the lifts at Conowingo Dam, sorted from non-target species, and rather than being loaded into a truck and transported upstream, they will be released to a large holding tank located at Conowingo Dam (size to be determined) and monitored for 72 hours post-release.

Treatment groups will consist of shad that are caught in the lifts at Conowingo Dam, sorted from non-target species, loaded into a truck, and driven around in the truck for a length of time equivalent to the trip duration to areas upstream of York Haven Dam. After simulating transport, the shad will be placed into a holding tank located at Conowingo Dam and monitored for 72 hours post-release.

Experimental tanks for both treatment and control groups will be located at Conowingo Dam in order to eliminate any confounding effects of differences in water temperature/chemistry between treatment and control groups and to isolate the effects of transport. Experimental tanks will be set up with flow through conditions using water pumped from the tailrace of Conowingo Dam.

Each week throughout the fish passage season, a truck load's worth of fish (exact number yet to be determined) will be used in both treatment and control groups. Thus, the experiment will be temporally replicated for 4 – 8 weeks depending on the duration of the spawning run in a given year. This will allow assessment of mortality over the range of water temperatures experienced by shad throughout the season.

During the 72 hour monitoring period, dead shad will be removed from the tank as soon as they are noticed. Mortality will be quantified as the number of dead shad divided by the number of shad that entered either the treatment or control group. Mortality in the treatment group will include all shad that died during the entire process from loading them into the truck to those found dead at the end of the 72 hour monitoring period.

Statistical Analysis

It will be assumed that total mortality of the treatment group consists of two components: 1) mortality associated with transport and release of the shad; and 2) mortality associated with experimental handling of the shad. Thus, total mortality of the treatment group = T&T mortality + handling mortality. The control group would only experience mortality associated with experimental handling. The instantaneous handling mortality rate (m_h) will be estimated from the control group as

$$M_h = -\ln(S_c)$$

where S_c is the survival of the control group over all replicates throughout the season. The instantaneous total mortality in the treatment group will be estimated as

$$M_t = -\ln(S_t)$$

where S_t is the survival of the treatment group over all replicates throughout the season. The conditional mortality associated with trap and transport (conditioned on handling mortality) is

$$u_{TT} = A - \left[\frac{A \cdot M_h}{-\ln(1 - A)} \right]$$

where A is the fraction of fish that die from all causes ($1-S_t$). This equation is based on the traditional fisheries expression $u = A \cdot F/Z$ where u = the expectation of death from fishing, A = total mortality rate from all causes, F = the instantaneous fishing mortality rate, and Z = the total instantaneous mortality rate. Estimation of the conditional mortality associated with trap and transport (u_{TT}) according the above equation is preferred because it accounts for the probability that the two sources of mortality, trap and transport stress and handling stress, occur simultaneously over the monitoring period (Millard et al. 2005).

Literature Cited

Millard, M.J., J.W. Mohler, A. Kahnle, and A. Cosman. 2005. Mortality associated with catch-and-release angling of striped bass in the Hudson River. *North American Journal of Fisheries Management*. 25: 1533-1541.

CERTIFICATE OF SERVICE

I hereby certify that I have this day served the foregoing document upon each person designated on the official service list compiled by the Secretary in this proceeding. Dated this 12th day of May 2016 in Washington, D.C.

/s/ Marcia Hook

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